NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM REPORT **70**

SOCIAL AND ECONOMIC FACTORS AFFECTING INTERCITY TRAVEL

VOGT, IVERS AND ASSOCIATES
CINCINNATI, OHIO

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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

Systematic, well-designed research provides the most effective approach to the solution of many problems facing highway administrators and engineers. Often, highway problems are of local interest and can best be studied by highway departments individually or in cooperation with their state universities and others. However, the accelerating growth of highway transportation develops increasingly complex problems of wide interest to highway authorities. These problems are best studied through a coordinated program of cooperative research.

In recognition of these needs, the highway administrators of the American Association of State Highway Officials initiated in 1962 an objective national highway research program employing modern scientific techniques. This program is supported on a continuing basis by funds from participating member states of the Association and it receives the full cooperation and support of the Bureau of Public Roads, United States Department of Transportation.

The Highway Research Board of the National Academy of Sciences-National Research Council was requested by the Association to administer the research program because of the Board's recognized objectivity and understanding of modern research practices. The Board is uniquely suited for this purpose as: it maintains an extensive committee structure from which authorities on any highway transportation subject may be drawn; it possesses avenues of communications and cooperation with federal, state, and local governmental agencies, universities, and industry; its relationship to its parent organization, the National Academy of Sciences, a private, nonprofit institution, is an insurance of objectivity; it maintains a full-time research correlation staff of specialists in highway transportation matters to bring the findings of research directly to those who are in a position to use them.

The program is developed on the basis of research needs identified by chief administrators of the highway departments and by committees of AASHO. Each year, specific areas of research needs to be included in the program are proposed to the Academy and the Board by the American Association of State Highway Officials. Research projects to fulfill these needs are defined by the Board, and qualified research agencies are selected from those that have submitted proposals. Administration and surveillance of research contracts are responsibilities of the Academy and its Highway Research Board.

The needs for highway research are many, and the National Cooperative Highway Research Program can make significant contributions to the solution of highway transportation problems of mutual concern to many responsible groups. The program, however, is intended to complement rather than to substitute for or duplicate other highway research programs.

This report is one of a series of reports issued from a continuing research program conducted under a three-way agreement entered into in June 1962 by and among the National Academy of Sciences-National Research Council, the American Association of State Highway Officials, and the U. S. Bureau of Public Roads. Individual fiscal agreements are executed annually by the Academy-Research Council, the Bureau of Public Roads, and participating state highway departments, members of the American Association of State Highway Officials.

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FOREWORD

By Staff

Highway Research Board

The prediction of intercity travel and the determination of the social and economic factors affecting the amount and distribution of the travel is the subject of this report. The findings will be of particular interest to the regional transportation planner who is concerned with travel estimates on transportation facilities at a regional scale. The researchers utilized the general techniques for estimating highway travel within urban areas as a basis for this analysis. The findings indicate the need to stratify trip generation and distribution into two separate predicting functions with social and economic factors used primarily to estimate trip generation.

The basic techniques for estimating travel within urban areas were believed to provide a relevant procedure for estimating travel in rural areas. The research was organized to process external origin-and-destination surveys in order to aggregate total trips and other activities by time rings from the survey area. A nationwide network was produced for trip distribution purposes. In this network more than 3,000 centroids were used, representing each county or county equivalent. A series of activity measures at each centroid was determined, including population, employment, income, bank deposits, etc. External origin-and-destination data were acquired and processed for 22 cities in Tennessee, Wisconsin and Missouri where coding of trips was by standard city-county-state notation.

Two distinctly different methods of analysis to develop predicting equations were undertaken. In the first, the generation and distribution functions are combined first for all of the survey cities and for total trips. Basic regression analyses are performed to produce the predicting equations. Subsequently, these are stratified by survey city size, by survey trip purpose, and by many of the social-economic measures of trip attraction in the rest of the universe. Using these stratifications, additional regression analyses are performed to test various equation forms and the correlation between variables. The predicted trips from the regression equations are then compared with actual survey data.

In the alternate analysis procedure, the survey data are utilized to determine the amount and characteristics of intercity trip generation. Equations are developed to estimate trips per capita for total trips, business oriented trips and non-business oriented trips using cordon population as the independent variable. Equations are also developed for total vehicle-hours of intercity travel by the same trip classifications. These results provide a basic estimating procedure for the number of intercity trips made to and from a specifically sized community. The distribution developed in the first method can then be used to determine the spatial distribution of the trip patterns.

Knowledge gained from this research will be useful in understanding the various factors which influence travel through the rural area. Although more effort is recommended to produce a more accurate predictive model, the results included here represent a contribution in the development of intercity traffic distribution techniques and a needed beginning in the development of intercity trip generation techniques.

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SUMMARY

This report describes a research study to define the social and economic factors affecting intercity travel and to use the resulting relationships with existing traffic prediction tools to predict intercity travel.

The basic data used in the study were the external origin-and-destination surveys of 22 cities. Extensive computer processing of these data was required in order to make the data comparable—a factor which limited to some degree the scope of the project. Although a wide geographical and city size range was sought in the selection of O-D samples, the 22 sample cities which were adaptable for use were not as varied as desired. In addition to the surveys, a second source was the U.S. Census, from which a series of 14 commonly available social and economic factors were selected and recorded on tape for every county or county equivalent in the continental United States.

The trip data from all the O-D studies were summarized by trip purposes and by increasing time rings from the study area centroids. This type of summarization enabled the analysts to obtain significant information from the study, particularly with regard to trip distribution by time ring.

A stepwise regression analysis computer program was used to determine the relationship between trips and social and economic data. Five basic equation forms and 395 regression equations were developed during the project. These forms and equations resulted from the stratification of the O-D data by population ranges and trip purposes. Comparisons of the actual O-D trips with the synthesized trips were made for selected cases using a "panacea" general computer program.

The significant findings of this research project include the following:

1. External origin-and-destinations surveys constitute an excellent source of data for use in the development of analytical procedures for estimation of intercity trips. This is particularly true when the predicting equations are for all trips or for trips by major purposes exclusive of social-recreation trips. The value of the external survey data for use is enhanced particularly if origins and destinations are coded to the IBM state and county code system, the cordon line location is well defined, and the purpose classifications used are in accordance with standard definitions. For future research in this area the identification of the location of residence (zone of production) of the survey trips would be an additional benefit.

For social and recreation trips the use of urban area external origin-and-destination survey data is not sufficient. Future studies of these trips depend on external origin-and-destination surveys taken at the recreation area. These surveys, however, should also be coded to the state-county classification system and should include standard identification of trip purposes if they are to have the maximum utility.

2. The use of readily available Census data on a county basis is recommended because it does provide sufficient variables for a study of this type. Also, many of

these variables are regularly projected by the Bureau of the Census, which permits the estimation of future travel through the use of data available on a nationwide basis.

3. Population relationships, combined with travel time, appear to be the major indicators of trip distribution characteristics. Although other social and economic variables appeared to be as significant as population, in certain instances the regression analysis showed that population was selected consistently as a principal independent variable in the formulation of the intercity distribution formulas.

4. Use of social and economic factors and stratification of cities by size and by social and economic characteristics appear to be significant in the development of trip generation formulas. The research has indicated that population relationships alone are not sufficient to predict trip generation even though this variable, with time, did correlate well with the origin-and-destination data as far as distribution was concerned. Analysis of data by population stratification indicates that additional research, relating the social and economic structure of a city to trip generations, is needed, particularly in cities with less than 10,000 people.

5. The research indicates that two views are possible in developing prediction equations for intercity travel. One stance involves the development of a single equation or family of equations to predict generation and distribution simultaneously. The second view holds that two sets of equations should be developed—the first to predict generation based on social and economic factors and the second to predict distribution using population and time relationships. Both procedures have been investigated in this study. However, because the problem of intercity trip estimation seems to be in the area of generation, it is anticipated that procedures which estimate generation and distribution separately will prove more promising. It is recommended that future research be directed to further classification of this method.

6. Existing trip prediction tools can be successfully used as the basis for developing intercity travel prediction equations providing some control can be exercised over the origin-and-destination data collection procedures. The lack of data standardization has introduced some error and unfortunate additional processing effort into the study. This was unfortunate, because the need to process additional surveys was evident but had to be limited during this study for the sake of economy and program continuity.

Intercity travel estimating procedures described in this report are a major first step in the continuing development of more accurate predicting procedures for this type of travel. To date, this study has been concerned with highway vehicle travel stratified by trip purpose and city size. In the work which follows and builds on the findings described herein, attention should be given to the refinement of these factors and to the inclusion of additional studies of recreation time, travel mode, trips defined as production and attraction, trip generation, and travel time and travel cost controls. In refining the procedures and in developing alternate ones, it will be necessary to expand data coverage to include more very small and very large cities and to provide a larger geographic coverage to determine whether regional influence significantly affects the results derived from the spacial and size interrelations as reported herein.

Without these additional refinements the equations developed probably provide a reasonably accurate description of intercity travel in most areas of the country. With the additional refinements the ability to predict intercity travel to the same standards of accuracy as is currently possible for intracity travel is nearly assured.

CHAPTER ONE

INTRODUCTION AND RESEARCH APPROACH

There has been considerable national interest in the prospect of high-speed intercity land travel in the Boston-Washington corridor. Other heavy transportation corridors between urban areas are also being considered for new transportation modes with improved operating characteristics. The effect of these new proposals on future travel patterns is receiving considerable attention from many public transportation agencies and private industry.

Travel has changed dramatically since 1945 when considered in terms of cost, speed, and comfort. Yet today only 28 percent of the present population has ever flown. Does this imply that air travel today is just a fraction of its ultimate potential? Existing air travel is overloading the air corridors between some urban areas and more particularly at the air terminals. Is this a restraint to the ultimate potential for intercity travel by air?

As the Interstate Highway System nears completion with its improvement to travel times and safety, the travel of people between urban areas rises at a rate that is not totally explained by the increases in population.

Rail passenger travel has continually decreased as a significant factor in the intercity travel market. Passenger comfort and convenience have been cited as principle causes.

Changing social conditions such as increased leisure time and rising family income are expected to modify current intercity travel patterns by increasing both time and money available to potential travelers.

The desire for intercity travel at a level in excess of the actuality of the occurrence is an inherent factor identified by Lansing (*1*).

The character of the nation has changed from rural orientation with 40 percent of the population in urban areas in 1900 to an urban orientation with over 63 percent of the population in urban areas in 1965.

These changes have a direct effect on the intercity travel in many ways, as follows:

1. Many social and business needs of people within an urban area are satisfied by the available activities within that urban area. This factor tends to reduce the intercity travel on a per capita basis below that which occurs in smaller urban places.
2. Business is becoming increasingly more flexible and mobile. Business travel is a manifestation of this new flexibility, with the result that business travel is an increasing proportion of intercity travel.
3. Business travel is a function of the affluence and value of the traveler to the organization he represents. Therefore, time becomes an important consideration and has a value to both the traveler and his organization. The distribution of per capita income in favor of residents of large urban areas encourages more travel by common carrier (air) in order to minimize the total cost of essential business travel by this group.
4. Common carrier service to small urban areas is not as available as it is to large metropolitan areas, with the result that less travel to and from the small areas is accomplished by common carrier on a per capita basis than is accomplished by residents of the large urban areas.
5. Travel is a function of disposable income, with the result that areas with higher per capita incomes will spend more dollars per capita in travel than will areas with correspondingly lower per capita incomes. This factor encourages higher total travel rates by residents of large urban areas than by residents of smaller ones providing that the larger urban areas have more disposable incomes per capita and it is well distributed over the entire population.
6. Intercity travel distances for the average trip vary with the size of the urban area from which the trip originates. The ability to satisfy a need of the traveler would appear to explain this characteristic.

From these factors a number of considerations which will affect the future patterns of intercity trip travel emerge with some consistency. More of the nation's population will be located in urban areas. Higher per capita incomes and more leisure time are projected for most of the population. Business relationships within organizations will continue to be less parochial. Advertising and communication will be more effective in describing the available attractions of all areas of the nation and the world. The time required to travel between desired points will decrease even more dramatically; however, the travel cost will not change as appreciably.

The present characteristics of intercity travel would indicate that travel by residents of small urban areas is predominately essential travel and that changes in accessibility will have only a relatively minor effect in increasing intercity travel from these areas. This is caused by the constraint of cost, which states that intercity travel is limited principally by its cost with time being a secondary but significant factor (*1*). In large metropolitan areas it appears that travel is constrained by available time for travel to activities which are not available within the urban area. Increases in accessibility which will result from the completion of the Interstate Highway System and the development of new intercity transportation modes will have an appreciable effect on the travel patterns of the residents of these areas. With more leisure time, higher per capita income and increased advertising, the future intercity travel by residents of these areas could increase dramatically.

Air travel has a large untapped market from which to draw if the problems associated with air corridor and terminal congestion can be solved. The development of larger-scale jet aircraft is expected to have a major effect on this problem, particularly for long trips (over 1,000 miles).

PURPOSE AND SCOPE

This report is based on the premise that correlations exist between the intercity trips produced and attracted by an area; the social-economic characteristics of the area; and the spacial distribution of the social-economic characteristics of those other areas competing for trips. Further, it is based on the philosophy that (1) the development of a method or methods to estimate these trips should be based on a systematic, uniform, and consistent approach utilizing commonly available transportation planning tools and techniques; and (2) the social-economic data used to obtain trip transfer data should be readily available and suitable for forecasting the future.

If these premises hold, it can be hypothesized that the relationships developed for test cities can be applied to other urban areas to determine unknown trip distributions of existing travel or applied to the projections of the various social-economic factors to develop future trip distributions to and from a particular urban area or to and from all urban communities in a region.

This research project, then, provides an opportunity to develop usable techniques for estimating intercity trip transfer based on economic and social factors.

RESEARCH APPROACH

Analysis procedures selected initially for this study were organized and the program was divided into phases which are described as follows:

Study Organization and Research of Previous Work

This phase included the study design and organizations, a survey of existing literature relating to the project, a search for data to be used in the project, and an assembly of all previous experience in the area of research.

Assembly and Reduction of Data

In this phase the assembly of origin-and-destination (O-D) and social and economic characteristic data, and the compilation and reduction of these data for use in the project, were completed.

Application of Present Techniques

Current techniques for predicting travel and the extent to which intercity traffic can be predicted with these methods were evaluated.

Development and Application of New Study Techniques

Based on the evaluations of the previous phase, methods were developed to estimate intercity travel. Included also was the evaluation of alternative or additional economic or social factors that could be used to improve the methods for predicting intercity travel.

Comparison and Evaluation

This phase involved the application of the method or methods developed in the previous phase and the comparison of the results to trip transfer data already developed. Trip production and its relation to social-economic factors and trip distribution were analyzed. Stratifications of data to develop independent equations were used where possible with attention given to regional variations, economic factors, spacial distribution of various sized cities or varying city functions and the effect of exceptional transportation service between city pairs.

PROCEDURES FOLLOWED

Urban transportation planning procedures have characteristically involved the conduct of origin-and-destination studies to determine patterns of urban travel. The external portion of the origin-and-destination study specifically obtains information pertaining to trips to, from, and through the urban area in question by interviewing a sample of the vehicle drivers crossing the boundary of the study area (external cordon). Information obtained from these drivers generally includes:

1. Date and time of trip interview.
2. Trip purpose.
3. Vehicle type.
4. Number of passengers.
5. Information pertaining to the place of origin and destination of the trip.

The information for each trip is generally coded on a data card along with factors which indicate the number of actual trips that the particular trip sample represents. The methods used for coding external origin-and-destination surveys vary from city to city; however, many studies have utilized a uniform coding procedure for describing places of origin and destination. This procedure uses the codes published in the 1961 IBM Manual *Numerical Code for States, Counties and Cities of the United States* (*16*) to systematically number states, counties within states, and cities within states. The use of this uniform origin-and-destination coding system in this project made possible the development of procedures to process data from any survey which utilized this system. Once processed, the origin-and-destination trip data could then be correlated with available social-economic data.

The procedure developed for processing the origin-and-destination data was based on the modification of a series of selected transportation computer programs which are currently being used for urban transportation planning. The programs were modified to enable many external origin-and-destination surveys to be processed economically and to permit the tabulation of trips between a specific survey area and 3,075 other locations (counties or county equivalents) in a nationwide network. The program modifications and their subsequent application to the study further allow for the distributed trips to be stratified by travel time, by purpose, or by selected origins and destinations. Social and economic data pertaining to each of the 3,075 counties were also stratified by travel time from each survey area. The stratified trip data and social-economic data were then coded for subsequent input into a series of regression analysis programs to determine the correlation between the available data.

National Network Development

A network representing all the major highways in the United States was developed to determine the time distribution of trips and social-economic factors relative to each individual origin-and-destination survey area (the network is illustrated in Figures 1 and 2). Each of the 3,075 counties or county equivalents in the nation is represented by a "centroid" representing the center of the population mass of the county. The centroids were interconnected by a series of links representing the existing roadway system in 1960. The year 1960 was selected so as to be compatible with the census data which comprise the majority of the social-economic data used in the project and with the external origin-and-destination surveys. (A majority of the O-D surveys were conducted within two years of 1960.) Each link was assigned a length and speed reflective of actual intercity driving times. Using the coded network data as input, trees were built for each survey city. In each case the network description was modified so that the survey city under study was Zone 1.

Collection of Origin-and-Destination Data

Origin-and-destination external cordon survey data were gathered from various state highway departments. A questionnaire requesting O-D data was sent to the following states: Missouri, Minnesota, Ohio, Tennessee, Michigan, Kentucky, Wisconsin, Illinois, Iowa, and Indiana. In addition, questionnaires were sent to selected cities, including Boston and San Antonio, regarding the availability of O-D data. Of the data available only those from eight cities in Tennessee, eleven cities in Wisconsin, and seven cities in Missouri existed in a format suitable for use in the project. These data were used. However, as the project progressed four of these sources had to be abandoned because some of the interview cards were missing. Sources of origin-and-destination data of other modes of travel were also investigated, including rail, bus, and air.

Processing External Origin-and-Destination Surveys

As previously indicated, a prerequisite for the selection of an external origin-and-destination survey for use in this study was adherence to the IBM Manual *Numerical Code for States, Counties and Cities of the United States.* In this coding system, each state is numbered sequentially from 1 to 49 in alphabetical order. The counties within each state are numbered in alphabetical order with a five-digit state-county code ranging from 01001 to 49047. These codes are not numbered in ascending numerical sequence. To facilitate the processing of the external survey data for the selected cities, the counties were reassigned numbers ranging from 2 to 3126 (the additional numbers are used to define a centroid for each state) through the use of an equivalent deck of data cards. The external origin-and-destination cards were then processed to determine the number of trips between the external survey city, representing a particular county, and each of the other 3,075 counties in the network.

In selecting the external surveys to be used in the study it was decided to analyze a number of varying sized cities in order to identify the relationship of city size to trip generation and distribution. The 26 cities enumerated in Table 1 were originally selected for processing. Those four cities indicated by asterisks were not used because interview cards were missing. Figure 3 shows the location of the 22 cities from which usable data were obtained. The processing of the O-D surveys varied slightly among cities, but the procedures were very similar.

A total of 664,022 trips between the usable 22 study areas and each of the 3,075 other zones in the nationwide network was processed. These trips were then categorized by purpose. They were (1) work, (2) business, (3) social-recreation, and (4) others.

Collection of Social-Economic Data

A major problem arose which had as its result a limiting effect upon the scope of the development of trip predicting equations based on varied social and economic factors. The problem involved the relationship of the social and economic factors which were collected on a county basis to the urbanized (city) cordon area. Thus, although the data could be readily related to destinations (other counties), they could not be easily related to origins (the O-D study city cordon area).

The only data common to both counties and city study areas represented area and population. Although a few of the larger studies had data on family income, employment, dwelling units, and vehicle ownership statistics, similar data were not obtainable in printed form for the other study areas, the reason being that the cordon line did not coincide with any political or census tract boundaries. It appeared that the only possible means of acquiring this information would be to assume it, using the populations and areas of the city, study area, and county as guide lines; however, in many cases such a procedure would have produced little else but a crude estimate and might have introduced considerable error into any results obtained using such data. Thus, only population and area, or some combination thereof (density, etc.) was usable. In the final analysis only the population within the cordon was incorporated into the trip predicting equations derived in this project. The following available and pertinent social-economic factors were obtained for the 3,075 counties in the network and punched into data cards:

1. Total population
2. Standard Metropolitan Statistical Area (SMSA) population
3. Population of counties not in a SMSA and having less than 50,000 inhabitants
4. Population of counties having more than 50,000 inhabitants
5. Population of SMSA's having less than 1,000,000 inhabitants

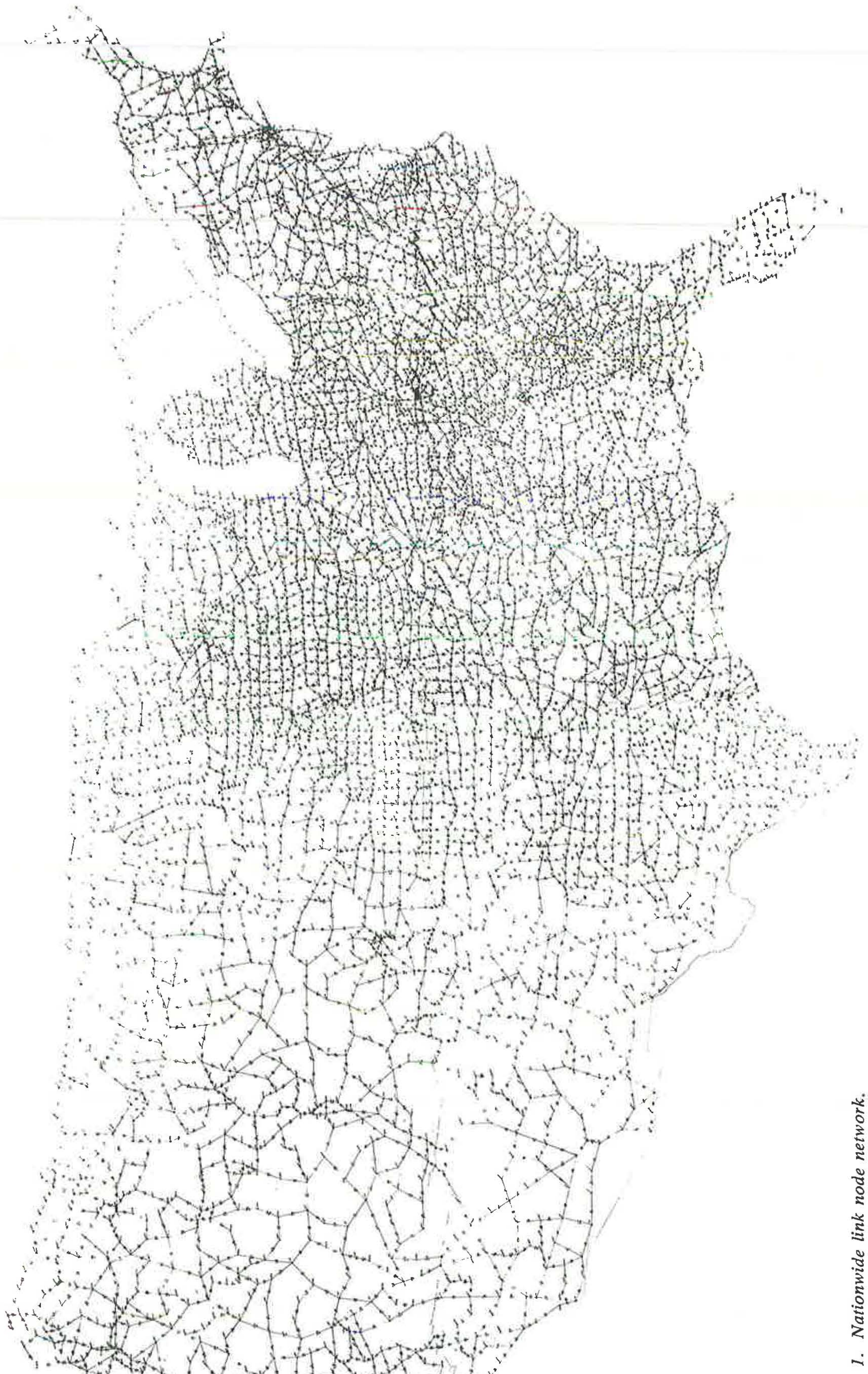


Figure 1. Nationwide link node network.

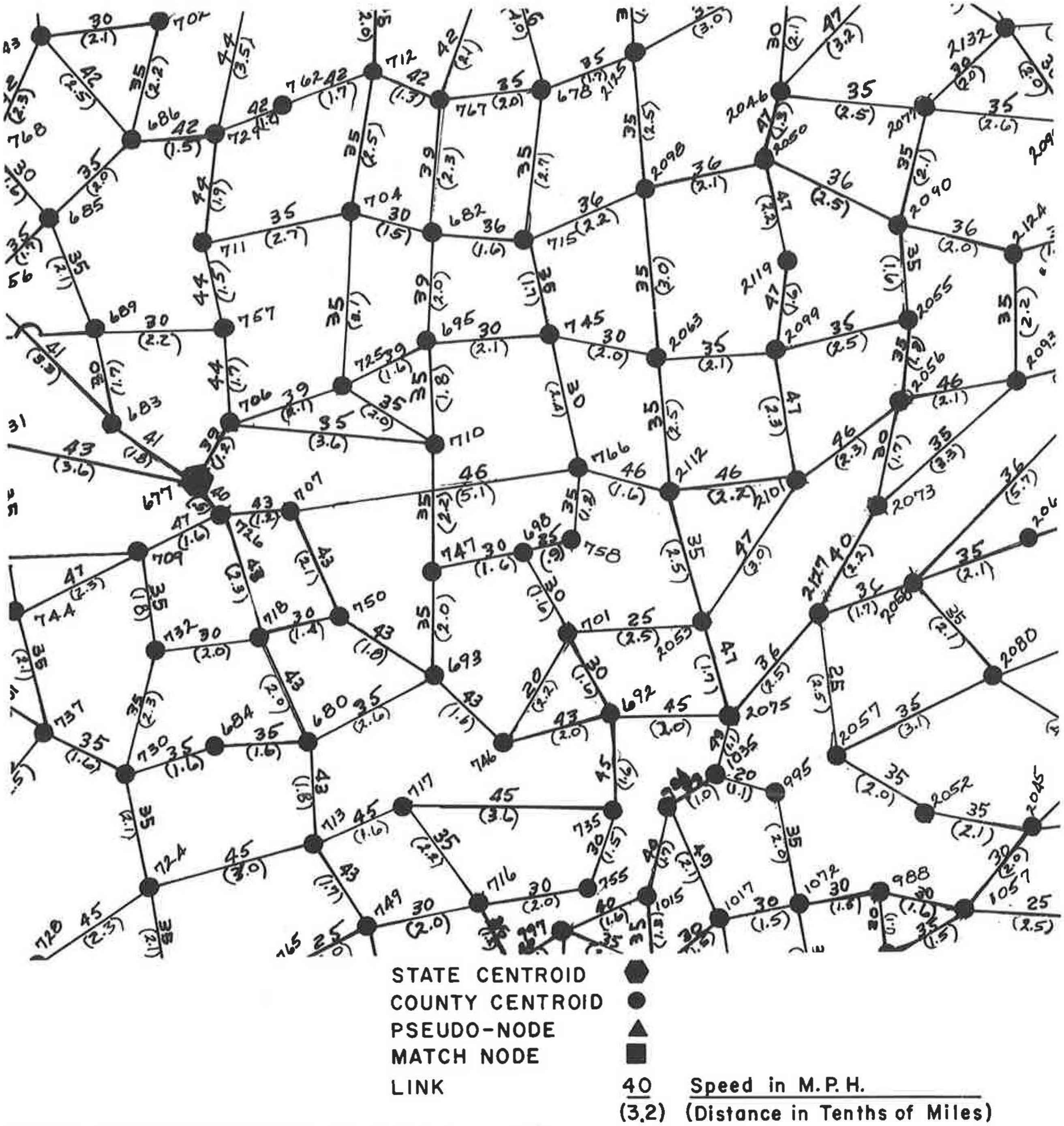


Figure 2. Section of nationwide link node network showing detail.

6. Population of SMSA's having more than 1,000,000 inhabitants
7. Population of urban counties
8. Population of rural non-farm counties
9. Aggregate income
10. Total employment
11. Total bank deposits
12. Recreation factor
13. Population of counties having less than 20% population increase from 1950 to 1960
14. Population of counties having more than 20% population decrease from 1950 to 1960

A time distribution of these factors was made from the twenty-two study areas to the 3,075 counties in the network. The output from this procedure was a tabulation of each of the total county factors by 10-minute increments from each study area. This information was then used as

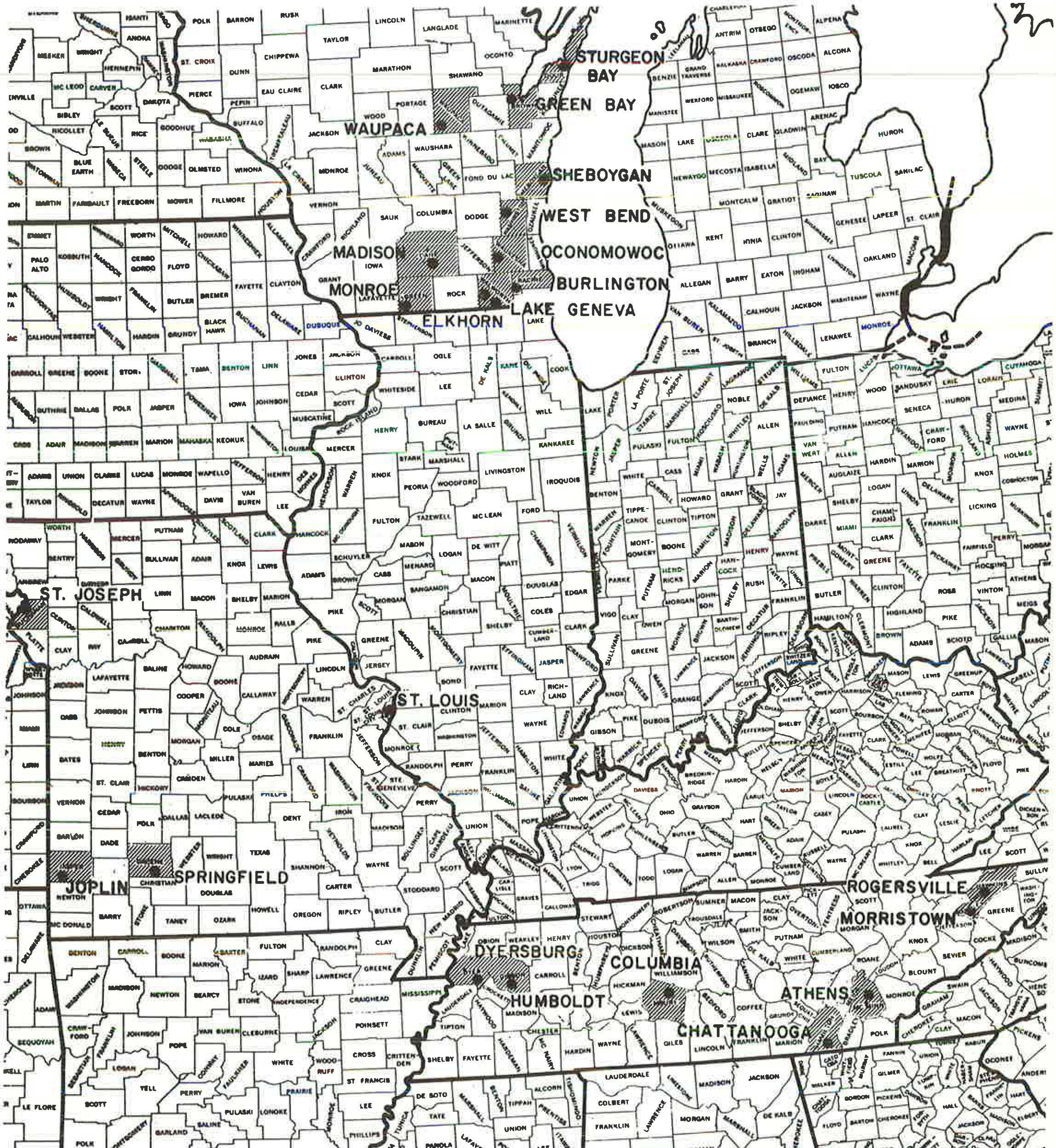


Figure 3. Location of the 22 study cities.

input for the regression analysis program so that a correlation could be established between trips and the various social and economic factors.

Based on the assumption that a better correlation would exist between trips categorized by purpose and various social and economic factors, the total all purpose data were reprocessed to obtain the four trip purposes (work, business, social-recreation, and others). The special trip distributions included:

1. Trips to SMSA's
2. Trips to counties whose population is greater than 50,000
3. Trips to counties not in an SMSA and whose population is less than 50,000
4. Trips to SMSA's whose population is greater than 1,000,000
5. Trips to SMSA's whose population is less than 1,000,000

This stratification of trips was intended to separate urban- and rural-oriented trips for subsequent correlation with social-economic factors.

Summary charts (Appendix C) include detailed information about trip classification for the 22 cities in the sample.

TABLE 1

CITIES FROM WHICH ORIGIN AND DESTINATION DATA WERE OBTAINED

CITY	1960 POP.
1. St. Louis, Mo.	750,026
2. Kansas City, Mo.[a]	475,539
3. Kansas City, Kan.[a]	121,901
4. Springfield, Mo.	95,865
5. St. Joseph, Mo.	79,673
6. Joplin, Mo.	38,958
7. Cape Girardeau, Mo.[a]	24,947
8. Elkhorn, Wis.	3,586
9. Green Bay, Wis.	62,888
10. Lake Geneva, Wis.	4,929
11. Waupaca, Wis.	3,984
12. Monroe, Wis.	8,178
13. Oconomowac, Wis.	6,682
14. Madison, Wis.	126,706
15. Sheboygan, Wis.	45,747
16. Sturgeon Bay, Wis.	7,353
17. West Bend, Wis.	9,969
18. Burlington, Wis.	5,856
19. Chattanooga, Tenn.	130,009
20. Nashville, Tenn.[a]	170,874
21. Rogersville, Tenn.	3,121
22. Athens, Tenn.	13,100
23. Humboldt, Tenn.	8,482
24. Morristown, Tenn.	21,300
25. Columbia, Tenn.	17,624
26. Dyersburg, Tenn.	12,499

[a] Not used; interview cards missing.

REGRESSION ANALYSIS

Several available regression analysis computer programs were reviewed as to their capabilities for use in this project. A program written by the University of California (Los Angeles) School of Medicine was selected. This program, BMD02R, provides for the transformation of variables to other forms, such as logarithm, reciprocal, exponential, etc. It computes a sequence of multiple linear regression equations in a stepwise manner. At each step, one variable is added to the regression equation.

The variable added is the one which makes the greatest reduction in the error (least sum of squares). Equivalently, it is the variable which has the highest partial correlation with the dependent variable partialed on the variables which have already been added, and equivalently, it is the variable which, if it were added, would have the highest F-value. In addition, variables can be forced into the regression equation and automatically removed when their F-values become too low. Regression equations with or without the regression intercept may be selected. Also, the program has flexibility in the choice of input formats so that both individual cities and groups of cities could be processed.

The origin-destination data, along with the social economic factors (which were processed independently), were combined and summarized on data cards for each study area for input to a series of regression analysis programs. These cards include the time ring, total trips, the fourteen social-economic factors, trips by purpose, the five special distributions of trips, trips greater than 35 minutes, and the population within the cordon.

The time rings were developed in the following manner: A distribution program was used to distribute total trips, purpose trips, and the fourteen social-economic factors from the study area (home node) to all other counties in the U. S. in 10-minute concentric circles. The input to this program is as many as nine binary trip tapes or tapes containing the social-economic factors and a binary tape of interzonal travel times (skim trees). The output lists in 10-minute time intervals the total trips or factors which fall in these groupings up to 2,000 minutes. For the regression cards it was decided that some grouping of the time rings would be necessary. Assuming that the trips which are to be predicted diminish as the distance from the study area increases, it was decided to group the data for the regression analysis in the following manner:

0 to 400 min in	10-min increments
400 to 600 min in	50-min increments
600 to 1000 min in	100-min increments
1000 to 2000 min in	200-min increments

The midpoint of the time ring is the value punched on the regression cards. Thus, in the first time ring, which ranges from 0 to 10 min, the midpoint is 5 min. The last value the distribution program lists is the number of trips, bank deposits, etc., which are more than 2,000 min from the study area. The midpoint of this value, which is the last observation on the regression cards, is halfway between 2,000 and the most distant point in the network. This point is read off the time tree, which lists the travel time from the home node to all other counties in the universe. By grouping the data, the number of observations was reduced from 200 to approximately 50. The number of observations did not remain constant for all the cities due to the fact that if there were no trips destined in a particular time ring the other data in the ring were split with half going to the preceding ring and half to the following ring. The time of the remaining two rings, then, had to be changed so that it represented the midpoint of the new data ring. This same procedure was followed in grouping all the data, population, bank deposits, etc., which were used in the regression equations. It was found by manual calculations and plotting that the relationship which exists between trips, ring population, cordon population and time is logarithmic; thus, it was necessary to take the log of every variable used.

Basically two types of regression runs were made—one where the equation form was fixed, and the other where the program picks the equation form. An example of the former case is where the input data took the form:

$$\log(\text{Trips}) = \log \frac{(\text{Cord. pop.} \times \text{Ring pop.})}{\text{Time}^3} \qquad (1)$$

and the solution became

$$\text{Trips} = \text{Constant} \frac{(\text{Cord. pop.} \times \text{Ring pop.})^{\text{exp}}}{\text{Time}^3} \qquad (2)$$

The basis for trying this particular equation form stems from the basic *P/D* relationship, where the interchange between any two areas is proportional to the mass of one area multiplied by the mass of the other divided by some type of friction factor. In this case mass is the population of the two areas and the friction factor is the cube of time.

In the other case, an initial run is made using trips as the independent variable with approximately 50 dependent variables to see which variables have a high correlation with trips. The program then selects, in a stepwise manner, the variable which makes the greatest reduction in the error (sum of squares). The run is terminated when the specified number of steps is reached. The result of a typical three-step regression analysis program takes the following form:

$$\text{Trips} = \text{Constant} \frac{(\text{Cord. pop.})^{\text{exp}} (\text{Ring pop.})^{\text{exp}}}{\text{Time}^{\text{exp}}} \qquad (3)$$

Regression runs were made:

1. For each city using total trips as the dependent variable.
2. For each city using trips to certain population stratifications as the dependent variables; that is, Standard Metropolitan Statistical Areas (SMSA's); SMSA's with population greater than 1,000,000; SMSA's with population less than 1,000,000; counties with population greater than 50,000; counties not in SMSA's with population less than 50,000.
3. For each city using purpose trips as the dependent variable; that is, work, business, social-recreational, other.
4. Grouping individual cities into population groups and using trips by city size group as the dependent variable.

There were 395 regression equations derived as the project progressed.

Comparisons of actual O-D trips with the synthesized trips (trips obtained by solving the regression analysis predicting equation) were made for all of the above cases using a "panacea" (general purpose) computer program which does repetitive form sheet calculations on the IBM 704, 7090, and 7094.

CHAPTER TWO

FINDINGS—RESULTS AND ANALYSIS

TRIP DATA

The results of processing the origin-and-distinction external cordon survey data are summarized in Tables C-1 and C-2, which report the various characteristics of trip distributions for the 22 individual cities, the four groups of cities based on cordon population, and the summary of all 22 cities. An external trip is where one end of the trip has its origin or destination within the cordon and the other end is located outside the study area. There were 664,022 external trips processed.

The average number of trips per study area is 30,183 and the average population for these areas is 109,710. The average trip length is 49.6 minutes, which appears to indicate the trend toward longer intercity trips and also reflects the longer commuter trips. The average number of counties which are linked to the study area by trip transfers is 396, or 13 percent of the counties in the nationwide network. There is, however, wide variation in this value among the individual study areas. For example, Athens is connected only to 80 counties, but at the other extreme the corresponding figure for St. Louis is 1,008. Thus, on an average day the trips originating or terminating in the St. Louis study area have origins or destinations in 33 percent of the counties in the continental United States. This is an astonishing figure when considering the area of the

U. S. It indicates the great importance of the large metropolitan areas in the nation today. Of all the trips, only 182,873, or 27.5 percent, have trip lengths greater than 35 minutes, which indicates that approximately three-fourths of the trips made have their origins or destinations in counties adjacent to the study area.

Characteristics of Intercity Travel

The real problem involved in the analysis of intercity travel is the determination of whether such travel is principally a function of location, a function of community size, or a function of the characteristics of the people who live within the community. With this in mind, the summary charts were analyzed and these relationships investigated. The results of this study indicate that city size is the most significant variable affecting the number of trips made and the total vehicle-miles of travel made during those trips. Table 2 summarizes the relationship of city size (population) to trips per capita, average trip length and vehicle hours per capita for total, business and non-business trips over 35 minutes in length. The total trip section of Table 2 indicates the significance of the city size. Figure 4 shows the city size-trips per capita relationship. Figure 5 shows the relationship of city size and average trip length for trips over 35 minutes in length for the study cities. Although the deviations from the curve in Figure 5 are not as consistent as those in Figure 4, it is evident that as city size decreases trips per capita increase and as city size increases the average trip length becomes longer. The variations which do occur from a normal, smooth curve are the result of spacial location and special characteristics of the community. This latter factor is most notably apparent in the smaller Wisconsin cities (Sturgeon Bay, Lake Geneva, Waupaca) where the survey data were taken on a summer week-day and reflect considerable non-business travel for vacation purposes and, therefore, longer trip length than would be the case if the survey had been conducted during the spring and fall months of the year. If the trips over 35 minutes are multiplied by the average trip length for trips over 35 minutes, the product is the number of vehicle-hours of travel per capita for trips over 35 minutes for each study area. These data, recorded in Table 2 and shown graphically in Figure 6, also emphasize the relationship of travel and city size as a meaningful indicator of intercity travel.

Analyzing all three parameters—trips per capita, average trip length, and vehicle-hours per capita—indicates certain general observations regarding intercity travel. First, the inverse relationship between population size and trips per capita emphasizes the role of the small city as a trip producer and that of the large city as a trip attractor. As pointed out in the literature survey (Appendix B), the logic behind this phenomenon is the fact that individuals can satisfy their needs—that is, work, shop, and transact business—much closer to their homes in large urban areas than in the smaller ones.

Second, the fact that trip lengths are longer for the larger cities appears to be explained by the location of a greater number of major businesses and industries producing long business trips. The fact that more people with larger amounts of disposable incomes are concentrated in the large cities could account for longer vacation-type trips.

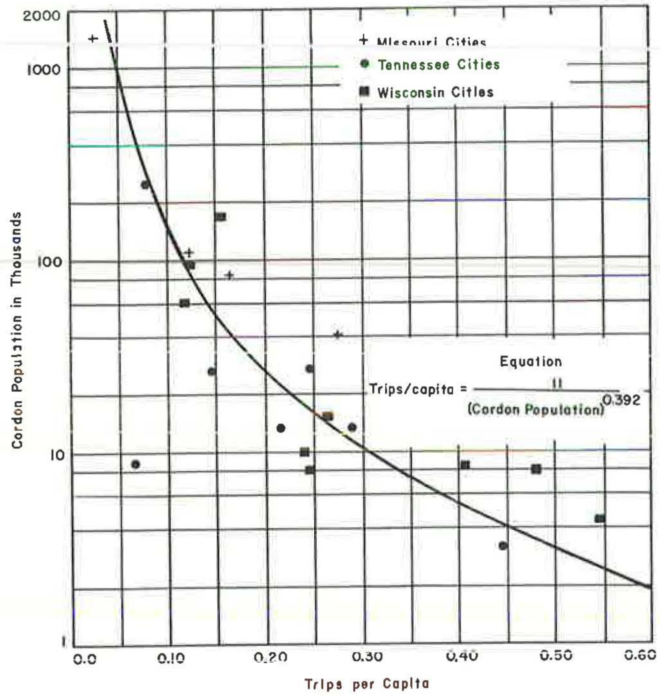
Third, the relationship between vehicle-hours per person and average trip length gives an indication of trip volume and distribution to and from the study area. That is, it would appear that a considerable volume of short-distance intercity trips are made per capita to and from the

TABLE 2

CHARACTERISTICS OF INTERCITY TRAVEL [a]

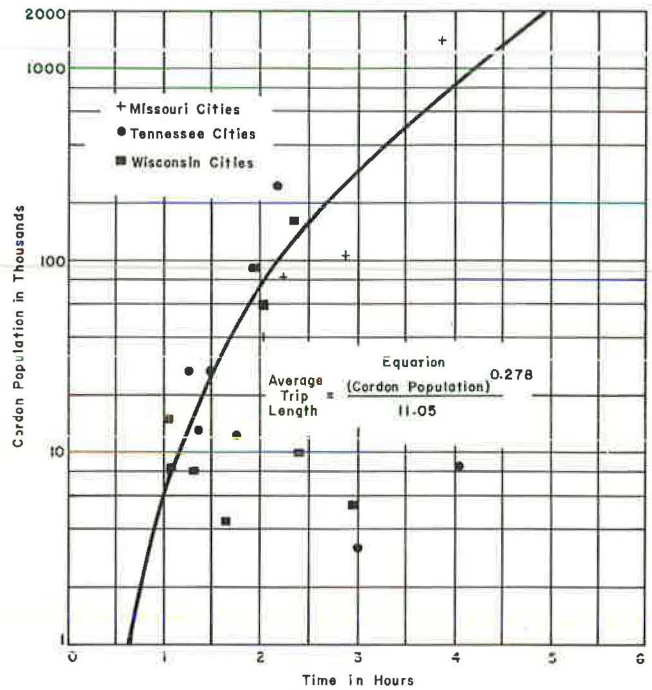
		TOTAL TRIPS			BUSINESS TRIPS [b]			NON-BUSINESS TRIPS [c]		
CITY	POPULATION	TRIPS/ CAPITA	AVG. TRIP LENGTH (MI)	VEH-HR/ CAPITA	TRIPS/ CAPITA	AVG. TRIP LENGTH (MI)	VEH-HR/ CAPITA	TRIPS/ CAPITA	AVG. TRIP LENGTH (MI)	VEH-HR/ CAPITA
St. Louis, Mo.	1,456,673	0.0238	3.89	0.0925	0.0141	3.72	0.0524	0.0097	4.14	0.0401
Chattanooga, Tenn.	242,096	0.0792	2.19	0.1732	0.0612	2.02	0.1235	0.0180	2.76	0.0497
Madison, Wis.	169,236	0.1515	2.38	0.3600	0.0971	2.25	0.2180	0.0544	2.61	0.1420
Springfield, Mo.	109,768	0.1220	2.88	0.3520	0.0738	2.58	0.1910	0.0482	3.35	0.1610
Green Bay, Wis.	96,407	0.1271	1.96	0.2430	0.0725	1.76	0.1275	0.0546	2.12	0.1155
St. Joseph, Mo.	84,165	0.1633	2.21	0.3620	0.0744	2.37	0.1762	0.0850	2.09	0.1775
Sheboygan, Wis.	60,000	0.1160	2.06	0.2390	0.0765	1.61	0.1235	0.0395	2.93	0.1155
Joplin, Mo.	40,914	0.2750	2.02	0.5530	0.1596	1.94	0.3090	0.1154	2.10	0.2440
Morristown, Tenn.	27,000	0.2450	1.25	0.3061	0.1842	1.22	0.2253	0.0614	1.32	0.0812
Columbia, Tenn.	26,000	0.1459	1.47	0.2130	0.1062	1.25	0.1326	0.0396	2.04	0.0808
West Bend, Wis.	15,520	0.2650	1.08	0.2880	0.1545	1.06	0.1640	0.1105	1.12	0.1240
Athens, Tenn.	13,100	0.2161	1.32	0.2861	0.1698	1.31	0.2218	0.0468	1.37	0.0645
Dyersburg, Tenn.	12,499	0.2900	1.71	0.4950	0.2170	1.62	0.3514	0.0718	1.98	0.1420
Sturgeon Bay, Wis.	10,000	0.2395	2.40	0.5779	0.0609	2.44	0.1489	0.1786	2.40	0.4290
Burlington, Wis.	8,700	0.4080	1.08	0.4400	0.2360	1.12	0.2630	0.1720	1.03	0.1770
Humboldt, Tenn.	8,650	0.0669	4.03	0.2695	0.0626	2.64	0.1653	0.0043	24.30	0.1039
Monroe, Wis.	8,170	0.4810	1.29	0.6210	0.2488	1.37	0.3414	0.2319	1.20	0.2793
Oconomowoc, Wis.	8,000	0.2450	1.30	0.3190	0.2079	1.17	0.2430	0.0370	2.05	0.0759
Lake Geneva, Wis.	5,500	0.9340	2.93	2.7200	0.2691	2.36	0.6356	0.6664	3.16	2.1054
Waupaca, Wis.	4,500	0.5450	1.67	0.9060	0.2910	1.51	0.4420	0.2540	1.82	0.4640
Elkhorn, Wis.	3,600	—[d]	—[d]	—[d]	—[d]	—[d]	—[d]	—[d]	—[d]	—[d]
Rogersville, Tenn.	3,121	0.4480	3.00	1.3480	0.3762	1.99	0.7494	0.0727	8.67	0.6306

[a] Trips greater than 35 min.
[b] Includes work and business as defined in this study.
[c] Includes all trips except work and business.
[d] Omitted because of inconsistent data.



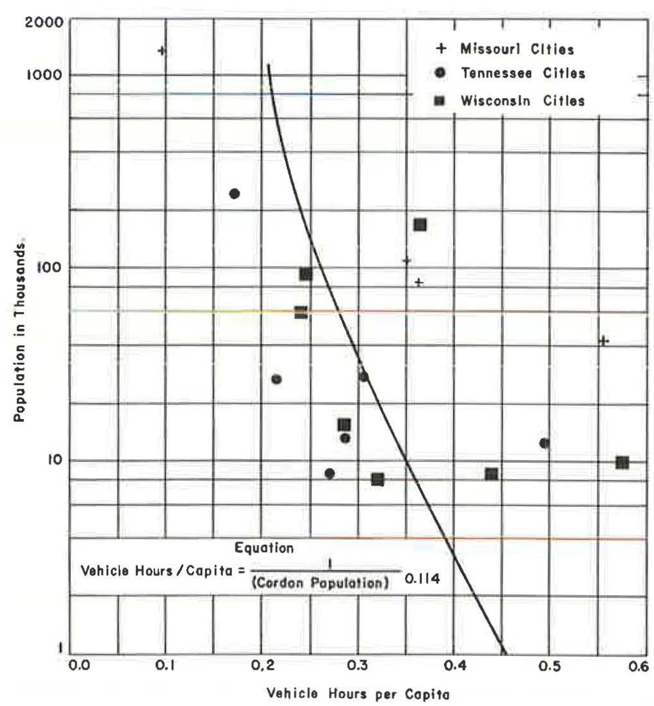
Not Plotted: Lake Geneva, Wisconsin 0.9340, 5500

Figure 4. Trips per capita (greater than 35 min) in relation to city size.



Points Omitted from Curve Calculations:
Sturgeon Bay, Wis. 2.4; 10,000
Humbolt, Tenn: 4.0; 8,656
Lake Geneva, Wis. 2.9; 5,500
No Data: Elkhorn, Wis.
Waupaca, Wis. 1.7; 4,500
Rogersville, Tenn. 3.0; 3,121

Figure 5. Average trip length for all trips greater than 35 min in relation to city size.



Not Plotted: Monroe, Wisconsin 0.6210; 8170
Lake Geneva, Wisconsin 2.720; 5500
Waupaca, Wisconsin 0.9060; 4500
Rogersville, Tennessee 1.348; 3121

Figure 6. Vehicle-hours per capita in relation to city size for all trips greater than 35 min.

smaller cities as opposed to the larger cities. Although large cities have longer trip lengths, the volume of these trips per capita is lower. This phenomenon can be related to social and economic characteristics of the different areas by hypothesizing that the trips about the smaller cities are trips to satisfy work and local personal business and are made to nearby service centers, whereas the longer trips in the larger urban areas are more of a regional business or recreation nature.

In each of these three cases, although the variations which occur from a smooth graph may be attributed to the spacial location of the community under study, relative to other communities in close proximity, these variations may also be caused by inconsistencies in and among the survey procedures used to obtain the data provided for this project. Furthermore, it is undoubtedly true that certain unusual conditions have occurred on the days of some surveys which are not average for the community under consideration. In the organization of the material for this study, it was impossible in many cases to determine whether such conditions actually existed, although in the case of the Wisconsin cities it is known that these surveys were conducted during a summer weekday and do reflect a considerable distortion because of the non-business vacation travel which occurs in these recreationally oriented areas.

From these relationships it can be inferred that equations expressing these relationships can be developed to predict the number of trips over 35 minutes for any area and to predict the total vehicle-hours of travel for any city. If formulas can be developed which accurately predict the distribution of trips for a given city or for cities in different population groups, it logically follows that the analytical procedures required to develop trip production and those procedures required to develop distribution can be combined to express completely intercity trip transfers. Any modifications which are required in order to make the two equation types compatible can be accomplished through the control relationship of total trips per capita or total vehicle-hours of travel for the given city under study. This conclusion is a basic finding of this study, and while it may not accurately describe all situations, it seems to give reasonable answers for those study areas which were investigated in this project. It is assumed that the basic relationships would hold for other communities in the United States; however, because the exact relationships determined in the study were based on only three states, representing only two or three regions, modifications may be necessary in applying them to the other regions of the United States. Only further research in this area will determine their applicability.

Equations developed describing production and trip length relationships on both a total basis and by business and non-business trip purposes are presented in the next section. Distribution equations are discussed in a later section of this report.

TRIP PRODUCTION EQUATION

The number of total external trips per capita over 35 minutes long crossing the cordon line around an urban area can be relatively well predicted by

$$\text{Trips/Capita} = \frac{11.0}{(\text{Cord. pop.})^{0.392}} \qquad (4)$$

which has been graphically depicted in Figure 4.

Comparison of Actual and Equation Values

Table 3 shows a comparison between the study data and the values obtained from Eq. 4.

The number of business trips per capita greater than 35 minutes can be predicted by

$$\text{Business trips/Capita} = \frac{61}{(\text{Cord. pop.})^{0.599}} \qquad (5)$$

Figure 7 graphically depicts and Table 3 compares the actual values with those obtained by use of Eq. 5.

The number of non-business trips per capita greater than 35 minutes can be predicted by

$$\text{Non-business trips/Capita} = \frac{435}{(\text{Cord. pop.})^{0.847}} \qquad (6)$$

Figure 8 graphically depicts and Table 3 compares the actual values with those obtained by use of Eq. 6.

It is evident that intercity trips greater than 35 minutes are closely related to the cordon population of the study areas under consideration.

From the data investigated, this relationship is one of the most stable developed in this study. However, al-

TABLE 3

COMPARISON OF ACTUAL AND EQUATION VALUES

	TRIPS PER CAPITA									
	TOTAL TRIPS [a]				BUSINESS TRIPS [b]			NON-BUSINESS TRIPS [c]		
CITY	POPULATION	ACTUAL	EQ.	DIFF.	ACTUAL	EQ.	DIFF.	ACTUAL	EQ.	DIFF.
St. Louis, Mo.	1,456,673	0.0238	0.0418	—0.0180	0.0141	0.0123	0.0018	0.0097	0.0026	0.0071
Chattanooga, Tenn.	242,096	0.0792	0.0865	—0.0073	0.0612	0.0363	0.0249	0.0180	0.0125	0.0055
Madison, Wis.	169,236	0.1515	0.0944	0.0571	0.0971	0.0452	0.0519	0.0544	0.0165	0.0379
Springfield, Mo.	109,768	0.1220	0.1178	0.0042	0.0738	0.0598	0.0140	0.0482	0.0239	0.0243
Green Bay, Wis.	96,407	0.1271	0.1234	0.0036	0.0725	0.0639	0.0086	0.0546	0.0262	0.0284
St. Joseph, Mo.	84,165	0.1633	0.1298	0.0335	0.0744	0.0685	0.0059	0.0850	0.0301	0.0549
Sheboygan, Wis.	60,000	0.1160	0.1466	—0.0306	0.0765	0.0843	—0.0078	0.0395	0.0392	0.0003
Joplin, Mo.	40,914	0.2750	0.1710	0.1040	0.1596	0.1048	0.0548	0.1154	0.0536	0.0618
Morristown, Tenn.	27,000	0.2450	0.2025	0.0425	0.1842	0.1350	0.0592	0.0614	0.0774	—0.0160
Columbia, Tenn.	26,000	0.1459	0.2048	—0.0589	0.1062	0.1396	—0.0334	0.0396	0.0791	—0.0395
West Bend, Wis.	15,520	0.2650	0.2520	0.0130	0.1545	0.1883	—0.0338	0.1105	0.1225	—0.0120
Athens, Tenn.	13,100	0.2161	0.2687	—0.0526	0.1698	0.2089	—0.0391	0.0468	0.1440	—0.0972
Dyersburg, Tenn.	12,499	0.2900	0.2763	0.0137	0.2170	0.2163	0.0007	0.0718	0.1510	—0.0792
Sturgeon Bay, Wis.	10,000	0.2395	0.2973	—0.0578	0.0609	0.2440	—0.1831	0.1786	0.1790	—0.0004
Burlington, Wis.	8,700	0.4080	0.3158	0.0922	0.2360	0.2663	—0.0303	0.1720	0.2014	—0.0294
Humboldt, Tenn.	8,650	0.0669	0.3171	—0.2502	0.0626	0.2699	—0.2073	—	—	—
Monroe, Wis.	8,170	0.4810	0.3231	0.1579	0.2488	0.2773	—0.0285	—	—	—
Oconomowoc, Wis.	8,000	0.2450	0.3261	—0.0811	0.2079	0.2798	—0.0719	0.0370	0.2208	—0.1838
Lake Geneva, Wis.	5,500	0.9340	0.3769	0.5571	0.2691	0.3506	—0.0815	0.6664	0.2979	0.3685
Waupaca, Wis.	4,500	0.5450	0.4086	0.1364	0.2910	0.3954	—0.1044	0.2540	0.3537	—0.0997
Elkhorn, Wis.	3,600	—[d]	—[d]	—[d]	—[d]	—[d]	—[d]	—[d]	—[d]	—[d]
Rogersville, Tenn.	3,121	0.4480	0.4714	—0.0234	0.3762	0.4959	—0.1197	0.0727	0.4769	—0.4042

[a] Equation: $\text{Trips/capita} = \frac{11.0}{(\text{Cordon population})^{0.392}}$

[b] Equation: $\text{Business trips/capita} = \frac{61}{(\text{Cordon population})^{0.599}}$

[c] Equation: $\text{Non-business trips/capita} = \frac{435}{(\text{Cordon population})^{0.847}}$

[d] Omitted because of inconsistent data.

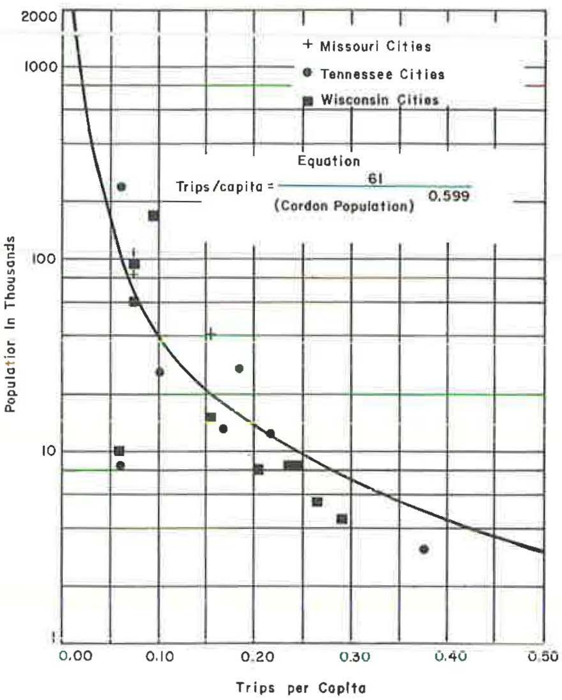
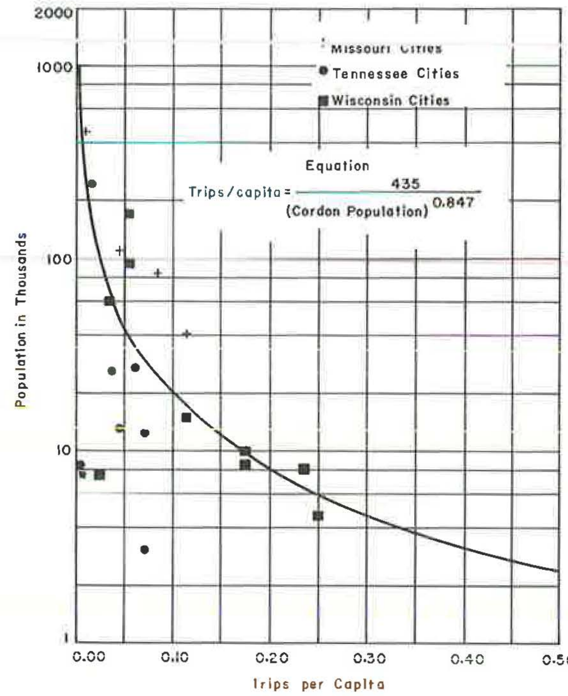


Figure 7. Business trips per capita in relation to city size, for trips greater than 35 min.



Not Plotted: Lake Geneva, Wisconsin 0.6664; 5,500;

Figure 8. Non-business trips per capita in relation to city size for trips greater than 35 min.

though this question holds very well for trips greater than 35 minutes, no similar equation could be developed with as good a correlation for trips less than 35 minutes.

Of the trips greater than 35 minutes, it is generally true that for average weekday travel the percentage of business trips increases as the city size increases, although the differences are minor. Percentages of business trips of the total trips range from 60% maximum to 25% minimum. However, as the longer trips are considered (8 hours or more) the percentage of the total trips for business purposes decreases. In this case, the range is 55% to 20% except for one or two special cases. This change implies that non-business trips are, on the average, longer than business trips.

It is significant to note that trips respond well to cordon population relationships despite the geographical location of the survey city. However, the geographical location of the survey city does affect trip distribution. In fact, it is probably the most important predictor of trip distribution.

TRIP LENGTH EQUATION

Although distribution is affected by the spacial relationship between populations, business trip and non-business trip lengths vary despite their common spacial relationship to population. This is shown by observing that business trips average approximately 10% shorter than the total trip average, whereas non-business trips average approximately 10% longer than the total trip average. It can also be shown that the longer the trips considered, the greater the percentage of non-business trips made.

Average Trip Length—All, Business, and Non-Business Comparison of Actual and Equation Values

The following equations have been developed to predict average trip lengths for total trips, business trips and non-business trips.

(1) Total trips:

$$\text{Avg. trip length} = \frac{(\text{Cord. pop.})^{0.278}}{11.05} \tag{7}$$

(2) Business trips:

$$\text{Avg. trip length} = \frac{(\text{Cord. pop.})^{0.274}}{11.25} \tag{8}$$

(3) Non-business trips:

$$\text{Avg. trip length} = \frac{(\text{Cord. pop.})^{0.315}}{15.4} \tag{9}$$

Figures 5, 9, and 10 graphically depict and Table 4 compares the actual values with those obtained from the equations.

VEHICLE-HOURS EQUATION

Vehicle-hours per capita is derived from multiplying trips per capita by average trip length for the various trip purposes. Thus, this product appears to be particularly valuable as a control parameter in relating trip volumes and distributions. The vehicle-hours-per-capita parameter is inversely related to population, although the scatter of

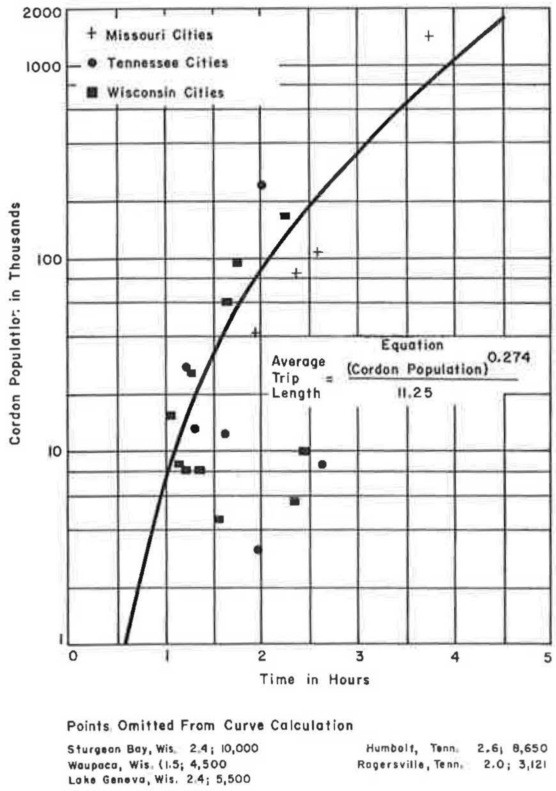


Figure 9. Average trip length in relation to city size for business trips greater than 35 min.

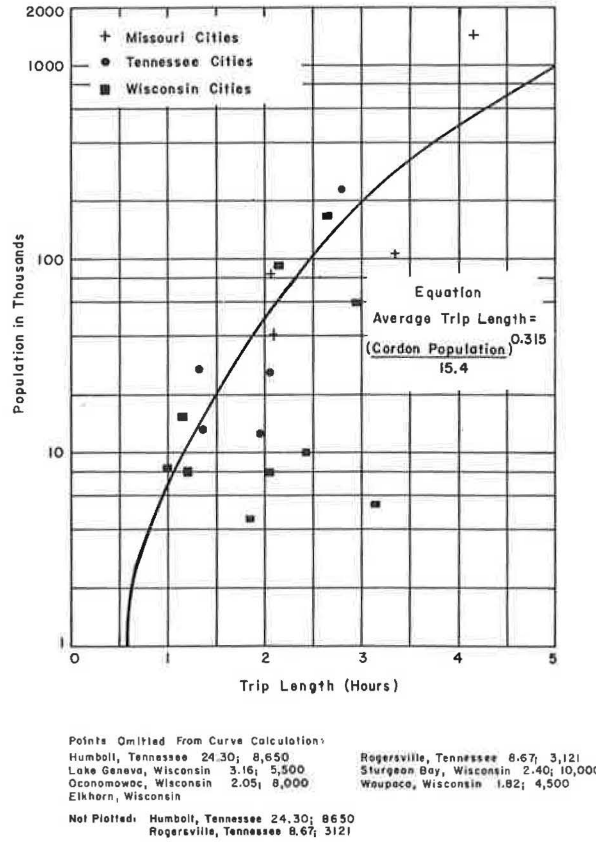


Figure 10. Average trip length in relation to city size for non-business trips greater than 35 min.

TABLE 4

COMPARISON OF ACTUAL AND EQUATION VALUES

	AVERAGE TRIP LENGTH (MI)									
	ALL TRIPS [a]				BUSINESS TRIPS [b]			NON-BUSINESS TRIPS [c]		
CITY	POPULATION	ACTUAL	EQ.	DIFF.	ACTUAL	EQ.	DIFF.	ACTUAL	EQ.	DIFF.
St. Louis, Mo.	1,456,673	3.89	4.66	— 0.77	3.72	4.35	— 0.63	4.14	5.66	— 1.52
Chattanooga, Tenn.	242,096	2.19	2.83	— 0.64	2.02	2.64	— 0.62	2.76	3.21	— 0.45
Madison, Wis.	169,236	2.38	2.56	— 0.18	2.25	2.41	— 0.16	2.61	2.87	— 0.26
Springfield, Mo.	109,768	2.88	2.27	0.61	2.58	2.12	0.46	3.35	2.49	0.86
Green Bay, Wis.	96,407	1.96	2.19	— 0.23	1.76	2.06	— 0.30	2.12	2.41	— 0.29
St. Joseph, Mo.	84,165	2.21	2.12	0.09	2.37	1.99	0.38	2.09	2.29	— 0.20
Sheboygan, Wis.	60,000	2.06	1.93	0.13	1.61	1.81	— 0.20	2.93	2.08	0.85
Joplin, Mo.	40,914	2.02	1.73	0.29	1.94	1.64	0.30	2.10	1.84	0.34
Morristown, Tenn.	27,000	1.25	1.54	— 0.29	1.22	1.45	— 0.23	1.32	1.61	— 0.29
Columbia, Tenn.	26,000	1.47	1.53	— 0.06	1.25	1.44	— 0.19	2.04	1.59	0.45
West Bend, Wis.	15,520	1.08	1.32	— 0.24	1.06	1.25	— 0.19	1.12	1.35	— 0.23
Athens, Tenn.	13,100	1.32	1.26	0.06	1.31	1.20	0.11	1.37	1.28	0.09
Dyersburg, Tenn.	12,499	1.71	1.24	0.47	1.62	1.17	0.45	1.98	1.26	0.72
Sturgeon Bay, Wis.	10,000	2.40	1.17	1.23	2.44	1.11	1.33	2.40	1.18	1.22
Burlington, Wis.	8,700	1.08	1.13	— 0.05	1.12	1.08	0.04	1.03	1.13	— 0.10
Humboldt, Tenn.	8,650	4.03	1.12	2.91	—	—	—	24.30	1.12	23.18
Monroe, Wis.	8,170	1.29	1.11	0.18	—	—	—	1.20	1.10	0.10
Oconomowoc, Wis.	8,000	1.30	1.10	0.20	1.17	1.04	0.13	2.05	1.10	0.95
Lake Geneva, Wis.	5,500	2.93	0.99	1.94	2.36	0.94	1.42	3.16	0.98	2.18
Waupaca, Wis.	4,500	1.67	0.94	0.73	1.51	0.89	0.62	1.82	0.92	0.90
Elkhorn, Wis.	3,600	—[d]	—[d]	—[d]	—[d]	—[d]	—[d]	—[d]	—[d]	—[d]
Rogersville, Tenn.	3,121	3.00	0.85	2.15	1.99	0.80	1.19	8.67	0.88	7.79

[a] Equation: Average trip length $= \frac{(\text{Cordon population})^{0.278}}{11.05}$

[b] Equation: Business trip average length $= \frac{(\text{Cordon population})^{0.274}}{11.25}$

[c] Equation: Non-business trip avg. length $= \frac{(\text{Cordon population})^{0.315}}{15.4}$

[d] Omitted because of inconsistent data.

the data is considerable, especially for total trips. Figures 6, 11, and 12 graphically depict these relationships. No doubt the scatter is indicative of cumulative errors involved in the multiplication of equations containing inherent normal errors. The following equations were derived to predict vehicle-hours per capita for total trips, business trips and non-business trips:

(1) Total trips:

$$\text{Veh-hr/Capita} = \frac{1}{(\text{Cord. pop.})^{0.114}} \tag{10}$$

(2) Business trips:

$$\text{Veh-hr/Capita} = \frac{5.45}{(\text{Cord. pop.})^{0.325}} \tag{11}$$

(3) Non-business trips:

$$\text{Veh-hr/Capita} = \frac{28.25}{(\text{Cord pop.})^{0.532}} \tag{12}$$

Table 5 compares the actual values with those determined from the equations.

TRIP PREDICTION EQUATIONS

As the result of trying a number of variables, it was found that in most cases the variables cordon population, ring population, and time, when used in an equation, expressed relationships which correlated with actual trips better than any other combination of three variables. Although some equations did incorporate other variables, most of the equation forms were built around the three variables for the sake of simplicity.

It was found that 395 equations derived as part of the study could be categorized into five basic equation forms. The first takes the form

$$\text{Time} = \text{Const. (Trips/Ring pop./Cord. pop.)}^{\text{exp}} \tag{13}$$

This particular equation form was used for trips to (1) the entire universe; (2) Standard Metropolitan Statistical Areas whose population is greater than 1,000,000; (4) SMSA's whose population is less than 1,000,000; (5) counties whose population is greater than 50,000; and (6) counties not in a SMSA and whose population is less than 50,000. Two runs for each of these categories were made for all time rings and all time rings greater than 35 minutes for the 22 individual cities, and all 22 cities combined, while the four groups of cities were processed for just the time rings greater than 35 minutes. These runs constitute 168 regression analysis equations. The objective of trying this equation form was to see how trips, modified by the ring and cordon population, varied with time. The best results were obtained when predicting trips greater than 35 minutes, so, for all the remaining regression runs, the trips less than 35 minutes in length were excluded. This verified an assumption made before the start of this project that it would be difficult, if not im-

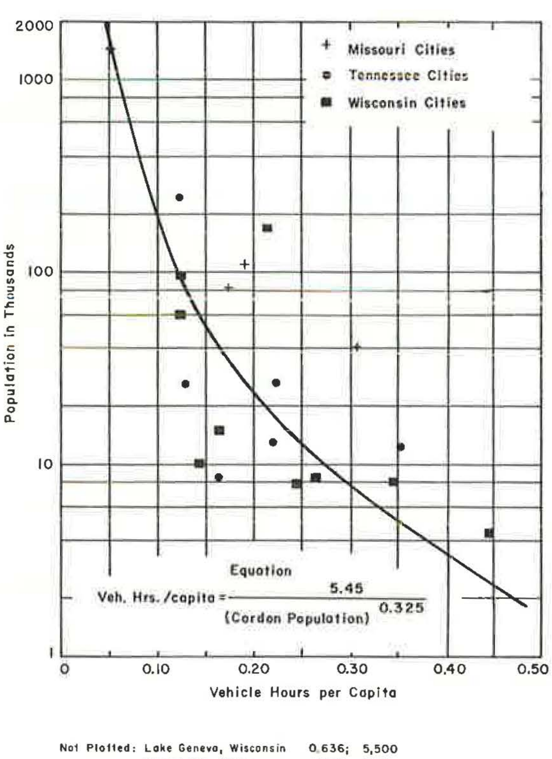


Figure 11. Vehicle-hours per capita in relation to city size for business trips greater than 35 min.

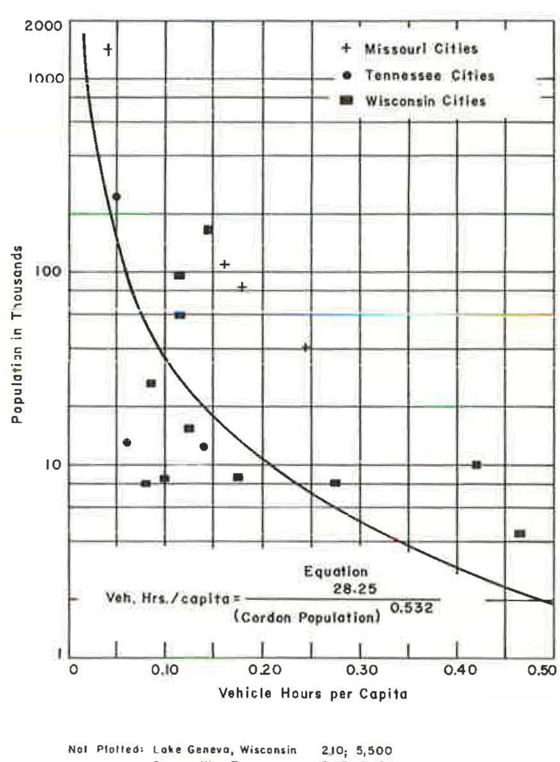


Figure 12. Vehicle-hours per capita in relation to city size for non-business trips greater than 35 min.

TABLE 5

COMPARISON OF ACTUAL AND EQUATION VALUES—VEHICLE HR PER CAPITA

	VEHICLE-HOURS PER CAPITA									
	ALL TRIPS [a]				BUSINESS TRIPS [b]			NON-BUSINESS TRIPS [c]		
CITY	POPULATION	ACTUAL	EQ.	DIFF.	ACTUAL	EQ.	DIFF.	ACTUAL	EQ.	DIFF.
St. Louis, Mo.	1,456,673	0.0925	0.1984	—0.1059	0.0524	0.0545	—0.0021	0.0401	0.0148	0.0253
Chattanooga, Tenn.	242,096	0.1732	0.2433	—0.0701	0.1235	0.0970	0.0265	0.0497	0.0390	0.0107
Madison, Wis.	169,236	0.3600	0.2538	0.1062	0.2180	0.1092	0.1088	0.1420	0.0468	0.0952
Springfield, Mo.	109,768	0.3520	0.2667	0.0853	0.1910	0.1262	0.0648	0.1610	0.0597	0.1013
Green Bay, Wis.	96,407	0.2430	0.2702	—0.0272	0.1275	0.1310	—0.0035	0.1155	0.0632	0.0523
St. Joseph, Mo.	84,165	0.3620	0.2754	0.0866	0.1762	0.1376	0.0386	0.1775	0.0679	0.1096
Sheboygan, Wis.	60,000	0.2390	0.2850	—0.0460	0.1235	0.1531	—0.0296	0.1155	0.0814	0.0341
Joplin, Mo.	40,914	0.5530	0.2976	0.2554	0.3090	0.1725	0.1365	0.2440	0.0991	0.1449
Morristown, Tenn.	27,000	0.3061	0.3125	—0.0064	0.2253	0.1989	0.0264	0.0812	0.1244	—0.0432
Columbia, Tenn.	26,000	0.2130	0.3144	—0.1014	0.1326	0.2011	—0.0685	0.0808	0.1250	—0.0442
West Bend, Wis.	15,520	0.2880	0.3333	—0.0453	0.1640	0.2380	—0.0740	0.1240	0.1682	—0.0442
Athens, Tenn.	13,100	0.2861	0.3401	—0.0540	0.2218	0.2512	—0.0294	0.0645	0.1846	—0.1201
Dyersburg, Tenn.	12,499	0.4950	0.3424	0.1526	0.3514	0.2547	0.0967	0.1420	0.1883	—0.0463
Sturgeon Bay, Wis.	10,000	0.5779	0.3496	0.2283	0.1489	0.2725	—0.1236	0.4290	0.2124	0.2166
Burlington, Wis.	8,700	0.4400	0.3546	0.0854	0.2630	0.2853	—0.0223	0.1770	0.2260	—0.0490
Humboldt, Tenn.	8,650	0.2695	0.3558	—0.0863	0.1653	0.2930	—0.1277	0.1039	0.2297	—0.1258
Monroe, Wis.	8,170	0.6210	0.3584	0.2626	0.3414	0.2946	0.0468	0.2793	0.2354	0.0439
Oconomowoc, Wis.	8,000	0.3190	0.3586	—0.0396	0.2430	0.2948	—0.0518	0.0759	0.2374	—0.1615
Lake Geneva, Wis.	5,500	2.7200	0.3745	2.3455	0.6356	0.3323	0.3033	2.1054	0.2891	1.9163
Waupaca, Wis.	4,500	0.9060	0.3831	0.5229	0.4420	0.3562	0.0858	0.4640	0.3243	0.1397
Elkhorn, Wis.	3,600	—[d]	—[d]	—[d]	—[d]	—[d]	—[d]	—[d]	—[d]	—[d]
Rogersville, Tenn.	3,121	1.3480	0.4500	0.8980	0.7494	0.4007	0.3487	0.6306	0.3929	0.2377

[a] Equation: All trips, vehicle-hours per capita $= \frac{1}{(\text{Cordon population})^{0.114}}$

[b] Equation: Business trips, vehicle-hours per capita $= \frac{5.45}{(\text{Cordon population})^{0.325}}$

[c] Equation: Non-business trips, vehicle-hours per capita $= \frac{28.25}{(\text{Cordon population})^{0.532}}$

[d] Omitted because of inconsistent data.

possible, to predict intra-metropolitan or intra-area trips, the reason being the multitude of factors which influence trips of this length.

In using the second equation form, it was decided to make trips the dependent variable so that they would be easier to work with, and so that the synthesized trips could be compared with the actual trips.

$$\text{Trips} = \text{Const.}\ \frac{(\text{Ring pop.} \times \text{Cord. pop.})^{\text{exp}}}{\text{Time}^3} \qquad (14)$$

This equation form was used to derive a general equation for all cities, four grouped equations, and 22 individual equations for total trips. This equation was modified by simply using cordon crossings greater than 35 minutes instead of cordon population and was called Equation 14A. The equation then becomes a distribution equation rather than a prediction equation. This type of equation would be quite useful in a city which had recently undertaken an external cordon O-D survey. For other cities, Equation 14 would have to be used.

In the third equation, the exponent 3 was removed from the variable, time, and the product of ring population and cordon population was separated into two variables, or

$$\text{Trips} = \text{Const.}\ \frac{(\text{Cord. pop.})^{\text{exp}}\ (\text{Ring pop.})^{\text{exp}}}{(\text{Time})^{\text{exp}}} \qquad (15)$$

A general equation for all cities, four grouped equations, and 22 individual equations were derived for total trips. Again these equations were modified by substituting cordon crossings greater than 35 minutes for cordon population (called Eq. 15A).

The form of the fourth equation is

$$\text{Trips} = \text{Const.}\ \frac{(\text{Cord. pop.} \times \text{Ring pop.})^{\text{exp}}}{(\text{Time})^{\text{exp}}} \qquad (16)$$

The same set of equations was derived for Eqs. 16 and 16A as for the previous basic equation forms.

A ten-step regression analysis program was run to determine the best correlation between trips and 16 selected variables; thus, many varied equation forms were likely to occur. The variables consisted of the log of time; total population; SMSA population; population of counties greater than 50,000; population of counties less than 50,000 and not in a SMSA; population of SMSA's greater than 1,000,000; population of SMSA's less than 1,000,000 urban population; rural population; aggregate income; total employment; bank deposits; population of counties with less than average growth; population of counties with greater than average growth; cordon crossings greater than 35 minutes; and total trips. For the general equation (all counties combined) the equation form was:

$$\text{Trips} = \text{Const.}\ \frac{(\text{Cord cross.} > 35\ \text{min})^{\text{exp}}\ (\text{Bank deps.})^{\text{exp}}}{(\text{Time})^{\text{exp}}} \qquad (17)$$

This was the most common equation form, but others did occur for the four city groupings and the 22 individual cities. This same procedure was followed for the purpose 1 (work trips), purpose 2 (business trips), purpose 3-4 (social-recreation trips), and purpose 5 (other trips). In all these ten stepwise regression runs there was little improvement in the multiple R after the third step. In fact, in a few instances, the F-level for the third variable was too small to be entered (less than 0.01).

The development of these equations proceeded in a logical manner from the preparation of total trip equations, of trip equations for certain population stratification and of trips by purpose through the preparation of trip equations for city population groupings. In each case, the multiple R indicator was used to check the ability of the variables selected to reproduce the O-D trip data.

After regression runs were made using total trips as the independent variable, it was felt that a better correlation could be obtained by using trips to (1) SMSA's, (2) SMSA's whose population is greater than 1,000,000, (3) SMSA's whose population is less than 1,000,000, (4) counties whose population is greater than 50,000 and (5) counties not in an SMSA and whose population is less than 50,000, instead of total trips. The results, however, were disappointing, for the multiple R was slightly less for these stratified trips than for total trips.

Trips by purpose were then run against the same selected variables; however, little improvement was anticipated after reviewing the above results. The multiple R in this case for all cities was 0.83, while this indicator was 0.85, 0.70, 0.78 and 0.70 for all cities, purpose 1, 2, 3-4 and 5 trips, respectively. This seems to indicate that purpose 1 (work) and purpose 3-4 (social-recreation) are more closely predicted than the purpose 2 (business) and purpose 5 (other) trips. Thus, subdividing total trips into the four trip purpose categories resulted in no improvement in prediction accuracy. This observation was confirmed when the actual O-D trips were compared with the synthesized trips (trips obtained by solving the regression analysis predicting equation). It seems evident, therefore, that by subdividing total trips by purpose or into the five population ranges no improvement in prediction accuracy can be expected. The reason for this appears to be related to the number of observations involved. For example, given that the all-purpose trips greater than 35 minutes for a particular city are 20,000 and the purpose 1, 2, 3-4 and 5 trips are 5,000 each and there are predicting equations for each of these, there would be a greater chance of significant errors occurring in the equations derived from the smaller number of samples. Thus, if total trips were predicted by adding purpose trips, a greater error might be made than if total trips were predicted. The latter method tends to rectify a proportion of the errors through compensation. The work trip prediction equation appears to be an exception.

Because the population of the generator has a significant effect on the rate of trip production (as the population increases, the ratio, trips per person, decreases), it was decided to categorize the 22 study areas into four groups based on cordon population. The groupings were (1) less than 10,000, (2) between 10,000 and 30,000, (3) between 30,000 and 100,000, and (4) greater than 100,000. This procedure does not stratify the trips of a city, but groups the cities together so that instead of having one general equation for all cities, four equations are obtained to be used according to the size of the area. Regression analysis runs were made upon grouping the cities as indicated.

For cities with:

Population < 10,000

$$\text{Trips} = 41{,}454 \left[\frac{(\text{Ring pop.})^{0.71485}}{(\text{Time})^{2.31228}}\right] A \qquad (18)$$

Population 10,000 to 30,000

$$\text{Trips} = 1{,}132{,}000 \left[\frac{(\text{Cord. pop.})^{0.31914}\,(\text{Ring pop.})^{0.73043}}{(\text{Time})^{2.78231}}\right] A \qquad (19)$$

Population 30,000 to 100,000

$$\text{Trips} = 2{,}367{,}000 \left[\frac{(\text{Cord. pop.})^{0.17490}\,(\text{Ring pop.})^{0.77084}}{(\text{Time})^{2.73632}}\right] A \qquad (20)$$

Population > 100,000

$$\text{Trips} = 1{,}326{,}100 \left[\frac{(\text{Cord. pop.})^{0.52563}\,(\text{Ring. pop.})^{0.80403}}{(\text{Time})^{2.57651}}\right] A$$

in which trips are two-way vehicle trips (inbound and outbound); cordon population is in 100,000's; ring population is the population of a time ring, in 1,000's; time is the time from the city center to the time ring, in minutes; A is a factor which is calculated from existing data

$$\left(= \frac{\text{Actual intercity trips}}{\text{Computed intercity trips}}\right).$$

In the research it was determined that A has the following tentative values based on the data evaluated to date:

Population < 10,000

$A = 4.71$ (based on Humboldt, Tenn., and Monroe, Wis.) (21)

Population 10,000-30,000

$A = 2.41$ (based on Columbia, Tenn.) (22)

Population 30,000-100,000

$A = 1.96$ (based on St. Joseph, Mo.) (23)

Population > 100,000

$A = 1.16$ (based on St. Louis, Mo.) (24)

Using Equation Form 15 as an example, the multiple R for the average of all cities is 0.83, while for cordon populations less than 10,000, between 10,000 and 30,000, between 30,000 and 100,000, and greater than 100,000, the multiple R's are 0.73, 0.77, 0.82 and 0.87. Thus, a trend is evident which says that as the areas increase in population the correlation increases. This is understandable for two reasons. First, from a statistical viewpoint, it is more difficult to predict smaller volumes than larger volumes, for the reliability of the data increases as the size of the sample increases. Second, the smaller cities are more noticeably affected by the surroundings. If, for example, a primarily residential city which has a population of 9,000

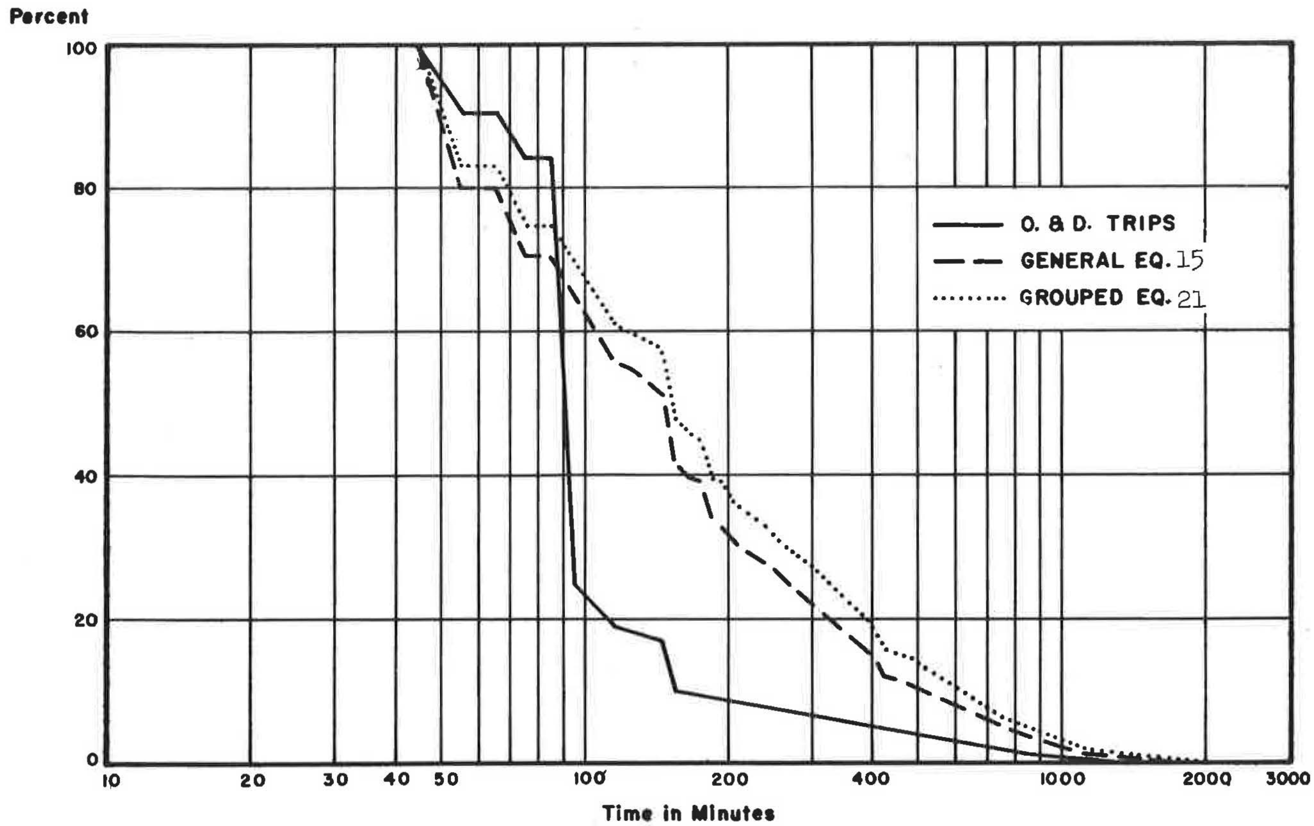


Figure 13. Comparison of the Humboldt, Tenn., O-D and synthesized trips greater than 35 min.

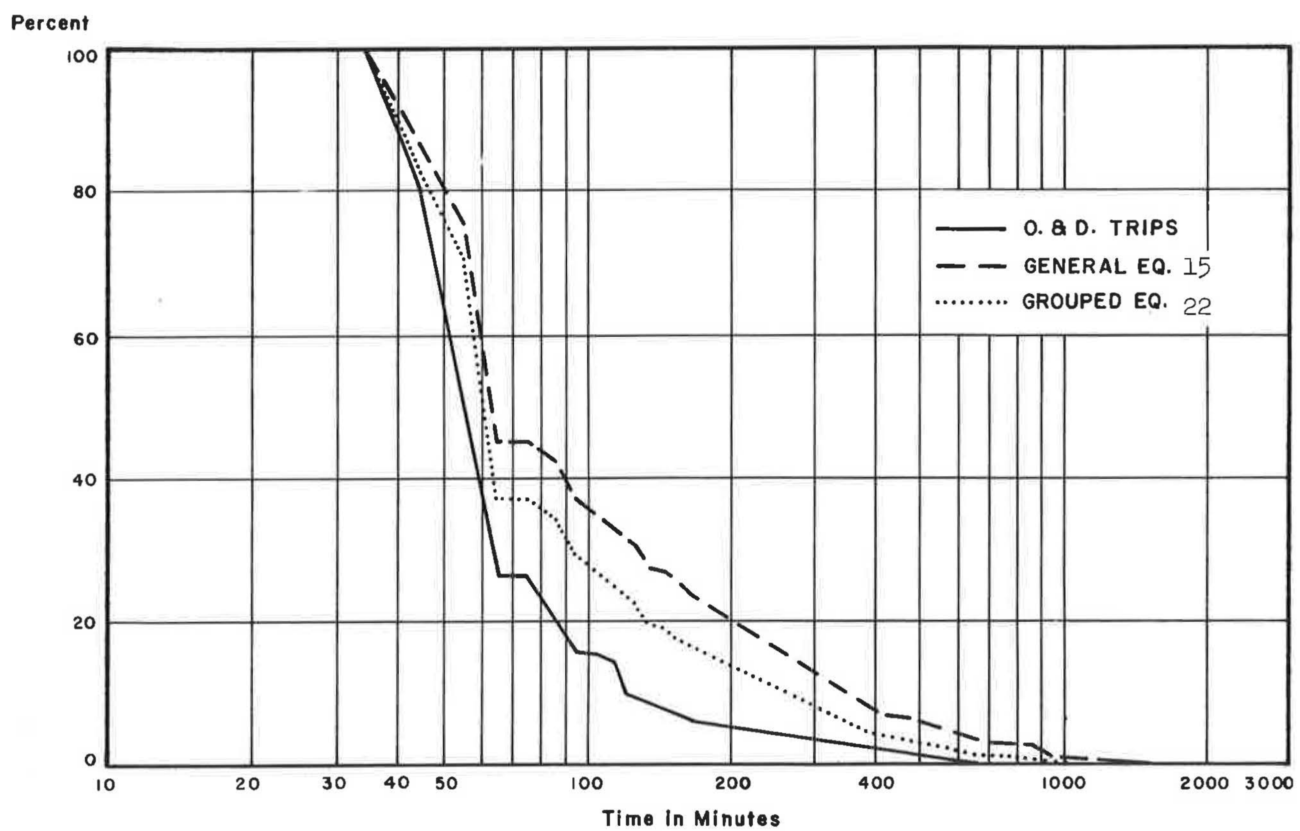


Figure 14. Comparison of the Columbia, Tenn., O-D and synthesized trips greater than 35 min.

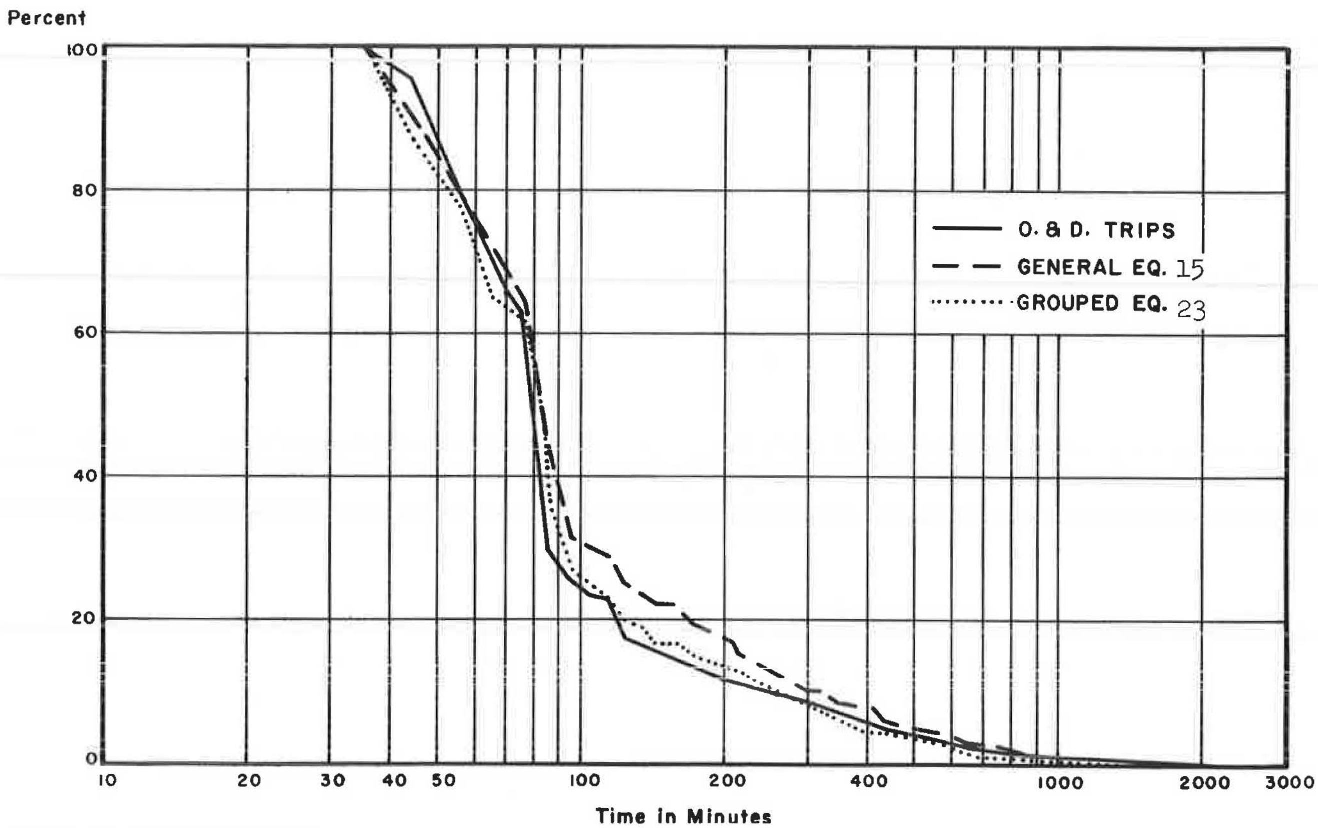


Figure 15. Comparison of the St. Joseph, Mo., O-D and synthesized trips greater than 35 min.

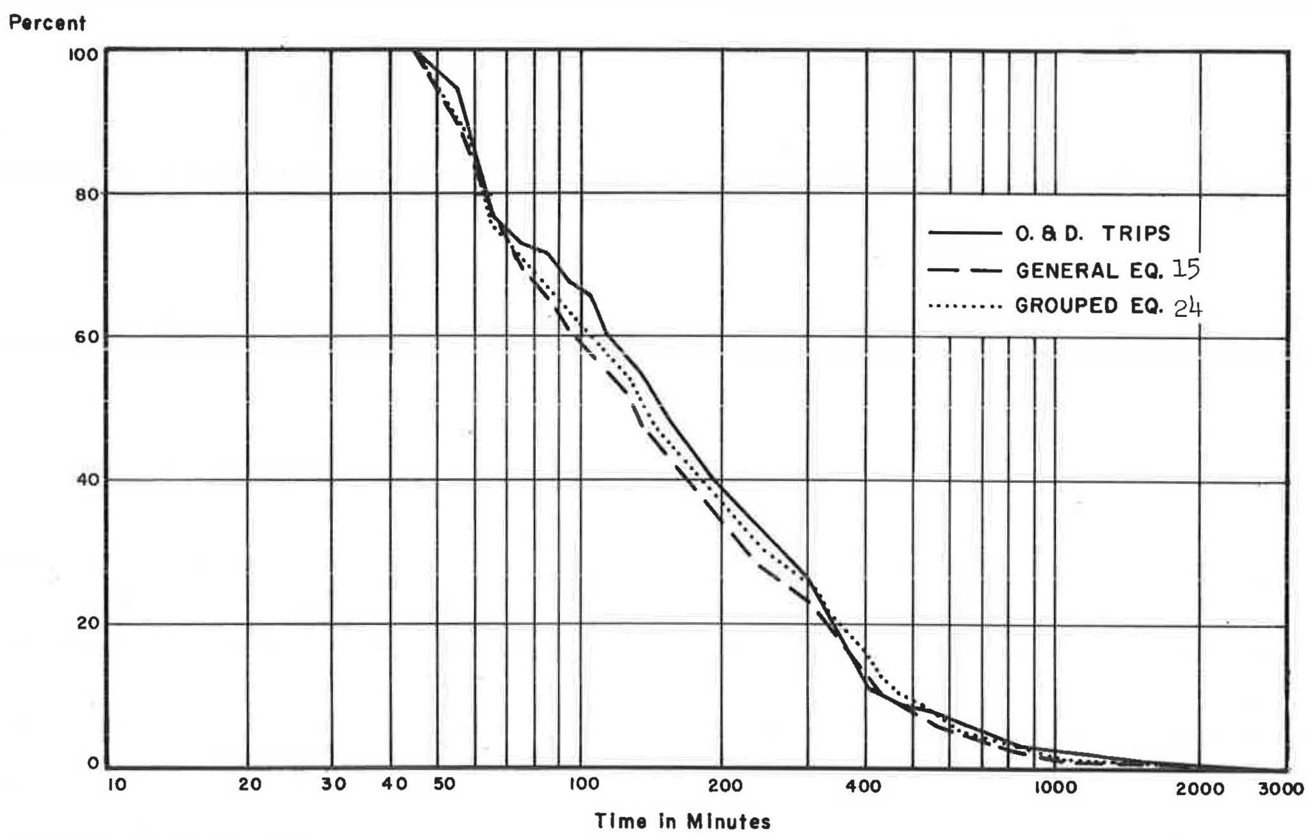


Figure 16. Comparison of the St. Louis, Mo., O-D and synthesized trips greater than 35 min.

is located 10 miles from a diversified city of 250,000 with no other large cities in the near vicinity, chances are that a majority of the trips crossing the city limits of the smaller city will be destined to the large center of population. And as a city increases in population to 100,000, 200,000, etc., it becomes more self-sufficient so fewer of its inhabitants will leave the city to carry out their everyday activities.

SELECTION OF A TRIP PREDICTION EQUATION

As mentioned, this project involved the generation of a great many equations expressing intercity travel. In selecting an equation or equations to predict travel the selection must be based upon ability to predict both volumes and distributions within generally accepted ranges of accuracy. Measures of accuracy include an analysis of the multiple *R* coefficient of correlation to determine the degree of correlation between the equation and the data from which it was developed and an analysis of measures of dispersion (that is, standard deviation, variance, etc.) between actual trips and predicted trips.

The analysis of the multitude of equations was made easier because of the similarity of many of them. The predicting equations (as opposed to the distribution describing equations) include Equation Forms 14, 15 and 16. The coefficients of correlation for the three general equation forms are 0.82, 0.83, and 0.83, respectively. Therefore, it appears that for all practical purposes any of these equation forms does as good a job of correlating with actual data as either of the other two.

Equation Form 15 was selected over the other equation forms as a trip production equation since it is more flexible in allowing for differing coefficients and exponents on the variables—a quality which fits in well with the advocation of such procedures by others. If, for instance, Equation 14 is used, one must accept the exponent 3 for the time variable. If Equation 16 is used, cordon population and ring population must be raised to the same power.

In view of the not too encouraging results of the trip productions, it was decided to compare the predicted trip distributions with the actual distributions to evaluate the equation's ability to distribute trips. It was assumed that if the distributions proved accurate then the magnitude-determining components of the equations, rather than the relative differences required revision or factoring up. Equation 15 was selected for this analysis in keeping with the previously mentioned selection logic.

Figures 13 through 16 illustrate the comparison between the actual O-D trip distribution and the synthesized distribution for selected study cities using both the general Equation 15 and the grouped Equation 3. (No comparison is shown for cities of less than 10,000 population since the predicting equation developed here was of a different format.)

Examining these figures, it will be noticed that Columbia, Tenn., which is in the 10,000 to 30,000 population class, exhibits similar distribution patterns for both the O-D and synthesized trips. This is true in spite of the fact that the general and grouped equations underpredicted the O-D trips greater than 35 minutes by 1,497 and 2,216, respectively. The actual number of O-D trips is 3,791.

St. Joseph, Mo., which is in the 30,000 to 100,000 population class, has 13,415 O-D trips greater than 35 minutes. The general equation underpredicted this value by 8,038, while the grouped equation was 6,567 low; however, the three distribution curves are nearly the same.

The final class of cities are those with cordon populations greater than 100,000. There are 34,722 O-D trips greater than 35 minutes crossing the St. Louis external cordon. The general equation overpredicts their value by 1,965 and the grouped equation underpredicts by 4,929 the actual number of trips. But here again the three distribution curves are very close throughout the entire length of the graph.

CHAPTER THREE

EVALUATION

This project has led to the selection of a family of equations as the best predictors of intercity travel. These equations are based on city population size—a factor which others (*5*) (*9*) have repeatedly indicated was a major indicator of economic importance and trip production and attraction. Although coefficients of correlation indicated a relatively close correspondence between the equation variables and the actual data, the comparison of actual trips with predicted trips did not exhibit this close correspondence as trips tended to be underpredicted. However, trip distributions, predicted and actual, did show a close correspondence, indicating that the major problem yet existing in the development of an accurate intercity trip predicting formula lies in the area of magnitude. The use of either of the two methods will correct for the discrepancies in trip magnitude inherent in the equations derived in this project.

The lack of a high degree of trip volume prediction accuracy in this project is not surprising in view of the ambitious undertaking of the project and the problems encountered along the way. As discussed earlier, problems of data availability and processing, which required substantial amounts of project time, limited the amount of time and the depth of analysis which this particular study could expend on the refinement of the basic equations. Thus, for instance, although trip purpose equations were developed, they did not exhibit a high level of prediction accuracy, probably in large part because of the lack of refinement of social and economic indicators of trip production.

Although it is shown in the literature review (Appendix B) that travel volume changes do not correspond well with population changes, the regression program evidently rejected a large number of social and economical variables as trip indicators in preference to population relationships. This phenomenon may or may not be considered significant. It may be that the procedure of grouping data by city size and then deriving equations may have in reality grouped "apples and oranges" with the result being the selection of population—a variable tending to blend data and perhaps offset significant characteristics—as the pertinent variable with the rejection of others. Also, it may be that other indices of community structure such as land use, industry type, etc., not used in this project, should be considered. What then appears to be of paramount importance in any further research along these lines is an in-depth analysis of city characteristics and a more definitive city grouping and analysis based on these characteristics. An analysis of seasonal travel differences may also be relevant here.

Although the lack of closer correlations or the involvement of a greater variety of social and economic factors in the equations may be viewed as disappointing by some, in light of the original intent of this project—the use of existing techniques and available data—this project has been of considerable value. This project has indicated that existing techniques can be used successfully in developing intercity travel prediction equations providing that some control can be exercised over the raw data used. Many errors have been introduced in the data by the lack of uniform criteria in conducting O-D studies across the nation. In connection with the analysis of data by region and season, this project had to abandon such hopes because of the lack of suitable samples, both in number and in seasonal and geographical distributions.

The value of this project then must be that of developing a solid base, both with regard to operating techniques and data handling and with regard to definite knowledge upon which to rely for further refinement of the basic relationships expressed. As such, a definite milestone in the analysis of intercity travel has been reached—one in fact in which, for the first time, so large an amount of data has been assembled and used for these purposes. As a result, a major portion of the investigation of intercity travel has been accomplished. The task of refinement can now proceed with greater ease.

CHAPTER FOUR

RECOMMENDED ADDITIONAL RESEARCH

This project has served to provide a foundation of basic relationships to predict intercity travel. Because of the vastness of such a field of investigation, additional research is necessary to follow upon and refine the results of this project. Those areas requiring further investigation include:

1. *Investigation of Additional Large City and Very Small City Data.*—The analysis of the cities by population grouping has indicated the need for more data in both the large city groups and the small city groups (population 10,000). The lack of enough data in the large city grouping no doubt has prejudiced the empirically derived equations considerably in favor of the smaller cities. The large deviations in the less than 10,000 city grouping appear to indicate that the characteristics of these cities bear further scrutiny in addition to the need for additional samples.

2. *Investigation of Regional and Seasonal Differences.*—Additional data samples should be obtained by census division (region) and by season so that regional and seasonal effects upon intercity travel can be accounted for. However, this latter data requirement might be quite difficult to fulfill.

3. *Investigation of Cities by Additional Stratifications.*—As has been pointed out, further investigations are required regarding the structures—social and economic—of the study cities. More definitive stratifications of data based on these characteristics, as well as city size stratifications, would appear to be of considerable value in future investigations.

4. *Determination of the Best Method of Trip Prediction.*—The method of predicting intercity travel, both trip volumes and distribution, also deserves further research. Two basic prediction-method stances have been mentioned, one using a single equation to predict both volume and

distribution and the other using two equations, one for generation and the other for distribution. This report does not recommend one over the other, although it may be that the second method might be more desirable since the project has led to the hypothesis that a family of distribution curves for various time rings from the study city might result in a better method of distributing trips. As part of the search for the best method of trip prediction, future studies should include the comparative analysis of travel time and travel costs expended to the social and economic characteristics of the study cities.

5. *Stratification of Travel by Resident-Non-Resident.*—The trip prediction equations developed in this report predict two-way daily trips by residents and non-residents combined. Studies should be made to determine whether trips by residents and trips by non-residents should be separately predicted for the representation of total intercity travel.

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APPENDIX A

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APPENDIX B

LITERATURE REVIEW

BASIC CHARACTERISTICS AND TRENDS IN INTERCITY TRAVEL

A series of well-documented existing characteristics and past trends were reviewed in an attempt to relate available data to preliminary hypotheses. The basic data which were considered in the initial stages of the study are discussed in the sections in this appendix under the following headings:

1. Intercity Travel—Magnitude and Frequency
2. Intercity Travel—Traveler Characteristics
3. Intercity Travel—Trip Purpose
4. Intercity Travel—Mode Choice
5. Intercity Travel—Regional Influences
6. Intercity Travel—Relation to City Size and Function

The purpose of this preliminary investigation of trends was to discern patterns from previous surveys and research which might be more clearly defined by the research program established for this study.

Intercity Travel—Magnitude and Frequency

Mobility is a significant characteristic of contemporary society. This trend is reflected in the growth of intercity travel, as shown in Figure B-1. Between 1930 and 1963, travel between cities increased 375 percent to a total of approximately 825 billion passenger miles (1963). Although intercity travel volume is increasing, it is increasing neither uniformly nor in relation to population changes. Per capita travel has increased from 1,792 miles per year in 1930 to 4,374 miles in 1963 (Table B-1). Figure B-2 shows the percentage changes in yearly travel (in passenger miles) and in population. While population changes are uniform, yearly travel volume changes are very erratic. That travel volume changes are not directly related to population changes suggests that other influences, such as the characteristics of people, weather, and general social and economic factors, significantly affect travel volumes.

While travel growth has not paralleled population growth in any consistent manner, it does show a very close relationship to the nation's economic growth as measured by the Gross National Product (Figure B-3). This relationship suggests that travel and technological advancement are closely related since the latter factor has fostered industrial growth and increased disposable income and has created a demand for improved transportation facilities.

Intercity travel magnitude has been measured historically in terms of passenger miles. Only recently (in the 1963 Census of Transportation (*2*)) has the measure been expanded to include person trip stratifications. The results of that census are summarized in Table B-2.

Travel magnitude in terms of passenger miles per capita is often used to identify travel trends (Table B-1). While this measure serves a statistical purpose, it does not indicate individual travel preferences and variations. Some groups of people make few trips * while others make many. Individual trip frequency is shown in Figure B-4. Note, for example, that a relatively small percentage (25%) of the

* Here and throughout this volume a *trip* means a journey between a point of origin and a point of destination unless otherwise noted. This definition is different from that of the Bureau of Census which defines a trip as being made *to and from* an out-of-town place (that is, a round trip).

TABLE B-1

INTERCITY TRAVEL 1930-1963

YEAR	PASS.-MI. (MILLIONS)	POPULATION (MILLIONS)	PASS.-MI./ CAPITA
1930	220,000	122.77	1792
1935	232,000	127.25	1823
1940	309,000	131.67	2347
1945	331,000	132.48	2498
1950	473,000	150.70	3139
1955	665,000	164.30	4047
1960	759,000	178.46	4253
1963 [a]	825,000	188.62	4374

[a] Estimated.

Source: National Association of Motor Bus Owners, *Bus Facts*, 31st Edition, p. 6.

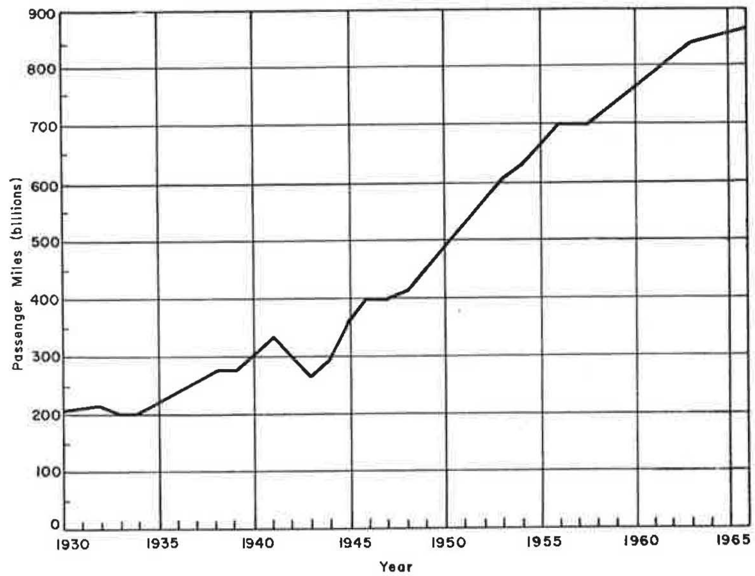

Figure B-1. Domestic intercity travel. (Source: Nat'l. Assn. of Motor Bus Owners, *Bus Facts*, 31st Ed., p. 6.)

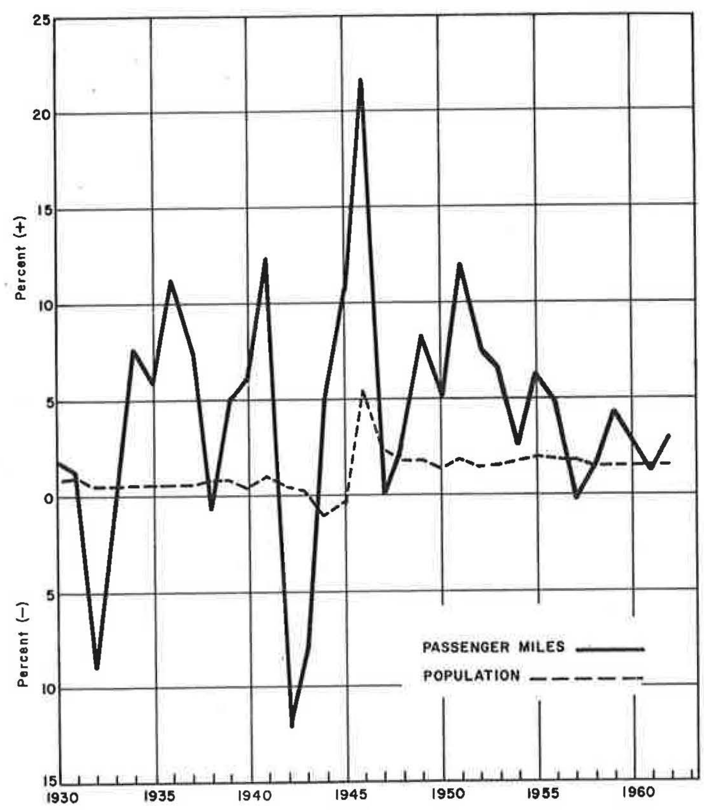

Figure B-2. Yearly changes in population and in total intercity passenger miles. (Source: Nat'l. Assn. of Motor Bus Owners, *Bus Facts*, 31st Ed., p. 6.)

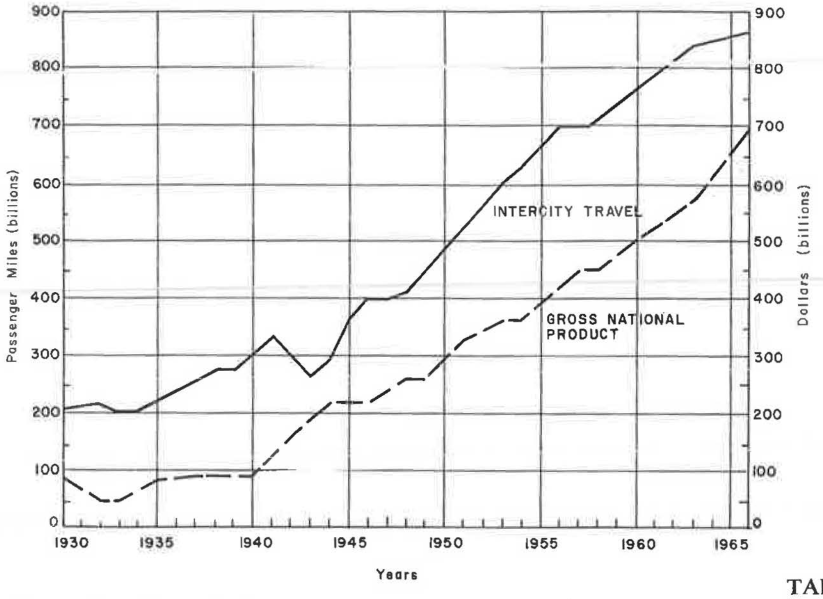

Figure B-3. Domestic intercity travel as compared with U. S. gross national product. (Source: Nat'l. Assn. of Motor Bus Owners, *Bus Facts*, 31st Ed., p. 6.)

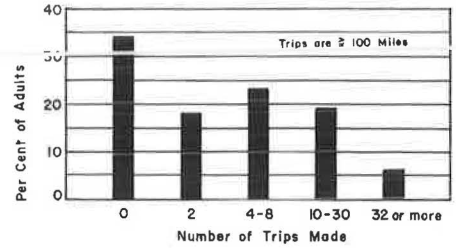

Figure B-4. Distribution percentage of adults by trip frequency, 1962. (Source: (*1*).)

people make ten or more trips in a year. While this group is small, it accounts for 81% of all trips made (Table B-3). Lansing (*1*) has characterized those who make frequent trips (those 6% making 32 or more trips) as having (1) high income, (2) a high school or college education, (3) a residence in a metropolitan area, and (4) an age in the 25-to-54-year range.

Intercity travel frequency varies not only with the individuals involved but also with the time of the year. Table B-4 indicates seasonal variations as determined by the 1963 Census of Transportation.

Intercity Travel—Traveler Characteristics

Although intercity travel is increasing in the United States, not every individual has the same propensity or ability to travel. Research indicates that the amount of travel a person does can be related to certain characteristics peculiar to him. Of these characteristics, income, education, occupation, and age are particularly indicative of travel propensity. Although these characteristics are discussed separately, it is really their composite effect which finally establishes a person's travel habits.

Figures B-5 and B-6 indicate the effect of income on travel; the higher the income, the lower the percentage of adults who take no trips in a year (Figure B-5) and the greater the number of people who take 10 or more trips (Figure B-6). The fact that the number of adults in the higher income ranges has increased between 1955 and 1962 helps to explain the general over-all increase in intercity travel.

Education is closely related to income. Therefore, adults of a higher educational level travel more than those of a lower educational level. Lansing (*1*) points out that adults with at least a high school education travel more at all stages in their life cycle than other adults.

TABLE B-2

TRIPS AND TRAVELERS SUMMARY OF SELECTED TRAVEL CHARACTERISTICS (IN MILLIONS)

FACTOR	TRIPS [b]	TRAVELERS [c]
Total	257	487
Purpose of trip:		
Business	54	66
Visits to friends and relatives	103	219
Other pleasure	55	123
Personal or family affairs	45	79
Size of party:		
1 person	141	141
2 persons	58	116
3 or 4 persons	42	145
5 + persons	16	85
Duration of trip:		
1 day	17	32
Overnight:		
1 night	78	157
2 nights	66	127
3 to 5 nights	49	87
6 to 9 nights	21	39
10 + nights	26	45
Distance:		
U.S. trips:		
Under 50 miles	59	103
50 to 99 miles	60	121
100 to 199 miles	73	141
200 to 499 miles	41	78
500 + miles	19	34
Outside U.S. [a]	5	10
Means of transportation:		
Automobile	215	435
Bus	11	13
Air carrier	14	17
Railroad	8	10
Other	9	12

[a] Includes destinations in Canada, Mexico, and U.S. outlying areas.
[b] Trips are vehicle round trips of 100 miles (one-way) or an overnight trip out of town at any distance.
[c] Travelers are individuals making a trip. If a person makes more than one trip, he is counted as a traveler each time he makes a trip. A single trip involving 5 persons from the same household would be counted as 1 trip and 5 travelers.

Source: U. S. Bureau of Census, *1963 Census of Transportation*, TC63 (A), p. 4.

TABLE B-3

TRAVEL FREQUENCY 1962

NUMBER OF TRIPS TAKEN [a]	DISTRIBUTION OF TRAVELERS (%)	DISTRIBUTION OF TRIPS (%)
2-4	42	9
6-8	20	10
10-18	18	17
20-38	12	22
40-78	6	20
80 or more	2	22
Total	100	100

[a] Round trips multiplied by two.
Source: (*1*).

TABLE B-4

SEASONAL VARIATIONS IN INTERCITY TRAVEL, 1963

SEASON	TRIPS [a] (MILLIONS)	PERCENT OF TOTAL
First quarter	57	22
Second quarter	65	25
Summer quarter	78	31
Fourth quarter	57	22
All	257	100

[a] Vehicle round trips (from origin to destination and back).

The relationships between occupation and intercity travel are noted in Figure B-7. The professional and managerial occupations account for the highest number of trips per capita.

The effect of age on travel can be seen in Figure B-8; the higher the age group, the greater the percentage of adults who make no trips during the survey year. It should also be noted that the percentage of adults who make no trips is either approximately constant or decreasing for age groups through age 44. After age 44, the percentage increases.

Generally speaking, although age has an effect on intercity travel, a characteristic closely related to age—one's position in the life cycle *—appears to have a pronounced effect not only upon travel generally but also upon some of the other dependent travel variables. Figures B-9 and B-10 show the effect of position in the life cycle on frequency of travel within income groups and by education level. These graphs seem to indicate that within income ranges and higher educational ranges, young married people with no children travel more frequently than others.

* Stages in the life cycle are defined as follows:
(1) Young, single
(2) Young, married, no children
(3) Married, children
(4) Over 45, married, no children
(5) Over 45, single

Intercity Travel—Trip Purpose

That a person's desires can be more completely satisfied in an area other than the one in which he resides is the basic reason for travel. While travel, therefore, attempts to fulfill a multiplicity of rational or irrational desires, these desires can be grouped into a few descriptive categories for analysis. The 1963 Census of Transportation (*2*) uses the following desire or trip purpose categories:

Business
Visits to friends and relatives
Other pleasure
Personal and family affairs

Lansing (*1*) has combined these categories into two groups—business and non-business—for ease of discussion by grouping the last three Census categories into the non-business group. Lansing described the non-business grouping as being composed of personal affairs, and vacation and pleasure travel; however, this latter grouping generally combines the two Census groupings, visits to friends and relatives and other pleasure.

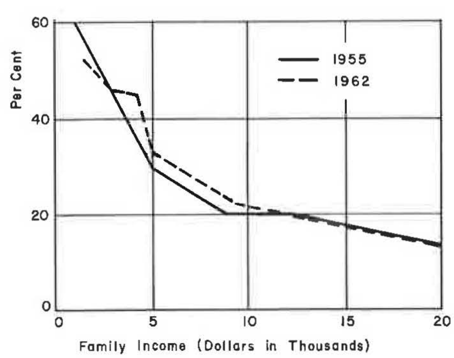

Figure B-5. Percentage of adults at different income levels who took no trips 100 miles by any mode during survey year. (Source: (*1*).)

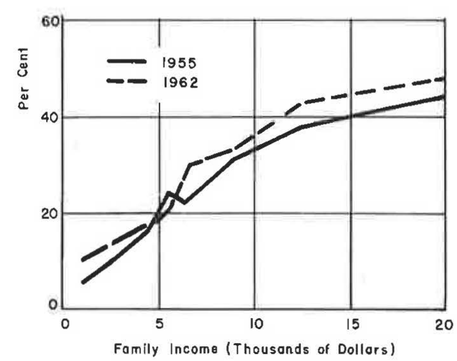

Figure B-6. Percentage of adults at different income levels who took 10 or more trips ≧ 100 miles by any mode during survey year. (Source: (*1*).)

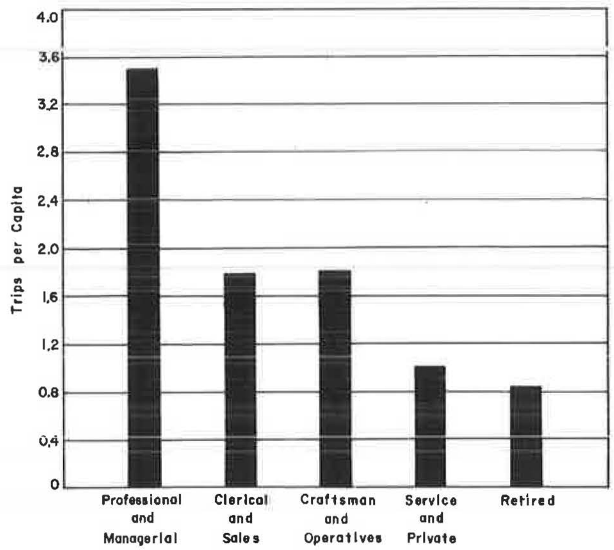

Figure B-7. Trips per capita by occupational grouping, 1963. (Source: Bur. of Census, Statistical Abstract of U.S. 1963, p. 219.)

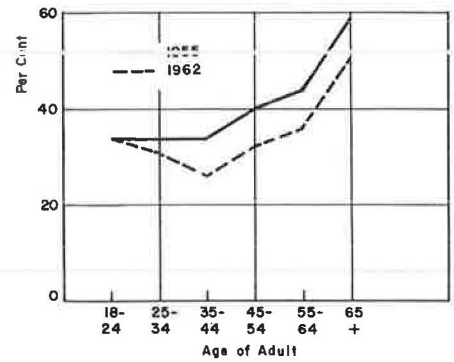

Figure B-8. Percentage of adults in different age groups who took no trips ≧ 100 miles by any mode during survey year. (Source: (*1*).)

Table B-5 indicates the percentages of trips made for each trip purpose as determined by the 1963 Census of Transportation. It is quite apparent that non-business trips account for the largest percentage (79%) of the total trips. Also, it should be noted that the majority of non-business trips are for vacation and pleasure. This could be significant when forecasting future travel. The motivations for business and personal affairs are logical, but the motivations for vacation and pleasure travel trips are not always so. Lansing (*1*) points out that the motivations for non-business trips are often varied and highly complex. He categorizes these motivations as follows: (1) desire for social prestige, (2) desire for social contact, and (3) desire for individual gratifications. The first category is difficult to isolate but there is no doubt that it does exist. The second motive arises in large part from the increased mobility of families, the subsequent separation of relatives and friends, and the desire to maintain personal ties. The third motive includes such desires as sight-seeing, adventure, and curiosity.

The fact that trips are made to satisfy certain desires indicates that a value is placed by the trip maker upon those desires. His decision to make a trip depends on how he reconciles his cost of traveling with the importance of satisfying a travel desire. Cost of traveling is based primarily on the mode used and thus trip purpose often affects mode choice.

The relationship of income, age, occupation and education to trip purpose is useful in more fully understanding intercity travel. Table B-6 indicates that most business

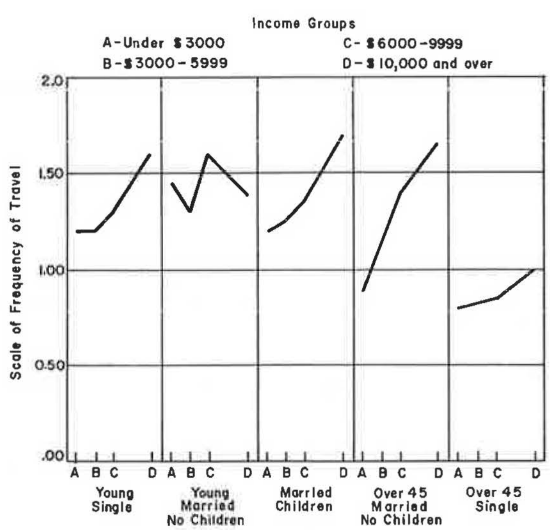

Figure B-9. Effect of income on frequency of travel on trips ≧ 100 miles for adults in different life cycle groups, 1962. (Source: (*1*).)

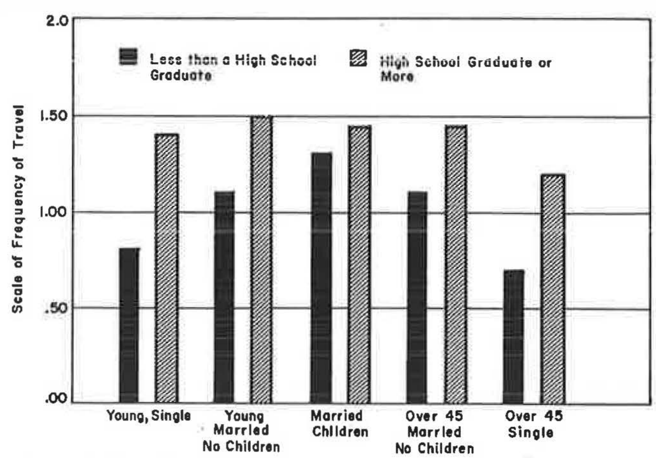

Figure B-10. Effect of education on frequency of travel on trips ≧ 100 miles for adults in different life cycle groups, 1962. (Source: (*1*).)

trips are made by persons in the $7,500 to $14,999 family income range. The highest percentages of non-business trips are made by persons in the $4,000-$5,999 family income brackets. Investigating the percentage of trips by purpose within income ranges shows that the higher the income bracket, the greater the percentage of trips made for business purposes and consequently the lower the percentage for non-business purposes.

Relationships between age and trip purpose are shown in Figure B-11. The preponderance of the total business trips accounted for by the 25-54 age groups (69%) is immediately evident. However, relatively little variation in non-business trip-making among groups can be found, except in the older age groups (55-64 and 65 or greater). The fact that distribution of non-business trips by age-group closely follows the distribution of all trips indicates that age has less an effect upon non-business trips than on business trips. Analyzing trip purpose distribution within age groups (Figure B-12) one also finds that the greater percentages of business trips are made by persons in the 25 through 54 age groups. These observations are consistent with the fact that these years are the major working years. Higher percentages of non-business trips are found in the 6-to-24-year age group. The highest percentage of business trips occurs in the 45-to-54 age group, and the highest proportion of non-business trips occurs in the under-6-years age group.

Figure B-13 seems to indicate a relationship between occupation and trip purpose. Considering all occupational groupings, the greater percentage of business trips made by the professional and managerial group is evident. When non-business trips are considered, one finds that the craftsman group makes about as many trips as the professional group, and together these groups account for 72% of the non-business trips. Within occupational groups (Figure B-14) the high percentage of business trips is again evident for the professional group, as well as the high proportion of non-business trips for the craftsman group.

Seasonal influences also affect trip purpose in intercity travel. The high percentage of yearly trips occurring in the summer quarter was mentioned and attributed to vacation trips. Table B-7 gives the seasonal travel variations by trip purpose. Here the high percentage of vacation trips in the summer months is obvious, as well as the corresponding lower percentage of vacation trips during the first six months of the year.

TABLE B-5

PERCENT DISTRIBUTION OF TRIPS BY PURPOSE, 1963

PURPOSE OF TRIP	PERCENT
Business	21
Non-business:	
Visits to friends and relatives	40
Other pleasure	21
Personal or family affairs	18
All	100

Intercity Travel—Mode Choice

Figure B-15 shows the percentage distribution of trips by mode for the years 1955 and 1962. The dominance of the automobile is illustrated, as is the fact that this popularity is increasing (82% in 1955 and 86% in 1962). While air travel comprises a small percentage of total travel, it should be noted that it is rapidly increasing in popularity. These increases have occurred at the expense of rail and bus travel, which have decreased during this period (combined loss of 5%). Figure B-16 depicts yearly changes in passengers carried by mode using 1964 as the index year. The rapid changes in airline and auto travel are quite apparent, as are the decreases in bus and railroad travel.

Modal choice is influenced by trip purpose. Figure B-17 compares the percentage use of a particular mode by trip

TABLE B-6

PERCENT DISTRIBUTION OF TRIPS BY PURPOSE OF TRIP AND BY FAMILY INCOME, 1963

	DISTRIBUTION BY PURPOSE WITHIN AN INCOME GROUP			DISTRIBUTION BY FAMILY INCOME WITHIN A TRIP PURPOSE GROUP		
FAMILY INCOME	ALL TRIPS	BUS. TRIPS	NON-BUS. TRIPS	ALL TRIPS	BUS. TRIPS	NON-BUS. TRIPS
All incomes	100	21	79	100	100	100
Under $2,000	100	9	91	11	5	13
$2,000 to $3,999	100	10	90	12	6	13
$4,000 to $5,999	100	14	86	20	14	21
$6,000 to $7,499	100	22	78	14	15	14
$7,500 to $9,999	100	25	75	16	19	15
$10,000 to $14,999	100	32	68	12	20	10
$15,000 and over	100	39	61	8	15	6
Not reported	100	16	84	7	6	8

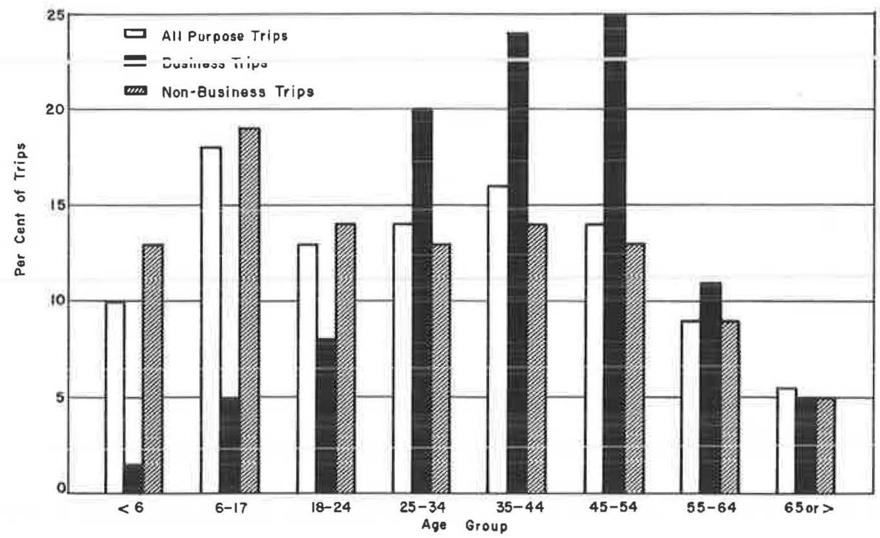

Figure B-11. Distribution percentage by purpose by age, 1963. (Source: Bur. of Census, 1963 Census of Transportation.)

purpose with the percentage use of these modes for all purposes. It indicates that although rail and bus uses are approximately the same, and thus do not seem to be significantly related to a particular trip purpose, significant differences do exist for automobile and air users when only business trips are considered. Here the automobile decreases in popularity as a travel mode (86% of all trips as compared to 78% for business trips) while the airlines have gained in popularity (7% of all trips as compared to 15% for business trips).

That there are modal choice differences in intercity travel is evident. Why these choices are made is paramount to the understanding of present and future intercity travel. In his study of modal choice in intercity travel, Lansing (*3*) divides the travel market according to trip purpose and distance traveled. He then asserts that three basic variables are important determinants of modal choice within these divisions. These variables are:

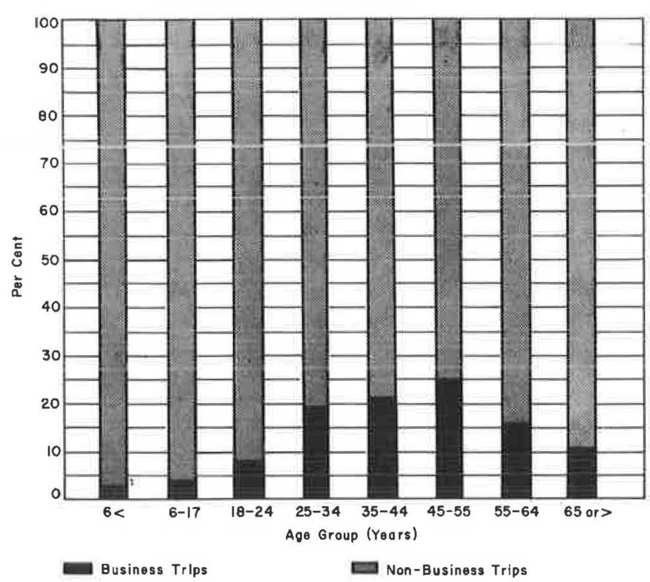

Figure B-12. Trip distribution by purpose within age groups, 1963. (Source: Bur. of Census, 1963 Census of Transportation.)

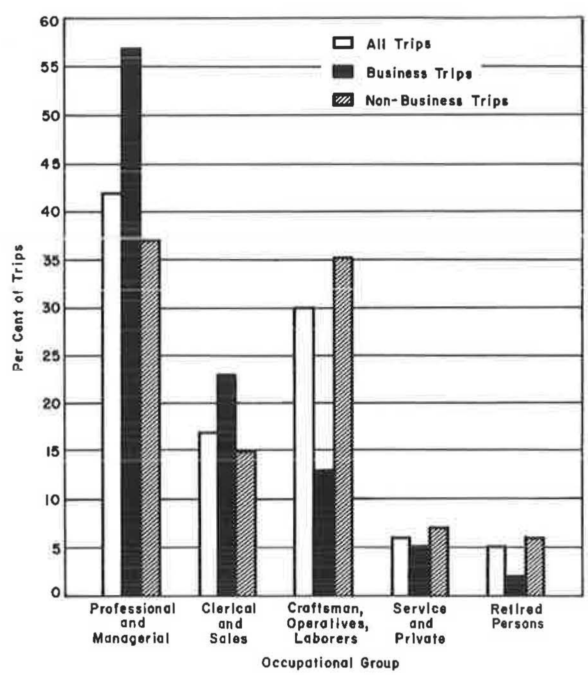

Figure B-13. Percent distribution of purpose trips by occupational groupings, 1963. (Source: Bur. of Census, 1963 Census of Transportation.)

TABLE B-7

PERCENT SEASONAL VARIATIONS IN INTERCITY TRAVEL BY PURPOSE, 1963

SEASON	BUSINESS	NON-BUSINESS			ALL
		VACATION AND PLEASURE	PERSONAL AND FAMILY AFFAIRS	TOTAL	
First qtr.	28	52	20	72	100
Second qtr.	22	58	20	78	100
Summer qtr.	16	70	14	84	100
Fourth qtr.	20	63	17	80	100

(1) *Financial Considerations.*—Factors such as income of the traveler and the relative price of transportation.

(2) *Availability and Accessibility of Mode.*—Factors related to auto ownership, terminal accessibility and scheduling problems.

(3) *Quality of Service and Personal Preferences.*—Choice of mode for business purposes appears to be affected by different variables than that for non-business travel. Time (and its cost) is probably the biggest single factor influencing mode choice for business trips.

In his multivariate analysis of modal choice Lansing (*3*) found that availability and frequency of service of common carriers between pairs of large cities greatly affected business purpose mode choice. In large cities, common carriers were selected over autos more often than in cities with a population of 50,000 or less. Since smaller cities generally have a lower common carrier availability and frequency of service than larger cities, this observation appears to indicate that auto travel to the smaller cities is selected to save time or, conversely, that time advantages accruing from the use of air carriers are only significant on major routes between large cities.

The accessibility of common carrier terminals is also important in choice of business purpose mode choice. Based on information obtained in a 1960 survey regarding the time to reach air terminals and board planes, Lansing estimated that the average air trip would involve over two hours of time in addition to the time in the aircraft.

For a distance equal to two hours driving time, an auto would more likely be chosen than an airplane. For non-business trips, time is usually not so critical and therefore availability and accessibility of common carrier service is not as significant in choice of mode. However, whether the traveler owns an auto is highly significant in choice of mode for non-business trips. If an auto is owned the owner has a greater tendency to use it instead of using common carriers.

Lansing's studies (*3*) also seem to indicate that family income is a much more powerful predictor of mode for business trips than for non-business trips. He points out that employers wish to economize on the time of well-paid employees, and therefore, send them by air because it is fastest.

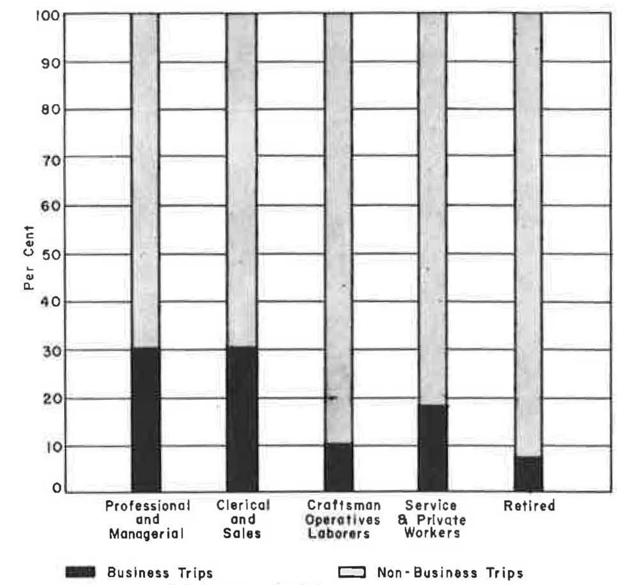

Figure B-14. Percent distribution of trips by purpose within occupational groups, 1963. (Source: Bur. of Census, Census of Transportation, 1963.)

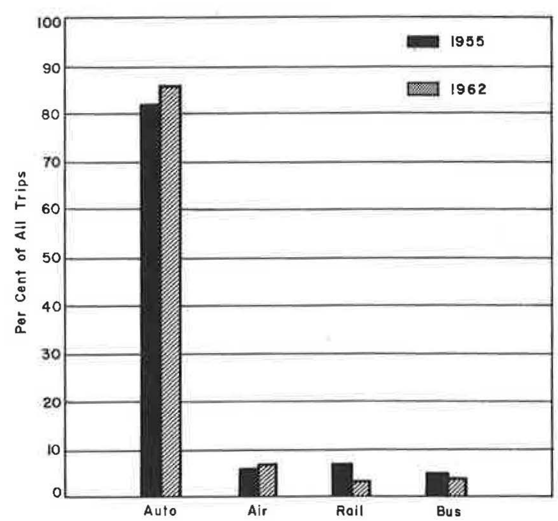

Figure B-15. Percent distribution of intercity trips. (Source: (*1*).)

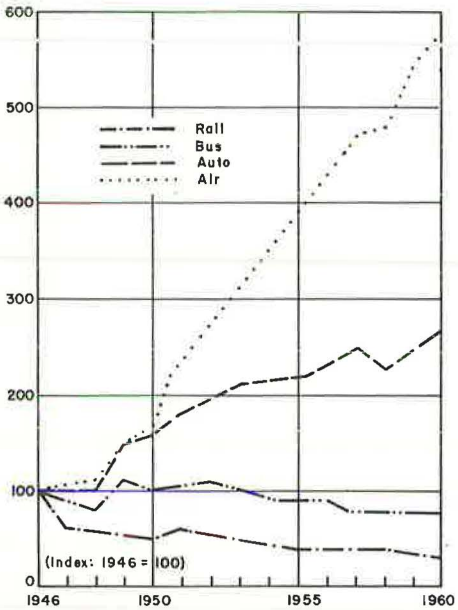

Figure B-16. Changes in passenger hauling. (Source: Assn. American Railroads, "The Gathering Transportation Storm," p. 9.)

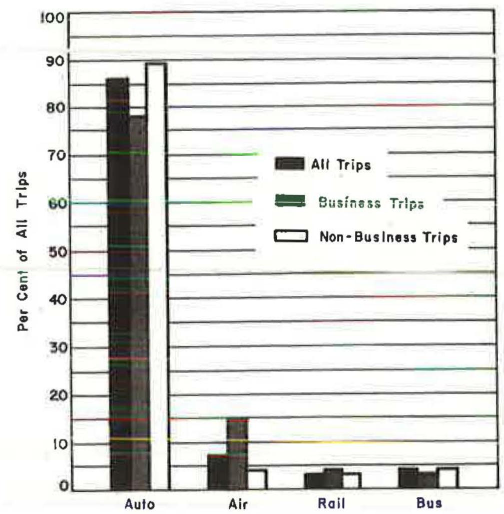

Figure B-17. Percent distribution of mode choice by trip purpose. (Source: (*1*).)

For non-business travel, choice of mode appears to be little affected by family income except in the selection of the type of common carrier. In this case high income people tend to select air and rail travel over bus travel for vacation and pleasure, non-business, common carrier trips (Figure B-18).

Another important consideration in choice of mode is relative price between the various modes for parties of several people. This is especially true for non-business travel. While choices among common carriers are little affected by this variable, the choice between an auto and a common carrier is highly affected. Lansing's studies (*3*) indicate that as the size of the party increases, the greater the tendency to travel by auto than by common carrier. This is because the cost of automobile travel is practically invariant up to parties of six while common carrier travel cost is additive.

Personal preferences also have an effect on choice of travel mode; however, they are more significant in determining a mode for non-business travel than for business travel. Business travel mode choice appears to be based on speed, not particularly on the way people like to travel. Preferences appear to be extremely significant in the choice between air and rail, and rail and bus for non-business travel. Although personal preferences do influence mode choice, other factors often appear to take precedence. Table B-8 indicates that of those people who preferred air travel, 41% were influenced by other considerations and traveled by auto.

Trip distance appears to significantly affect the competitive position of the various travel modes. Figure B-19 indicates the percentage of passenger miles accounted for by each mode by trip distance in 1955. Note the decrease in auto use as trip length increases and the increase in air travel. While rail travel increases slightly at longer distances, bus travel remains constant at all distances. Figure B-20 indicates the percentages of trips accounted for by each mode at various distance ranges by trip purpose. While the trends in Figure B-19 are similar to those in Figure B-20, the latter graph emphasizes the greater use of autos at all distances for non-business trips and the greater use of aircraft for business trips.

Availability of service is related to choice of mode at various distances. Lansing notes (*3*) that at shorter distance all trips (especially business trips) are made by common carrier more often on frequent-service highly traveled routes (denoted by city size), whereas at distances

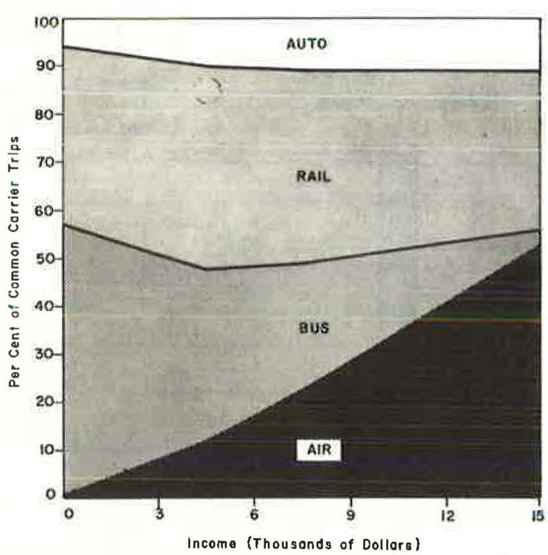

Figure B-18. Percent of common carrier vacation and pleasure trips by mode for different income levels, 1956.

greater than 1,000 miles, service availability is not as important a factor in mode selection.

Few statistical data appear to be available on the effect of income and personal preferences on mode choice as trip distance increases. However, inferences are possible. For example, from the fact that air travel increases with income and that more air trips are made at greater distances, one could infer that more long-distance air trips are made by individuals with high incomes than those of lower incomes. Also, it would appear safe to say that personal preferences as to the selection of a travel mode for longer distances are based on comfort and convenience factors.

Intercity Travel—Regional Influences

That regional differences in intercity travel do exist is clearly evident in Table B-9. More trips are made in the South and North Central census regions than in the others. Not only are there differences in regional travel volumes, but there are also differences in the frequency with which people make trips in various regions. Figure B-21 approximates the number of regional trips per capita and points out the increased travel frequency in the western and southern regions. Lansing's studies of adults making frequent trips (10 or greater) also verifies the regional differences in trip frequency (Figure B-22).

In discussing regional travel differences this report is concerned only with intra-regional trips. Although it could be argued that economic differences in the regions affect interregional travel, the fact that over 82% of all trips made are intra-regional (Table B-10), and that the percentages of origins and destinations to other regions are relatively small makes it quite difficult to relate social and economic characteristics significantly to these differences.

TABLE B-8

RELATIONSHIP OF ACTUAL MODE USED TO THAT PREFERRED FOR AUTO AND AIR TRAVEL, 1962

ACTUAL MODE USED	ALL (%)	PREFERRED MODE [a] (%) AIR	AUTO
Air	28	59	4
Auto	72	41	96
Total	100	100	100

[a] Indicates mode preference of those persons using the mode in Col. 1.
Source: (*1*).

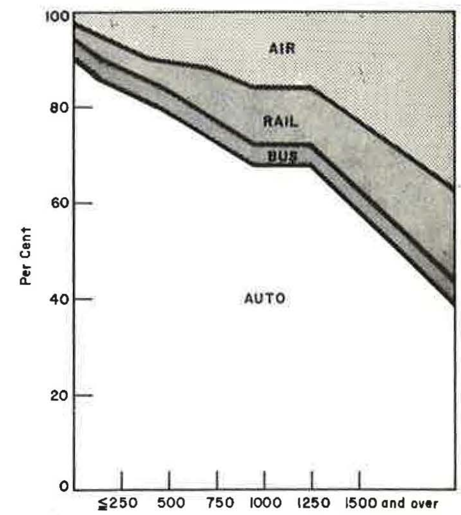

Figure B-19. Percent of passenger miles accounted for by each mode of travel by distance to destination. (Source: (*1*).)

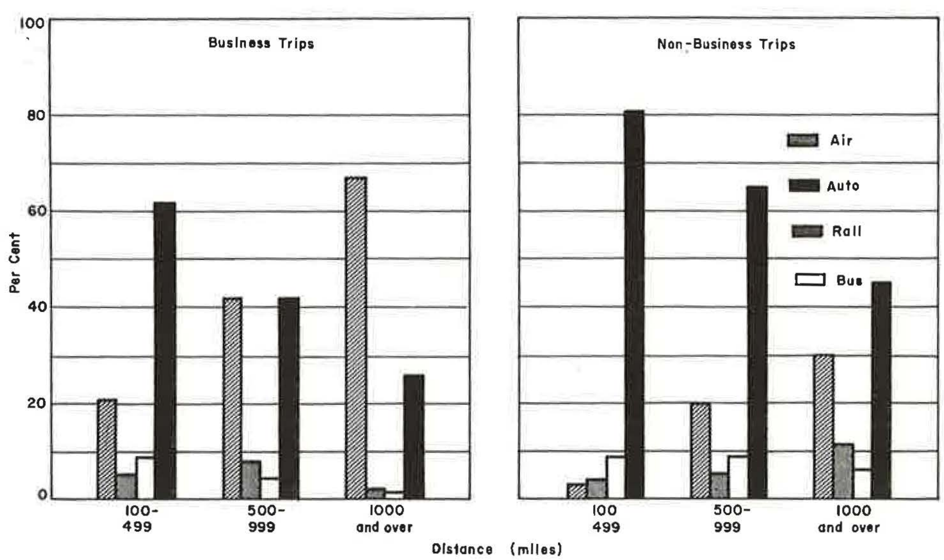

Figure B-20. Percent of most recent business and non-business trips at different distances accounted for by air, rail, bus, and auto, 1962. (Source: (*1*).)

TABLE B-9

REGIONAL INTERCITY TRIP ORIGINS, 1957

CENSUS REGION	NO. OF TRIPS (MILLIONS)	% OF TOTAL
Northeast	44	19
North Central	68	29
South	76	33
West	42	18
Total	231	100

An understanding of regional travel differences must begin with an assessment of the factors which influence travel. By isolating these variables, one can then inspect regional attributes with respect to these variables and attempt to relate travel to them.

Table B-11 is a listing, by region, of those population characteristics mentioned above as significantly related to travel. Basing travel propensity on frequent-traveler characteristics (such as income, educational level, age, and occupation) it might be expected that regional travel intensity, as measured by per capita trips, would be ranked from high to low as follows:

1. West
2. Northeast
3. North Central
4. South

Figure B-21 shows that this expectation of ranking is not realized except for the West region. The South, last in all frequent-traveler characteristics except age, is second in per capita intercity trips. The fact that regional per capita trips disagree with frequent-traveler characteristics does not necessarily invalidate these relationships. Rather, what these findings indicate is that the characteristics apparently have different weights or that other factors have a greater effect on travel.

Other factors which appear to affect travel are population distribution and density. As given in Table B-12, the ranking of regions by population and by total trips coincide, thus apparently indicating a direct relationship between population and trips. However, these regional rankings do not hold for per capita trips. But, if regional population density is compared with per capita trips, as in Table B-12, an exact inverse correspondence results. It seems, then, that regional travel differences can be explained more easily by population distribution and population density, no doubt as reflected by city size and spacing, than by the social and economic characteristics of the travelers.

Data relating to trip purpose by region are not readily available; however, it would appear that certain per capita differences should exist. For instance, fewer business trips might be made in the highly population concentrated Northeast and North Central regions than in the South and in the West. The logic behind this generalization is based on the theory that there are more opportunities to transact business without making intercity trips in the more densely

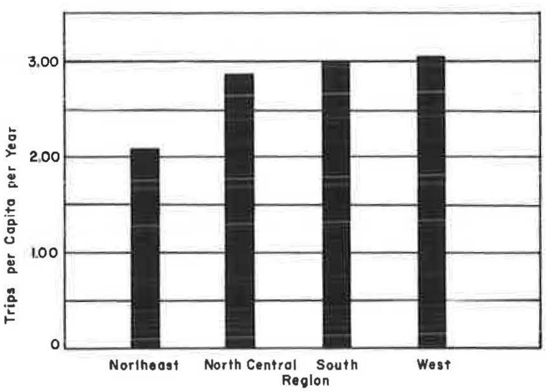

Figure B-21. Trips per capita by region, 1963. (Source: Bur. of Census, "Population Estimates"—1965.)

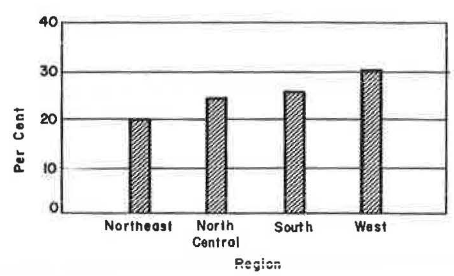

Figure B-22. Percent of adults living in different regions who took 10 or more trips by any mode, 1962. (Source: (*1*).)

TABLE B-10

PERCENT DISTRIBUTION OF TRIP ORIGINS BY REGION, 1963

	DESTINATIONS (PERCENT OF TRIPS OF ORIGIN)					
ORIGIN	NORTHEAST	NORTH CENTRAL	SOUTH	WEST	OUTSIDE U.S.	TOTAL
Northeast	85	3	8	1	3	100
North Central	4	82	8	4	2	100
South	6	5	87	1	1	100
West	1	4	3	89	3	100

TABLE B-11

REGIONAL CHARACTERISTICS

REGION	POPULATION (1960)	PERCENT OF U.S. POP.	AREA (SQ. MI.)	PERCENT U.S. AREA	POP. PER SQ. MI.
	POPULATION				
Northeast	44,677,819	24.9	163,593	4.6	273.1
North Central	51,619,139	28.8	754,485	21.2	68.1
South	54,973,113	30.7	876,935	24.9	62.7
West	28,053,104	15.6	1,753,961	49.3	16.0

	INCOME				EDUCATION
	AGGREGATE INCOME (MILLION $)	MEDIAN INCOME (DOLLARS)	PERCENT UNDER $3,000	PERCENT OVER $10,000	MEDIAN SCHOOL YRS. COMPLETED
Northeast	93,462	6,191	14.2	17.9	10.7
North Central	97,942	5,892	18.7	15.5	10.7
South	80,911	4,465	33.0	10.3	9.6
West	59,350	6,348	15.7	19.0	12.0

	AGE				OCCUPATION
	MEDIAN AGE (YR.)	PERCENT 5 YR. OR LESS	PERCENT OVER 21 YEARS	PERCENT 65 OR OVER	PERCENT WHITE COLLAR
Northeast	32.4	10.4	63.6	10.1	43.7
North Central	29.7	11.6	60.3	9.8	39.8
South	27.3	11.7	57.9	8.3	37.7
West	28.8	11.5	59.8	8.6	45.6

populated areas—the Northeast and the North Central regions—than there are in the more sparsely populated areas.

As shown in Figure B-23, mode choice appears to be affected somewhat by regional differences. Looking first at the use of automobiles, the ranking of regions is in reverse order to the population density magnitudes in these regions (see Table B-12). A check of automobiles owned in the regions revealed that those regions low in auto choice are also low in the proportion of the population owning autos (Table B-13). Thus, lower auto use appears to be prevalent in the highly populated areas where auto ownership may be low because of traffic congestion problems, availability of other transportation modes, or low-income economic conditions. Choice of air travel for intercity trips appears to be significantly different only in the West. Here, no doubt, the greater distances between cities and the advantage of air travel for long distances account for the increased percentage of air travel in the west. Rail travel choices appears to be fairly consistent throughout the nation, although slight differences occur in the Northeast and West. Bus travel appears to be more popular in the West and South. In the West, this may be because bus service is more suited to the low-density western areas than other types of common carrier transportation. In the South, where incomes are much lower than in other regions, the price advantage of buses over other common carriers might be reflected in the greater bus popularity.

TABLE B-12

REGIONAL RANKINGS BY POPULATION, TOTAL TRIPS, TRIPS PER CAPITA AND POPULATION DENSITY, 1963 (FROM HIGH TO LOW)

RANK	BY POP.	POP. (MILLIONS)	BY TOTAL TRIPS	TRIPS (MILLIONS)	BY TRIPS/ CAPITA	T/C	BY POP. DENSITY	POP./ SQ MI
1	South	58	South	85	West	1.52	Northeast	287
2	North Central	53	North Central	76	South	1.46	North Central	70
3	Northeast	47	Northeast	49	North Central	1.43	South	66
4	West	31	West	47	Northeast	1.04	West	18

TABLE B-13

AUTO OWNERSHIP BY REGION, 1962

REGION	PERCENT OWNING
Northeast	66
North Central	77
South	69
West	76
All	72

Source: (*1*).

Intercity Travel—Relation to City Size and Function

Travel enables people to satisfy their desires in areas other than the one in which they live. Opportunities to satisfy human desires increase with city size, for as city size increases so do the number and variety of goods available for consumption and the opportunities for entertainment. Thus, it might be expected that as city size increases the amount of travel away from the city (by residents) decreases and the amount of travel to it (by non-residents) increases. That this is true is evidenced by the graph (Figure B-24) compiled from Bureau of Public Road statistics from various origin-and-destination studies. The graph shows that as the populations of cities increase, the motor vehicle trips per resident decrease.

City size and spatial distribution is based on the city's economic importance and on its accessibility. Cristaller's Central Place Theory broadly illustrates these relationships. Cristaller assumed that a certain amount of productive land supports an urban center, and that the center exists to perform services for the surrounding land. From this assumption, the hypothesis followed that the larger the city the larger the tributary area it possesses. Thus, it would be expected to find a hierarchy of cities ranging from small trading villages which perform the simpler functions for a small tributary area to larger cities which perform more varied and complicated functions for larger tributary areas, which, incidentally, encompass the smaller areas. Cristaller's theory works well for a homogeneous area; however, the location of natural resources and transportation facilities (as influenced by physical geography) somewhat modifies the theory.

Location near resources and transportation routes has caused cities to develop through their performance of specialized functions for the nation in addition to their performance of central place functions. Nelson (*4*) has classified American cities as to economic function based on employment percentages. His classifications include (1) manufacturing, (2) retail trade, (3) professional service, (4) transportation and communication, (5) personal service, (6) public administration, (7) wholesale trade, (8) finance, insurance and real estate, and (9) mining towns. Table B-14 gives the average percentage of persons gainfully employed in these activity groups by city size (population) groupings. The predominance of retail and professional services in the smaller cities is readily apparent, as are the greater percentages of manufacturing, personal service, administration, and finance activities in the larger cities. These data emphasize the general position of the smaller cities as retailing centers and of the larger cities as centers of production, administration, and varied services.

Accessibility to transportation facilities has encouraged city development and functional specialization. The location of the largest cities of the nation along the sea coasts and along major transcontinental transportation routes is no mere coincidence. It reflects the fact that cities have located in the best economic position in relation to a trading market and to the transportation routes in the market area.

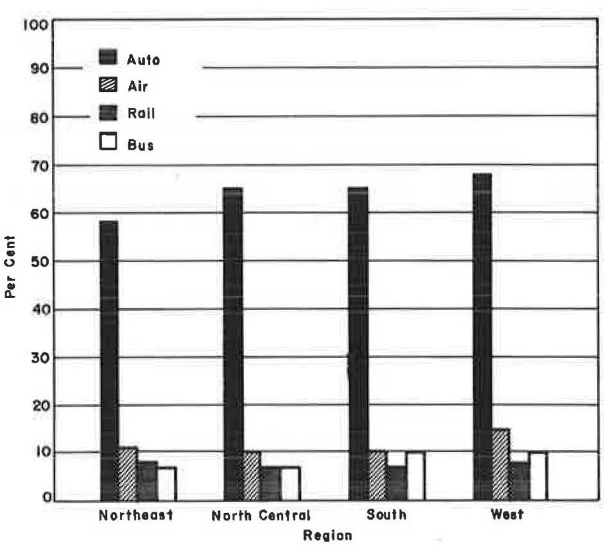

Figure B-23. Percent of adults living in different regions who traveled by various modes, 1962. (Source: (*1*).)

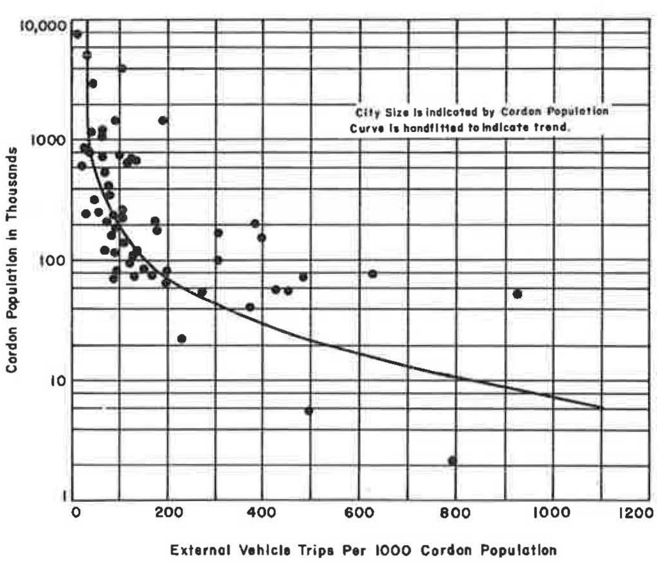

Figure B-24. City size in relation to external cordon crossings. (Bur. Public Roads.)

Reviewing the foregoing statements about city size and function and relating them to intercity travel, it would be expected that most intercity travel gravitates toward the larger cities in a hierarchical manner as people attempt to satisfy their desires. The ability for a city to satisfy desires is indicative of the attraction it possesses. The area from which it attracts trips is the city's trading area. Since travel requires time and money it would be expected that a person would minimize his travel time and cost in most cases. Thus, it should also be expected that most of the trips to or from a city would be concentrated in the city's trading area.

The analysis of city size and function as related to travel appears to explain certain regional differences in per capita travel noted. Figure B-25 indicates the percentage of cities which fall into population groupings by region. The large percentage of smaller cities (those having a population of 10,000 or less) in the South is quite evident, as is the lack of cities of over 500,000. Figure B-26 compares regional population distribution by city size. The large percentage of the population in smaller southern towns (those less than 10,000) and the low percentage of regional population in larger cities in the South is apparent. In relating this population distribution to intercity travel, it appears that a larger proportion of the population in the South is not able to satisfy its needs at its place of residence. Thus these people are forced to travel more often and farther. The large percentages of population living in the bigger cities in the Northeast and North Central regions apparently accounts for the lower per capita travel in these regions, since desires are more likely to be satisfied by these residents in their own urban area. High per capita trips in the West, however, appear not to be explained by city size. In fact one might expect that with the smaller number of cities in the largest areal region—indicative of greater distances between population centers—intercity travel per capita would be less. On the other hand, the greater affluency of the population in the West, as shown by income and education statistics, might serve as a stimulus for more frequent travel even with the greater city spacings.

INTERCITY LINKAGE

The intercity linkage concept is one that encompasses many fields of study and brings together a number of disciplines, including the fields of transportation, engineering, economics, business, planning, communications, geography, government, and sociology. The examination of the literature relating to these fields is a momentous task, but one in which a considerable amount of work has already been accomplished. In particular, the work of Marcou (*5*) was extremely helpful in bringing together the literature from these many fields. A complete list of the literature reviewed in connection with this research project regarding both inter-city linkage and characteristics and trends in inter-city travel can be found in the References and Appendix A.

The basic concepts thus far advanced behind the phenomena of interactance between two activities is based on the observance of a natural law describing such an occurrence—the Law of Gravity. Ullman (*6*) enlarges upon this basic concept and expresses the system of interaction as being composed of three major factors, which he describes as follows:

1. *Complementarity.*—In order to have an interaction between two areas there must be a demand in one and a supply in the other. For example, a steel industry in one area would use the iron ore produced in another area, not the copper produced in still another area.

TABLE B-14

AVERAGE PERCENTAGE OF THOSE GAINFULLY EMPLOYED IN SELECTED ACTIVITY GROUPS

IN CITIES OF FROM [a]	MANU-FACTURE	RETAIL	PRO-FESSIONAL	WHOLE-SALE	PERSONAL SERVICE	PUBLIC ADM.	TRANS. COMM.	FINAN., INSUR., REAL EST.	MINING	NO. OF CITIES
10,000-24,999	26.65	19.66	11.34	3.72	5.79	4.39	7.03	2.96	2.11	550
25,000-49,999	26.07	19.07	11.98	3.87	7.09	4.80	6.98	3.22	1.03	166
50,000-99,999	29.31	18.56	9.76	4.24	6.47	4.79	7.75	3.39	0.48	59
100,000 249,000	29.77	18.07	9.05	4.21	6.61	5.22	7.14	3.74	0.71	71
250,000-499,999	28.10	17.81	9.22	4.40	6.86	6.40	7.58	4.38	1.24	25
500,000-999,999	27.21	18.16	9.17	5.10	6.72	4.96	8.83	5.06	0.41	14
1,000,000 or more	30.86	16.32	8.97	4.15	6.42	6.92	7.35	4.75	0.16	12
Average	27.07	19.23	11.09	3.85	6.20	4.58	7.12	3.19	1.62	897

[a] Population range.

Source: Nelson, Howard J., "A Service Classification of American Cities." *Economic Geography,* Vol. 31, pp. 189-210 (1955).

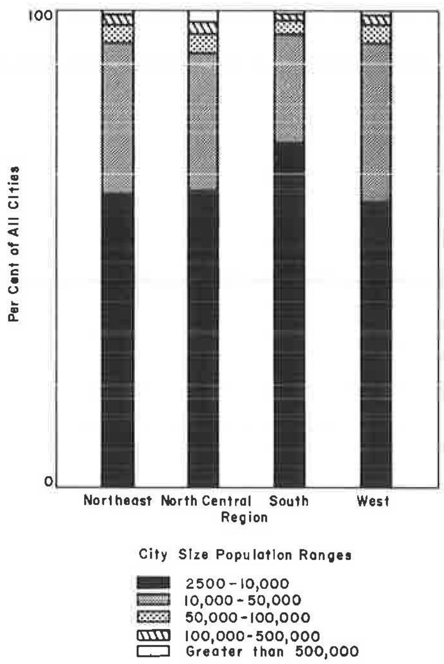

Figure B-25. Distribution of regional cities by size grouping, 1960. (Source: Bur. of the Census, 1960.)

2. *Intervening opportunity.*—Complementarity, however, generates interchange between two areas only if no intervening complementary source of supply is available. Thus, Florida attracts more amenity-seeking migrants from the Northeast than does more distant California.

3. *Transferability.*—A final factor is required in an interaction system where transferability or distance is measured in real terms of transfer and time cost. If the distance between market and supply were too great and too costly to overcome, interaction would not take place in spite of perfect complementarity and lack of intervening opportunity. Alternate goods would be substituted where possible; that is, bricks would be used instead of wood, and so forth.

As early as 1885, E. G. Ravenstine observed that a population center attracts migrants from other centers in relation to its population size and its distance away and that migrants leave according to the same principle. This statement is often called the P/D relationship.

In 1929, W. J. Reilly suggested a law of retail gravitation which states the same basic law as Ravenstine except that Reilly used retail trade as the dependent variable and he placed an exponent of 2 on the distance variable.

Probably the first major expression of what has been called the "gravity model" originated simultaneously with John Q. Stewart and George K. Zipf. Stewart based his theory on Boyle's investigation of gases and the study of matter as a mass. Stewart's expression describes demographic force as follows:

$$F = G \frac{P_i P_j}{d_{ij}^2} \qquad \text{(B-1)}$$

in which

P_i = population of area i
d_{ij} = distance between areas i and j
G = a constant

Starting with the P/D relationship, George K. Zipf expressed the theory that the number of persons that move between any two communities in the United States whose respective populations are P_1 and P_2 and which are separated by the shortest transportation distance, D, will be proportionate to the ratio P_1P_2/D, subject to the effect of modifying factors.

While Stewart's and Zipf's expressions are basically the same, Zipf's relationship differs in that it raises the entire P_iP_j/d_{ij} factor to a power.

Although the above inter-community linkage concepts were not historically developed with regard to the laws of probability, a considerable amount of work has been done relating these laws to the concepts. A particularly helpful

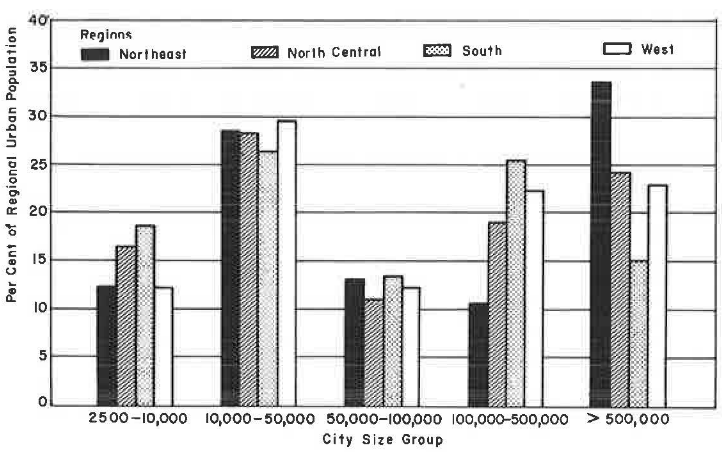

Figure B-26. Distribution of urban population by city size grouping, 1960. (Source: Bur. of the Census, 1960.)

description can be found in Charles Dodd's discussion of interactance (*2*). Here, using population as a measure, and assuming all other attributes equal, the probability of, for example, a New Yorker selecting Seattle to which to travel, is the population of Seattle divided by the population of the nation, or P_s/P. Likewise, the probability of a person in Seattle selecting New York is P_n/P. Using the Law of Joint Probability, the probability of these two independent events occurring jointly is P_sP_n/P^2. The joint occurrence of these two events represents the force or interactance between the two locations. Carrying this further, if this probability is multiplied by the total number of external trips between points in the nation, then the number of trips leaving Seattle for New York is $T_{sn} = P_sP_n/P^2$.

Further, since it was assumed that all attributes are equal, then T/P is the average number of trips per capita. Representing T/P by k, the equation reduces to $T_{sn} = k\,P_sP_n/P$. Comparing the trips predicted by this equation with actual trips at known distances results in a regression equation which can be manipulated to yield the following equation—a basic form of the gravity model.

$$T_{sn} = G\frac{P_sP_n}{d_{sn}^{\,b}} \qquad \text{(B-2)}$$

in which

T_{sn} = trips from Seattle to New York
G = a constant combining k, P and the slope of the regression equation
P_sP_n = same as above
d_{sn} = distance from Seattle to New York
b = some power of the distance

Dodd's interactance hypothesis utilizes the probability laws as a basis for his equation but in addition makes provision for the fact that the attributes of all areas are not equal by introducing weighting factors. Also, he includes a time factor to enable interactance to be measured in any unit of time. Dodd states his hypothesis as follows:

> . . . Groups of people interact more as they become faster, nearer, larger, and leveled up in activity. Conversely, people will interact less in proportion as their groups (a) have fewer actions per period, (b) are further apart, (c) are smaller in population, and (d) are more unlike each other in average activity . . .

His equation of interactance predicts the number of interactions of any one specific kind, among people when observed in groups, from their basic dimensions of time, space, population, and per capita activity. That is, if in a set of n groups, the index of interacting, I_o, is defined as the observed number of interacts of one kind between the members of the two groups in each of the $(n^2 - n)/2$ possible pairs of groups; and if the index of the interactance, I_e, or expected interactance is defined as the calculated $(n^2 - n)/2$ products of the following observed factors, namely:

T = the total time in interacting.
L^{-1} = the inverse of the distance between two groups, where the exponent 1, in amount weights its base factor.
P_AP_B = the population of any two groups, A and B.
I_AI_B = the "specific indices of level" or per capita activity.
k = a constant for each type of interacting (in a given culture and period).

Then the interactance between two points can be expressed as

$$I_e = \frac{kI_A\,P_A\,I_B\,P_B\,T}{L} \qquad \text{(B-3)}$$

The two indices of specific level, I_A and I_B, are weighting factors introduced to equate the heterogeneity of the groups. They are constants specific to each group, and they correspond in the human mass to the specific weights of molecules in the physical mass. The subfactors determining an index of specific levels of activity may be or could be composed of many items, including such common influences as sex, age, income, education, occupation, marital status, potential, religious, and other affiliations.

Since the unit acts in the activity are the same kind of unit acts in the interacting, the constant k, can be shown to be the reciprocal of the total number of acts (ΣI) by all persons in the n groups. In practice, k may not exactly equal I, since it may have two further factors in it; namely, a factor to adjust for the unit of distance, whether miles, kilometers, feet, etc. The exponent of 1 associated with the distance, L, is based on the fact that the population density is assumed uniform in the area studied. While this assumption may hold, although not necessarily correct, a power other than the first power may result in a better fit between the actual and the predicted. The evidence supporting this interactance equation seems sufficient to rank it as a most promising hypothesis but not yet as a verified law of group gravity.

Samuel A. Stouffer's (*8*) theory of movement between areas introduces the concept of intervening opportunities. It implies that the number of persons going a given distance is directly proportional to the number of opportunities at that distance and inversely proportional to the number of intervening opportunities.

An initial problem in applying this theory is the formulation of an operational definition of opportunities. Such a definition could be stated as follows: If a person moves from Tract X to a house or apartment in Tract Y, there must have been previously created in Tract Y a vacancy which he could occupy. The particular vacancy which he occupied and similar vacancies anywhere in the city which he might have occupied but did not are called opportunities. Similar vacancies which are closer to his former residence in Tract X than the dwelling he occupied in Tract Y are called intervening opportunities. While this description generally explains the concept, it is still not complete. What is meant, for instance, by the term similar vacancies? Since no two vacancies are exactly alike, certain relevant characteristics must be selected in order to place them into groups exhibiting approximately the same attributes. The economic character of the dwelling as measured by the rental cost might be used. For example, if the person moving in this case pays $50 per month for his dwelling, then similar opportunities would be limited to other vacant dwellings at about this same rental value. Other attributes must also be considered, such as aesthetics and convenience, of which many do not easily lend themselves to quantification.

Willa Mylroie (*9*) whose work "Evaluation of Intercity—Travel Desires" (*Highway Research Board Bulletin 119* (1956) pp. 69-92) was of considerable help in this project, sums up the basic hypotheses and formulas developed to predict travel desire between cities in general terms as follows:

1. The larger a population center is the more traffic it generates and the more traffic it attracts.
2. The greater the distance between two population centers the less the travel between them.
3. The population of a city is a strong index of its economic importance and thus a measure of its traffic attraction. The more mature the population center the more true this would be.
4. According to the 1944 Interregional Highway Report to Congress, 90 percent of the travel on main highways originates or terminates in a population center.
5. Motor-vehicle registration figures can be used to measure travel as well as population figures because of the uniformity of the per-capita motor-vehicle registration.
6. The mathematical form of the law of attraction between physical masses, $F = M_1 M_2 / D^2$, might be applicable to social masses in the form of $Pop._1 \times Pop._2 / D^2$ where *Pop.* stands for the population and *D* stands for the shortest highway distance.

In this study, Mylroie investigated reports of road classification studies in Michigan and Illinois (*10, 11*). Both of these studies grouped cities into economic classifications based on studies of trade area, assessed valuation, banking resources, and newspaper circulation. These classifications were (1) metropolitan centers, (2) regional centers, (3) intermediate market centers, (4) minor market centers, and (5) neighborhood centers. In the Illinois study, when the towns were plotted by classification and population the plot indicated that the greater the economic importance of the trade center the larger its population. Although some overlapping did occur in the classification, the results were significant. Thus, the size of the town, although not indicating, for example, whether the town is primarily industrial, or a rural trade center, does indicate whether it is an economically important center. In her study Mylroie developed travel desire factors which were correlated with the minimum AADT (annual average daily traffic). It was assumed reasonable that if the travel desire factor would correlate with the minimum AADT for any given stretch of road it could be used as a measure of intercity travel desire or through traffic interest on any road. The minimum AADT between population centers was chosen because it would more nearly reflect through traffic than the higher AADT nearer the town limits or road junctions.

The desire-for-travel factor was computed so as to reflect all desire for travel between two population centers whether the travel would be (1) between the two centers only, (2) from beyond the first center to or through the second center, or (3) from beyond the second center to or through the first center. Any of these cases would necessitate travel from the one population center to the other.

The larger percentage of the local-travel desire was eliminated in this travel-desire factor, because rural population not gathered into incorporated centers over 1,000 was not considered and the metropolitan district population, rather than the population within the political boundaries, was used for towns over 50,000, thus, eliminating the local suburban travel desire in the vicinity of the larger towns. To insure consistent application of the weighted intercity travel-desire factor, the additional policies were established as:

(1) Contingent cities which were approximately five miles or less apart and had much the same characteristics as a single town were considered as one population unit instead of two.

(2) If two feasible routes exist between two cities, their weighted, cumulative intercity travel-desire factor was split on a mileage basis. If the difference in the mileage of the two routes is more than 15 to 20 percent, only the shortest route was considered.

(3) If more than two feasible routes existed between the two cities only the two shortest routes were considered.

Using seven roads as representative for testing purposes, it was found that the factor $Pop._1 \times Pop. / D$ gave a correlation ratio, computed from raw data, of 0.68 with the minimum AADT. In an endeavor to decrease the scatter (increase the correlation) of the travel desire factor with the AADT, three other combinations of Populations 1 and 2 and the distance between them were tried:

(1) $$\frac{Pop._1 \times Pop._2}{D^2}$$

(2) $$\frac{\sqrt{Pop._1 \times Pop._2}}{D}$$

(3) $$\frac{\sqrt{Pop._1 \times Pop._2}}{D^2}$$

All three of these were plotted on log-log paper against the minimum 1950 AADT, with equation (3) giving the best correlation (86%).

In a 1960 Panel Discussion of Inter-Area Travel Formulas (*12*), Glenn E. Brokke made the following observations. Outside of the urban field, a formula of the gravity model type appears to have much merit in predicting travel between cities. Using data obtained from the external cordon survey at Detroit, the following equation was developed:

$$Trips_{AB} = \frac{(K)\ Pop._A \times Pop._B}{Dist._{AB}{}^n} \quad \text{(B-4)}$$

where *Pop.* is in thousands, distance in miles, $K = 156$, and $n = 2.44$ for the total trips between any two areas. He further stipulated that the principal problem is one of evaluating the various formulas. Until this is done any discussion or criticism of them is merely subjective and speculative.

Another form of the gravity formula indicating the values for traffic interaction between city pairs in North Carolina in terms of population and distance is described by James S. Burch (*13*). This formula is:

$$T = 10.04\ m^2 + 4.9\ m + 160 \qquad \text{(B-5)}$$

in which T = number of 24-hour (September-October 1958) weekday trips starting in City A and ending in City B, plus vice-versa, excluding any partial or through trips; and m = square root of the product of the population of City A and City B, divided by the square of the travel distance between chosen centroids in Cities A and B or

$$m = \frac{Pop.\ A \times Pop.\ B}{(\text{dist. } A \text{ to } B)^2} \qquad \text{(B-6)}$$

This equation has been developed and used for many years and is a common expression of the gravity model.

Marcou (*5*) summarizes the major hypotheses advanced regarding intercity linkage as follows:

1. *A community's capacity to produce trips to another community or to attract trips from that community is a function of the travel friction between them.*

This is a widely accepted and well-demonstrated hypothesis based on the assumption that the greater the distance from a population center, the smaller the influence of that center. Questions raised in the literature concern the ways of measuring travel friction or distance between communities.

Distance has been measured in terms of actual mileage or travel time. Distance has also been measured in terms of cost of travel, including direct transportation costs such as the cost of motor fuel consumed or indirect costs resulting from delay or fatigue. Of these, time-distance appears to be the most appropriate to inter-community traffic studies because it can take into account factors that affect the movement of motor vehicles, such as traffic congestion, road conditions, or topography.

The literature suggests that the impact of distance on the extent of intercommunity traffic is not uniform. It is suggested that the distance factor itself is a variable that is affected by the size of population of communities linked, or by the magnitude of the distance involved. Another consideration regarding the variation in the impact of the distance factor is the difference in value placed by people on distance depending on the purpose of the trip. People are willing to travel longer distances for medical purposes, for example, than for shopping purposes, or for less frequent trips than for daily trips. Finally, there is a great likelihood that the impact of the distance factor will vary depending on whether trips produced or trips attracted are under consideration.

2. *A community's capacity to produce or to attract trips is a function of its population size.*

This hypothesis assumes that the larger the population of a community, the greater is its influence and the more likely it is to produce and attract trips. This is also a widely accepted hypothesis whose validity has been demonstrated in a number of empirical studies. Population size has been used as a measure of a community's importance as a retail trade center or as a center of absorption in migration studies. It has also been used as an indication of a community's capacity to produce and attract trips in studies in Illinois, Michigan, and Washington.

But some researchers have criticized the use of population size as a measure of a community's traffic generation potential on the grounds that size alone does not reflect the social or economic structures of the community, factors that are believed to be of significance in traffic generation. In answer, some researchers state that population size is a reliable indicator of a community's economic importance. In other cases, population size has been modified by the addition of factors accounting for differences in the sex, education, and other characteristics of the population. Similarly, population size data have been supplemented with indexes of the community's economic structure, such as assessed valuation or banking resources.

There has been no sufficient evidence advanced to demonstrate that population size in itself is a reliable enough index of a community's ability to produce and attract trips. . . .

3. *A community's capacity to produce trips is a function of the extent of car ownership in the community.*

This hypothesis is derived from recent investigations of the traffic generation of residential areas and has found application in at least one intercommunity traffic study in New Jersey.

In these studies, the average number of cars owned per dwelling unit was found to correlate highly with residential trip production. Similarly, the total number of cars in a residential area was also found to correlate highly with the number of trips produced by the area.

This method of measuring a community's capacity to produce trips may be preferable to the use of population size, because the former gives an indication of population size as well as the ability of community residents to travel. The difference between using car ownership and population size is particularly important where the per capita car ownership is not uniform for all communities linked. . . .

4. *A community's capacity to produce or to attract trips varies from one purpose to another.*

This recognizes that the degree of influence of a community over the surrounding area is not uniform for all functions performed by the community. The existence of a hierarchy of functions that a central city performs for its hinterland has been demonstrated in general studies and in studies dealing with the Lansing, Mich., area, the Champaign-Urbana area, and the Springfield, Ill., area. . . .

5. *A community's capacity to produce or to attract trips for any one person will vary within that purpose.*

This hypothesis recognizes the difference between activities of a local and those of a regional nature, within any one purpose category. As an illustration, shopping for groceries has often been mentioned as an activity likely to take place within the community of residence; by contrast, shopping for apparel is an activity that may generate a large amount of regional traffic. . . .

6. *A community's capacity to attract trips is conditioned by competition with other communities.*

This recognizes the limitations put on a community's area of influence by competing communities, and the overlapping nature of community influence. This is taken into account in delimiting the primary regional labor markets and trade areas of communities. In the literature, a procedure is established to define the point of equilibrium at which the influences of two competing communities are equal. This is accomplished through the use of population size and distance data. An adaptation of this procedure can be developed to measure competition as a variable in the intercommunity traffic. . . .

7. *A community's capacity to attract trips is a function of the attractiveness of the community with respect to the purpose of the trip.*

How to allocate trips produced by residential areas to nonresidential attractions, or on what basis to distribute trips produced by one part of a community to all other parts has been the subject of a number of recent research activities.

The use of land area and building floor area classified by use have been suggested as units of traffic generation.

Other suggestions for measuring the attractiveness of an area with respect to the purpose for which trips are taken, are received next under each purpose category.

Work Purposes

The purpose work applies to trips made to the location of a person's place of employment (such as a factory, a shop, a store, or an office) and also to locations that must be visited in performing a normal day's work.

Migration and commuting studies indicate that economic opportunity is a major determinant of movement between communities. More specifically, the existence of a surplus of labor supply in one community coupled with an expansion in the economy of another community is a prime factor in causing a permanent (migration) or recurring (commuting) movement of workers from one community to the other. Also, in rural areas, farmers located around a community with an expanding economy will often work in that community for income not connected with their farms.

The number of workers employed in work places located within the community has been suggested as a measure of a community's capacity to attract work trips. This number includes community residents as well as commuters. It would appear that the number of workers would be a more useful measure if it is related to the number of workers residing in the community, or in case this is not available, to the population of the community.

It has also been suggested that work places employing a substantial number of workers tend to attract the larger portion of community workers. There is some question as to the employment size level at which a work place ceases to be a local concern and becomes a work place of regional significance. . . .

Business Purposes

Business refers to trips made to complete transactions not considered part of a person's regular employment. Examples are trips to the bank to transact business, to the post office to mail a letter or package, and to an office to pay a bill.

This purpose category presents some difficulties. A business trip could conceivably be undertaken to any type of establishment or land use. Past research to establish a basis for measurement of business trip attraction is scarce and inconclusive. There are suggestions in the literature that business trips may be considered as shopping trips, but there is little evidence to warrant this. One type of business activity (banking) is often referred to in the literature as an activity as likely to be found in small communities as in central cities. . . .

Medical and Dental Purposes

This is one of the more precisely defined purposes and refers to trips made for consultation about health with doctors and dentists.

The literature indicates that medical and dental services are predominantly found in the central cities and are tending toward centralization away from smaller communities. But no specific ways of measuring a community's capacity to attract trips for this purpose were found in the literature. Here again some testing is necessary. Among the measures that are available are the number of medical and dental professionals in the community, the number of beds in the community's hospitals and clinics, and the number of persons employed in these institutions.

School Purposes

School refers to trips by students who are actually attending school. This includes public and private schools, universities, colleges, and high schools.

Of the many types of institutions covered by this definition, only a few may be of regional significance. These include major private schools, technical schools, colleges and universities.

Here again no specific measurement suggestions were found in the literature. Some measures (which might) be tested include the number of students registered in these regional institutions or the number of teaching and non-teaching staff employed.

Pleasure Purposes

Pleasure refers to cultural trips made to church, civic meetings, lectures, and concerts as well as trips to attend parties or to visit friends. Also included are trips made for golfing, fishing, movies, and bowling.

This broad-purpose category includes trips to residential areas, to public and semi-public facilities as well as to commercial recreation establishments. Because no attempt has been made at differentiating between trips taken to these largely different types of facilities, little is known about their traffic-generating patterns.

Also, the rapid changes that are currently taking place in leisure-type activities tend to render obsolete much of the research that has taken place and to complicate the problem of measuring a community's capacity to attract pleasure trips.

Findings in the literature indicate a large degree of interdependence between rural areas, small communities, and central cities in regard to pleasure trips. Rural and small community residents are willing to travel some distance to patronize a central city's recreation facilities, yet they also attempt to decrease their social dependence on the central city by strengthening the role of local schools, churches, community centers, and civic organizations in the social sense. Similarly, central city residents seek to occupy their leisure time with activities that require large amounts of open space, seldom found within the confines of the city limits.

The lack of precise definition as to what constitutes a pleasure trip coupled with the high degree of interdependence of rural areas, small towns, and central cities in matters of recreation suggest that a meaningful measure of a community's ability to attract pleasure trips must rest on two premises. The first is that the variety of types of establishments that attract pleasure trips suggest that the measure would be of a composite nature taking into account both social and commercial recreation. Among the measures available to arrive at this composite measure are the resident population of a community, the number of public and semi-public institutions, and the number and employment of commercial recreation establishments of regional significance. The second premise is that when trips produced by (the Central City) residents are under consideration emphasis will be placed on the types of recreation facilities located outside the (city) . . . which attract these pleasure trips. Similarly, when trips produced by residents of other communities are analyzed, emphasis will be placed on the types of establishment within (the Central City) which attract these pleasure trips.

Shopping Purposes

Shopping applies whenever a trip is made to do some shopping but also includes window shopping (without purchase), trips for repairs to automobiles, radios, etc., and for such personal services as haircuts, and cleaning and pressing clothes.

Shopping practices have received a large amount of research. The existence of a heirarchy of types of goods in terms of the distance that consumers are willing to travel to make purchases and, in the case of small communities, in terms of the percentage of goods purchased out of town, has been established in a number of studies. These studies indicate that consumers from rural areas or small communities tend to purchase shopping goods (apparel and furniture) in the central city and convenience goods (food and drugs) either in the small community or in the central city.

Various ways of measuring a community's capacity to attract shopping trips are suggested in the literature—for convenience goods, the floor area in food stores and drug stores; for shopping goods, the floor area in apparel; for all goods, or if the data are available by type of goods sold, dollar sales, and the number of business units.

Eat Meal, Overnight, and All Other Purposes

In terms of intercommunity traffic analysis, these purpose categories are considered to be of little significance.

FACTORS AFFECTING INTERCITY LINKAGE

Generally, the gravity model form of equation involves two basic types of variables, mass and distance, and can include modifying factors in the form of other variables, coefficients, and exponents. Assuming that some form of the gravity model describes the interactance between cities relatively well, the next step in developing an equation which will more accurately provide the interactance involves the identification and selection of these variables. The preceding investigation of intercity linkage points to population and the distance separating the points of population concentration as the two major variables describing intercity movement. Although population is a relatively good indication of potential, it does not appear to correlate closely with travel volume. Population is therefore, a gross variable which aggregates a number of more definitive variables dealing with the social and economic characteristics of the population. Thus, these social and economic variables could be used to refine the basic P/D relationship so that a more accurate correlation can be obtained between synthesized trips, obtained from the application of the formula, and the actual trips reported.

An investigation to determine those social and economic factors which appear to influence intercity travel resulted in the following listing:

1. Population:
   (a) Total population.
   (b) Urban population.
   (c) Rural population.
   (d) Population by age (5- or 10-year increments).
   (e) Population by sex.
   (f) Population by race.
   (g) SMSA or non-SMSA population.
   (h) School enrollment.
   (i) Migration rates.
   (j) Birth and death rates.
2. Vehicle ownership:
   (a) Total vehicle ownership.
   (b) Vehicle ownership by age (5- or 10-year increments).
   (c) Vehicle ownership by sex.
   (d) Vehicle ownership by race.
3. Employment:
   (a) Total employment.
   (b) Employment by age (5- or 10-year increments).
   (c) Employment by sex.
   (d) Employment by race.
   (e) Percent unemployed.
   (f) Number of employment opportunities available.
4. Indices of productivity:
   (a) Total income.
   (b) Family income.
   (c) Per capita income.
   (d) Property taxes.
   (e) Total bank deposits.
   (f) Investment in various types of facilities.
   (g) Commodity output.
   (h) Gross Regional Product (GNP of a region).
   (i) Value added in manufacture.
   (j) Dollar volume of retail and wholesale sales.
5. Education:
   (a) Average number of school years completed.
   (b) Percent of population with less than a high school education.
   (c) Percent of population with a high school education.
   (d) Percent of population with a college education.
6. Indices of community structure:
   (a) Density (persons per square mile).
   (b) Accessibility (miles of roadway per square mile).
   (c) Service classification of cities—a classification of cities by the following groups: (1) manufacturing, (2) retail trade, (3) professional service, (4) transportation and communication, (5) personal service, (6) public administration, (7) wholesale trade, (8) finance, insurance and real estate, (9) mining, and (10) diversified. Measures used for classification include employment ratios, number of establishments, etc. See (*4, 14*).
   (d) Rank order of cities by size—A ranking of cities based primarily on population but also on the influences of retail trade, wholesale trade, newspaper circulation, and bank deposits.
   (e) Population ratios; e.g., $\text{Sex ratio} = \frac{\text{No. males}}{\text{No. females}}$

   $$\text{Index of aging} = \frac{\text{No. 65 and over} \times 100}{\text{No. 0-14 years}}$$

   (f) Basic-non-basic ratio—This ratio indicates the relationship of industries selling goods to areas outside the city to those selling primarily within the city. Employment is generally used as a measure and is usually divided into basic employment and non-basic (or service) employment.
   (g) Location quotient—The ratio of the city's percentage of a particular measure (e.g., employment, sales, etc.) to the national percentage of this measure. Other similar measures include the coefficients of localization, redistribution, deviation, and others. See (*15*).

(h) Total height index of city buildings—

$$\text{THI} = \frac{\text{Total floor space}}{\text{Total ground floor space}}$$

(also CBHI using only central business district space).

(i) Central business intensity index.

$$\text{CBII} = \frac{\text{Central business space}}{\text{Total ground floor space}}$$

(j) Degree of centrality—A measure of the assessed valuation of the businesses and services in the city or the area dependent on the city for goods and services.

(k) Number of tourist attractions, such as professional and collegiate sports activities, amusement parks, cultural institutions, scenic attractions.

7. Social indices:
   (a) Percent of impoverished families.
   (b) Crime rates.
   (c) Literacy rate.
   (d) Influence of ethnic ties.
8. Indices of interactance:
   (a) Number of long-distance telephone calls.
   (b) Newspaper circulation.
   (c) Number of correspondent banks.

Relating the listed factors to a gravity-type equation, population, employment, sales, value added, vehicle registration, etc., may be used as measures of mass depending upon the results desired. Thus, if intercity migration is being studied, employment rather than population can be used as a measure, or if the marketing possibilities of a manufactured item are being investigated, sales might be used.

To measure distances one might use one of the following:

1. Miles.
2. Time.
3. Cost of travel or other interactance.
4. Social distance—This concept takes into account the phenomena of the linkages of certain areas because of cultural or economic influences and the bypassing of intervening opportunities. For example, the New York to Florida migration for recreation and the New York-Hollywood communications volume (*15*, pp. 542-544).

Although the standard gravity model equation has been derived with the coefficient of the masses used being the same and equal to one, as Isard (*15*) points out, both Stewart and Dodd take exception to this and recommend the weighting of these masses. Isard, in defining such a procedure, indicates that "it is reasonable to expect that, *ceteris paribus*, an area with high per capita income will generate a larger volume of such travel than an area of equal population but lower per capita income." To correct this situation Isard recommends the multiplying of the population of each subarea by its average per capita income. Thus, the gravity model formula with weighted masses would take the following form:

$$T_{ij} = G\,\frac{(W_iP_i)\,(W_jP_j)}{d_{ij}^{\,b}} \qquad \text{(B-7)}$$

In which W_{ij} = the weights and the other variables are the same as previously.

Variables which might be used as weights include:

1. Per capita income.
2. Educational level.
3. Sex or age composition.
4. Percent income above a certain level.
5. Urban-rural ratio.
6. Occupational structure.
7. Capital investment per employee.
8. Social weights.

In using weighting factors it should be noted that when per capita variables (used as weights) are multiplied by population the mass measure becomes the gross variable; that is, income per capita times population equals income.

Generally the exponents to which the variables will be raised are derived empirically and while many researches have, for instance, derived exponents for the distance variable none have been universally accepted. A review of the literature suggests these exponents have ranged from 0.5 to 3.0. In most cases, the exponents of the masses have been unity; however, Anderson and Carrothers (*15*) have suggested the validity of other powers. Carrothers bases this on the fact that agglomeration (deglomeration) economics imply that the exponent to be applied to any mass is a function of the mass. What these exponents should be, though, is also a matter of conjecture and they have been empirically determined to fit available data. Mass exponents have been in the 0.5 to 1.0 range.

In developing the various weights and exponents it would appear that use could be made of the indices of community structure and of interactance, in addition to the other measures.

APPENDIX C

SUMMARY TABLES

Column	*Description*
1	The number of trips in each classification—The purpose 1, 2, 3, 4, and 5 and/or the purpose 1, 2, 3-4, and 5 trips when added are equal to the all purpose trips within the rounding limits of Program 333. The trips to Standard Metropolitan Statistical Areas whose populations are greater than and less than 1,000,000 add to equal trips to SMSA's. However, the trips to counties whose populations are greater than 50,000 and to counties not in a SMSA whose populations are less than 50,000 do not necessarily add to equal the all purpose trips, the reason being the exclusion of trips to counties in SMSA's whose populations are less than 50,000.
2	This is a percentage of the all purpose trips.
3	This is the average trip length.
4	The number of counties which are linked to the study area by a trip transfer (the combined inbound and outbound trip tape). The maximum value that could be entered here is 3,075, which is the number of counties in the network.
5	The adjacent counties were those which shared a common boundary with the home county, whether it was for 1 or 10 miles.
6	The values in column 5 expressed as a percentage of the corresponding numbers from column 1. Thus, the value in column 5 is divided by the corresponding value in column 1 and multiplied by 100 to obtain the desired results.
7	The trips within 35 minutes driving time from the home node are entered here. The time is computed by the computer using the speed, distance, and link configuration from the network.
8	The values in Column 7 expressed as a percentage of the corresponding numbers from Column 1; i.e., (Col. 7/Col. 1) × 100.
9	The trips greater than 35 minutes driving time from the home node are entered here.
10	The values in Column 9 expressed as a percentage of the corresponding numbers from Column 1; i.e., (Col. 9/Col. 1) × 100.

Column	*Description*
11	This is the average trip length of just the trips greater than 35 minutes in length.
12	The number of trips that are within one hour's driving time from the home node.
13	The values in Column 12 expressed as a percentage of the corresponding numbers from Column 1; i.e., (Col. 12/Col. 1) × 100.
14	The number of trips that are between 35 and 60 minutes driving time from the home node.
15	The values in Column 14 expressed as a percentage of the corresponding numbers from Column 1; i.e., (Col. 14/Col. 1) × 100.
16-19	Same as Columns 12-15, except these values deal with trips within two hours instead of one hour.
20-23	Same as Columns 12-15, except these values deal with trips within four hours instead of one hour.
24-27	Same as Columns 12-15, except these values deal with trips within six hours instead of one hour.
28-31	Same as Columns 12-15, except these values deal with trips within eight hours instead of one hour.
32-35	Same as Columns 12-15, except these values deal with trips within 16 hours instead of 1 hour.
36-39	Same as Columns 12-15, except these values deal with trips within 24 hours instead of 1 hour.
40	The number of trips that are greater than 24 hours driving time from the home node.
41	The values in Column 40 expressed as a percentage of the corresponding numbers from Column 1; i.e., (Col. 40/Col. 1) × 100.

Columns 42-82 refer to the four groups of cities based on cordon population, and the summary of all 22 cities. These columns are comparable to 1-41, except that they pertain to a group of study areas intead of just one. Column 45 is the average number of counties which are linked to the study areas by trip transfer (the combined inbound and outbound trip tapes). The maximum value that could be entered here is 3,075, which is the number of counties in the network.

TABLE C-1

SUMMARY OF FOUR CLASSES OF CITIES AND THE 22 CITIES SELECTED FOR THE STUDY

Time Distribution of	(42) Trips	(43) % of Total	(44) Avg. Trip Len. (Min.)	(45) Avg. No. of Cos. Attra. Trips	(46) Trips to Adj. Cos. Trips	(47) Trips to Adj. Cos. % of Total	(48) Trips Within 35 min. Trips	(49) Trips Within 35 min. % of Total	(50) Trips > 35 min. Trips	(51) Trips > 35 min. % of Total	(52) Trips > 35 min. Avg. Trip Length (Min.)	(53) Trips Within 1 hr. Trips	(54) Trips Within 1 hr. % of Total	(55) Trips Within 35 min. to 1 hr. Trips	(56) Trips Within 35 min. to 1 hr. % of Total	(57) Trips Within 2 hrs. Trips	(58) Trips Within 2 hrs. % of Total	(59) Trips Within 35 min. to 2 hrs. Trips	(60) Trips Within 35 min. to 2 hrs. % of Total
SUMMARY OF ALL CLASS I CITIES																			
All Purpose Trips	86822	100.0	37.0	118	75663	87.1	62008	71.4	24814	28.6	123.8	73251	84.4	11243	13.0	80840	93.1	18832	21.7
Purpose 1 Work Trips	32927	38.1	28.0	53	29568	89.8	23897	72.6	9030	27.4	94.9	29028	88.2	5131	15.6	31673	96.2	7776	23.6
Purpose 2 Business Trips	12256	14.2	27.8	29	10874	88.7	9594	78.3	2662	21.7	116.2	10855	88.6	1261	10.2	11748	95.9	2154	17.6
Purpose 3 Recr. Trips[1]	4137	16.9	85.7	63	2776	67.1	2703	65.3	1434	34.7	241.6	2892	69.9	189	4.6	3428	82.9	725	17.5
Purpose 4 SocialTrips[1]	1579	6.4	50.7	19	1114	70.5	1021	64.7	558	35.3	124.7	1165	73.8	144	9.1	1388	87.9	367	23.2
Purpose 5 Other Trips	17372	20.1	17.0	20	15264	87.9	13861	79.8	3511	20.2	77.7	16020	92.2	2159	12.4	17061	98.2	3200	18.4
Purpose 3-4 Soc.-Rec. Trips	24222	27.9	67.3	84	17918	74.0	14656	60.5	9566	39.5	167.4	16352	67.5	1696	7.0	20353	84.0	5697	23.5
Trips to SMSA's	29456	34.1	65.3	50	21412	72.7	18545	63.0	10911	37.0	168.5	20061	68.1	1516	5.1	24147	82.0	5602	19.0
Trips to SMSA > 1,000,000	17466	20.2	66.4	18	11808	67.6	11222	64.3	6244	35.7	175.2	11702	67.0	480	2.7	13152	75.3	1930	11.0
Trips to SMSA < 1,000,000	11990	13.9	63.6	31	9604	80.1	7323	61.1	4667	38.9	158.0	8359	69.7	1036	8.6	10995	91.7	3672	30.6
Trips to Cos. > 50,000	51262	59.3	49.7	69	39885	77.8	32309	63.0	18953	37.0	128.6	39970	78.0	7661	14.9	45430	88.6	13121	25.6
Trips to Cos. < 50,000[2]	35569	41.1	18.9	49	33869	95.2	29699	83.5	5870	16.5	105.9	33233	93.4	3534	9.9	34606	97.3	4907	13.8
SUMMARY OF ALL CLASS II CITIES																			
All Purpose Trips	80904	100.0	23.1	117	74541	92.1	59818	73.9	21086	26.1	82.3	75364	93.2	15546	19.3	78828	97.4	19010	23.5
Pur. 1 Work Trips	33916	41.9	20.6	58	31801	93.8	25486	75.1	8430	24.9	75.5	31983	94.2	6497	19.1	33220	97.9	7734	22.8
Pur. 2 Business Trips	24292	30.0	24.0	57	21492	88.5	17648	72.6	6644	27.4	81.5	22155	91.2	4507	18.6	23540	96.9	5892	24.3
Pur. 3 Recr. Trips	6860	8.5	43.2	49	6089	88.8	4591	66.9	2269	33.1	109.6	6194	90.3	1603	23.4	6483	94.5	1892	27.6
Pur. 4 Soc. Trips	4249	5.2	24.5	27	3788	89.2	3091	72.7	1158	27.3	82.8	3930	92.5	839	19.8	4139	97.4	1048	24.7
Pur. 5 Other Trips	11573	14.3	15.4	22	10920	94.4	9009	77.8	2564	22.2	61.9	11116	96.0	2107	18.2	11454	99.0	2445	21.2
Pur. 3-4 Soc.-Rec. Trips	11109	13.7	36.0	62	9877	88.9	7682	69.2	3427	30.8	111.1	10124	91.1	2442	22.0	10622	95.6	2940	26.5
Trips to SMSA's	5979	7.4	107.6	33	2223	37.2	0	0.0	5979	100.0	107.6	3348	56.0	3348	56.0	5028	84.1	5028	84.1
Trips to SMSA's > 1,000,000	2438	3.0	85.0	16	2223	91.2	0	0.0	2438	100.0	85.0	2008	82.4	2008	82.4	2224	91.2	2224	91.2
Trips to SMSA's < 1,000,000	3541	4.4	123.2	23	0	0.0	0	0.0	3541	100.0	123.2	1340	37.8	1340	37.8	2804	79.2	2804	79.2
Trips to Cos. > 50,000	8079	10.0	105.4	49	3692	45.7	3	0.0	8076	100.0	105.4	4820	59.7	4817	59.7	6809	84.3	6806	84.3
Trips to Cos. < 50,000[2]	72770	89.9	14.2	67	70849	97.4	59818	82.2	12952	17.8	249.4	70547	96.9	10729	14.7	71915	98.8	12097	16.6
SUMMARY OF ALL CLASS III CITIES																			
All Purpose Trips	126358	100.0	45.5	270	103383	81.8	82472	65.3	43886	34.7	119.1	100247	79.3	17775	14.0	117751	93.2	35279	27.9
Pur. 1 Work Trips	55028	43.5	46.1	164	44289	80.5	34880	63.4	20148	36.6	116.8	42646	77.5	7766	14.1	50758	92.2	15878	28.8
Pur. 2 Business Trips	21575	17.1	45.9	94	16873	78.2	13656	63.3	7919	36.7	115.5	16579	76.8	2923	13.5	19987	92.6	6331	29.3
Pur. 3 Recr. Trips[3]	1832	9.9	37.7	57	1572	85.8	1309	71.5	523	28.5	131.9	1529	83.5	220	12.0	1680	91.7	371	20.2
Pur. 4 Soc. Trips[3]	2234	12.1	45.8	75	1868	83.3	1368	61.2	866	38.8	117.8	1833	82.1	465	20.9	2091	92.1	723	30.9
Pur. 5 Other Trips	18317	14.5	42.7	70	15716	85.8	11935	65.2	6382	34.8	112.0	15091	82.4	3156	17.2	17474	95.4	5539	30.2
Pur. 3-4 Soc.-Rec. Trips	31418	24.9	45.6	143	26512	84.4	22007	70.0	9411	30.0	137.1	25938	82.6	3931	12.6	29552	94.1	7545	24.1
Trips to SMSA's	35958	28.4	55.6	74	26972	75.0	26972	75.0	8986	25.0	222.6	27116	75.4	144	0.4	32178	89.5	5206	14.5
Trips to SMSA's > 1,000,000	6583	52.1	179.1	16	0	0.0	0	0.0	6583	100.0	179.0	144	2.9	144	2.9	4463	67.8	4463	67.8
Trips to SMSA's < 1,000,000	29375	23.2	27.9	54	26972	91.8	26972	91.8	2403	8.2	340.9	26972	91.8	0	0.0	27715	94.3	743	2.5
Trips to Cos. > 50,000	78070	61.8	35.0	106	66634	85.4	62736	80.4	15334	19.6	169.6	67159	86.0	4423	5.6	73363	94.0	10627	13.6
Trips to Cos. < 50,000[2]	48282	38.2	62.9	164	36749	76.1	19736	40.9	28546	59.1	84.7	33088	68.5	13352	27.6	44388	91.9	24652	51.0
SUMMARY OF ALL CLASS IV CITIES																			
All Purpose Trips	369938	100.0	59.8	602	244200	66.0	276851	74.8	93087	25.2	182.2	207672	83.2	30821	8.4	331848	89.7	54997	14.9
Pur. 1 Work Trips	176171	47.6	46.2	308	118245	67.1	134906	76.6	41265	23.4	147.2	151060	85.7	16154	9.1	161274	91.5	26368	14.9
Pur. 2 Business Trips	65556	17.7	64.8	248	41639	63.5	46818	71.4	18738	28.6	186.9	51274	78.2	4456	6.8	56947	86.9	8819	15.5
Pur. 3 Recr. Trips[4]	4377	7.5	60.5	100	3329	76.1	2625	60.0	1752	40.0	130.0	3349	76.5	724	16.5	3973	90.8	1348	30.8
Pur. 4 Soc. Trips[4]	5783	9.9	43.6	105	5027	86.9	4184	72.4	1599	27.6	114.0	4979	86.1	795	13.7	5471	94.6	1287	22.2
Pur. 5 Other Trips	37767	10.2	47.9	175	29187	77.3	28579	75.7	9188	24.3	176.1	31918	84.5	3339	8.8	34994	92.7	6415	17.0
Pur. 3-4 Soc.-Rec. Trips	90343	24.4	69.0	378	59516	65.9	66231	73.3	24112	26.7	214.6	73122	80.9	6891	7.6	78750	87.2	12519	13.9
Trips to SMSA's	277047	74.9	40.1	169	140479	50.7	257504	92.9	19543	7.1	375.9	257504	92.9	0	0.0	258441	93.3	937	0.4
Trips to SMSA's > 1,000,000	188702	51.0	37.3	48	61069	32.4	178094	94.4	10608	5.6	343.9	178094	94.4	0	0.0	178596	94.6	502	0.2
Trips to SMSA's < 1,000,000	88342	23.9	46.4	116	79410	89.9	79410	89.9	8932	10.1	431.4	79410	89.9	0	0.0	79845	90.4	435	0.5
Trips to Cos. > 50,000	273754	74.0	45.0	240	131834	48.2	245310	89.6	28444	10.4	289.4	247782	90.5	2472	0.9	251269	91.8	5959	2.2
Trips to Cos. < 50,000[2]	82237	22.2	96.9	362	40583	49.3	17619	21.4	64618	78.6	116.8	45968	55.9	28349	34.5	66657	81.1	49038	59.7
SUMMARY OF ALL 22 CITIES																			
All Purpose Trips	664022	100.0	49.6	396	497787	75.0	481149	72.5	182873	27.5	147.6	556534	83.8	75385	11.3	609267	91.8	128118	19.3
Purpose 1 Work Trips	298042	44.9	41.3	200	223903	75.1	219169	73.5	78873	26.5	125.8	254717	85.5	35548	11.9	276925	92.9	57756	19.4
Purpose 2 Business Trips	123679	18.6	49.7	172	90878	73.5	87716	70.9	35963	29.1	146.5	100863	81.5	13147	10.6	112222	90.7	24506	19.4
Purpose 3 Recr. Trips[5]	17206	16.9	57.2	67	13766	80.0	11228	65.3	5978	34.7	149.2	13964	81.2	2736	15.9	15564	90.5	4336	25.2
Purpose 4 Social Trips[5]	13845	13.6	38.9	56	11797	85.2	9664	69.8	4181	30.2	107.6	11907	86.0	2243	16.2	13089	94.5	3425	24.7
Purpose 5 Other Trips	85029	12.8	36.0	86	71087	83.6	63384	74.5	21645	25.5	127.7	74145	87.2	10761	12.6	80983	95.2	17599	20.7
Purpose 3-4 Soc.-Rec. Trips	157092	23.6	61.7	367	113823	72.4	110576	70.4	46516	29.6	181.6	125536	79.9	14960	9.5	139277	88.6	28701	18.3
Trips to SMSA's	348440	52.5	45.6	112	191086	54.8	303021	87.0	45419	13.0	260.4	308029	88.4	5008	1.4	319794	91.8	16773	4.8
Trips to SMSA > 1,000,000	215189	32.4	44.5	30	75100	34.9	189316	88.0	25873	12.0	236.8	191948	89.2	2632	1.2	198435	92.2	9119	4.2
Trips to SMSA < 1,000,000	133248	20.0	45.9	72	115986	87.0	113705	85.3	19543	14.7	299.1	116081	87.1	2376	1.8	121359	91.1	7654	5.8
Trips to Cos. > 50,000	411165	61.9	44.9	156	242045	58.9	340358	82.8	70807	17.2	199.4	359731	87.5	19373	4.7	376871	91.7	36513	8.9
Trips to Cos. < 50,000[2]	238858	36.0	53.2	237	222633	93.2	126872	53.1	111986	46.9	123.4	182836	76.5	55964	23.4	217566	91.1	90694	38.0

[1] Humboldt, Rogersville, and Sturgeon Bay are the only cities in this classification, but all the cities in this class are included in the combined social-recreation purpose.

[2] These counties are not contained within a SMSA; all counties (27) less than 50,000 and within SMSA's were excluded.

[3] Sheboygan is the only city in this classification, but all the cities in this class are included in the combined social-recreation purpose.

(61)	(62)	(63)	(64)	(65)	(66)	(67)	(68)	(69)	(70)	(71)	(72)	(73)	(74)	(75)	(76)	(77)	(78)	(79)	(80)	(81)	(82)
Trips Within 4 hrs.		Trips Within 35 min. to 4 hrs		Trips Within 6 hrs.		Trips Within 35 min. to 6 hrs		Trips Within 8 hrs.		Trips Within 35 min. to 8 hrs		Trips Within 16 hrs.		Trips Within 35 min. to 16 hrs		Trips Within 24 hrs.		Trips Within 35 min. to 24 hrs		Trips>24 hrs.	
Trips	% of Total	Trips	% of Total	Trips	% of Total	Trips	% of Total	Trips	% of Total	Trips	% of Total	Trips	% of Total	Trips	% of Total	Trips	% of Total	Trips	% of Total	Trips	% of Total
84850	97.7	22842	26.3	85494	98.5	23486	27.0	85853	98.9	23841	27.5	86416	99.5	24408	28.1	86755	99.9	24747	28.5	67	0.1
32496	98.7	8599	26.1	32638	99.1	8741	26.5	32734	99.4	8837	26.8	32880	99.9	8983	27.3	32917	100.0	9020	27.4	10	0.0
12072	98.5	2478	20.2	12114	98.8	2520	20.6	12171	99.3	2577	21.0	12215	99.7	2621	21.4	12246	99.9	2652	21.6	10	0.1
3713	89.6	1010	24.4	3939	95.2	1236	29.9	3971	96.0	1268	30.6	4076	98.5	1373	33.2	4120	99.6	1417	34.3	17	0.4
1523	96.4	502	31.8	1569	99.4	548	34.7	1571	99.5	550	34.8	1578	99.9	557	35.3	1578	99.9	557	35.3	1	0.1
17307	99.6	3446	19.8	17333	99.8	3472	20.0	17342	99.8	3481	20.0	17366	100.0	3505	20.2	17371	100.0	3510	20.2	1	0.0
22955	94.8	8299	34.3	23378	96.5	8722	36.0	23574	97.3	8918	36.8	23915	98.7	9259	38.2	24176	99.8	9520	39.3	46	0.2
28129	95.5	9584	32.5	28503	96.8	9958	33.8	28735	97.6	10192	34.6	29106	98.8	10561	35.8	29407	99.8	10862	36.8	49	0.2
16765	96.0	5543	31.7	17003	97.3	5781	33.0	17113	98.0	5891	33.7	17246	98.7	6024	34.4	17458	100.0	6236	35.7	8	0.0
11364	94.8	4041	33.7	11500	95.9	4177	34.8	11622	96.9	4299	35.8	11860	98.9	4537	37.8	11949	99.7	4626	38.6	41	0.3
49763	97.1	17452	34.0	50229	98.0	17920	35.0	50485	98.5	18176	35.5	50892	99.3	18583	36.3	51209	99.9	18900	36.9	53	0.1
35098	98.7	5399	15.2	35285	99.2	5584	15.7	35402	99.5	5703	16.0	35537	99.9	5838	16.4	35558	100.0	5859	16.5	11	0.0
80032	98.9	20214	25.0	80391	99.4	20573	25.5	80556	99.6	20738	25.7	80814	99.9	20996	26.0	80878	100.0	21060	26.1	26	0.0
33651	99.2	8165	24.1	33764	99.6	8278	24.5	33809	99.7	8323	24.6	33887	99.9	8401	24.8	33907	100.0	8421	24.9	9	0.0
24009	98.8	6361	26.2	24171	99.5	6523	26.9	24228	99.7	6580	27.1	24285	100.0	6637	27.4	24288	100.0	6640	27.4	4	0.0
6633	96.7	2042	29.8	6677	97.3	2086	30.4	6723	98.0	2132	31.1	6811	99.3	2220	32.4	6849	99.8	2258	32.9	11	0.2
4197	98.8	1106	26.1	4214	99.2	1123	26.5	4222	99.4	1131	26.7	4245	99.9	1154	27.2	4247	100.0	1156	27.3	2	0.0
11538	99.7	2529	21.9	11555	99.8	2546	22.0	11562	99.9	2553	22.1	11572	100.0	2563	22.2	11573	100.0	2564	22.2	0	0.0
10830	97.5	3148	28.3	10891	98.0	3209	28.9	10945	98.5	3263	29.4	11056	99.5	3374	30.4	11096	99.9	3414	30.7	13	0.1
5614	93.9	5614	93.9	5725	95.8	5725	95.8	5780	96.7	5780	96.7	5915	98.9	5915	98.9	5966	99.8	5966	99.8	13	0.2
2320	95.2	2320	95.2	2330	95.6	2330	95.6	2350	96.4	2350	96.4	2420	99.3	2420	99.3	2431	99.7	2431	99.7	7	0.3
3294	93.0	3294	93.0	3395	95.9	3395	95.9	3430	96.9	3430	96.9	3495	98.7	3495	98.7	3535	99.8	3535	99.8	6	0.2
7560	93.6	7557	93.6	7744	95.8	7741	95.8	7834	97.0	7831	97.0	8004	99.1	8001	99.1	8062	99.8	8059	99.8	17	0.2
72362	99.4	12544	17.2	72559	99.7	12741	17.5	72653	99.8	12835	17.6	72751	100.0	12933	17.8	72758	100.0	12940	17.8	12	0.0
122845	97.2	40373	31.9	124196	98.3	41724	33.0	125059	99.0	42587	33.7	125956	99.7	43484	34.4	126116	99.8	43644	34.5	242	0.2
53463	97.2	18583	33.8	54102	98.3	19222	34.9	54544	99.1	19664	35.7	54926	99.8	20046	36.4	54976	99.9	20096	36.5	52	0.1
20959	97.1	7303	33.8	21260	98.5	7604	35.2	21427	99.3	7771	36.0	21542	99.8	7886	36.5	21557	99.9	7901	36.6	18	0.1
1771	96.7	462	25.2	1812	98.9	503	27.4	1819	99.3	510	27.8	1826	99.7	517	28.2	1828	99.8	519	28.3	4	0.2
2175	97.4	807	36.2	2187	97.9	819	36.7	2203	98.6	835	37.4	2220	99.4	852	38.2	2229	99.8	861	38.6	5	0.2
17932	97.9	5997	32.7	18003	98.3	6068	33.1	18080	98.7	6145	33.5	18235	99.6	6300	34.4	18271	99.7	6336	34.5	46	0.3
30492	97.1	8485	27.1	30819	98.1	8812	28.1	30992	98.6	8985	28.6	31233	99.4	9226	29.4	31294	99.6	9287	29.6	124	0.4
34109	94.9	7137	19.9	34697	96.5	7725	21.5	35137	97.7	8165	22.7	35645	99.1	8673	24.1	35754	99.4	8782	24.4	204	0.6
5349	81.3	5349	81.3	5932	90.1	5932	90.1	6229	94.6	6229	94.6	6437	97.8	6437	97.8	6470	98.3	6470	98.3	113	1.7
28460	96.9	1488	5.1	28765	97.9	1793	6.1	28908	98.4	1936	6.6	29208	99.4	2236	7.6	29284	99.7	2312	7.9	91	0.3
75915	97.2	13179	16.8	76664	98.2	13928	17.8	77146	98.8	14410	18.4	77725	99.6	14989	19.2	77848	99.7	15112	19.3	222	0.3
46915	97.2	27179	56.3	47516	98.4	27780	57.5	47896	99.2	28160	58.3	48221	99.9	28485	59.0	48261	100.0	28526	59.1	21	0.0
352274	95.2	75423	20.4	359415	97.2	82564	22.4	364107	98.4	87256	23.6	368006	99.5	91155	24.7	369394	99.9	92543	25.1	544	0.1
170276	96.7	35370	20.1	172615	98.0	37709	21.4	174385	99.0	39479	22.4	175740	99.8	40834	23.2	176101	100.0	41195	23.4	70	0.0
61268	93.5	14450	22.1	63341	96.6	16523	25.2	64539	98.4	17721	27.0	65255	99.5	18437	28.1	65468	99.9	18650	28.5	88	0.1
4253	97.2	1628	37.2	4287	98.0	1662	38.0	4307	98.4	1682	38.4	4353	99.5	1728	39.5	4369	99.8	1744	39.8	8	0.2
5663	97.9	1479	25.5	5711	98.8	1527	26.4	5725	99.0	1541	26.6	5777	99.9	1593	27.5	5781	100.0	1597	27.6	2	0.0
36678	97.1	8099	21.4	37160	98.4	8581	22.7	37314	98.8	8735	23.1	37554	99.4	8975	23.7	37649	99.7	9070	24.0	118	0.3
83521	92.4	17290	19.1	86513	95.8	20282	22.5	88076	97.5	21845	24.2	89480	99.0	23249	25.7	90119	99.8	23888	26.5	224	0.2
266848	96.3	9344	3.4	269971	97.4	12467	4.5	273028	98.5	15524	5.6	275587	99.5	18083	6.6	276642	99.9	19138	7.0	405	0.1
183531	97.3	5437	2.9	185348	98.2	7254	3.8	187018	99.1	8924	4.7	188033	99.6	9939	5.2	188515	99.9	10421	5.5	187	0.1
83317	94.3	3907	4.4	84623	95.8	5213	5.9	86010	97.4	6600	7.5	87551	99.1	8141	9.2	88124	99.8	8714	9.9	218	0.2
261931	95.7	16621	6.1	265864	97.1	20554	7.5	269239	98.4	23929	8.8	272103	99.4	26793	9.8	273289	99.8	27979	10.2	465	0.2
76410	92.9	58791	71.5	79647	96.9	62028	75.5	80941	98.4	63322	77.0	81951	99.7	64332	28.3	82152	99.9	64532	78.5	85	0.1
640001	96.4	158852	23.9	649496	97.8	168347	25.3	655575	98.7	174426	26.3	661192	99.6	180043	27.1	663143	99.9	181994	27.4	879	0.1
289886	97.3	70717	23.7	293119	98.3	73950	24.8	295432	99.1	76303	25.6	297433	99.8	78264	26.3	297901	100.0	78732	26.4	141	0.0
118308	95.7	30592	24.9	120886	97.7	33170	27.0	122365	98.9	34649	28.0	123297	99.7	35581	28.8	123559	99.9	35843	29.0	120	0.1
16370	95.1	5142	29.9	16715	97.1	5487	31.9	16820	97.8	5592	32.5	17066	99.2	5838	33.9	17166	99.8	5938	34.5	40	0.2
13558	97.9	3894	28.1	13681	98.8	4017	29.0	13721	99.1	4057	29.3	13820	99.8	4156	30.0	13835	99.9	4171	30.1	10	0.1
83455	98.1	20071	23.6	84051	98.8	20658	24.3	84298	99.1	20914	24.6	84727	99.6	21343	25.1	84864	99.8	21480	25.2	165	0.2
147798	94.1	37222	23.7	151601	96.5	41025	26.1	153587	97.8	43011	27.4	155684	99.1	45108	28.7	156685	99.7	46109	29.3	407	0.3
334700	96.1	31679	9.1	338896	97.3	35875	10.3	342680	98.3	39659	11.3	346253	99.4	43232	12.4	347769	99.8	44748	12.8	671	0.2
207965	96.6	18649	8.6	210613	97.9	21297	9.9	212710	98.8	23394	10.8	214136	99.5	24820	11.5	214874	99.9	25558	11.9	315	0.1
126435	94.9	12730	9.6	128283	96.3	14578	11.0	129970	97.5	16265	12.2	132114	99.1	18409	13.8	132892	99.7	19187	14.4	356	0.3
395169	96.1	54811	13.3	400501	97.4	60143	14.6	404704	98.4	64346	15.6	408724	99.4	68366	16.6	410408	99.8	70050	17.0	757	0.2
230785	96.6	103913	43.5	235007	98.4	108135	45.3	236892	99.2	110020	46.1	238460	99.8	111588	46.7	238729	99.9	111857	46.8	129	0.1

[4] Chattanooga is the only city in this classification, but all the cities in this class are included in the combined social-recreation purpose.

[5] Humboldt, Rogersville, Sturgeon Bay, Sheboygan, Chattanooga, Athens, Columbia, Dyersburg, Morristown, and West Bend are the only cities in this classification, but all the cities in this class are included in the combined social-recreation purpose.

TABLE C-2

SUMMARIES OF THE 22 INDIVIDUAL CITIES IN THE STUDY

Time Distribution of	(1) Trips	(2) % of Total	(3) Avg. Trip Len. (Min.)	(4) Avg. No. of Cos. Attra. Trips	(5) Trips to Adj. Cos. Trips	(6) % of Total	(7) Trips Within 35 min. Trips	(8) % of Total	(9) Trips > 35 min. Trips	(10) % of Total	(11) Avg. Trip Len. (Min.)	(12) Trips Within 1 hr. Trips	(13) % of Total	(14) Trips Within 35 min. to 1 hr. Trips	(15) % of Total	(16) Trips Within 2 hrs. Trips	(17) % of Total	(18) Trips Within 35 min. to 2 hrs. Trips	(19) % of Total
HUMBOLDT, TENNESSEE, STUDY AREA																			
All Purpose Trips	7032	100.0	30.5	91	6496	92.4	6253	88.9	779	11.1	199.9	6431	91.5	178	2.5	6679	95.0	426	6.1
Purpose 1 Work Trips	2652	37.7	20.5	31	2047	77.2	2432	91.7	220	8.3	136.7	1567	59.1	59	2.2	2585	97.5	153	5.8
Purpose 2 Business Trips	2495	35.5	27.1	43	1956	78.4	2175	87.2	320	12.8	155.4	2241	89.8	66	2.6	2349	94.2	174	7.0
Purpose 3 Recr. Trips	927	13.2	83.3	50	638	68.8	749	80.8	178	19.2	396.5	770	83.1	21	2.3	800	86.3	51	5.5
Purpose 4 Social Trips	148	2.1	24.1	8	87	58.8	134	90.5	14	9.5	100.7	140	94.6	6	4.1	146	98.6	12	8.1
Purpose 5 Other Trips	811	11.5	14.1	14	652	80.4	766	94.5	45	5.5	84.2	792	97.6	26	3.2	799	98.5	33	4.1
Purpose 3-4 Soc.-Rec. Trips	1075	15.3	73.1	51	725	10.3	883	82.1	192	17.9	374.9	910	84.7	27	0.4	946	88.0	63	5.9
Trips to SMSA's	199	2.8	337.5	26	0	0.0	0	0.0	199	100.0	337.5	0	0.0	0	0.0	0	0.0	0	0.0
Trips to SMSA > 1,000,000	13	0.2	780.0	8	0	0.0	0	0.0	13	100.0	780.0	0	0.0	0	0.0	0	0.0	0	0.0
Trips to SMSA < 1,000,000	186	2.6	306.6	18	0	0.0	0	0.0	186	100.0	306.6	0	0.0	0	0.0	0	0.0	0	0.0
Trips to Cos. > 50,000	1336	19.0	86.1	35	1116	83.5	1116	83.5	220	16.5	368.5	1116	83.5	0	0.0	1116	83.5	0	0.0
Trips to Cos. < 50,000[1]	5707	81.2	18.3	59	5380	94.3	5137	90.0	570	10.0	139.2	5315	93.1	178	3.1	5563	97.5	426	7.5
ROGERSVILLE, TENNESSEE, STUDY AREA																			
All Purpose Trips	8869	100.0	31.9	102	7977	89.9	7468	84.2	1401	15.8	190.3	8033	90.6	565	6.4	8608	97.1	1140	12.9
Purpose 1 Work Trips	3063	35.9	20.2	34	2894	94.5	2576	84.1	487	15.9	114.9	2830	92.4	254	8.3	3012	98.3	436	14.2
Purpose 2 Business Trips	3811	44.7	24.6	45	3609	94.7	3217	84.4	594	15.6	144.2	3444	90.4	227	6.0	3743	98.2	526	13.8
Purpose 3 Recr. Trips	795	9.0	144.2	70	626	78.7	570	71.7	225	28.3	503.2	610	76.7	40	5.0	662	83.3	92	11.6
Purpose 4 Soc. Trips	72	0.8	116.7	5	71	98.6	62	86.1	10	13.9	42.0	69	95.8	7	9.7	72	100.0	10	13.9
Purpose 5 Other Trips	1123	13.2	11.1	14	1097	97.7	1042	92.8	81	7.2	139.6	1078	96.0	36	3.2	1114	99.2	72	6.4
Purpose 3-4 Soc.-Rec. Trips	867	9.8	133.2	70	697	80.4	632	72.9	235	27.1	483.6	679	78.3	47	5.4	734	84.7	102	11.8
Trips to SMSA's	295	3.5	429.2	38	0	0.0	0	0.0	295	100.0	429.2	0	0.0	0	0.0	164	55.6	164	55.6
Trips to SMSA's > 1,000,000	25	0.3	1037.2	8	0	0.0	0	0.0	25	100.0	1037.2	0	0.0	0	0.0	0	0.0	0	0.0
Trips to SMSA's < 1,000,000	270	3.2	372.8	30	0	0.0	0	0.0	270	100.0	372.8	0	0.0	0	0.0	164	60.7	164	60.7
Trips to Cos. > 50,000	941	11.0	192.8	51	617	65.6	0	0.0	941	100.0	192.8	498	52.9	498	52.9	788	83.7	788	83.7
Trips to Cos. < 50,000[1]	7931	93.0	12.9	55	7691	97.0	7468	94.2	463	5.8	185.7	7535	95.0	67	0.8	7820	98.6	352	4.4
BURLINGTON, WISCONSIN, STUDY AREA																			
All Purpose Trips	11773	100.0	25.4	100	11008	93.5	8225	69.7	3548	30.3	74.0	11132	94.6	2907	24.9	11583	98.4	3358	28.7
Purpose 1 Work Trips	5489	46.6	28.0	65	5080	92.5	3745	68.2	1744	31.8	77.2	5141	93.7	1396	25.5	5376	98.0	1633	29.8
Purpose 2 Business Trips	1268	10.8	19.3	22	1229	96.9	956	75.4	312	24.6	68.8	1234	97.3	278	21.9	1253	98.8	297	23.4
Purpose 3 Recr. Trips[2]																			
Purpose 4 Soc. Trips[2]																			
Purpose 5 Other Trips	2590	22.0	19.5	14	2531	97.7	1866	72.0	724	28.0	60.9	2550	98.5	684	26.5	2586	99.8	720	26.8
Purpose 3-4 Soc.-Rec. Trips	2426	20.6	29.1	49	2169	89.4	1659	68.4	767	31.6	79.7	2207	91.0	548	22.6	2368	97.6	709	29.2
Trips to SMSA's	9006	77.4	11.9	37	8468	94.0	8225	91.3	781	8.7	91.2	8584	95.3	359	4.0	8922	99.1	697	7.8
Trips to SMSA's > 1,000,000	1611	13.6	42.9	15	1145	71.1	902	56.0	709	44.0	71.9	1261	78.3	359	22.3	1595	99.0	693	43.1
Trips to SMSA's < 1,000,000	7395	62.5	5.2	21	7323	99.0	7323	99.0	72	1.0	272.9	7323	99.0	0	0.0	7327	99.1	4	0.1
Trips to Cos. > 50,000	11681	99.2	23.9	56	11008	94.2	8225	70.4	3456	29.6	70.0	11124	95.2	2899	24.8	11562	99.0	3337	28.6
Trips to Cos. < 50,000[1]	91	0.1	221.0	40	0	0.0	0	0.0	91	100.0	218.0	8	8.8	8	8.8	21	23.1	21	23.1
ELKHORN, WISCONSIN, STUDY AREA																			
All Purpose Trips	8047	100.0	60.6	191	6349	78.9	5605	69.7	2442	30.3	199.5	6281	78.1	676	8.4	7519	93.4	1914	23.7
Purpose 1 Work Trips	3049	37.9	36.2	67	2583	84.7	2209	72.5	840	27.5	130.7	2560	84.0	351	11.5	2946	96.6	737	24.1
Purpose 2 Business Trips	966	12.0	30.8	34	822	85.1	709	73.4	257	26.6	114.4	809	83.7	100	10.3	942	97.5	233	24.1
Purpose 3 Recr. Trips[2]																			
Purpose 4 Soc. Trips[2]																			
Purpose 5 Other Trips	1328	16.5	6.7	16	59	4.4	1237	93.1	91	6.9	92.3	1295	97.5	58	4.4	1323	99.6	86	6.5
Purpose 3-4 Soc.-Rec. Trips	2692	33.5	123.4	149	1646	61.1	1449	53.8	1243	46.2	266.9	1617	60.1	168	6.3	2306	85.7	857	31.9
Trips to SMSA's	2076	25.8	209.7	106	498	24.0	0	0.0	2076	100.0	206.1	387	18.6	387	18.6	852	41.0	852	41.0
Trips to SMSA's > 1,000,000	1383	17.2	202.7	35	115	8.3	0	0.0	1383	100.0	202.7	67	4.8	67	4.8	373	27.0	373	27.0
Trips to SMSA's < 1,000,000	693	8.6	223.8	68	383	9.1	0	0.0	693	100.0	223.8	320	46.2	320	46.2	479	69.1	479	69.1
Trips to Cos. > 50,000	7971	99.0	57.9	134	6344	79.6	5605	70.3	2366	29.7	195.0	6233	78.2	628	7.9	6703	84.1	1098	13.8
Trips to Cos. < 50,000[1]	76	1.0	418.8	56	5	6.3	0	0.0	76	100.0	418.8	0	0.0	0	0.0	12	15.8	12	15.8
LAKE GENEVA, WISCONSIN, STUDY AREA																			
All Purpose Trips	12188	100.0	63.2	175	8674	71.2	7043	57.8	5145	42.2	149.6	7976	65.4	933	7.6	9412	77.2	2369	19.4
Purpose 1 Work Trips	3247	26.6	39.6	55	2683	82.6	2146	66.1	1101	33.9	116.6	2518	77.5	372	11.4	2868	88.3	722	22.2
Purpose 2 Business Trips	872	7.2	62.7	39	642	73.6	493	56.5	379	43.5	144.1	596	68.3	103	11.8	717	82.2	224	25.7
Purpose 3 Recr. Trips[2]																			
Purpose 4 Soc. Trips[2]																			
Purpose 5 Other Trips	2542	20.9	20.8	26	2298	90.4	2017	79.3	525	20.7	99.4	2137	84.1	120	4.8	2386	93.9	369	14.6
Purpose 3-4 Soc.-Rec. Trips	5521	45.3	95.9	150	3055	55.3	2387	43.2	3134	56.8	168.9	2727	49.4	340	6.2	3443	62.4	1056	19.2
Trips to SMSA's	4783	39.2	148.1	93	1422	29.7	0	0.0	4783	100.0	148.1	733	15.3	733	15.3	2133	44.6	2133	44.6
Trips to SMSA's > 1,000,000	3226	26.5	157.4	31	228	7.1	0	0.0	3226	100.0	157.4	54	1.7	54	1.7	784	24.3	784	24.3
Trips to SMSA's < 1,000,000	1557	12.8	128.7	60	1194	76.8	0	0.0	1557	100.0	128.7	679	43.7	679	43.7	1349	86.8	1349	86.8
Trips to Cos. > 50,000	12087	99.1	60.9	124	8664	71.7	7043	58.3	5044	41.7	146.1	7975	66.0	932	7.7	9379	77.6	2336	19.3
Trips to Cos. < 50,000[1]	98	0.8	307.5	49	10	10.2	0	0.0	98	100.0	307.5	1	1.0	1	1.0	33	33.7	33	33.7
MONROE, WISCONSIN, STUDY AREA																			
All Purpose Trips	9596	100.0	32.0	119	8936	93.1	5668	59.1	3928	40.9	78.2	8215	85.6	2547	26.5	9196	95.8	3528	36.7
Purpose 1 Work Trips	4508	46.9	32.4	76	4183	92.7	2735	60.7	1773	29.3	82.2	3816	84.7	1081	24.0	4291	95.2	1556	34.5
Purpose 2 Business Trips	741	7.7	24.1	15	708	95.5	482	65.0	259	35.0	67.2	682	92.0	200	27.0	721	97.3	239	32.3
Purpose 3 Recr. Trips[2]																			
Purpose 4 Soc. Trips[2]																			
Purpose 5 Other Trips	2334	24.3	27.2	28	2226	95.3	1304	55.9	1030	44.1	61.2	2055	88.0	751	32.1	2301	98.6	997	42.7
Purpose 3-4 Soc.-Rec. Trips	2016	21.0	40.0	71	1819	90.2	1147	56.9	869	43.1	92.5	1664	82.5	517	25.6	1885	93.5	738	36.6
Trips to SMSA's	934	9.7	121.0	45	670	71.7	0	0.0	934	100.0	121.0	0	0.0	0	0.0	688	73.7	688	73.7
Trips to SMSA's > 1,000,000	184	1.9	219.7	15	0	0.0	0	0.0	184	100.0	129.7	0	0.0	0	0.0	0	0.0	0	0.0
Trips to SMSA's < 1,000,000	750	7.8	96.8	30	670	89.4	0	0.0	750	100.0	96.8	0	0.0	0	0.0	688	91.8	688	91.8
Trips to Cos. > 50,000	1530	15.9	102.8	67	1157	75.6	0	0.0	1530	100.0	102.8	487	31.8	487	31.8	1217	79.5	1217	79.5
Trips to Cos. < 50,000[1]	8066	84.1	18.6	52	7779	96.4	5668	70.3	2398	29.7	62.2	7728	95.8	2060	25.5	7979	98.9	2311	28.6

(20) Trips Within 4 hrs.	(21)	(22) Trips Within 35 min. to 4 hrs	(23)	(24) Trips Within 6 hrs.	(25)	(26) Trips Within 35 min. to 6 hrs	(27)	(28) Trips Within 8 hrs.	(29)	(30) Trips Within 35 min. to 8 hrs.	(31)	(32) Trips Within 16 hrs.	(33)	(34) Trips Within 35 min. to 16 hrs.	(35)	(36) Trips Within 24 hrs.	(37)	(38) Trips Within 35 min. to 24 hrs.	(39)	(40) Trips > 24 hrs.	(41)
Trips	% of Total	Trips	% of Total	Trips	% of Total	Trips	% of Total	Trips	% of Total	Trips	% of Total	Trips	% of Total	Trips	% of Total	Trips	% of Total	Trips	% of Total	Trips	% of Total
22716	98.9	6377	27.8	22813	99.3	6474	28.2	22846	99.5	6507	28.4	22942	99.9	6603	28.8	22964	100.0	6625	28.9	6	0.0
10472	99.0	2752	26.0	10507	99.4	2787	26.4	10517	99.5	2797	26.5	10556	99.8	2836	26.8	10572	100.0	2852	27.0	2	0.0
6548	99.1	2059	31.2	6583	99.6	2094	31.7	6591	99.7	2102	31.8	6608	100.0	2119	32.1	6609	100.0	2120	32.1	0	0.0
1756	96.5	561	30.3	1772	97.4	577	31.7	1784	98.1	589	32.4	1811	99.5	616	33.8	1816	99.7	621	34.1	4	0.2
946	98.6	261	27.2	949	99.0	264	27.5	951	99.2	266	27.7	859	100.0	274	28.6	959	100.0	274	28.6	0	0.0
2989	99.7	735	24.5	2993	99.9	739	24.7	2994	99.9	740	24.7	2997	100.0	743	24.9	2997	100.0	743	24.9	0	0.0
2702	97.2	822	29.6	2721	97.9	841	30.3	2735	98.4	855	30.8	2770	99.7	890	32.0	2775	99.9	895	32.2	4	0.1
1008	90.1	1008	90.1	1042	93.1	1042	93.1	1061	94.8	1061	94.8	1101	98.4	1101	98.4	1117	99.8	1117	99.8	2	0.2
0	0.0	0	0.0	10	27.8	10	27.8	14	38.9	14	38.9	33	91.7	33	91.7	35	97.2	35	97.2	1	2.8
1008	93.1	1008	93.1	1032	95.3	1032	95.3	1047	96.7	1047	96.7	1068	98.6	1068	98.6	1082	99.9	1082	99.9	1	0.7
1124	87.1	1124	87.1	1190	92.2	1190	92.2	1212	93.9	1212	93.9	1268	98.2	1268	98.2	1286	99.6	1286	99.6	5	0.4
21485	99.5	5146	23.8	21538	99.7	5199	24.1	21549	99.8	5210	24.1	21592	100.0	5253	24.3	21596	100.0	5257	24.3	4	0.0
13876	99.4	4039	28.9	13904	99.6	4067	29.1	13931	99.8	4094	29.3	13945	99.9	4108	29.4	13951	100.0	4114	29.5	4	0.0
6452	99.6	2088	32.3	6459	99.7	2095	32.4	6468	99.8	2104	32.5	6474	99.9	2110	32.6	6477	99.9	2113	32.6	3	0.1
1254	99.4	279	22.1	1257	99.6	282	22.3	1261	99.9	286	22.6	1262	100.0	287	22.7	1262	100.0	287	22.7	0	0.0
1664	99.0	644	38.3	1670	99.4	650	38.7	1677	99.8	657	39.1	1678	99.9	658	39.2	1680	100.0	660	39.3	0	0.0
1716	98.7	467	26.9	1726	99.3	477	27.5	1731	99.5	482	27.7	1737	99.9	488	28.1	1738	100.0	489	28.2	1	0.0
2781	99.9	551	19.8	2783	99.9	553	19.8	2785	100.0	555	19.9	2785	100.0	555	19.9	2785	100.0	555	19.9	0	0.0
3380	98.9	1111	32.5	3396	99.3	1127	32.9	3408	99.7	1139	33.3	3415	99.9	1146	33.5	3418	100.0	1149	33.6	1	0.0
2377	98.8	2377	98.8	2378	98.8	2378	98.8	2391	99.4	2391	99.4	2399	99.7	2399	99.7	2403	99.9	2403	99.9	3	0.1
2285	99.6	2285	99.6	2285	99.6	2285	99.6	2293	99.7	2293	99.7	2296	99.9	2296	99.9	2298	100.0	2298	100.0	1	0.0
92	86.0	92	86.0	93	86.9	93	86.9	98	91.6	98	91.6	103	96.3	103	96.3	105	98.1	105	98.1	2	1.9
3963	99.1	3963	99.1	3969	99.3	3969	99.3	3981	99.6	3981	99.6	3989	99.8	3989	99.8	3995	99.9	3995	99.9	3	0.1
9913	99.6	76	0.8	9935	99.8	98	1.0	9949	99.9	112	1.1	9955	100.0	118	1.2	9955	100.0	118	1.2	1	0.0
32951	97.9	11527	34.3	33347	99.0	11923	35.4	33494	99.5	12070	35.9	33619	99.8	12195	36.2	33645	99.9	12221	36.3	28	0.1
16633	97.5	6508	38.2	16890	99.0	6765	39.7	16981	99.5	6856	40.2	17044	99.9	6919	40.6	17056	99.9	6931	40.6	12	0.1
2946	98.1	989	33.0	2981	99.2	1024	34.1	2996	99.7	1039	34.6	3000	99.9	1043	34.8	3003	100.0	1046	34.9	1	0.0
6094	99.5	1831	29.9	6106	99.7	1843	30.1	6110	99.8	1847	30.2	6117	99.9	1854	30.3	6118	99.9	1855	30.3	5	0.1
7274	97.5	2195	29.4	7359	98.6	2280	30.5	7391	99.1	2312	31.0	7441	99.7	2362	31.6	7451	99.9	2372	31.8	9	0.1
17837	97.8	771	4.3	18078	99.1	1012	5.6	18143	99.4	1077	5.9	18210	99.8	1144	6.3	18229	99.9	1163	6.4	18	0.1
585	65.5	585	65.5	814	91.2	814	91.2	860	96.3	860	96.3	879	98.4	879	98.4	885	99.1	885	99.1	8	0.9
17252	99.4	186	1.0	17264	99.5	198	1.1	17283	99.6	217	1.2	17331	99.9	225	1.5	17344	100.0	276	1.5	10	0.0
24804	98.0	3380	13.3	25101	99.2	3677	14.5	25177	99.5	3753	14.8	25267	99.8	3843	15.1	25288	99.9	3864	15.2	20	0.1
8147	97.2	8147	97.2	8246	98.4	8246	98.4	8319	99.3	8319	99.3	8364	99.8	8364	99.8	8370	99.9	8370	99.9	8	0.1
18131	98.4	6658	36.0	18310	99.0	6777	36.6	18366	99.3	6833	36.9	18451	99.8	6918	37.4	18471	99.9	6938	37.5	20	0.1
9575	98.5	3947	40.6	9624	99.0	3996	41.1	9648	99.3	4020	41.4	9701	99.8	4073	41.9	9707	99.9	4079	42.0	10	0.1
1592	99.2	486	30.3	1599	99.6	493	30.7	1601	99.7	495	30.8	1603	99.8	497	30.9	1605	99.9	499	31.0	1	0.1
1771	96.7	462	25.2	1812	98.9	503	27.4	1819	99.3	510	27.8	1826	99.7	517	28.2	1828	99.8	519	28.3	4	0.2
2175	97.4	807	36.2	2187	97.9	819	36.7	2203	98.6	835	37.4	2220	99.4	852	38.2	2229	99.8	861	38.6	5	0.2
3083	99.4	958	30.9	3090	99.6	965	31.1	3097	99.8	972	31.3	3101	100.0	976	31.5	3102	100.0	977	31.5	0	0.0
3946	97.0	1269	31.2	3999	98.4	1322	32.6	4022	98.9	1345	33.1	4046	99.5	1369	33.7	4057	99.8	1380	34.0	9	0.2
2046	95.1	2046	95.1	2062	95.3	2062	95.3	2076	99.5	2076	99.5	2131	99.0	2131	99.0	2140	99.4	2140	99.4	12	0.6
1656	97.5	1656	97.5	1657	97.5	1657	97.5	1657	97.5	1657	97.5	1701	99.5	1701	99.5	1704	99.7	1704	99.7	5	0.3
390	88.4	390	88.4	405	91.8	405	91.8	419	95.0	419	95.0	430	97.1	430	97.1	436	98.4	436	98.4	7	1.6
16920	99.0	5387	31.5	16968	99.3	5435	31.8	16994	99.5	5461	32.0	17054	99.8	5521	32.3	17068	99.9	5535	32.4	17	0.1
1271	90.1	1271	90.1	1342	95.2	1342	95.2	1373	97.4	1373	97.4	1398	99.2	1398	99.2	1406	99.7	1406	99.7	4	0.3
38194	97.1	10133	25.8	38647	98.3	10586	26.9	38924	99.0	10863	27.6	39161	99.6	11100	28.2	39219	99.7	11158	28.4	106	0.3
14579	97.1	3606	24.0	14749	98.3	3776	25.2	14895	99.2	3922	26.1	14985	99.8	4012	26.7	15004	100.0	4031	26.9	7	0.0
7719	96.9	2246	28.2	7853	98.6	2380	29.9	7917	99.4	2444	30.7	7949	99.8	2476	31.1	7955	99.9	2482	31.2	8	0.1
5020	99.1	1663	32.8	5044	99.0	1687	33.3	5054	99.8	1697	33.5	5059	99.9	1702	33.6	5063	99.9	1706	33.6	3	0.1
10863	96.4	2604	23.1	10985	97.5	2726	24.2	11041	98.0	2782	24.7	11150	98.9	2891	25.6	11181	99.2	2922	25.9	87	0.8
1001	58.2	1001	58.2	1272	74.0	1272	74.0	1446	84.1	1446	84.1	1586	92.2	1586	92.2	1626	94.5	1626	94.5	94	5.5
292	45.3	292	45.3	345	53.6	345	53.6	506	78.6	506	78.6	567	87.9	567	87.9	585	90.7	585	90.7	60	9.3
709	66.0	709	66.0	927	86.2	927	86.2	940	87.4	940	87.4	1019	94.8	1019	94.8	1041	96.8	1041	96.8	34	3.2
20944	96.5	1071	5.0	21232	97.8	1359	6.3	21420	98.6	1547	7.1	21568	99.3	1695	7.8	21615	99.5	1742	8.0	101	0.5
17235	98.0	9047	51.5	17399	98.9	9211	52.4	17488	99.4	9300	52.9	17574	99.9	9386	53.4	17585	100.0	9397	53.5	5	0.0
33509	96.1	12055	34.6	33892	97.2	12438	35.7	34275	98.3	12821	36.8	34725	99.6	13271	38.1	34781	99.8	13327	38.3	88	0.2
12676	95.8	4522	34.2	12839	97.0	4685	35.4	13020	98.4	4866	36.8	13196	99.7	5042	38.1	13209	99.8	5055	38.2	23	0.2
8702	96.7	3582	39.2	8827	98.1	3707	41.2	8911	99.0	3791	42.1	8990	99.9	3870	43.0	8994	99.9	3874	43.0	8	0.1
3735	92.8	1545	38.4	3763	93.5	1573	39.1	3819	94.7	1629	40.3	3958	98.3	1768	43.9	3988	99.1	1798	44.7	38	0.9
8409	97.5	2417	28.0	8476	98.3	2484	28.8	8538	99.0	2546	29.5	8596	99.7	2604	30.2	8605	99.8	2613	30.3	19	0.2
13225	95.6	3319	24.0	13285	96.0	3379	24.4	13472	97.4	3566	25.8	13718	99.1	3812	27.5	13759	99.4	3853	27.8	80	0.6
3116	93.4	3116	93.4	3116	93.4	3116	93.4	3206	96.1	3206	96.1	3290	98.6	3290	98.6	3296	98.8	3296	98.8	40	1.2
10109	96.2	203	1.9	10169	96.8	263	2.5	10266	97.7	360	3.4	10428	99.3	522	5.0	10463	99.6	557	5.3	40	0.4
13247	94.9	3341	23.9	13363	95.7	3457	24.7	13555	97.1	3649	26.1	13836	99.1	3930	28.1	13877	99.4	3971	28.4	84	0.6
20262	96.9	8714	41.7	20529	98.2	8981	43.0	20716	99.1	9168	43.9	20885	99.9	9337	44.7	20900	100.0	9352	44.8	4	0.0

TABLE C-2 ***(Continued)***

Time Distribution of	(1) Trips	(2) % of Total	(3) Avg. Trip Len. (Min.)	(4) Avg. No. of Cos. Attra. Trips	(5) Trips to Adj. Cos. Trips	(6) Trips to Adj. Cos. % of Total	(7) Trips Within 35 min. Trips	(8) Trips Within 35 min. % of Total	(9) Trips > 35 min. Trips	(10) Trips > 35 min. % of Total	(11) Trips > 35 min. Avg. Trip Len. (Min.)	(12) Trips Within 1 hr. Trips	(13) Trips Within 1 hr. % of Total	(14) Trips Within 35 min. to 1 hr. Trips	(15) Trips Within 35 min. to 1 hr. % of Total	(16) Trips Within 2 hrs. Trips	(17) Trips Within 2 hrs. % of Total	(18) Trips Within 35 min. to 2 hrs Trips	(19) Trips Within 35 min. to 2 hrs % of Total
CHATTANOOGA, TENNESSEE, STUDY AREA																			
All Purpose Trips	58491	100.0	77.2	394	48894	83.6	20880	67.2	19154	32.8	131.8	48512	82.9	9175	15.7	53823	92.0	14486	24.8
Purpose 1 Work Trips	34229	58.5	52.6	269	27808	81.2	22050	64.4	12179	35.6	123.9	27506	80.4	5456	16.0	30973	90.5	8923	26.1
Purpose 2 Business Trips	8402	14.4	43.3	100	7284	86.7	5781	68.8	2621	31.2	104.0	7238	86.2	1457	17.4	7998	95.2	2217	26.4
Purpose 3 Recr. Trips	4377	7.5	60.5	100	3329	76.1	2625	60.0	1752	40.0	130.1	3349	76.5	724	16.5	3973	90.8	1348	30.8
Purpose 4 Social Trips	5783	9.9	43.6	105	5027	86.9	4184	72.4	1599	27.6	113.7	4979	86.1	795	13.7	5471	94.6	1287	22.2
Purpose 5 Other Trips	5827	10.0	31.1	55	5372	92.2	4608	79.1	1219	20.9	85.7	5369	92.1	761	13.0	5737	98.5	1129	19.4
Purpose 3-4 Soc.-Rec. Trips	10160	17.4	50.9	155	8356	82.2	6809	67.0	3351	33.0	122.3	8328	82.0	1519	15.0	9444	93.0	2635	26.0
Trips to SMSA's	35416	60.5	40.6	104	32378	91.4	32378	91.4	3038	8.6	335.7	32378	91.4	0	0.0	32378	91.4	0	0.0
Trips to SMSA > 1,000,000	988	2.5	346.8	28	0	0.0	0	0.0	988	100.0	346.8	0	0.0	0	0.0	0	0.0	0	0.0
Trips to SMSA < 1,000,000	34428	58.9	31.8	70	32378	94.0	32378	94.0	2050	6.0	330.4	32378	94.0	0	0.0	32378	94.0	0	0.0
Trips to Cos. > 50,000	22153	37.9	55.7	152	18457	83.3	18457	83.3	3696	16.7	333.8	18457	83.3	0	0.0	18739	84.6	282	1.3
Trips to Cos. < 50,000[1]	22447	56.1	64.7	242	17084	76.1	6959	31.0	15488	69.0	83.3	16134	71.9	9175	40.9	21163	94.3	14204	63.3
MADISON, WISCONSIN, STUDY AREA																			
All Purpose Trips	56711	100.0	62.2	588	43940	77.5	30940	54.6	25771	45.4	134.9	41712	73.6	10772	19.0	47265	83.3	16325	28.7
Purpose 1 Work Trips	31793	56.1	58.1	373	24747	77.8	17309	54.4	14484	45.6	125.5	23528	74.0	6219	19.6	26584	83.6	9275	29.2
Purpose 2 Business Trips	4680	8.2	59.6	151	3622	77.4	2600	55.6	2080	44.4	131.6	3426	73.2	826	17.6	3899	83.3	1299	27.7
Purpose 3 Recr. Trips[2]																			
Purpose 4 Social Trips[2]																			
Purpose 5 Other Trips	8429	14.9	40.9	115	7051	83.6	5069	60.1	3360	39.9	100.0	6624	78.6	1555	18.5	7582	90.0	2513	29.9
Purpose 3-4 Soc.-Rec. Trips	11831	20.9	91.5	395	8524	72.0	5962	50.4	5869	49.6	182.9	8137	68.8	2175	18.4	9203	77.8	3241	27.4
Trips to SMSA's	36159	63.7	45.2	182	29213	80.8	29213	80.8	6946	9.2	235.4	29213	80.8	0	0.0	30150	83.4	937	2.6
Trips to SMSA > 1,000,000	5178	9.1	208.5	59	0	0.0	0	0.0	5178	100.0	208.5	0	0.0	0	0.0	502	9.7	502	9.7
Trips to SMSA < 1,000,000	30981	54.6	17.9	122	29213	94.3	29213	94.3	1768	5.7	314.3	29213	94.3	0	0.0	29648	95.7	435	1.4
Trips to Cos. > 50,000	43510	76.7	52.9	294	34488	79.3	30940	71.1	12570	28.9	179.0	33412	76.8	2472	5.7	35888	82.5	4948	11.4
Trips to Cos. < 50,000[1]	13189	23.3	93.0	302	9452	71.7	0	0.0	13189	100.0	93.0	8300	62.9	8300	62.9	11377	86.3	11377	86.3
SPRINGFIELD, MISSOURI, STUDY AREA																			
All Purpose Trips	41919	100.0	63.0	419	31661	75.5	28479	67.9	13440	32.1	176.4	31251	74.6	2772	6.7	37769	90.1	9290	22.2
Purpose 1 Work Trips	12318	29.4	36.2	125	10643	86.4	9660	78.4	2658	21.6	133.6	10354	84.1	694	5.7	11682	94.8	2022	16.4
Purpose 2 Business Trips	13350	31.8	73.2	215	8885	66.6	7909	59.2	5441	40.8	165.0	8772	65.7	863	6.5	11498	86.1	3589	26.9
Purpose 3 Recr. Trips[2]																			
Purpose 4 Social Trips[2]																			
Purpose 5 Other Trips	6123	14.8	118.6	205	4133	67.5	3577	58.4	2546	41.6	270.7	4083	66.7	506	8.3	5190	84.8	1613	26.4
Purpose 3-4 Soc.-Rec. Trips	10127	24.2	45.5	148	8003	79.0	7335	72.4	2882	27.6	143.7	8045	79.4	711	7.0	9408	92.9	2074	20.5
Trips to SMSA's	19573	46.4	47.4	126	17819	91.0	17819	91.0	1754	9.0	529.9	17814	91.0	0	0.0	17819	91.0	0	0.0
Trips to SMSA > 1,000,000	1143	3.2	483.5	40	0	0.0	0	0.0	1143	100.0	481.9	0	0.0	0	0.0	0	0.0	0	0.0
Trips to SMSA < 1,000,000	18430	44.7	20.5	85	17819	97.1	17819	96.7	611	3.3	618.1	17819	96.7	0	0.0	17819	96.7	0	0.0
Trips to Cos. > 50,000	20520	48.3	54.0	159	17819	86.8	17819	86.9	2701	13.2	372.8	17819	86.9	0	0.0	18548	90.4	729	3.5
Trips to Cos. < 50,000[1]	21395	51.1	71.8	264	13842	64.7	10660	49.8	10735	50.2	118.2	13432	62.8	2772	13.0	19221	89.8	8561	40.0
ST. LOUIS, MISSOURI, STUDY AREA																			
All Purpose Trips	212817	100.0	53.8	1008	138161	64.9	178095	83.7	34722	16.3	232.8	186197	87.5	8102	3.8	192991	90.7	14896	7.0
Purpose 1 Work Trips	97831	46.0	41.4	469	66477	68.0	85887	87.8	11944	12.2	201.4	89672	91.7	3785	3.9	92035	94.1	6148	6.3
Purpose 2 Business Trips	39124	18.4	67.2	527	24190	61.8	30528	78.0	8596	22.0	240.3	31838	81.4	1310	3.4	33552	85.8	1714	4.4
Purpose 3 Recr. Trips[2]																			
Purpose 4 Social Trips[2]																			
Purpose 5 Other Trips	17388	8.2	32.0	192	12631	72.6	15325	88.1	2063	11.9	238.8	15842	91.1	517	3.0	16490	94.8	1165	6.7
Purpose 3-4 Soc.-Rec. Trips	58225	27.4	71.7	814	34633	59.5	46125	79.2	12100	20.8	273.2	48612	83.5	2487	4.3	50695	87.1	4570	7.9
Trips to SMSA's	185899	87.4	38.3	265	61069	32.9	178094	95.7	7805	4.3	482.3	178094	95.7	0	0.0	178094	95.7	0	0.0
Trips to SMSA > 1,000,000	181393	85.2	27.9	64	61069	33.7	178094	98.2	3299	1.8	510.3	178094	98.2	0	0.0	178094	98.2	0	0.0
Trips to SMSA < 1,000,000	4503	21.1	458.9	156	0	0.0	0	0.0	4503	100.0	458.9	0	0.0	0	0.0	0	0.0	0	0.0
Trips to Cos. > 50,000	187571	88.1	40.9	357	61069	32.6	178094	95.0	9477	5.1	512.7	178094	95.0	0	0.0	178094	95.0	0	0.0
Trips to Cos. < 50,000[1]	25206	11.8	148.8	639	205	0.8	0	0.0	25206	100.0	148.8	8102	32.1	8102	32.1	14896	59.1	14896	59.1

[1] These counties are not contained within a SMSA; all counties (27) less than 50,000 and within SMSA's were excluded.

[2] This type of trip was not coded separately for this city, but was included in the combined social-recreation purpose.

(20) Trips Within 4 hrs.	(21)	(22) Trips Within 35 min. to 4 hrs.	(23)	(24) Trips Within 6 hrs.	(25)	(26) Trips Within 35 min. to 6 hrs.	(27)	(28) Trips Within 8 hrs.	(29)	(30) Trips Within 35 min. to 8 hrs.	(31)	(32) Trips Within 16 hrs.	(33)	(34) Trips Within 35 min. to 16 hrs.	(35)	(36) Trips Within 24 hrs.	(37)	(38) Trips Within 35 min. to 24 hrs.	(39)	(40) Trips > 24 hrs.	(41)
Trips	% of Total	Trips	% of Total	Trips	% of Total	Trips	% of Total	Trips	% of Total	Trips	% of Total	Trips	% of Total	Trips	% of Total	Trips	% of Total	Trips	% of Total	Trips	% of Total
12961	99.4	2641	20.3	12977	99.5	2657	20.4	12998	99.6	2678	20.5	13035	99.9	2715	20.8	13041	100.0	2721	20.9	4	0.0
5694	99.7	1510	26.5	5698	99.7	1514	26.5	5703	99.8	1519	26.6	5713	100.0	1529	26.8	5713	100.0	1529	26.8	1	0.0
608	99.3	119	19.2	608	99.3	119	19.2	610	99.7	121	19.6	611	99.8	122	19.7	612	100.0	123	19.9	0	0.0
3035	99.6	357	11.7	3035	99.6	357	11.7	3035	99.6	357	11.7	3035	100.0	367	11.9	3046	100.0	368	11.9	0	0.0
3611	98.7	646	17.7	3623	99.0	658	18.0	3638	99.4	673	18.4	3652	99.8	687	18.8	3656	99.9	691	18.9	3	0.1
10573	99.7	253	2.3	10575	99.8	255	2.4	10582	99.8	262	2.4	10592	99.9	272	2.5	10597	99.9	277	2.5	4	0.1
10401	99.8	81	0.7	10401	99.8	81	0.7	10406	99.9	86	0.8	10411	99.9	91	0.8	10416	100.0	96	0.9	1	0.0
172	93.5	172	93.5	174	94.6	174	94.6	176	95.6	176	95.6	181	98.4	181	98.4	181	98.4	181	98.4	3	1.6
12780	99.7	2460	19.2	12786	99.8	2466	19.3	12794	99.9	2474	19.4	12804	99.9	2484	19.4	12809	100.0	2489	19.5	4	0.0
181	78.0	181	78.0	191	82.3	191	82.3	204	87.9	204	87.9	231	99.6	231	99.6	232	100.0	232	100.0	0	0.0
8230	95.8	2030	23.7	8524	99.2	2324	27.1	8543	99.4	2343	27.3	8580	99.8	2380	27.7	8585	99.9	2385	27.8	10	0.1
2362	97.3	414	17.1	2405	99.1	457	18.8	2409	99.3	461	19.0	2418	99.6	470	19.4	2422	99.8	474	19.5	5	0.2
726	99.2	124	16.9	729	99.6	127	17.3	729	99.6	127	17.3	730	99.7	128	17.5	730	99.7	128	17.5	2	0.3
2193	90.8	809	33.5	2383	98.7	999	41.4	2394	99.1	1010	41.8	2412	99.9	1028	42.6	2413	99.9	1029	42.6	2	0.1
1305	96.0	480	35.3	1349	99.3	524	38.6	1351	99.4	526	38.1	1358	99.9	533	39.2	1358	99.9	533	39.2	1	0.1
1639	99.2	197	11.9	1649	99.8	207	12.5	1650	99.9	208	12.6	1652	100.0	210	12.7	1652	100.0	210	12.7	0	0.0
3498	92.7	1289	34.1	3732	98.9	1523	40.4	3745	99.2	1536	40.7	3770	99.9	1561	41.4	3771	99.9	1562	41.4	3	0.1
904	78.0	904	78.0	1120	96.6	1120	96.6	1121	96.7	1121	96.7	1147	99.0	1147	99.0	1150	99.2	1150	99.2	9	0.8
183	48.8	183	48.8	355	94.7	355	94.7	355	94.7	355	94.7	370	98.7	370	98.7	373	99.5	373	99.5	2	0.5
721	92.0	721	92.0	765	97.6	765	97.6	766	97.7	766	97.7	777	99.1	777	99.1	777	99.1	777	99.1	7	0.1
1344	82.1	1344	82.1	1591	97.2	1591	97.2	1596	97.5	1596	97.5	1624	99.2	1624	99.2	1627	99.4	1627	99.4	10	0.6
6886	99.0	686	9.9	6933	99.6	733	10.5	6947	99.8	747	10.7	6956	100.0	756	10.9	6958	100.0	758	10.9	0	0.0
7539	98.2	2313	30.1	7630	99.4	2404	31.3	7644	99.6	2418	31.5	7663	99.8	2437	31.7	7674	100.0	2448	31.9	3	0.0
2752	99.1	830	29.9	2769	99.7	847	30.5	2770	99.7	848	30.5	2774	99.9	852	30.7	2777	100.0	855	30.8	1	0.0
742	97.8	271	35.7	753	99.2	282	37.2	757	99.7	286	37.7	758	99.9	287	37.8	759	100.0	288	37.9	0	0.0
1931	99.2	422	21.7	1943	99.8	434	22.3	1945	99.9	436	22.4	1946	100.0	437	22.5	1946	100.0	437	22.5	0	0.0
2114	96.4	789	36.0	2162	98.6	837	38.2	2170	98.0	845	38.6	2183	99.6	858	39.1	2190	99.9	865	39.5	2	0.1
306	75.9	306	75.9	366	90.8	366	90.8	376	93.3	376	93.3	391	97.0	391	97.0	401	99.5	401	99.5	2	0.5
155	66.8	155	66.8	213	91.8	213	91.8	219	94.4	219	94.4	224	96.6	224	96.6	232	100.0	232	100.0	0	0.0
151	88.3	151	88.3	153	89.5	153	89.5	157	91.8	157	91.8	167	97.7	167	97.7	169	98.8	169	98.8	2	1.2
1163	91.9	1163	91.9	1227	96.9	1227	96.9	1237	97.7	1237	97.7	1253	99.0	1253	99.0	1263	99.8	1263	99.8	3	0.2
6376	99.5	1150	17.9	6403	99.9	1177	18.4	6406	99.9	1180	18.4	6409	100.0	1183	18.5	6410	100.0	1184	18.5	0	0.0
15283	99.1	2699	17.5	15348	99.5	2764	17.9	15395	99.8	2811	18.2	15414	99.9	2830	18.3	15418	100.0	2834	18.4	3	0.0
5813	99.2	892	15.2	5840	99.7	919	15.7	5852	99.9	931	15.9	5856	99.9	935	15.9	5856	99.9	935	15.9	3	0.1
5964	99.0	1225	20.3	5996	99.5	1257	20.8	6019	99.9	1280	21.2	6025	100.0	1286	21.3	6025	100.0	1286	21.3	0	0.0
818	97.4	209	24.9	820	97.6	211	25.1	827	98.5	218	26.0	836	99.5	227	27.0	840	100.0	231	27.5	0	0.0
311	100.0	38	12.2	311	100.0	38	12.2	311	100.0	38	12.2	311	100.0	38	12.2	311	100.0	38	12.2	0	0.0
2381	99.7	338	14.2	2385	99.8	342	14.3	2389	100.0	346	14.5	2389	100.0	346	14.5	2389	100.0	346	14.5	0	0.0
1129	98.0	247	21.4	1131	98.2	249	21.6	1138	98.8	256	22.2	1147	99.6	265	23.0	1151	100.0	269	23.4	0	0.0
919	94.8	919	90.7	945	97.5	945	97.5	950	98.0	950	98.0	965	99.6	965	99.6	969	100.0	969	100.0	0	0.0
35	74.5	35	74.5	35	74.5	35	74.5	35	74.5	35	74.5	44	93.6	44	93.6	47	100.0	47	100.0	0	0.0
884	95.9	884	95.9	910	98.7	910	98.7	915	99.2	915	99.2	921	99.9	921	99.9	922	100.0	922	100.0	0	0.0
920	91.5	920	91.5	952	94.6	952	94.6	984	97.8	984	97.8	1001	99.5	1001	99.5	1005	99.9	1005	99.9	1	0.1
14359	99.5	1775	12.3	14392	99.8	1808	12.6	14422	100.0	1838	12.8	14424	100.0	1840	12.8	14424	100.0	1840	12.8	2	0.0
15089	98.6	3576	23.4	15187	99.2	3674	24.0	15216	99.4	3703	24.2	15272	99.8	3759	24.6	15301	100.0	3788	24.8	3	0.0
6856	99.3	1410	20.4	6880	99.6	1434	20.7	6889	99.8	1443	20.9	6903	100.0	1457	21.1	6904	100.0	1458	21.1	1	0.0
4336	98.5	1235	28.1	4385	99.6	1284	29.2	4392	99.7	1291	29.3	4400	99.9	1299	29.5	4402	100.0	1301	29.6	1	0.0
1239	94.0	263	19.9	1255	95.2	279	21.1	1267	96.1	291	22.0	1294	98.2	318	24.1	1318	100.0	342	25.9	0	0.0
1048	98.7	270	25.4	1052	99.1	274	25.8	1052	99.1	274	25.8	1060	99.8	282	26.5	1061	99.9	283	26.6	1	0.1
1615	99.6	402	24.8	1620	99.9	407	25.1	1620	99.9	407	25.1	1620	99.9	407	25.1	1621	100.0	408	25.2	0	0.0
2287	96.1	533	22.4	2307	96.9	553	23.2	2319	97.4	565	23.7	2354	98.9	600	25.2	2379	100.0	625	26.3	1	0.0
966	88.4	966	88.4	1016	93.0	1016	93.0	1028	94.1	1028	94.1	1069	97.8	1069	97.8	1093	100.0	1093	100.0	0	0.0
0	0.0	0	0.0	0	0.0	0	0.0	6	19.4	6	19.4	29	93.5	29	93.5	31	100.0	31	100.0	0	0.0
966	91.0	966	91.0	1016	95.7	1016	95.7	1022	96.2	1022	96.2	1040	97.9	1040	97.9	1062	100.0	1062	100.0	0	0.0
1066	88.1	1063	87.9	1118	92.4	1115	92.2	1135	93.8	1132	93.6	1183	97.8	1180	97.6	1210	100.0	1207	99.8	0	0.0
14024	99.5	2511	17.9	14070	99.8	2557	18.2	14087	99.9	2574	18.3	14095	100.0	2582	18.4	14098	100.0	2585	18.4	3	0.0
13068	98.6	3523	26.6	13139	99.1	3594	27.1	13168	99.4	3623	27.4	13241	99.9	3696	27.9	13244	99.9	3699	27.9	10	0.1
4058	99.0	1023	24.9	4078	99.5	1043	25.5	4083	99.6	1048	25.6	4098	100.0	1063	25.9	4098	100.0	1063	25.9	0	0.0
5907	98.6	1563	26.1	5950	99.3	1606	26.8	5965	99.5	1621	27.0	5990	99.9	1646	27.5	5990	99.9	1646	27.5	3	0.1
1156	96.2	365	30.4	1160	96.5	369	30.7	1168	97.2	377	31.4	1192	99.2	401	33.4	1195	99.4	404	33.6	7	0.6
176	98.9	70	39.3	176	98.9	70	39.3	177	99.4	71	39.9	178	100.0	72	40.4	178	100.0	72	40.4	0	0.0
1772	99.5	503	28.2	1774	99.6	505	28.4	1774	99.6	505	28.4	1781	100.0	512	28.7	1781	100.0	512	28.7	0	0.0
1332	96.5	435	31.5	1336	96.8	439	31.8	1345	97.5	448	32.5	1370	99.3	473	34.3	1373	99.5	476	34.5	7	0.5
344	87.8	344	87.8	344	87.8	344	87.8	350	89.3	350	89.3	381	97.2	381	97.2	384	98.0	384	98.0	8	2.0
0	0.0	0	0.0	0	0.0	0	0.0	2	8.0	2	8.0	18	72.0	18	72.0	20	80.0	20	80.0	5	20.0
344	93.7	344	93.7	344	93.7	344	93.7	348	94.8	348	94.8	363	98.9	363	98.9	364	99.2	364	99.2	3	0.8
487	84.8	487	84.8	515	89.7	515	89.7	522	90.9	522	90.9	563	98.0	563	98.0	566	98.6	566	98.6	8	1.4
12581	99.2	3036	23.9	12624	99.5	3079	24.3	12646	99.7	3101	24.4	12685	100.0	3140	24.7	12685	100.0	3140	24.7	2	0.0

TABLE C-2 (*Continued*)

	(1) Trips	(2) % of Total	(3) Avg. Trip Len (Min.)	(4) Avg. No. of Cos. Attra. Trips	(5) Trips To Adj. Cos. Trips	(6) Trips To Adj. Cos. % of Total	(7) Trips Within 35 min. Trips	(8) Trips Within 35 min. % of Total	(9) Trips > 35 min. Trips	(10) Trips > 35 min. % of Total	(11) Trips > 35 min. Avg. Trip Len (Min.)	(12) Trips Within 1 hr. Trips	(13) Trips Within 1 hr. % of Total	(14) Trips Within 35 min. to 1 hr. Trips	(15) Trips Within 35 min. to 1 hr. % of Total	(16) Trips Within 2 hrs. Trips	(17) Trips Within 2 hrs. % of Total	(18) Trips Within 35 min. to 2 hrs Trips	(19) Trips Within 35 min. to 2 hrs % of Total
MORRISTOWN, TENNESSEE, STUDY AREA																			
All Purpose Trips	22970	100.0	25.5	166	20946	91.2	16339	71.1	6631	28.9	76.5	21299	92.7	4960	21.6	22596	98.4	6257	27.3
Purpose 1 Work Trips	10574	46.0	23.4	89	9866	93.3	7720	73.0	2854	27.0	74.1	10016	94.7	2296	21.7	10437	98.7	2717	25.7
Purpose 2 Business Trips	6609	28.8	26.5	81	5753	87.0	4489	67.9	2120	32.1	70.6	5911	89.4	1422	21.5	6504	98.4	2015	30.5
Purpose 3 Recr. Trips	1820	7.9	45.7	68	1608	88.4	1195	65.7	625	34.3	121.5	1614	88.7	419	23.0	1725	94.8	530	29.1
Purpose 4 Social Trips	959	4.2	25.9	28	867	90.4	685	71.4	274	28.6	80.4	878	91.6	193	20.1	942	98.2	257	26.8
Purpose 5 Other Trips	2997	13.0	17.1	23	2856	95.3	2254	75.2	743	24.8	57.1	2884	96.2	630	21.0	2988	99.7	734	24.5
Purpose 3-4 Soc.-Rec. Trips	2779	12.1	38.9	74	2475	89.1	1880	67.7	899	32.3	109.7	2492	89.7	612	22.0	2667	96.0	787	28.3
Trips to SMSA's	1119	4.9	129.6	52	0	0.0	0	0.0	1119	100.0	129.6	0	0.0	0	0.0	966	86.3	966	86.3
Trips to SMSA > 1,000,000	36	0.6	665.0	14	0	0.0	0	0.0	36	100.0	665.0	0	0.0	0	0.0	0	0.0	0	0.0
Trips to SMSA < 1,000,000	1083	4.7	111.8	38	0	0.0	0	0.0	1083	100.6	111.8	0	0.0	0	0.0	966	89.2	966	89.2
Trips to Cos. > 50,000	1291	5.6	145.9	83	0	0.0	0	0.0	1291	100.0	145.9	0	0.0	0	0.0	1081	83.7	1081	83.7
Trips to Cos. < 50,000[1]	21600	94.0	18.6	88	20946	97.0	16339	75.6	5261	24.4	61.5	21299	98.6	4960	23.0	21408	99.1	5069	23.5
WEST BEND, WISCONSIN, STUDY AREA																			
All Purpose Trips	13955	100.0	21.2	109	13529	96.9	9837	70.5	4118	29.5	64.0	13320	95.4	3483	24.9	13671	98.0	3834	27.5
Purpose 1 Work Trips	6480	46.4	23.3	51	6285	97.0	4364	67.3	2116	32.7	62.6	6158	95.0	1794	27.7	6361	98.2	1997	30.9
Purpose 2 Business Trips	1262	9.0	16.6	26	1148	91.0	975	77.3	287	22.7	42.5	1215	96.3	240	19.0	1235	97.9	260	20.6
Purpose 3 Recr. Trips	1680	12.0	27.0	41	1527	90.9	1020	60.7	660	39.3	64.6	1574	93.7	554	33.0	1621	96.5	601	35.8
Purpose 4 Social Trips	1739	12.5	24.4	47	1539	88.5	1249	71.8	490	28.2	78.1	1638	94.2	389	22.4	1684	96.8	435	25.0
Purpose 5 Other Trips	2785	20.0	12.9	24	2558	91.8	2230	80.1	555	19.9	53.1	2736	98.2	506	18.1	2766	99.3	536	19.2
Purpose 3-4 Soc.-Rec. Trips	3419	24.5	25.6	68	3066	89.7	2269	66.4	1150	33.6	70.9	3212	93.9	943	27.5	3305	96.7	1036	30.3
Trips to SMSA's	2406	17.2	60.0	30	2223	92.4	0	0.0	2406	100.0	60.0	2014	83.7	2014	83.7	2239	93.1	2239	93.1
Trips to SMSA > 1,000,000	2299	16.4	52.3	13	2223	96.9	0	0.0	2299	100.0	52.3	2008	87.5	2008	87.5	2224	96.9	2224	96.9
Trips to SMSA < 1,000,000	107	0.8	225.5	17	0	0.0	0	0.0	107	100.0	225.5	6	5.6	6	5.6	15	14.0	15	14.0
Trips to Cos. > 50,000	3998	28.6	58.5	48	3692	92.3	0	0.0	3998	100.0	58.5	3483	87.1	3483	87.1	3812	95.3	3812	95.3
Trips to Cos. < 50,000[1]	9956	71.3	6.2	52	9837	98.8	9837	98.8	119	1.2	243.0	9837	98.8	0	0.0	9859	99.0	22	0.2
GREEN BAY, WISCONSIN, STUDY AREA																			
All Purpose Trips	33673	100.0	43.9	210	27845	82.7	21424	63.6	12249	36.4	110.1	25009	74.3	3585	10.7	30888	91.7	9464	28.1
Purpose 1 Work Trips	17068	50.7	49.2	151	13550	79.4	10125	59.3	6943	40.7	111.1	12285	72.0	2160	12.7	15315	89.7	5190	30.4
Purpose 2 Business Trips	3004	8.9	42.0	57	2503	83.3	1957	65.1	1047	34.9	107.9	2260	75.2	303	10.1	2744	91.3	787	26.2
Purpose 3 Recr. Trips[2]																			
Purpose 4 Social Trips[2]																			
Purpose 5 Other Trips	6123	18.2	31.1	51	5537	90.4	4263	69.6	1860	30.4	90.2	4794	78.3	531	8.7	5901	96.4	1638	26.8
Purpose 3-4 Soc.-Rec. Trips	7460	22.2	42.2	129	6257	83.9	5079	68.1	2381	31.9	121.0	5668	76.0	589	7.9	6931	92.9	1852	24.8
Trips to SMSA's	18247	54.2	18.3	71	17066	93.5	17066	93.5	1181	6.5	283.0	17066	93.5	0	0.0	17066	93.5	0	0.0
Trips to SMSA > 1,000,000	893	2.7	245.2	21	0	0.0	0	0.0	893	100.0	245.2	0	0.0	0	0.0	0	0.0	0	0.0
Trips to SMSA < 1,000,000	17354	51.5	6.6	49	17066	98.4	17066	98.4	288	1.6	394.4	17066	98.4	0	0.0	17066	98.4	0	0.0
Trips to Cos. > 50,000	25308	75.2	27.7	104	22432	88.7	21424	94.7	3884	15.3	147.2	23266	91.9	1842	7.2	23715	93.7	2291	9.0
Trips to Cos. < 50,000[1]	8378	24.9	93.5	108	5413	64.6	0	0.0	8378	100.0	93.5	1743	20.8	1743	20.8	7173	85.6	7173	85.6
SHEBOYGAN, WISCONSIN, STUDY AREA																			
All Purpose Trips	18491	100.0	38.0	171	15513	83.9	11533	62.4	6958	37.6	100.9	15060	81.4	3527	19.0	17380	94.0	5847	31.6
Purpose 1 Work Trips	9717	52.5	41.7	115	7901	81.3	5628	57.9	4089	42.1	99.0	7592	78.1	1964	20.2	9076	93.4	3448	35.5
Purpose 2 Business Trips	1606	8.7	29.7	36	1376	85.7	1106	68.9	500	31.1	94.8	1344	83.7	238	14.8	1531	95.3	425	26.4
Purpose 3 Recr. Trips	1832	9.9	37.7	57	1572	85.8	1309	71.5	523	28.5	131.9	1529	83.5	220	12.0	1680	91.7	371	20.2
Purpose 4 Social Trips	2234	12.1	45.8	75	1868	83.3	1368	61.2	866	38.8	117.8	1833	82.1	465	20.9	2091	92.1	723	30.9
Purpose 5 Other Trips	3102	16.8	24.5	40	2802	90.3	2125	68.5	977	31.5	77.4	2766	89.2	641	20.7	3012	97.1	887	28.6
Purpose 3-4 Soc.-Rec. Trips	4066	22.0	42.2	104	3440	84.6	2677	65.8	1389	34.2	123.1	3362	82.7	685	16.9	3771	92.7	1094	26.9
Trips to SMSA's	2152	11.6	140.4	57	0	0.0	0	0.0	2152	100.0	140.4	0	0.0	0	0.0	1607	74.7	1607	74.7
Trips to SMSA > 1,000,000	1709	9.2	123.8	18	0	0.0	0	0.0	1709	100.0	123.8	0	0.0	0	0.0	1347	79.3	1347	79.3
Trips to SMSA < 1,000,000	443	2.4	204.4	39	0	0.0	0	0.0	443	100.0	204.4	0	0.0	0	0.0	260	59.0	260	59.0
Trips to Cos. > 50,000	17085	92.4	32.8	91	14423	84.4	11533	67.5	5552	32.5	100.9	13970	81.8	2437	14.3	16270	95.2	4737	27.7
Trips to Cos. < 50,000[1]	1410	7.6	104.2	84	1090	77.3	0	0.0	1410	100.0	104.2	1090	77.3	1090	77.3	1110	78.7	1110	78.7
JOPLIN, MISSOURI, STUDY AREA																			
All Purpose Trips	39325	100.0	39.7	387	34113	86.7	28061	71.4	11264	28.6	124.1	34674	88.2	6613	16.8	36973	94.0	8912	22.7
Purpose 1 Work Trips	15011	38.2	35.2	207	13064	87.0	10973	73.1	4038	26.9	125.9	13247	88.2	2274	15.1	14101	93.9	3128	20.8
Purpose 2 Business Trips	7963	20.2	39.8	154	6662	83.7	5473	68.7	2490	31.3	116.2	6737	84.6	1264	15.9	7309	92.5	1896	23.8
Purpose 3 Recr. Trips[2]																			
Purpose 4 Social Trips[2]																			
Purpose 5 Other Trips	5066	12.9	27.8	72	4545	89.7	3357	66.3	1709	33.7	71.1	4655	91.9	1298	25.6	4927	97.3	1570	31.0
Purpose 3-4 Soc.-Rec. Trips	11268	28.7	50.7	221	9838	87.3	8259	73.3	3009	26.7	170.6	10034	89.0	1775	15.7	10571	93.8	2312	20.5
Trips to SMSA's	1720	4.4	352.8	114	0	0.0	0	0.0	1720	100.0	352.8	0	0.0	0	0.0	483	28.1	483	28.1
Trips to SMSA > 1,000,000	645	1.6	494.3	34	0	0.0	0	0.0	644	100.0	493.8	0	0.0	0	0.0	0	0.0	0	0.0
Trips to SMSA < 1,000,000	1075	2.7	267.9	80	0	0.0	0	0.0	1075	100.0	267.9	0	0.0	0	0.0	483	44.9	483	44.9
Trips to Cos. > 50,000	21716	55.2	30.3	135	19873	91.5	19873	91.5	1843	8.5	356.4	19873	91.5	0	0.0	20356	93.8	483	2.3
Trips to Cos. < 50,000[1]	17590	44.7	51.1	246	14240	80.9	8188	46.5	9402	53.5	78.3	14801	84.1	6613	37.6	16617	94.5	8429	48.0
ST. JOSEPH, MISSOURI, STUDY AREA																			
All Purpose Trips	34869	100.0	57.7	312	25912	74.3	21454	61.5	13415	38.5	132.7	25504	73.1	4050	11.6	32510	93.2	11056	31.7
Purpose 1 Work Trips	13232	38.0	57.8	182	9774	73.9	8154	61.6	5078	38.4	131.7	9522	72.0	1368	10.4	12266	92.7	4112	31.1
Purpose 2 Business Trips	9002	25.8	55.6	131	6332	70.3	5120	56.9	3882	43.1	119.8	6238	69.3	1118	12.4	8343	92.7	3223	35.8
Purpose 3 Recr. Trips[2]																			
Purpose 4 Social Trips[2]																			
Purpose 5 Other Trips	4026	11.5	93.3	115	2832	70.3	2190	54.4	1836	45.6	190.7	2876	71.4	686	17.0	3634	90.3	1444	35.9
Purpose 3-4 Soc.-Rec. Trips	8624	24.7	43.3	118	6977	80.9	5992	69.5	2632	30.5	120.7	6874	79.7	882	10.2	8279	96.0	2287	26.5
Trips to SMSA's	13839	39.7	54.7	76	9906	71.6	9906	71.6	3933	28.4	192.4	10050	72.6	144	1.0	13022	94.1	3116	22.5
Trips to SMSA > 1,000,000	3336	9.6	128.8	22	0	0.0	0	0.0	3336	100.0	128.8	144	4.3	144	4.3	3116	93.4	3116	93.4
Trips to SMSA < 1,000,000	10503	30.1	31.2	54	9906	94.3	9906	94.3	597	5.7	547.7	9906	94.3	0	0.0	9906	94.3	0	0.0
Trips to Cos. > 50,000	13961	40.0	58.2	95	9906	71.0	9906	71.0	4055	29.0	200.3	10050	72.0	144	2.0	13022	93.3	3116	22.3
Trips to Cos. < 50,000[1]	20904	60.0	57.3	218	16006	76.6	11548	55.2	9356	44.8	91.1	15454	73.9	3906	18.7	19488	93.2	7940	38.0

(20) Trips Within 4 hrs.	(21)	(22) Trips Within 35 min. to 4 hrs.	(23)	(24) Trips Within 6 hrs.	(25)	(26) Trips Within 35 min. to 6 hrs.	(27)	(28) Trips Within 8 hrs.	(29)	(30) Trips Within 35 min. to 8 hrs.	(31)	(32) Trips Within 16 hrs.	(33)	(34) Trips Within 35 min. to 16 hrs.	(35)	(36) Trips Within 24 hrs.	(37)	(38) Trips Within 35 min. to 24 hrs.	(39)	(40) Trips > 24 hrs.	(41)
Trips	% of Total	Trips	% of Total	Trips	% of Total	Trips	% of Total	Trips	% of Total	Trips	% of Total	Trips	% of Total	Trips	% of Total	Trips	% of Total	Trips	% of Total	Trips	% of Total
6886	97.9	633	9.0	6918	98.4	665	9.4	6952	98.9	699	9.9	7014	99.7	761	10.8	7032	100.0	779	11.1	0	0.0
2626	99.0	194	7.3	2631	99.2	199	7.5	2643	99.7	211	8.0	2651	100.0	219	8.2	2652	100.0	220	8.3	0	0.0
2459	98.6	284	11.4	2468	98.9	293	11.7	2482	99.5	307	12.3	2493	99.9	318	12.7	2495	100.0	322	12.9	0	0.0
845	91.2	96	10.4	861	92.9	112	12.1	869	93.7	120	12.9	912	98.4	163	17.6	927	100.0	178	19.2	0	0.0
146	98.6	12	8.1	148	100.0	14	9.5	148	100.0	14	9.5	148	100.0	14	9.5	148	100.0	14	9.5	0	0.0
811	100.0	45	5.5	811	100.0	45	5.5	811	100.0	45	5.5	811	100.0	45	5.5	811	100.0	45	5.5	0	0.0
991	92.2	108	10.0	1009	93.9	126	11.7	1017	94.6	134	12.5	1060	98.6	177	16.5	1075	100.0	192	17.9	0	0.0
131	65.8	131	65.8	142	71.4	142	71.4	154	77.4	154	77.4	191	96.0	191	96.0	199	100.0	199	100.0	0	0.0
0	0.0	0	0.0	0	0.0	0	0.0	4	30.7	4	30.7	10	76.9	10	76.9	13	100.0	13	100.0	0	0.0
131	70.4	131	70.4	142	76.3	142	76.3	150	80.6	150	80.6	181	97.3	181	97.3	186	100.0	186	100.0	0	0.0
1254	93.9	139	10.3	1266	94.8	150	11.2	1278	95.7	162	12.1	1323	99.0	207	15.5	1336	100.0	220	16.5	0	0.0
5638	98.8	501	8.8	5658	99.1	521	9.1	5680	99.5	543	9.5	5702	99.9	565	9.9	5707	100.0	570	10.0	0	0.0
8636	97.4	1168	13.2	8668	97.7	1200	13.5	8708	98.2	1240	14.0	8810	99.3	1382	15.1	8846	99.7	1378	15.5	23	0.3
3017	98.5	441	14.4	3021	98.6	445	14.5	3033	99.0	457	14.9	3063	100.0	487	15.9	3063	100.0	487	15.9	0	0.0
3750	98.4	533	14.0	3759	98.6	542	14.2	3772	99.0	555	14.6	3796	99.6	579	15.2	3803	99.8	586	15.4	8	0.2
675	84.9	105	13.2	695	87.4	125	15.7	708	89.1	138	17.4	752	94.6	182	22.9	780	98.1	210	26.4	15	1.9
72	100.0	10	13.9	72	100.0	10	13.9	72	100.0	10	13.9	72	100.0	10	13.9	72	100.0	10	13.9	0	0.0
1116	99.4	74	6.6	1116	99.4	74	6.6	1118	99.6	76	6.8	1121	99.8	79	7.0	1123	100.0	81	7.2	0	0.0
747	86.2	115	13.3	767	88.5	135	15.6	780	90.0	148	17.1	824	95.0	192	22.1	852	98.3	220	25.4	15	1.7
164	55.6	164	55.6	181	61.4	181	61.4	198	67.1	198	67.1	249	84.4	249	84.4	279	94.6	279	94.6	16	5.4
0	0.0	0	0.0	0	0.0	0	0.0	8	32.0	8	32.0	13	52.0	13	52.0	20	80.0	20	80.0	5	20.0
164	60.7	164	60.7	181	67.0	181	67.0	190	70.4	190	70.4	236	87.4	236	87.4	259	95.9	259	95.9	11	4.1
788	83.7	788	83.7	808	85.8	808	85.8	825	87.7	825	87.7	892	94.8	892	94.8	925	98.3	925	98.3	16	1.7
7843	98.9	380	4.8	7863	99.1	393	5.0	7886	99.4	418	5.3	7921	99.9	453	5.7	7924	99.9	456	5.7	7	0.1
11698	99.4	3473	29.7	11732	99.6	3507	29.9	11750	99.8	3525	31.0	11767	99.9	3542	31.2	11772	100.0	3547	30.3	1	0.0
5437	99.1	1692	30.9	5460	99.5	1715	31.3	5475	99.7	1730	31.5	5487	100.0	1742	31.8	5489	100.0	1744	31.8	0	0.0
1265	99.8	309	24.4	1266	99.8	310	24.4	1267	99.9	311	24.5	1267	99.9	311	24.5	1268	100.0	312	24.6	0	0.0
2590	100.0	724	28.0	2590	100.0	724	28.0	2590	100.0	724	28.0	2590	100.0	724	28.0	2590	100.0	724	28.0	0	0.0
2406	99.2	747	30.8	2416	99.6	757	31.2	2418	99.7	759	31.3	2423	99.9	764	31.5	2425	100.0	766	31.6	1	0.0
8973	99.6	748	8.3	8983	99.7	758	8.4	8991	99.8	768	8.5	9001	99.9	776	8.6	9005	100.0	780	8.7	1	0.0
1597	99.1	695	43.2	1597	99.1	695	43.2	1605	99.6	703	43.7	1610	99.9	708	0.9	1611	100.0	709	1.0	0	0.0
7376	99.7	53	0.7	7386	99.9	63	0.9	7386	99.9	63	0.9	7391	100.0	68	1.0	7394	100.0	71	1.0	1	0.0
11638	99.6	3413	29.2	11654	99.8	3429	29.4	11664	99.9	3439	29.5	11675	99.9	3450	29.5	11680	100.0	3455	29.5	1	0.0
60	65.9	60	65.9	78	85.7	78	85.7	86	94.5	86	94.5	91	100.0	91	100.0	91	100.0	91	100.0	0	0.0
7633	94.9	2028	25.2	7679	95.4	2074	25.7	7755	96.4	2150	26.7	7908	98.3	2303	28.6	8033	99.8	2428	30.1	14	0.2
2968	97.3	759	24.8	2979	97.7	770	25.2	3000	98.4	791	25.9	3037	99.6	828	27.1	3048	100.0	839	27.5	1	0.0
947	98.0	238	24.6	952	98.6	243	25.2	958	99.2	249	25.8	962	99.6	253	26.2	966	100.0	257	26.6	0	0.0
1326	99.9	89	6.8	1326	99.9	89	6.8	1326	99.9	89	6.8	1321	99.9	90	6.8	1327	99.9	90	6.8	1	0.1
2387	88.7	938	34.9	2417	89.8	968	36.0	2467	91.6	1018	37.8	2573	95.6	1124	41.8	2680	99.5	1231	45.7	12	0.5
1744	84.0	1744	84.0	1765	85.0	1765	85.0	1840	88.6	1840	88.6	1949	93.9	1949	93.9	2066	99.5	2066	99.5	10	0.5
1213	87.7	1213	87.7	1216	87.9	1216	87.9	1249	90.3	1249	90.3	1292	93.4	1292	93.4	1383	100.0	1383	100.0	0	0.0
531	76.6	531	76.6	549	79.2	549	79.2	591	85.3	591	85.3	657	94.8	657	94.8	683	98.6	683	98.6	10	1.7
7610	95.5	2005	25.2	7645	95.9	2040	25.6	7727	96.9	2122	26.6	7841	98.4	2236	28.1	7961	99.9	2356	29.6	10	0.1
28	36.8	28	36.8	45	59.2	45	59.2	54	71.1	54	71.1	69	90.8	69	90.8	75	98.7	75	98.7	1	1.3
11790	96.7	4747	38.9	11833	97.1	4790	39.3	11932	97.9	4889	40.1	12054	98.9	5011	41.1	12179	99.9	5136	42.1	9	0.1
3188	98.2	1042	32.1	3195	98.4	1049	32.3	3208	98.8	1062	32.7	3236	99.7	1090	33.6	3246	100.0	1100	33.9	1	0.0
841	96.4	348	39.9	842	96.6	349	40.1	856	98.2	363	41.7	857	98.3	364	41.8	872	100.0	379	43.5	0	0.0
2530	99.5	513	20.2	2532	99.6	515	20.3	2533	99.6	516	20.3	2540	99.9	523	20.6	2542	100.0	525	20.7	0	0.0
5231	94.7	2844	51.5	5264	95.3	2877	52.1	5332	96.6	2945	53.4	5418	98.1	3031	54.9	5513	99.8	3126	56.6	8	0.2
4455	93.1	4455	93.1	4474	93.5	4474	93.5	4560	95.3	4560	95.3	4660	97.4	4660	97.4	4777	99.9	4777	99.9	6	0.1
3050	94.6	3050	94.6	3055	94.7	3055	94.7	3094	95.9	3094	95.9	3137	97.2	3137	97.2	3226	100.0	3226	100.0	0	0.0
1405	90.4	1405	90.4	1419	91.3	1419	91.3	1466	94.3	1466	94.3	1523	97.9	1523	97.9	1551	99.6	1551	99.6	6	0.4
11734	97.1	4689	38.8	11762	97.3	4719	39.0	11856	98.1	4813	39.8	11959	98.9	4916	40.6	12080	99.9	5037	41.6	7	0.1
56	57.1	56	57.1	71	72.4	71	72.4	76	77.5	76	77.5	94	95.9	94	95.9	96	98.0	96	98.0	2	1.9
9477	98.8	3809	39.7	9533	99.3	3865	40.2	9571	99.7	3903	40.6	9585	99.8	3917	40.7	9593	100.0	3925	40.9	3	0.0
4446	98.6	1711	37.9	4480	99.4	1745	38.7	4493	99.7	1758	39.0	4501	99.8	1766	39.1	4507	100.0	1772	39.3	1	0.0
734	99.1	252	34.1	737	99.5	255	34.5	740	99.9	258	34.9	741	100.0	259	35.0	741	100.0	259	35.0	0	0.0
2329	99.8	1025	43.9	2331	99.9	1027	44.0	2334	100.0	1030	44.1	2334	100.0	1030	44.1	2334	100.0	1030	44.1	0	0.0
1970	97.7	823	40.8	1988	98.6	841	41.7	2007	99.6	860	42.7	2012	99.8	865	42.9	2014	99.9	867	43.0	2	0.1
879	94.1	879	94.1	897	96.0	897	96.0	913	97.8	921	97.8	926	99.1	926	99.1	933	99.9	933	99.9	1	0.1
166	90.2	166	90.2	166	90.2	166	90.2	173	94.0	173	94.0	179	97.3	179	97.3	184	100.0	184	100.0	0	0.0
713	95.1	713	95.1	731	97.5	731	97.5	740	98.7	740	98.7	747	99.6	747	99.6	749	99.9	749	99.9	1	0.1
1452	94.9	1452	94.9	1490	97.4	1490	97.4	1508	98.6	1508	98.6	1521	99.4	1521	99.4	1528	99.9	1528	99.9	2	0.1
8025	99.5	2357	29.2	8043	99.7	2375	29.4	8063	100.0	2395	29.7	8064	100.0	2396	29.7	8065	100.0	2397	29.7	1	0.0

TABLE C-2 (*Continued*)

Time Distribution of	(1) Trips	(2) % of Total	(3) Avg. Trip Len. (Min.)	(4) Avg. No. of Cos. Attra. Trips	(5) Trips to Adj. Cos. Trips	(6) Trips to Adj. Cos. % of Total	(7) Trips Within 35 min. Trips	(8) Trips Within 35 min. % of Total	(9) Trips > 35 min. Trips	(10) Trips > 35 min. % of Total	(11) Trips > 35 min. Avg Trip Len. (Min.)	(12) Trips Within 1 hr. Trips	(13) Trips Within 1 hr. % of Total	(14) Trips Within 35 min. to 1 hr. Trips	(15) Trips Within 35 min. to 1 hr. % of Total	(16) Trips Within 2 hrs. Trips	(17) Trips Within 2 hrs. % of Total	(18) Trips Within 35 min. to 2 hrs. Trips	(19) Trips Within 35 min. to 2 hrs. % of Total
OCONOMOWOC, WISCONSIN, STUDY AREA																			
All Purpose Trips	13045	100.0	19.7	99	12587	96.5	10320	79.1	2725	20.9	79.9	12023	92.2	1703	13.1	12874	98.7	2554	19.6
Purpose 1 Work Trips	5714	44.3	22.1	53	5473	95.8	4184	73.2	1530	26.8	68.5	5178	90.6	994	17.4	5654	99.0	1470	25.8
Purpose 2 Business Trips	612	4.7	16.7	16	596	97.3	489	79.9	123	20.1	77.6	571	93.3	82	13.4	607	99.2	118	19.1
Purpose 3 Recr. Trips[2]																			
Purpose 4 Social Trips[2]																			
Purpose 5 Other Trips	3046	23.7	10.8	17	3017	99.0	2678	87.9	368	12.1	77.0	2909	95.5	231	7.6	3031	99.5	353	11.6
Purpose 3-4 Soc.-Rec. Trips	3659	28.9	23.6	71	3488	95.3	2965	81.0	694	19.0	104.8	3359	91.8	394	10.8	3572	97.6	607	16.6
Trips to SMSA's	10601	81.5	8.0	34	10354	97.7	10320	97.4	281	2.6	159.5	10357	97.7	37	0.3	10555	99.6	235	2.2
Trips to SMSA > 1,000,000	10417	79.8	5.8	18	10320	99.1	10320	99.1	97	0.9	222.3	10320	99.1	0	0.0	10400	99.8	80	0.7
Trips to SMSA < 1,000,000	184	1.4	129.8	16	34	18.5	0	0.0	184	100.0	129.8	37	20.1	37	20.1	155	84.2	155	84.2
Trips to Cos. > 50,000	12813	98.3	16.8	50	10320	80.5	10320	80.5	2493	19.5	70.5	11917	93.0	1597	12.5	12740	99.4	2420	18.9
Trips to Cos. < 50,000[1]	232	1.7	181.6	49	0	0.0	0	0.0	232	100.0	181.6	106	45.7	106	45.7	134	57.8	134	57.8
STURGEON BAY, WISCONSIN, STUDY AREA																			
All Purpose Trips	8595	100.0	39.4	94	6722	78.2	6200	72.1	2395	27.9	141.0	6722	78.2	522	6.1	7738	90.0	1538	17.9
Purpose 1 Work Trips	2427	28.2	28.4	45	2114	87.1	1948	80.2	479	19.7	142.8	2114	87.1	166	6.8	2292	94.4	344	14.2
Purpose 2 Business Trips	732	8.5	21.1	19	650	88.8	602	88.2	130	17.8	115.4	650	88.8	48	6.6	700	95.6	98	13.4
Purpose 3 Recr. Trips	2415	28.1	67.4	70	1512	62.6	1384	57.3	1031	42.7	157.7	1512	62.6	128	5.3	1966	81.4	582	24.1
Purpose 4 Social Trips	1359	15.8	50.0	44	956	70.3	825	60.7	534	39.3	126.9	956	70.3	131	9.6	1170	86.1	345	25.4
Purpose 5 Other Trips	1652	19.2	12.5	26	1492	90.3	1442	87.3	210	12.7	97.1	1492	90.3	50	3.0	1613	97.6	171	10.4
Purpose 3-4 Soc.-Rec. Trips	3774	43.9	61.1	79	2468	65.4	2209	58.5	1565	41.5	147.2	2468	65.4	259	6.9	3136	83.1	927	24.6
Trips to SMSA's	1159	13.5	167.3	38	0	0.0	0	0.0	1159	100.0	167.3	0	0.0	0	0.0	721	62.2	721	62.2
Trips to SMSA > 1,000,000	375	4.4	295.2	19	0	0.0	0	0.0	375	100.0	295.2	0	0.0	0	0.0	0	0.0	0	0.0
Trips to SMSA < 1,000,000	784	9.1	106.2	19	0	0.0	0	0.0	784	100.0	98.9	0	0.0	0	0.0	721	92.0	721	92.0
Trips to Cos. > 50,000	1637	19.0	158.1	56	0	0.0	0	0.0	1637	100.0	158.1	0	0.0	0	0.0	1002	61.2	1002	61.2
Trips to Cos. < 50,000[1]	6958	81.0	11.4	38	6722	96.6	6200	89.1	758	10.9	164.5	6722	96.6	522	7.5	6736	96.8	536	7.7
WAUPACA, WISCONSIN, STUDY AREA																			
All Purpose Trips	7677	100.0	33.1	90	6914	90.1	5226	68.1	2451	31.9	107.9	6438	83.9	1212	15.8	7231	94.2	2005	26.1
Purpose 1 Work Trips	2778	36.2	28.6	47	2511	90.4	1922	69.2	856	30.8	92.5	2380	85.7	458	16.5	2647	95.3	725	26.1
Purpose 2 Business Trips	759	9.9	34.8	31	662	87.2	471	62.1	288	37.9	91.7	628	82.7	157	20.7	716	94.3	245	32.3
Purpose 3 Recr. Trips[2]																			
Purpose 4 Social Trips[2]																			
Purpose 5 Other Trips	1946	25.3	21.5	26	1892	97.2	1509	77.5	437	24.6	94.7	1712	88.0	203	10.4	1908	98.0	399	20.5
Purpose 3-4 Soc.-Rec. Trips	2192	28.6	48.3	69	1851	84.4	1325	60.4	867	39.6	121.8	1721	78.5	396	18.1	1963	89.6	638	29.1
Trips to SMSA's	403	5.2	214.1	33	0	0.0	0	0.0	403	100.0	214.1	0	0.0	0	0.0	112	27.8	112	27.8
Trips to SMSA > 1,000,000	232	3.0	238.9	14	0	0.0	0	0.0	232	100.0	238.9	0	0.0	0	0.0	0	0.0	0	0.0
Trips to SMSA < 1,000,000	171	2.2	180.5	19	0	0.0	0	0.0	171	100.0	180.5	0	0.0	0	0.0	112	65.5	112	65.5
Trips to Cos. > 50,000	1266	16.5	112.7	48	659	52.1	0	0.0	1266	100.0	112.7	620	49.0	620	49.0	923	72.9	923	72.9
Trips to Cos. < 50,000[1]	6410	83.5	17.4	41	6282	98.0	5226	81.5	1184	18.5	93.8	5818	90.8	592	9.2	6308	98.4	1082	16.9
ATHENS, TENNESSEE, STUDY AREA																			
All Purpose Trips	15421	100.0	16.4	80	14128	91.6	12584	81.6	2837	18.4	81.7	14551	94.4	1967	12.8	15187	98.5	2603	16.9
Purpose 1 Work Trips	5859	38.0	14.5	46	5460	93.2	4921	84.0	938	16.0	82.4	5583	95.3	662	11.3	5777	98.6	856	14.6
Purpose 2 Business Trips	6025	39.1	18.5	48	5351	88.8	4739	78.7	1286	21.3	80.6	5583	92.7	844	14.0	5915	98.2	1176	19.5
Purpose 3 Recr. Trips	840	5.5	34.4	28	721	85.8	609	72.5	231	27.5	119.0	773	92.0	164	19.5	813	96.8	204	24.3
Purpose 4 Social Trips	311	2.0	10.9	12	287	92.3	273	87.8	38	12.2	67.4	296	95.2	23	7.4	308	99.0	35	11.2
Purpose 5 Other Trips	2389	15.5	9.9	20	2314	96.9	2043	85.5	346	14.5	58.7	2320	97.1	277	11.6	2377	99.5	334	14.0
Purpose 3-4 Soc.-Rec. Trips	1151	7.5	28.0	31	1008	87.5	882	76.6	269	23.4	106.1	1069	92.8	187	16.2	1121	97.3	239	20.8
Trips to SMSA's	969	6.3	107.1	23	0	0.0	0	0.0	969	100.0	107.1	390	40.2	390	40.2	879	90.7	879	90.7
Trips to SMSA > 1,000,000	47	0.3	391.1	7	0	0.0	0	0.0	47	100.0	391.1	0	0.0	0	0.0	0	0.0	0	0.0
Trips to SMSA < 1,000,000	922	6.0	92.7	17	0	0.0	0	0.0	922	100.0	92.7	390	42.3	390	42.3	879	95.3	879	95.3
Trips to Cos. > 50,000	1006	6.5	120.4	33	0	0.0	0	0.0	1006	100.0	120.4	390	38.8	390	38.8	879	87.4	879	87.4
Trips to Cos. < 50,000[1]	14426	93.5	9.5	48	14128	91.6	12584	87.2	1842	12.8	63.3	14161	98.2	1577	11.0	14308	99.2	1724	12.0
COLUMBIA, TENNESSEE, STUDY AREA																			
All Purpose Trips	15304	100.0	22.7	132	13666	89.3	11513	75.2	3791	24.8	91.5	14273	93.3	2760	18.1	14926	97.5	3413	22.3
Purpose 1 Work Trips	6905	45.1	16.5	65	6371	92.3	5446	78.9	1459	21.1	77.7	6515	94.4	1069	15.5	6774	98.1	1328	19.2
Purpose 2 Business Trips	4403	28.8	23.9	68	3748	85.1	3101	70.4	1302	29.6	80.6	4091	92.9	990	22.5	4293	97.5	1192	27.1
Purpose 3 Recr. Trips	1318	8.6	56.3	66	1147	87.0	976	74.1	342	25.9	215.8	1172	88.9	196	14.8	1218	92.4	242	18.3
Purpose 4 Social Trips	1062	6.9	25.4	35	933	87.9	778	73.3	284	26.7	92.9	969	91.2	191	17.9	1039	97.8	261	24.5
Purpose 5 Other Trips	1621	10.6	17.0	23	1471	90.7	1213	74.8	408	25.2	66.2	1530	94.4	317	19.6	1607	99.1	394	24.3
Purpose 3-4 Soc.-Rec. Trips	2380	15.5	42.5	83	2080	87.4	1754	73.7	626	26.3	161.0	2141	90.0	387	16.3	2257	94.8	503	21.1
Trips to SMSA's	1093	7.1	126.2	36	0	0.0	0	0.0	1093	100.0	126.2	944	86.4	944	86.4	944	86.4	944	86.4
Trips to SMSA > 1,000,000	31	0.2	670.7	11	0	0.0	0	0.0	31	100.0	670.7	0	0.0	0	0.0	0	0.0	0	0.0
Trips to SMSA < 1,000,000	1062	6.9	110.3	25	0	0.0	0	0.0	1062	100.0	110.3	944	88.9	944	88.9	944	88.9	944	88.9
Trips to Cos. > 50,000	1210	7.9	131.1	52	0	0.0	3	0.2	1207	99.8	131.2	947	78.3	944	78.1	1037	85.7	1034	85.5
Trips to Cos. < 50,000[1]	14101	92.1	13.6	82	13666	96.9	11513	81.6	2588	18.4	148.6	13329	94.5	1816	12.9	13892	98.5	2379	16.9
DYERSBURG, TENNESSEE, STUDY AREA																			
All Purpose Trips	13254	100.0	29.2	98	12272	92.6	9545	72.0	3709	28.0	104.2	11921	89.9	2376	17.9	12448	93.9	2903	21.9
Purpose 1 Work Trips	4098	30.9	25.0	41	3819	93.2	3035	74.1	1063	25.9	96.0	3711	90.6	676	16.5	3871	94.5	836	20.4
Purpose 2 Business Trips	5993	45.2	28.6	63	5492	91.6	4344	72.5	1649	27.5	103.7	5355	89.4	1011	16.9	5593	93.3	1249	20.8
Purpose 3 Recr. Trips	1202	9.1	54.1	42	1086	90.3	791	65.8	411	34.2	157.7	1061	88.3	270	22.5	1106	92.0	315	26.2
Purpose 4 Social Trips	178	1.3	37.1	14	162	91.0	106	59.6	72	40.4	91.7	149	83.7	43	24.2	166	93.3	60	33.7
Purpose 5 Other Trips	1781	13.4	22.5	21	1721	96.6	1269	71.3	512	28.7	77.3	1646	92.4	377	21.2	1716	96.3	447	25.1
Purpose 3-4 Soc.-Rec. Trips	1380	10.4	51.9	45	1248	90.4	897	65.0	483	35.0	147.8	1210	87.7	313	22.7	1272	92.2	375	27.2
Trips to SMSA's	392	3.0	286.7	22	0	0.0	0	0.0	392	100.0	286.7	0	0.0	0	0.0	0	0.0	0	0.0
Trips to SMSA > 1,000,000	25	0.2	950.4	6	0	0.0	0	0.0	25	100.0	950.4	0	0.0	0	0.0	0	0.0	0	0.0
Trips to SMSA < 1,000,000	367	2.8	241.4	16	0	0.0	0	0.0	367	100.0	241.4	0	0.0	0	0.0	0	0.0	0	0.0
Trips to Cos. > 50,000	574	4.3	259.9	31	0	0.0	0	0.0	574	100.0	259.9	0	0.0	0	0.0	0	0.0	0	0.0
Trips to Cos. < 50,000[1]	12687	95.7	19.0	67	12272	96.7	9545	75.2	3142	24.8	767.7	11921	94.0	2376	18.7	12448	98.1	2903	22.9

(20) Trips Within 4 hrs.	(21)	(22) Trips Within 35 min. to 4 hrs	(23)	(24) Trips Within 6 hrs.	(25)	(26) Trips Within 35 min. to 6 hrs.	(27)	(28) Trips Within 8 hrs.	(29)	(30) Trips Within 35 min. to 8 hrs.	(31)	(32) Trips Within 16 hrs.	(33)	(34) Trips Within 35 min. to 16 hrs.	(35)	(36) Trips Within 24 hrs.	(37)	(38) Trips Within 35 min. to 24 hrs.	(39)	(40) Trips>24 hrs.	(41)
Trips	% of Total	Trips	% of Total	Trips	% of Total	Trips	% of Total	Trips	% of Total	Trips	% of Total	Trips	% of Total	Trips	% of Total	Trips	% of Total	Trips	% of Total	Trips	% of Total
56701	96.9	17364	29.7	57273	97.9	17936	30.7	57535	98.4	18198	31.2	58249	99.6	18912	32.4	58423	99.9	19086	32.7	68	0.1
33157	96.9	11107	32.5	33575	98.1	11525	33.7	33767	98.7	11717	34.3	34163	99.8	12113	35.4	34219	100.0	12169	35.6	10	0.0
8278	93.5	2497	29.7	8312	98.9	2531	30.1	8332	99.2	2551	30.4	8378	99.7	2597	30.9	8394	99.9	2613	31.1	8	0.1
4253	97.2	1620	37.2	4287	98.0	1662	38.0	4307	98.4	1682	38.4	4353	99.5	1728	39.5	4369	99.8	1744	39.8	8	0.2
5663	97.9	1979	25.5	5711	98.8	1527	26.4	5725	99.0	1541	26.6	5777	99.9	1593	27.5	5781	100.0	1597	27.6	2	0.0
5796	99.4	1185	20.3	5805	99.6	1197	20.5	5813	99.8	1205	20.7	5821	99.9	1213	20.8	5821	99.9	1213	20.8	6	0.1
9916	97.6	3107	30.6	9998	98.4	3189	31.4	10032	98.7	3223	31.7	10130	99.7	3321	32.7	10150	99.9	3341	33.9	10	0.1
34514	97.5	2136	6.1	34656	97.8	2278	6.4	34758	98.1	2380	6.7	35244	99.5	2866	8.1	35376	99.9	2998	8.5	40	0.1
780	78.9	780	78.9	780	78.9	780	78.9	780	78.9	780	78.9	910	92.1	910	92.1	956	96.8	956	96.8	32	3.2
33734	97.9	1356	3.9	33876	98.4	1498	4.4	33978	98.7	1600	4.7	34334	99.7	1956	5.7	34420	100.0	2042	6.0	8	0.0
20911	94.4	2454	11.1	21219	95.8	2762	12.5	21383	96.5	2926	13.2	21955	99.1	3498	14.7	22105	99.8	3648	15.4	48	0.2
21861	97.4	14902	66.4	22157	98.7	15203	67.7	22257	99.2	15298	68.2	22401	99.8	15442	68.8	22427	99.9	15468	68.9	20	0.1
54332	95.8	23392	41.2	55227	97.4	24287	42.8	55754	98.3	24814	43.7	56276	99.2	25336	44.6	56595	99.8	25655	45.2	116	0.2
30684	96.5	13375	42.1	31095	96.5	13786	42.1	31343	98.6	14034	44.2	31607	99.4	14298	45.0	31759	99.9	14450	45.5	34	0.1
4516	96.5	1916	40.9	4576	97.8	1976	42.2	4613	98.6	2013	43.0	4648	99.3	2048	43.7	4669	99.8	2069	44.2	11	0.2
8262	98.0	3193	37.9	8358	99.2	3289	39.1	8387	99.5	3313	39.4	8417	99.9	3348	39.8	8428	100.0	3359	39.9	1	0.0
10886	92.0	4904	41.6	11207	94.7	5245	44.3	11413	96.5	5451	46.1	11612	98.1	5650	47.7	11754	99.3	5792	48.9	77	0.7
35094	97.1	5881	16.3	35199	97.3	5986	16.5	35488	98.1	6275	17.3	35837	99.1	6624	18.3	36077	99.8	6864	19.0	82	0.2
4657	89.9	4657	89.9	4658	90.0	4658	90.0	4793	92.6	4793	92.6	4989	96.4	4989	96.4	5148	99.4	5148	99.4	30	0.6
30437	98.2	1224	4.0	30541	98.6	1328	4.3	30695	99.1	1482	4.8	30848	99.6	1635	5.3	30929	99.8	1716	5.5	52	0.2
42086	96.8	11146	25.7	42429	97.5	11489	26.4	42736	98.2	11796	27.1	43137	99.1	12197	28.0	43409	99.8	12469	28.7	101	0.2
12246	92.8	12246	92.8	12799	97.0	12799	97.0	12994	98.5	12994	98.5	13121	99.5	13121	99.5	13173	99.9	13173	99.9	16	0.1
39364	93.9	10885	26.0	40836	97.4	12357	29.5	41149	98.2	12670	30.3	41598	99.2	13119	31.3	41739	99.6	13260	31.7	180	0.4
11964	97.1	2304	18.7	12181	98.8	2521	20.4	12234	99.3	2574	20.9	12289	99.8	2629	21.4	12312	99.9	2652	21.5	6	0.1
12271	91.9	4362	32.7	13010	97.5	5101	38.3	13149	98.5	5240	38.3	13292	99.6	5383	40.4	13315	99.7	5406	40.5	35	0.3
5470	89.3	1893	30.9	5703	93.1	2126	34.7	5744	93.8	2167	35.4	5932	96.9	2355	38.5	6012	98.2	2435	39.8	111	1.8
9675	95.5	2341	23.1	9962	98.4	2628	26.0	10044	99.2	2710	26.8	10097	99.7	2763	27.3	10110	99.8	2776	27.5	17	0.2
17949	91.7	130	0.7	19003	97.1	1184	6.1	19081	97.5	1262	6.5	19331	98.8	1512	7.8	19433	99.3	1614	8.3	140	0.7
0	0.0	0	0.0	916	80.1	916	80.1	916	80.1	916	80.1	1019	89.1	1019	89.1	1068	93.4	1068	93.4	75	6.5
17949	97.8	130	0.7	18087	98.1	268	1.5	18165	98.6	346	1.9	18312	99.4	493	2.7	18365	99.6	463	2.5	65	0.4
18771	91.5	952	4.6	19871	96.9	2052	10.0	19974	97.4	2155	10.5	20248	98.7	2429	11.8	20363	99.2	2544	12.3	157	0.8
20590	96.2	9930	46.4	20959	97.9	10299	48.1	21169	98.9	10509	49.1	21345	99.8	10685	50.0	21367	99.9	10707	50.1	28	0.1
201877	94.9	23782	11.2	206079	96.8	27984	13.1	209669	98.5	31574	14.8	211883	99.6	33788	15.9	212637	99.9	34542	16.2	180	0.1
94471	96.6	8584	8.8	95774	97.9	9887	10.1	97041	99.2	11154	11.4	97681	99.8	11794	12.0	97811	100.0	11924	12.2	20	0.0
36203	92.5	5675	14.5	37443	95.7	6915	17.7	38445	98.3	7917	20.3	38937	99.5	8409	21.5	39090	99.9	8562	21.9	34	0.1
17150	98.6	1825	10.5	17294	99.5	1969	11.4	17370	99.9	2045	11.8	17384	100.0	2059	11.9	17388	100.0	2063	11.9	0	0.0
53844	92.5	7719	13.3	55346	95.1	9221	15.9	56587	97.2	10462	18.0	57641	99.0	11516	20.2	58105	99.8	11980	20.6	120	0.2
179291	96.4	1197	6.5	181113	97.4	3019	1.6	183701	98.8	5607	3.0	185175	99.6	7081	3.8	185756	99.9	7662	4.1	143	0.1
178094	98.2	0	0.0	178994	98.7	900	0.5	180529	99.5	2435	1.3	181115	99.8	3021	1.7	181343	100.0	3249	1.8	50	0.0
1197	26.6	1197	26.6	2119	47.1	2119	47.1	3172	70.4	3172	70.4	4057	90.1	4057	90.1	4410	97.9	4410	97.9	93	2.0
180163	96.1	2069	1.1	182345	97.2	4251	2.3	185146	98.7	7052	3.8	186763	99.6	8669	4.6	187412	99.9	9318	5.0	159	0.1
21713	86.1	21713	86.1	23732	94.1	23732	94.1	24521	97.3	24521	97.3	25084	99.5	25084	99.5	25185	99.9	25184	99.9	21	0.1

APPENDIX D

TIME DISTRIBUTION OF TRIPS

Time distributions of total trips and trips greater than 35 minutes were developed for each of the 22 study cities and are illustrated in Figures D-1 through D-22. The horizontal segments of the plots, common in the total trip curves, denote zero trips for that particular time range. This variation from the normal, rather than smooth, plot is a result of the inherent inaccuracies in some of the procedures followed. For instance, because of the macroscopic stance of the project and, consequently, the use of the nationwide network which lacked the detail that a network developed for a single urban area would have, it was impossible to predict with any reliability trips less than 35 minutes. Also, the fact that the network centroids were located at or near the population center of the county or county equivalents and the fact that the program allocates trips in 10-minute time rings introduced inaccuracies when counties adjacent to the study area were considered. For example, it is evident that the adjacent counties may be 25 to 35 minutes driving time from a study area. Since trips were allocated on a county basis, the allocation of trips from the study area to the nearest adjacent county centroids lead to zero trip allocations for those 10-minute time rings between 0 and 35 minutes. This occurrence is apparent from the output, where, in most cases, there are three or four zero trip rings, depending on the adjacent link node configuration. The most frequently occurring trip distribution pattern began as follows:

Time Ring (min.)	Trips
0- 5	5,050
5-15	0
15-25	0
25-35	0
35-45	995
45-55	820

The trips falling in the first ring were those which have origins or destinations in the home county. These trips, then, are not depicted on the total trip curve, for the plot begins at 10 minutes. There are no centroids between 5 and 35 minutes, which is the reason for the absence of trips here. As the time increases from the study area more centroids are located within each time ring, but the number of trips diminishes because of the increased travel time involved. In these latter rings, zero trips are possible. However, because of the grouping of the time rings, as previously explained, there were not many time rings with zero trips beyond 35 minutes, except in the case of extremely small cities.

When examining the figures, it is noticed that there are certain prevalent characteristics related to the time distribution of trips. The study areas were categorized into four groups based on cordon population for analysis purpose. The time distribution of trips greater than 35 minutes in length is very erratic for those cities in Group 1 (cordon population less than 10,000). Thus, these are the cities most noticeably affected by a lack of opportunities to satisfy locally the resident needs and desires. It appears that the inhabitants of these cities are forced to travel outside the city in order to satisfy their needs. Considering only the curve for trips greater than 35 minutes, it is noted that Lake Geneva, Wisconsin, has 58 percent of its trips greater than 100 minutes in length. This phenomenon appears to be explained by city location and function. For example, the driving time from Lake Geneva to Chicago is 129 minutes, with the two-way trip transfer being 2,171, or 42.3% of the trips greater than 35 minutes. Of these trips, 1,670 are categorized as social-recreation, which while appearing unique is explained by the fact that Lake Geneva is a large resort area and thus would generate a relatively high percentage of this type trip. Because Lake Geneva is oriented to recreational activities, it does not possess the variety of opportunities for people to satisfy other needs, thus these people are forced to travel outside the city in order to carry out effectively most of their everyday activities. Chicago (Cook County), with its 5,129,725 population and its relative abundance of opportunities to satisfy needs, is the area which attracts a large share of these trips. The fact that Chicago is 129 minutes from Lake Geneva accounts for the high percentage of trips greater than 100 minutes.

The distribution patterns of the remaining eight cities in this group can be similarly analyzed if so desired. However, the point of interest is not in the individual city patterns, but in the four classifications of cities stratified by cordon population.

The cities having 10,000 to 30,000 population exhibit more consistency with regard to trip distribution than the smaller areas previously discussed. In fact, there is very little difference in the trips-greater-than-35-minutes curve for Athens, Columbia, Dyersburg, Morristown, and West Bend. For this plot, Morristown has 7% of its trips greater than 100 minutes, while the corresponding value for Dyersburg is 24%. The other three cities fall between these limits.

The third class of cities, those with cordon populations between 30,000 and 100,000, all have very similar distribution patterns for trips greater than 35 minutes. In fact, there is only a 6% difference (23% to 29%) in the plot for the four cities in this classification.

In the final category of cities, those greater than 100,000 population, the curves for trips greater than 35 minutes are nearly the same for Chattanooga, Madison, and Springfield; however, the plot for St. Louis is considerably different. The explanation here can be attributed

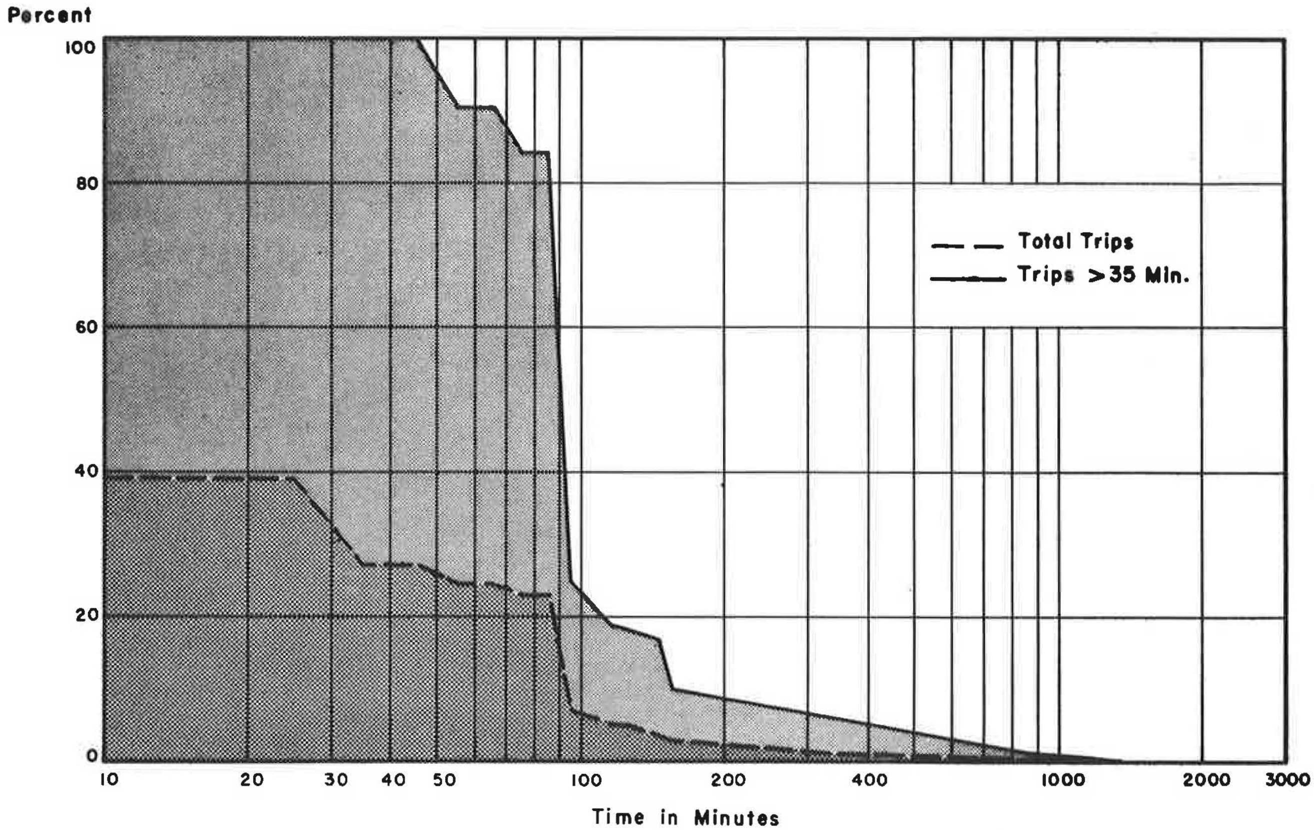

Figure D-1. Time distribution of Humbodt, Tenn., O-D trips.

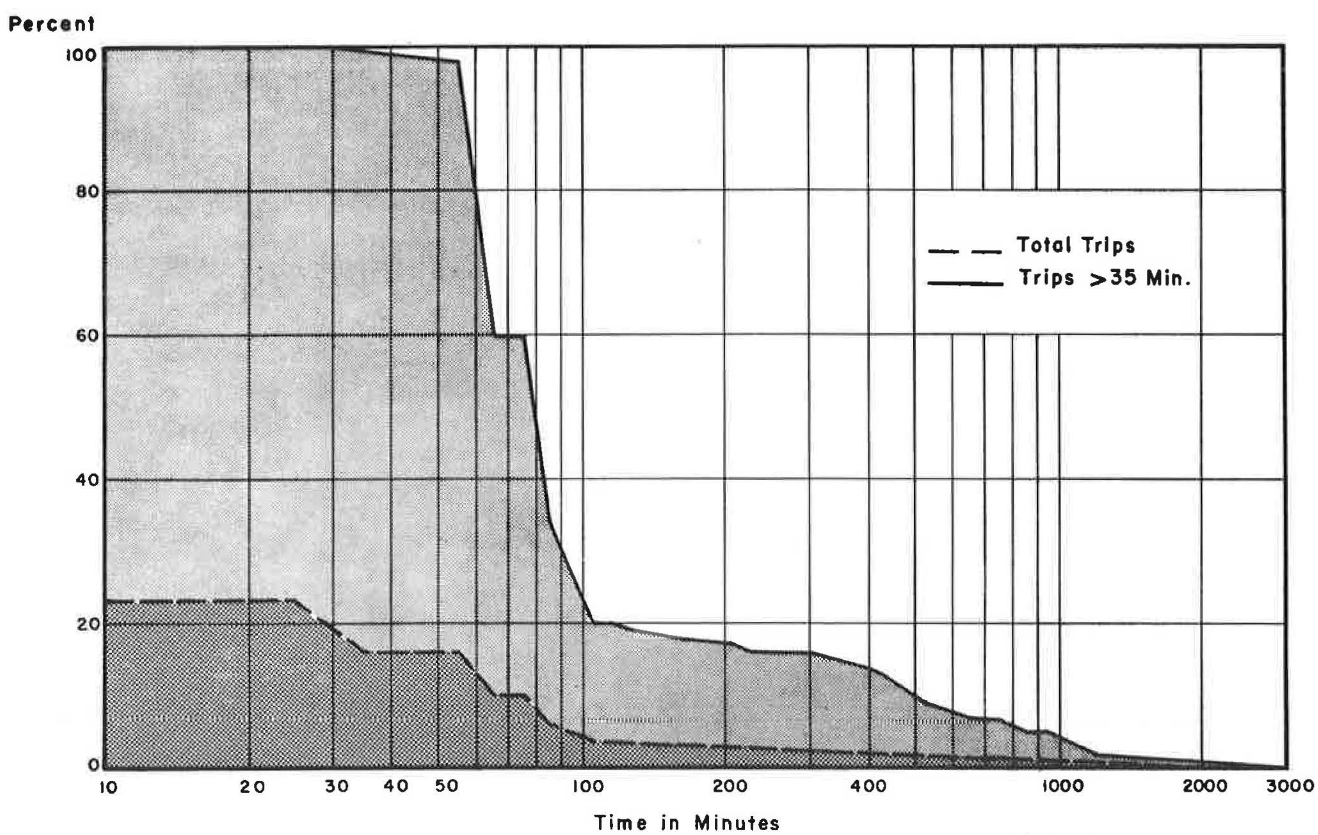

Figure D-2. Time distribution of Rogersville, Tenn., O-D trips.

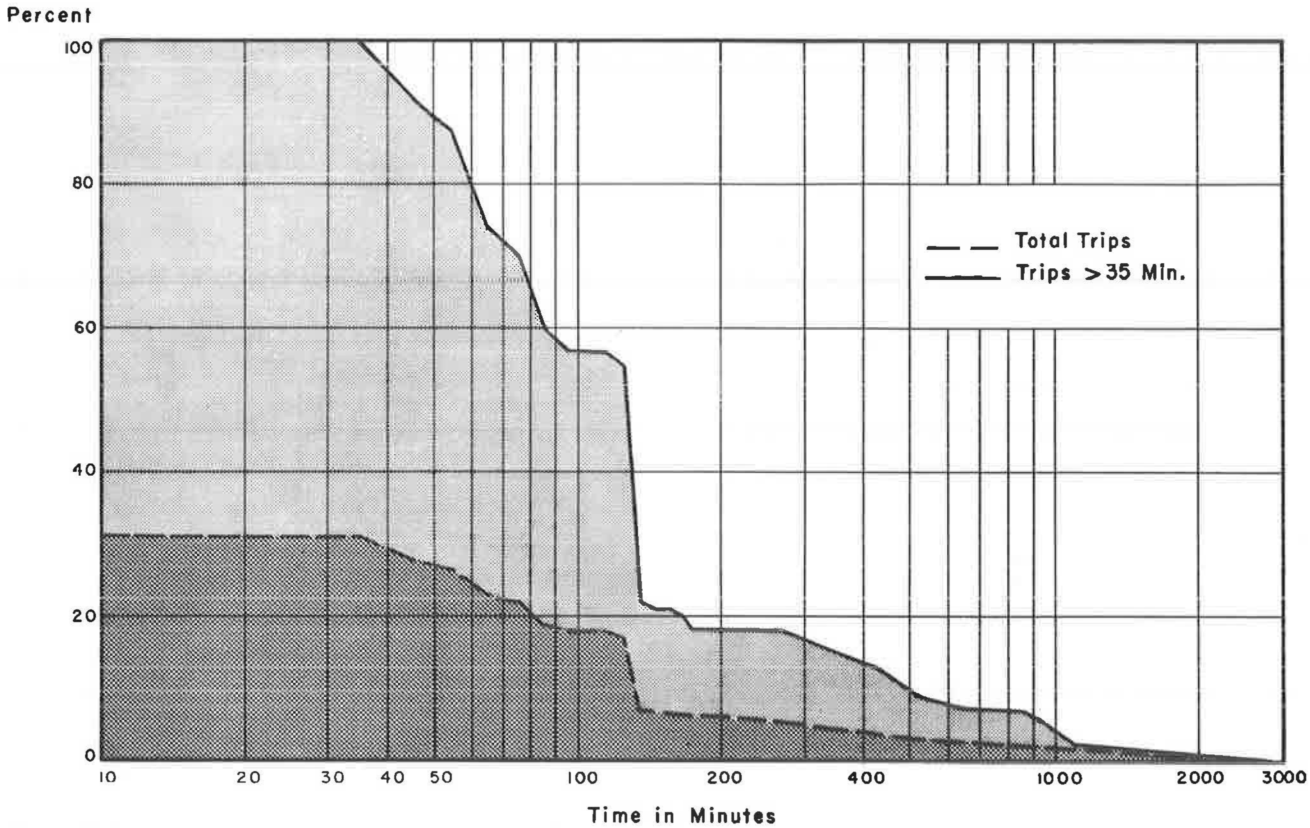

Figure D-3. Time distribution of Elkton, Wis., O-D trips.

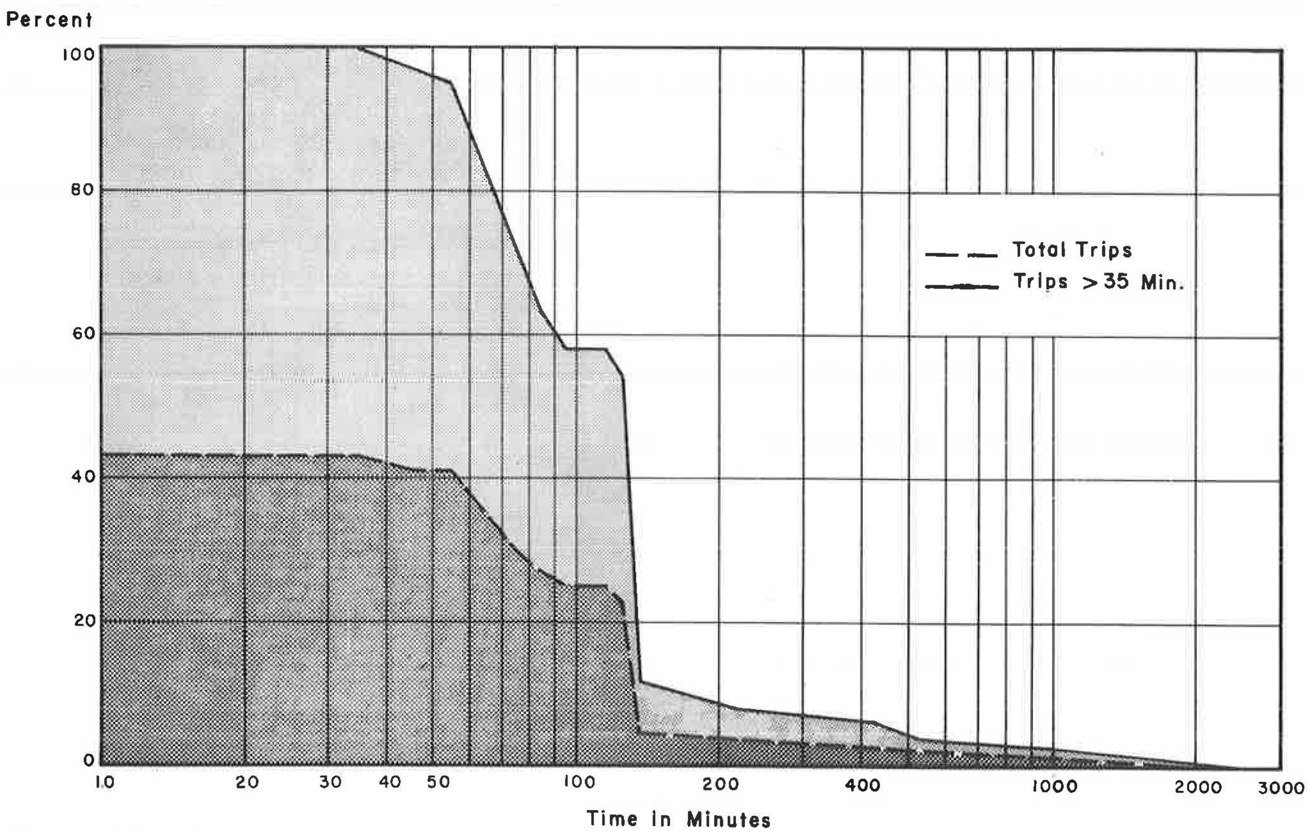

Figure D-4. Time distribution of Lake Geneva, Wis., O-D trips.

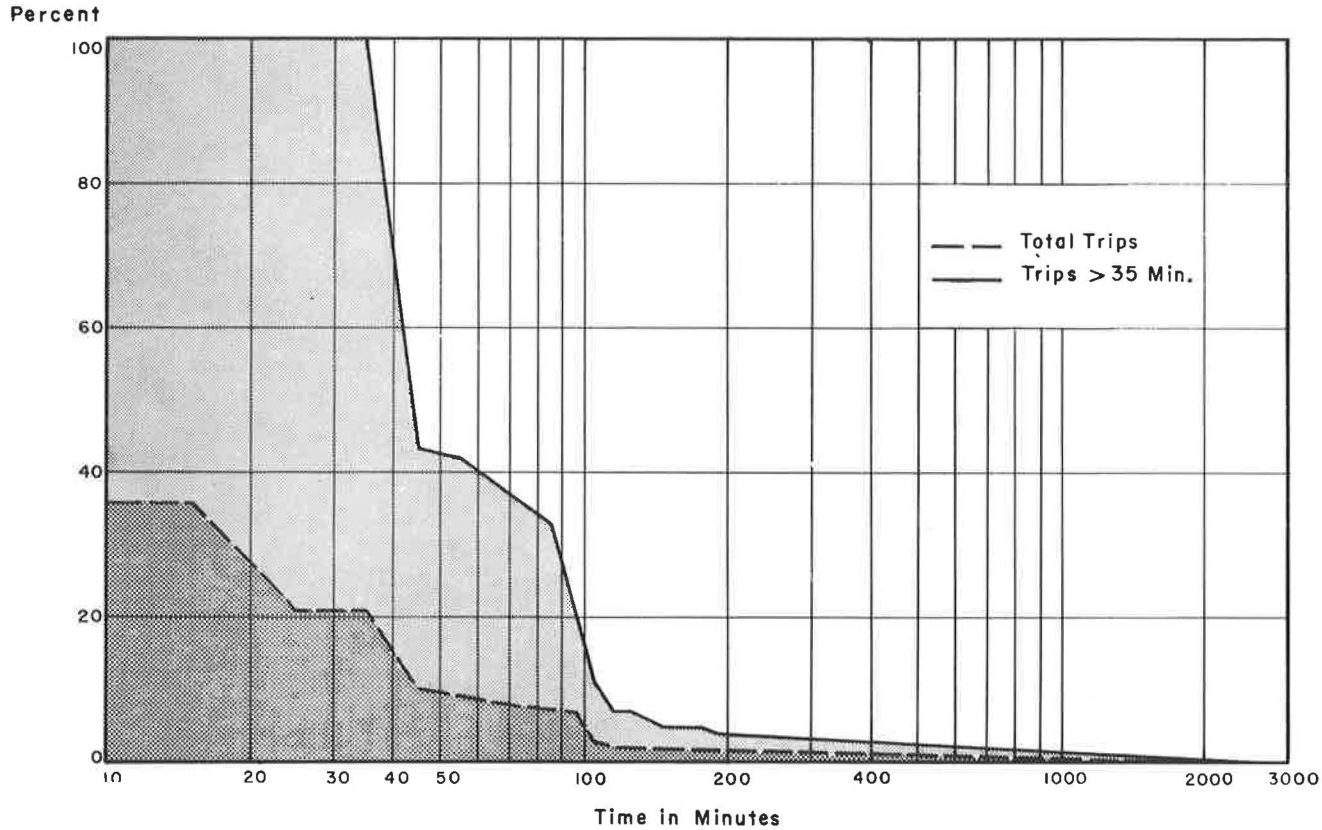

Figure D-5. Time distribution of Oconomowoc, Wis., O-D trips.

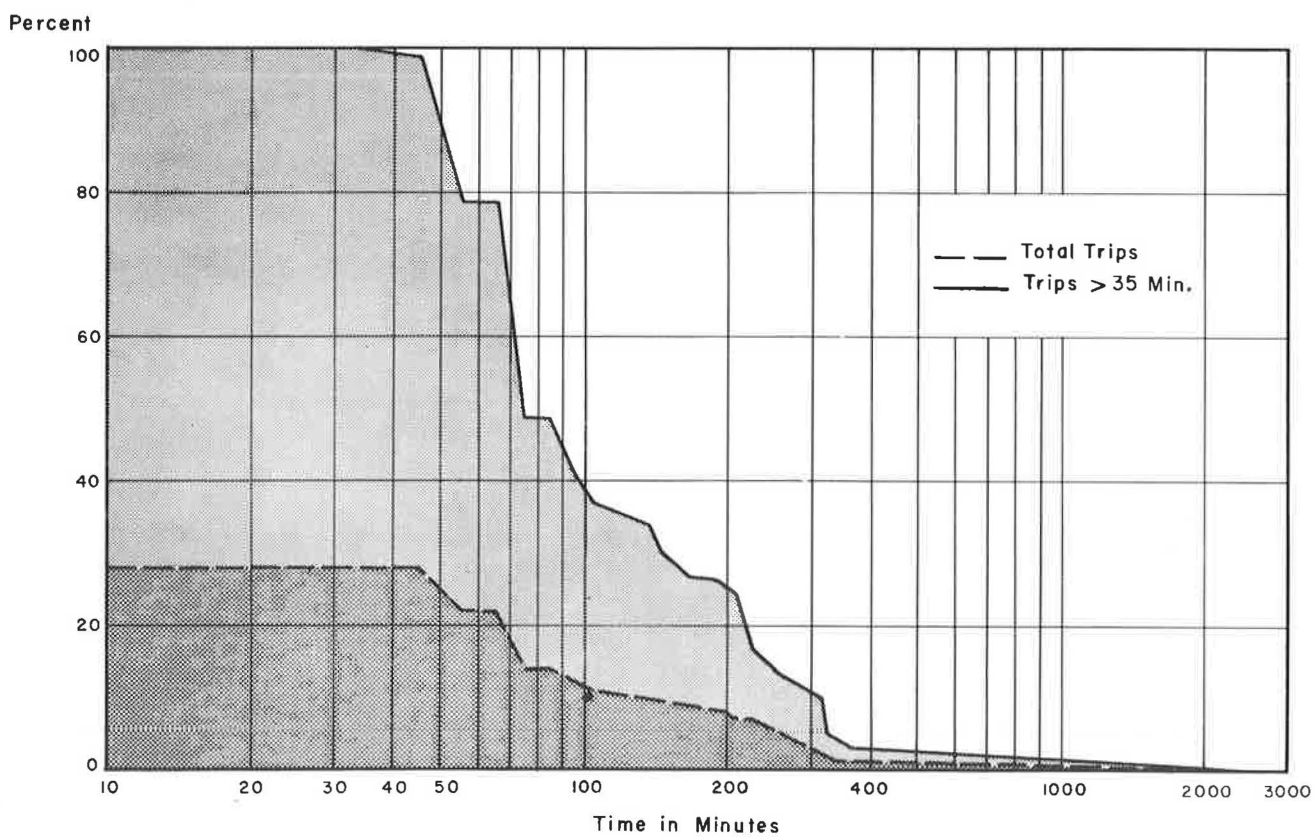

Figure D-6. Time distribution of Sturgeon Bay, Wis., O-D trips.

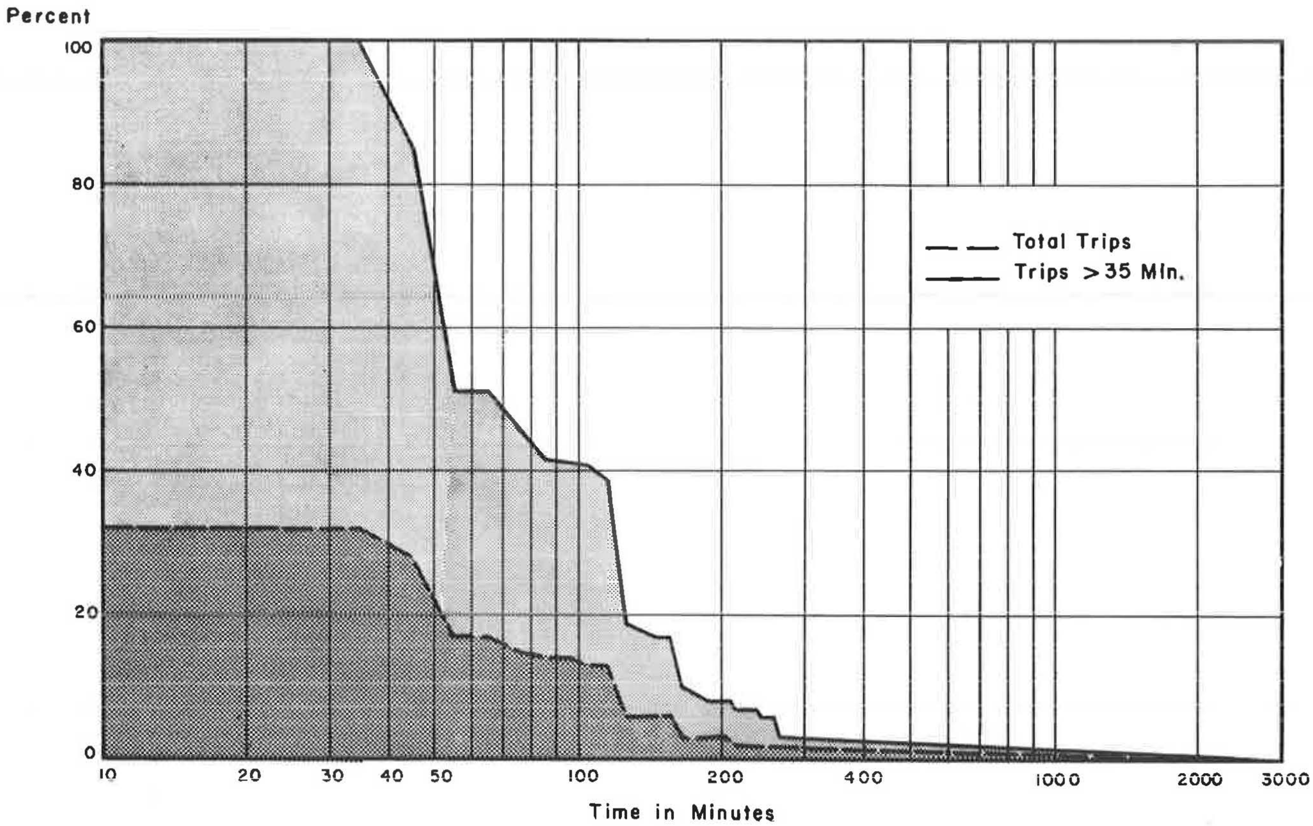

Figure D-7. Time distribution of Waupaca, Wis., O-D trips.

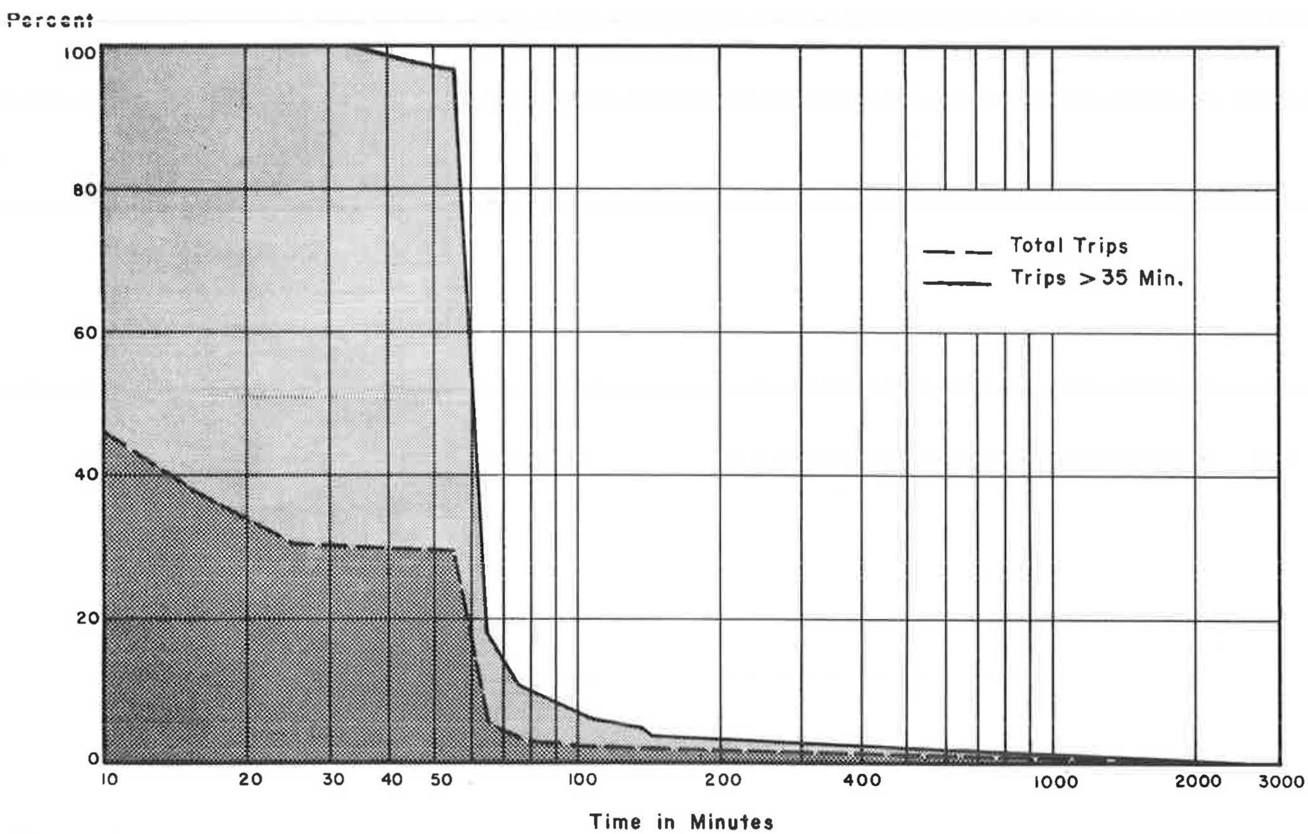

Figure D-8. Time distribution of Burlington, Wis., O-D trips.

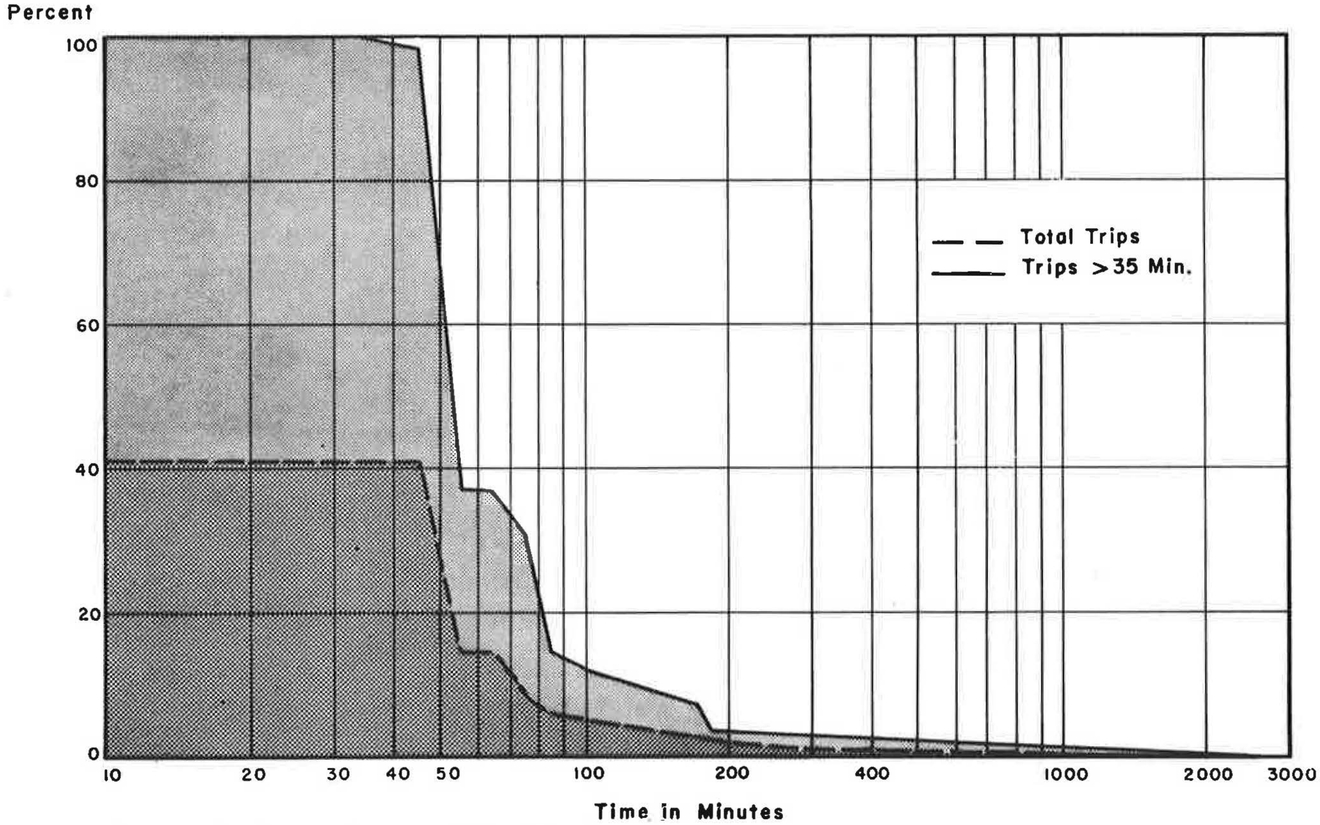

Figure D-9. Time distribution of Monroe, Wis., O-D trips.

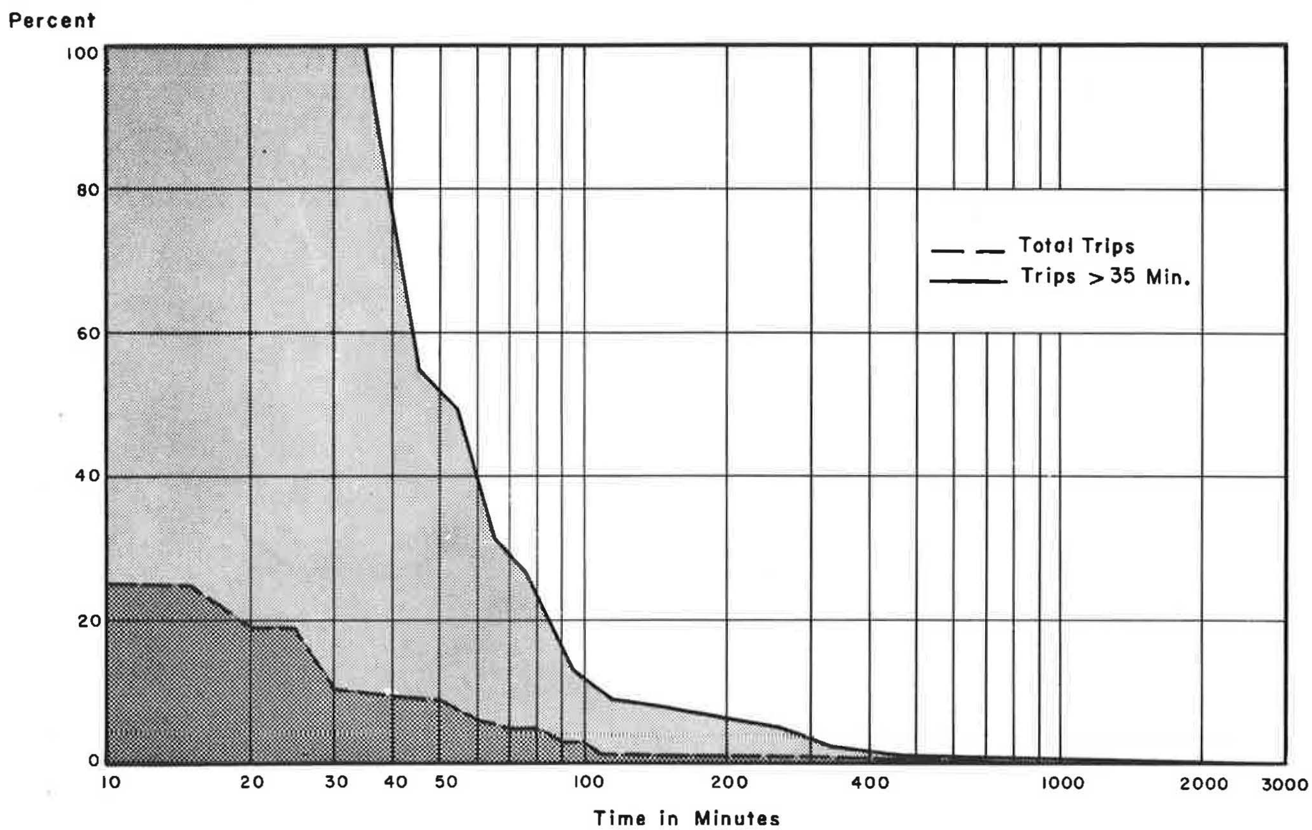

Figure D-10. Time distribution of Athens, Tenn., O-D trips.

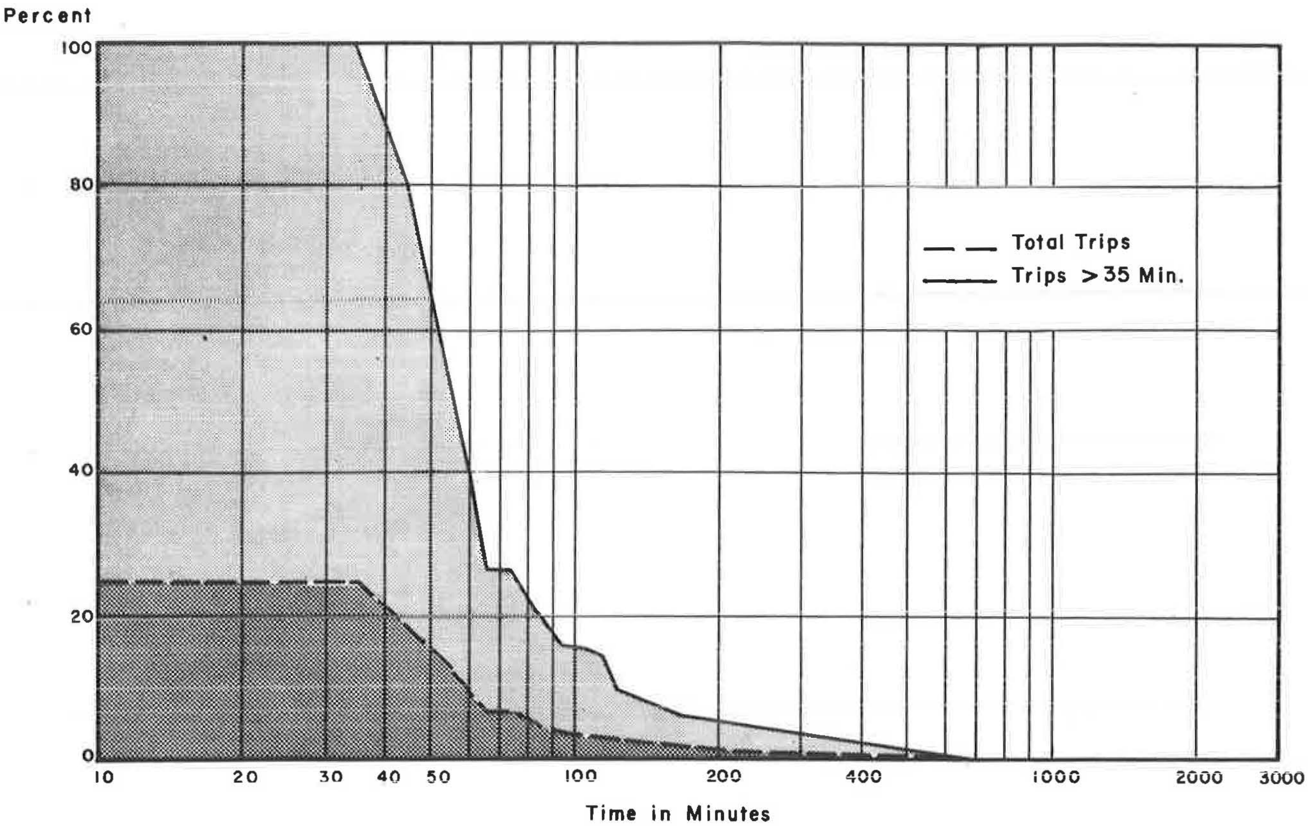

Figure D-11. Time distribution of Columbia, Tenn., O-D trips.

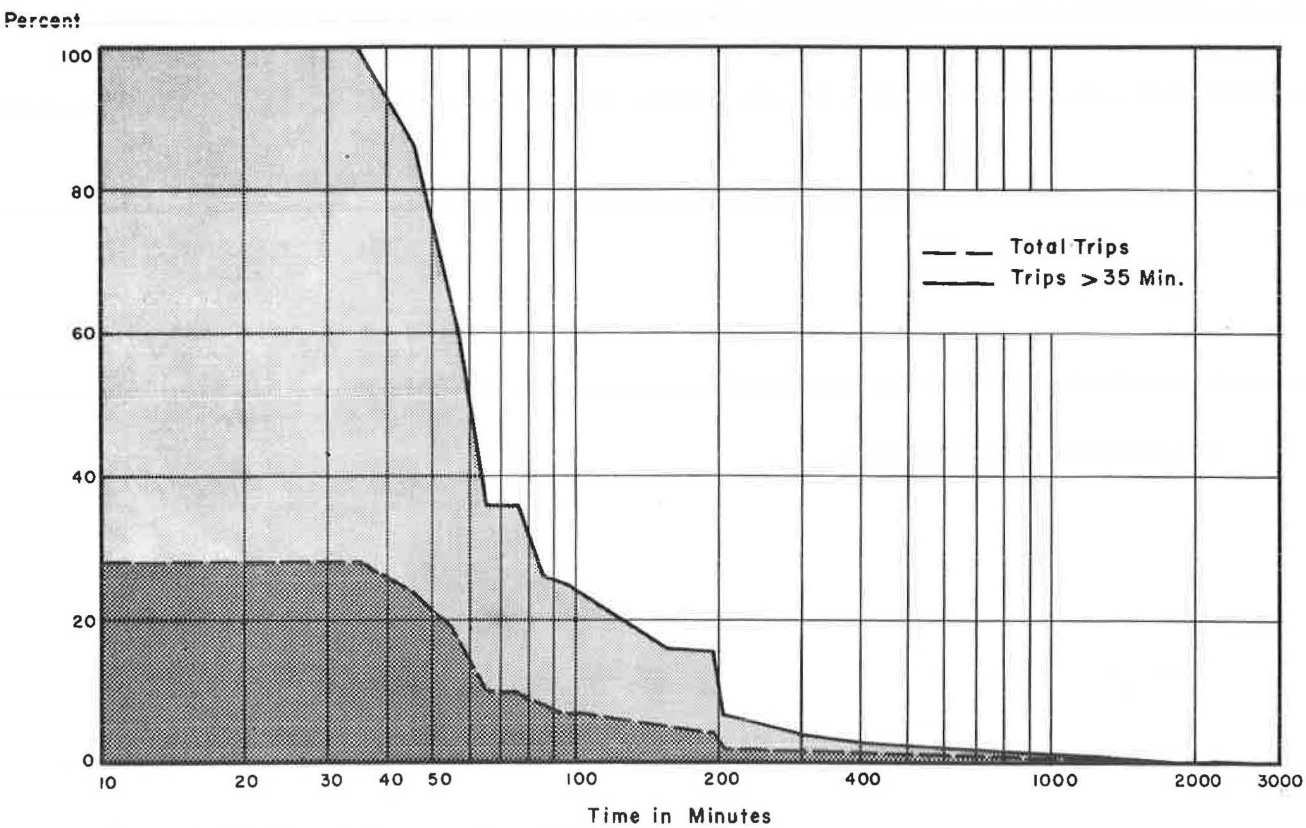

Figure D-12. Time distribution of Dyersburg, Tenn., O-D trips.

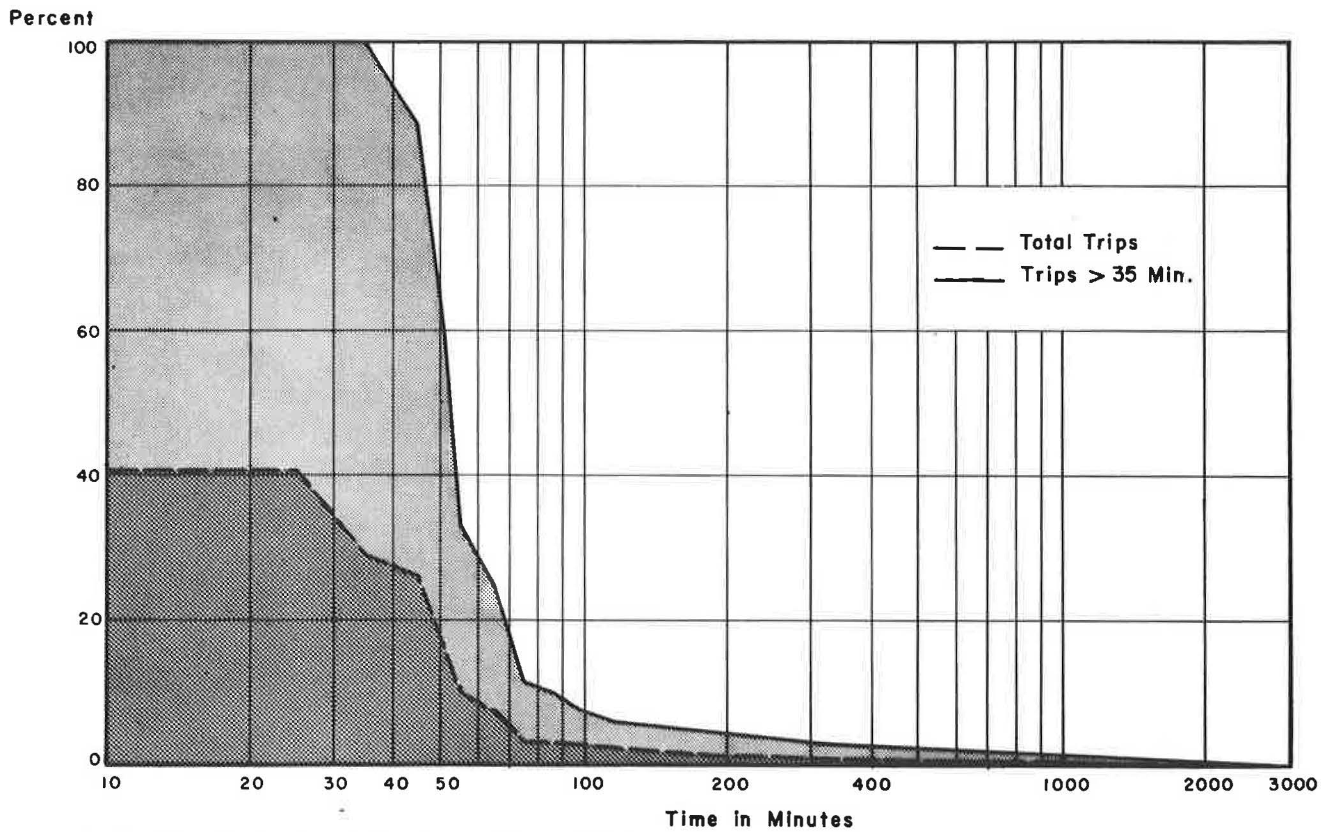

Figure D-13. Time distribution of Morristown, Tenn., O-D trips.

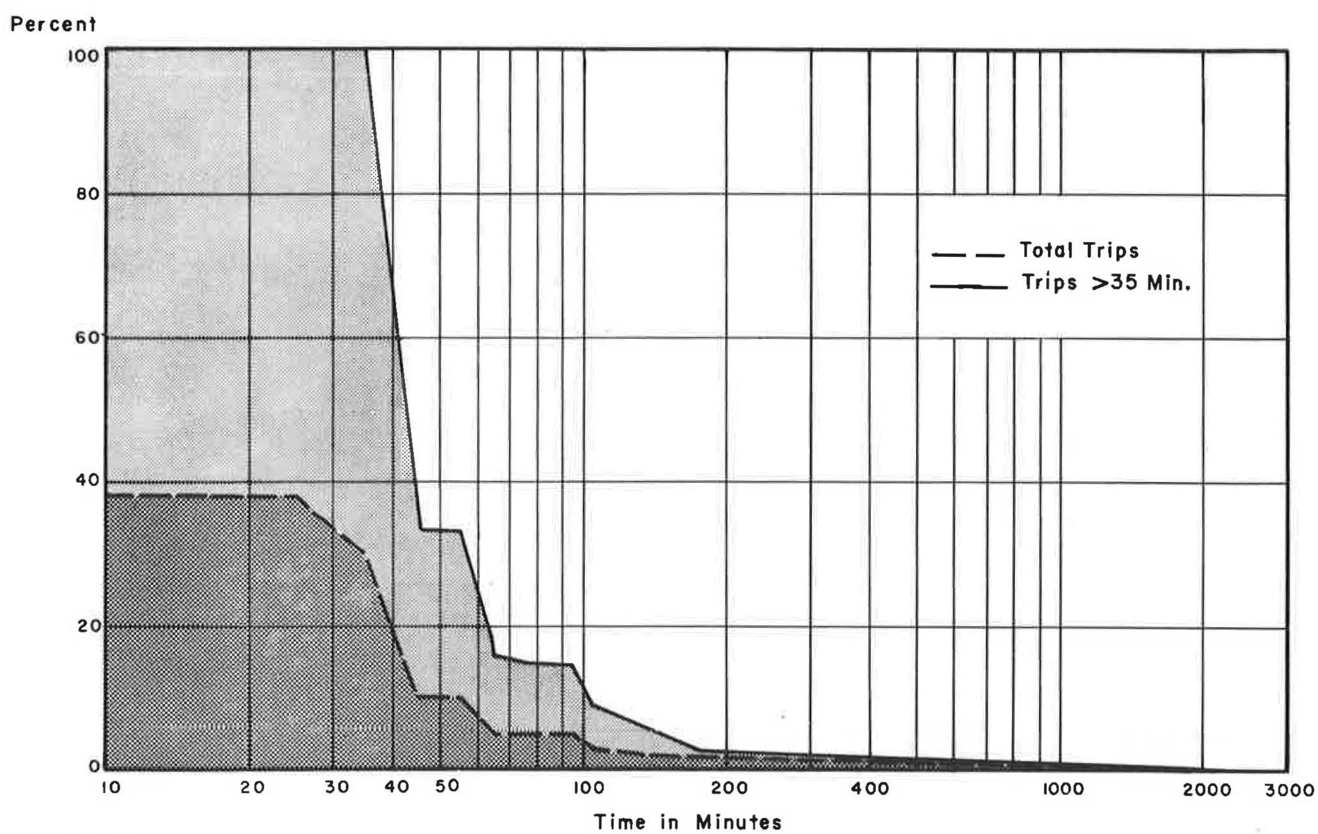

Figure D-14. Time distribution of West Bend, Wis., O-D trips.

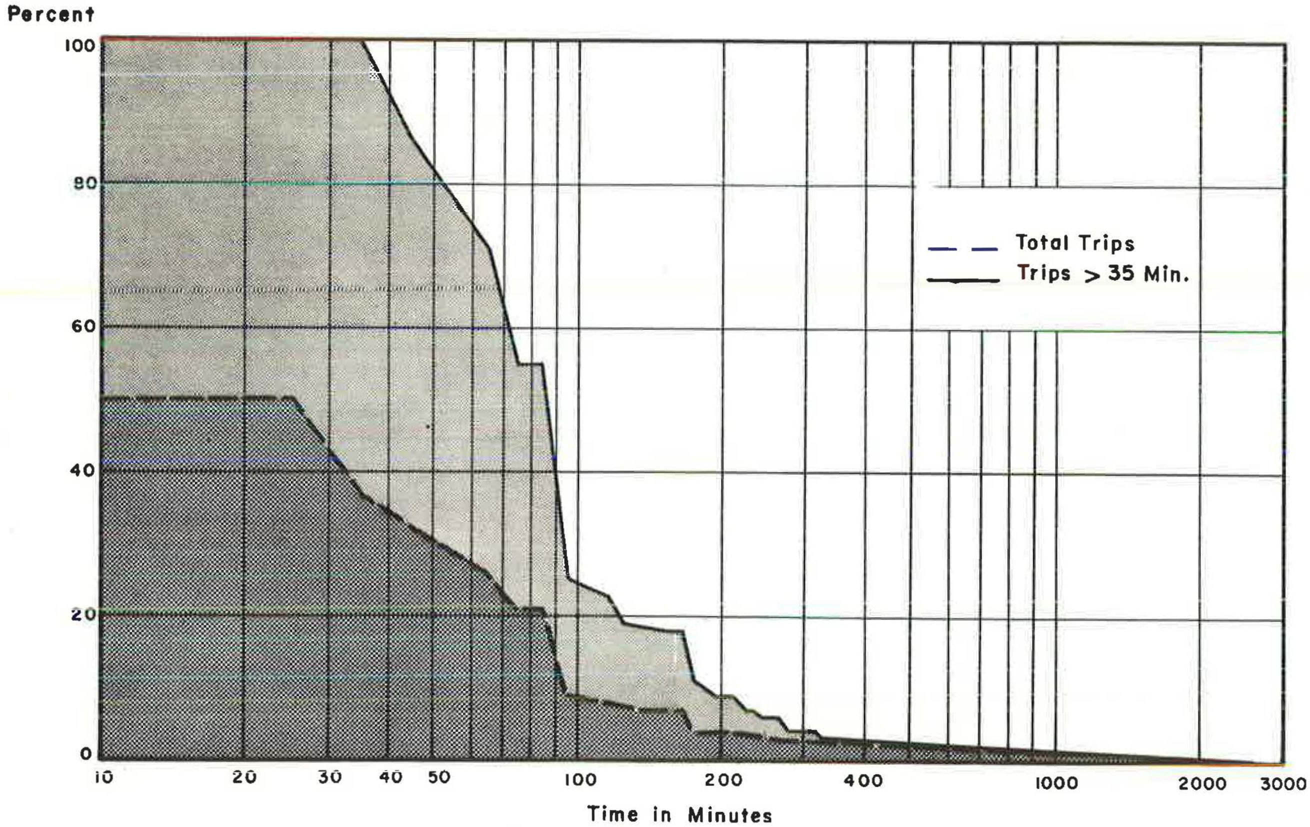

Figure D-15. Time distribution of Green Bay, Wis., O-D trips.

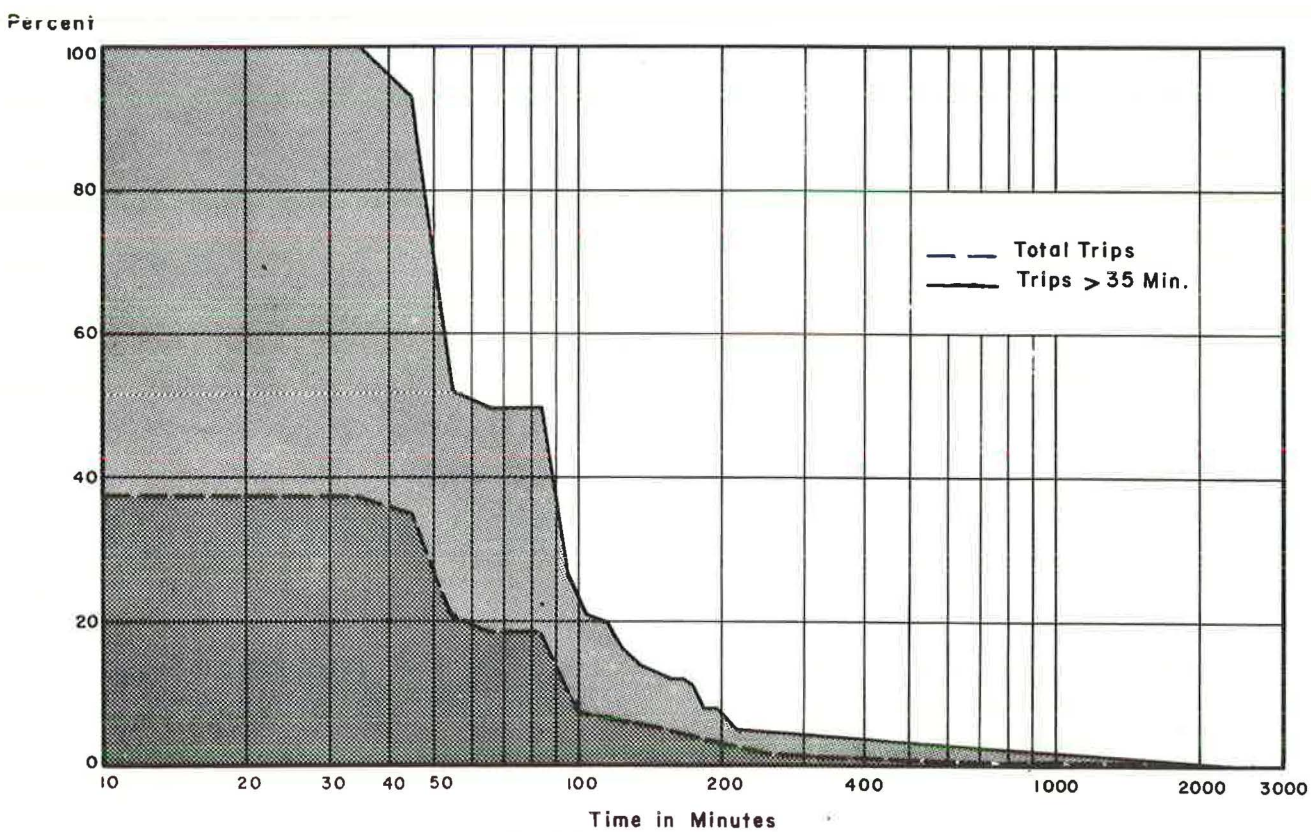

Figure D-16. Time distribution of Sheboygan, Wis., O-D trips.

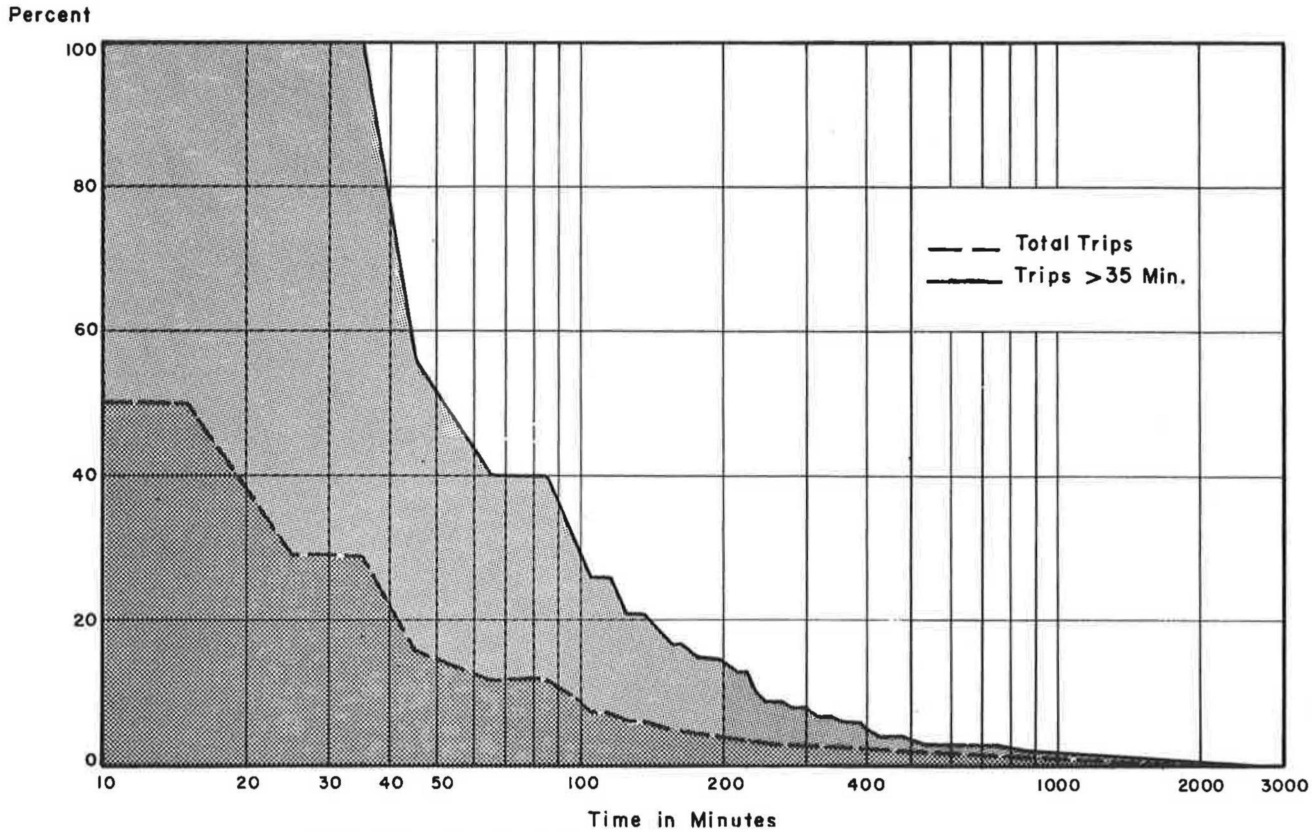

Figure D-17. Time distribution of Joplin, Mo., O-D trips.

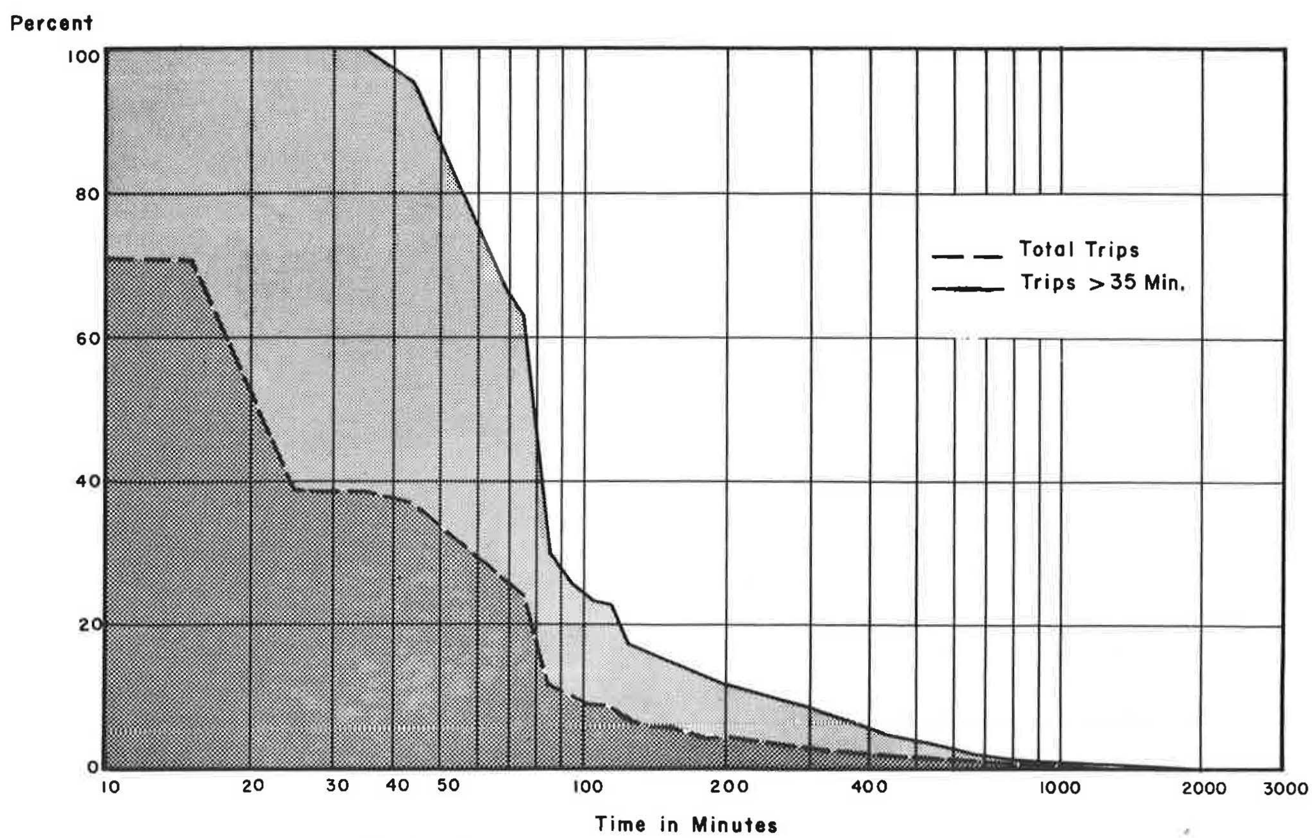

Figure D-18. Time distribution of St. Joseph, Mo., O-D trips.

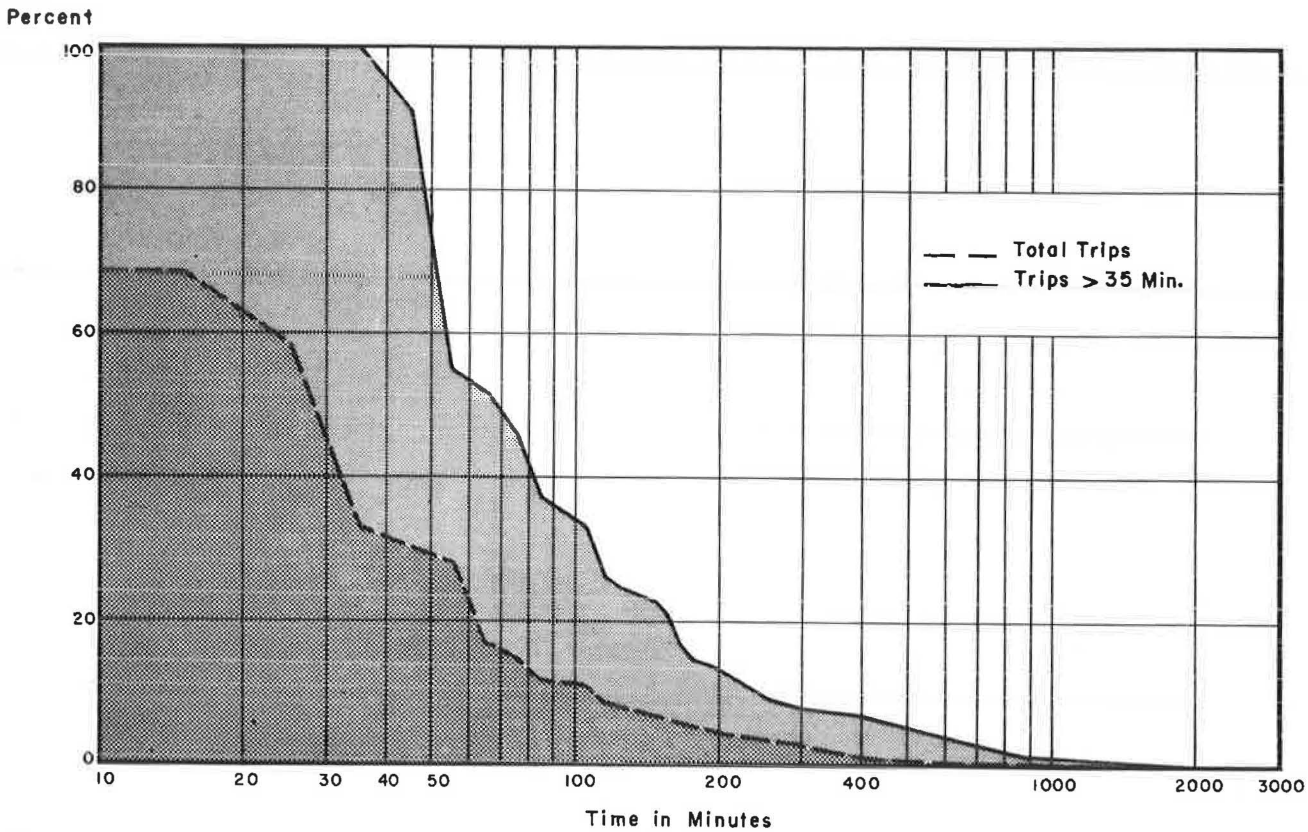

Figure D-19. Time distribution of Chattanooga, Tenn., O-D trips.

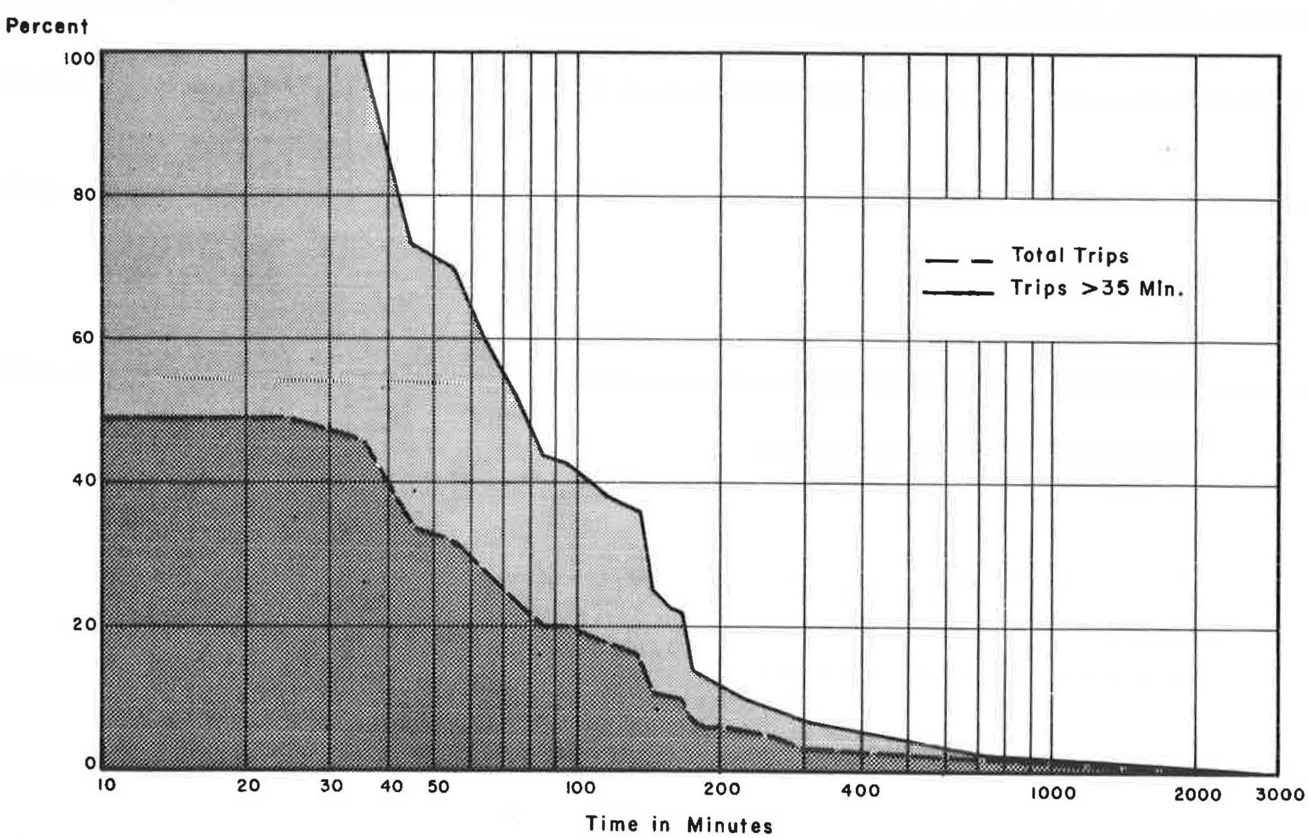

Figure D-20. Time distribution of Madison, Wis., O-D trips.

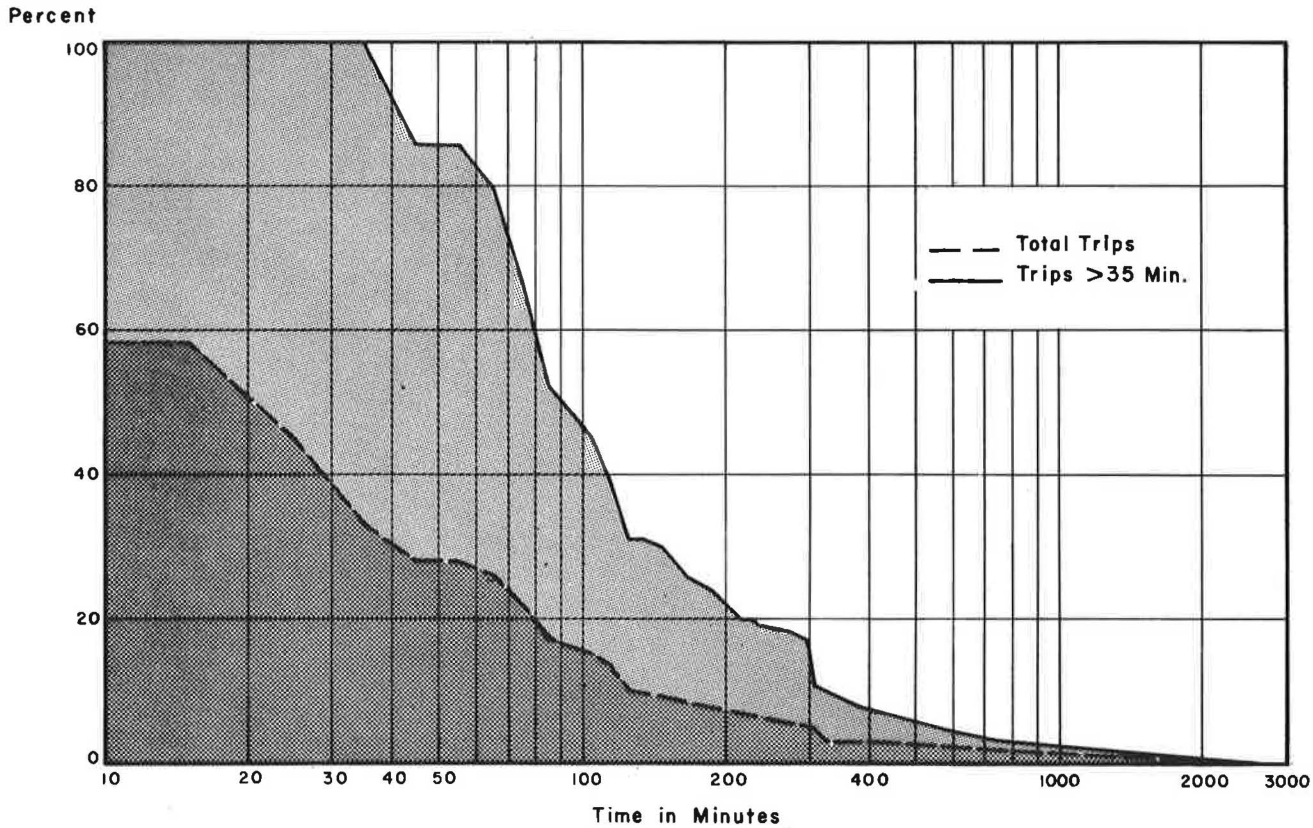

Figure D-21. Time distribution of Springfield, Mo., O-D trips.

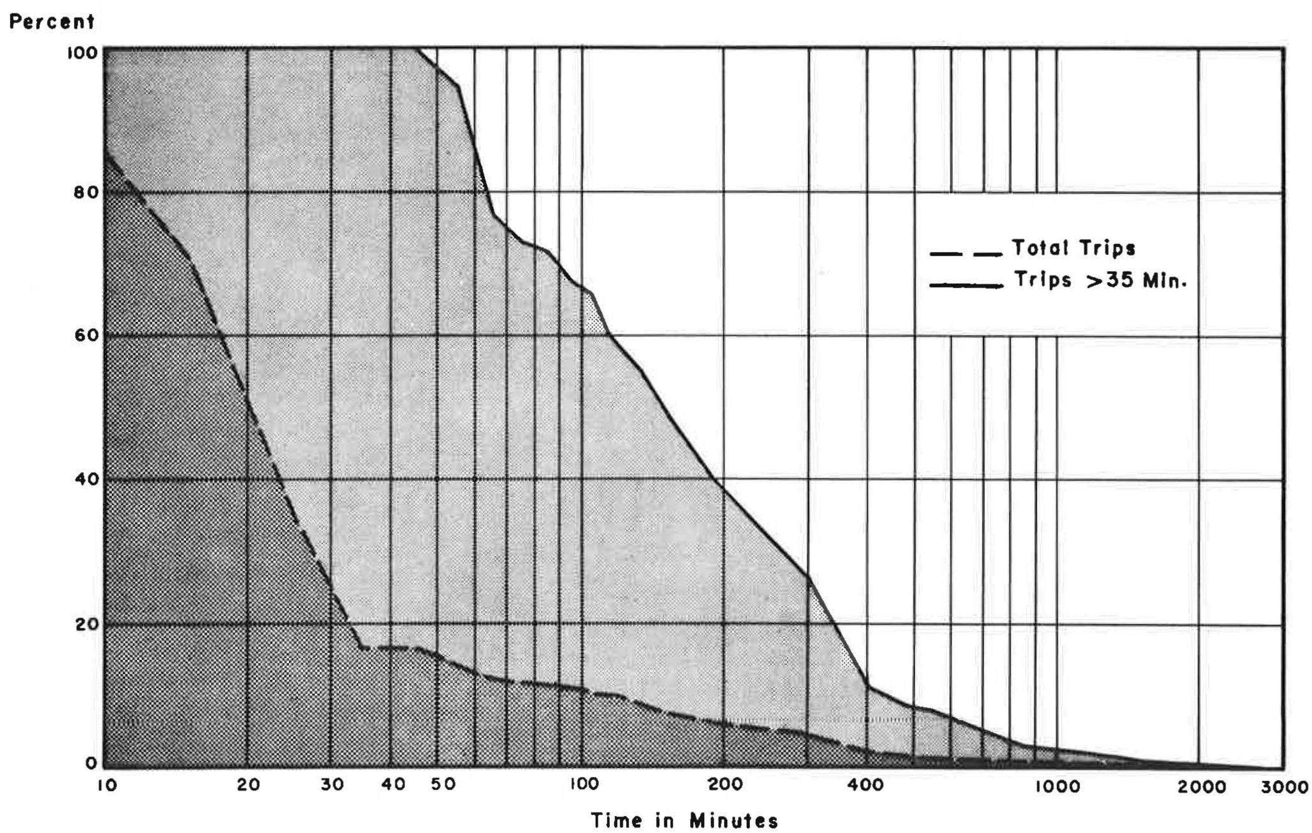

Figure D-22. Time distribution of St. Louis, Mo., O-D trips.

to the size of St. Louis, which has a cordon population of 1,456,673 as compared with a corresponding value of 242,096 for Chattanooga, the next largest city. Since St. Louis displays different characteristics as related to the distribution of trips, it seems that this cordon population grouping should be split somewhere near 50,000. This was originally intended in the project, but the data from Kansas City, Missouri, and Kansas City, Kansas (which were to be combined into one study area), had to be rejected because of incompleteness. This left only one city in the greater-than-500,000 class so St. Louis was placed in the greater-than-100,000 classification.

After examining these time distribution figures, it is apparent that all cities can be classified into four or five categories, based on the cordon populations of the areas in question. For the cities with less than 10,000 cordon population it is difficult to predict trip distribution with any reliability. However, when analyzing the cities in the 10,000 to 30,000; 30,000 to 100,000; and greater than 100,000 class, one notices similar trip distribution patterns within each category. These relationships lead to the development of a set of predicting equations which will closely approximate the actual O-D trip distribution pattern.

APPENDIX E

SUMMARY OF APPENDIX ITEMS NOT PUBLISHED

Other appendix materials contained in the report as submitted by the research agency are not published herein, but are listed here for the convenience of qualified researchers. Any or all copies of these materials may be obtained by written request to the Program Director, NCHRP, Highway Research Board. The items available are as follows:

1. Tabulation of data for illustrations and graphs appearing in the report.
2. External cordon questionnaire requesting origin and destination data sent to the following states: Missouri, Minnesota, Ohio, Tennessee, Michigan, Kentucky, Wisconsin, Illinois, Iowa, and Indiana. Only the data available from eight cities in Tennessee, eleven cities in Wisconsin, and seven cities in Missouri were suitable for processing. Four of these cities had to be abandoned because of missing interview cards.
3. Pertinent data tabulations of selected origin and destination information from the twenty-two cities providing usable origin and destination information.
4. County zone format for data cards from which statistics were developed.
5. Format for regression data tabulation cards.
6. Regression equations.
7. Sample calculations for the regression analysis equations.
8. Tabulation comparing the origin and destination trips with the synthesized trips for the selected cities.
9. Comparison of synthesized and origin and development trip designations.