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7/25/68
AN INVESTIGATION OF THE EFFECT OF TRAVELTIME ON
TRIPS ATTRACTED TO A MAJOR RECREATIONAL AREA

A THESIS
Presented to
The Faculty of the Graduate Division
by
Clarence Dorsey Dyer, Jr.

In Partial Fulfillment
of the Requirements for the Degree
Master of Science
in the School of Civil Engineering

Georgia Institute of Technology
June, 1970
AN INVESTIGATION OF THE EFFECT OF TRAVEL TIME ON TRIPS ATTRACTED TO A MAJOR RECREATIONAL AREA

Approved:

Chairman

Date approved by Chairman: May 24, 1970
ACKNOWLEDGMENTS

The writer is grateful to Dr. Donald O. Covault, thesis advisor, and to the other members of the Thesis Advisory Committee, Dr. Paul H. Wright and Professor Malcolm G. Little, Jr., for their assistance in this study.

Mr. Bill Crandall of Six Flags Over Georgia was very helpful in providing information during the course of this research.

Special thanks go to Miss Judy DeWitt for the assistance she gave in adapting the data for use in this study.

Thanks are also due Mrs. Claudia Shumpert, 625 Concord Road, for typing this thesis.

The financial assistance of the Automotive Safety Foundation is greatly appreciated.
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SUMMARY

The purpose of this research was to investigate the effect of traveltime on the number of inter-city trips attracted to a major recreational facility. The facility studied was Six Flags Over Georgia, a large, modern amusement park near Atlanta.

The effect of traveltime was expressed in the form of impedance factors, approximately equal to the ratios of trips to population for areas separated from Six Flags by various traveltimes. When the impedance factors were thus determined, a mathematical expression relating the values of these factors to traveltimes was derived. Using impedance factors determined from this expression, the number of trips from an area to Six Flags can be estimated.

The results of this research indicate that these impedance factors, and therefore trips made to Six Flags, decrease according to an exponential function as traveltime increases. For traveltimes greater than fifteen hours, the rate of decrease appears to be best described by another exponential relationship.
DEFINITIONS

In order to facilitate the understanding of this research and to avoid confusion resulting from the use of similar terminology elsewhere in the literature, the following definitions are given:

Actual Trips--The number of vehicle-trips made to Six Flags Over Georgia in 1968.

Predicted Trips--The estimated number of vehicle-trips to Six Flags Over Georgia in 1968.

Reported Trips--The number of vehicle-trips made to Six Flags Over Georgia that were reported on the returned questionnaires in 1968.

Corrected Reported Trips--An adjusted value used for reported trips (for Georgia only) due to particularly low questionnaire response.

Traveltime--The estimated time required to travel via automobile from a particular area to Six Flags Over Georgia in 1968.

Impedance Factor--A value used to predict the number of vehicle-trips from an area separated from Six Flags Over Georgia by a known traveltime. The impedance factor is approximately the ratio of vehicle-trips (to Six Flags) to population (of the area from which the trips came).

Input Impedance Factor--An impedance factor value used to calculate the number of predicted trips from various areas and used as input to the two computer programs described in the Appendix.

Adjusted Impedance Factor--An impedance factor value calculated using the impedance factor program. It is equal to the product of the number of reported trips and the input impedance factor divided by the number of predicted trips calculated using the input impedance factors.
DEFINITIONS (Continued)

Adjustment Factor--The ratio of reported trips to predicted trips for a zone or group of zones.

Income Adjustment Factor--Same as Adjustment Factor. The term Income Adjustment Factor is frequently used (instead of Adjustment Factor) to emphasize that a relationship between income levels and adjustment factors is being considered.
CHAPTER I

INTRODUCTION

Americans are devoting more time to recreational activities than at any time in the past, and indications are that this trend will continue indefinitely. The United States Bureau of Outdoor Recreation, for example, expects that "by the year 2000, our participation in the major forms of summertime outdoor recreation activities will be four times greater than it was in 1960" (1). This increase is partially brought about by increased personal incomes and greater amounts of leisure time. The character of recreation trips is also influenced by this country's continually improving transportation system, which permits easier access to major recreational areas, such as parks and stadiums.

Trips made for recreational purposes are particularly important to transportation planners concerned with regional planning. The 1963 Census of Transportation, conducted by the Bureau of the Census (2), indicates that 25% of all inter-city person-trips and 26% of inter-city person-trips made by automobile were for recreational purposes. In order to permit adequate transportation planning on a regional or statewide level, therefore, a method of predicting recreational trips is needed. Before such a method can be devised,
however, the effect of traveltime, as well as income and other socio-economic factors, must be more clearly understood.

The purpose of this study was to investigate the effect of traveltime (via automobile) on the number of trips made to a major recreational facility. It was believed by this writer that knowledge of the effect of traveltime would be more valuable to transportation planners than would knowledge of the effects of any socio-economic factors. Although the value of such understanding to transportation planners was the primary reason for this study, perhaps a more immediate benefit can be realized by the management of recreational facilities similar to the one studied, Six Flags Over Georgia. A better understanding of the effect of traveltime upon the number of trips made would be useful in both the planning and operational phases of such establishments.

Little research has been conducted that is concerned with the prediction of inter-city recreational trips for regional transportation planning purposes. Charles C. Cervo (3) of the Connecticut State Highway Department did some early work in this field and reached some preliminary conclusions concerning the effect of traveltime. However, his study dealt with five similar recreation areas, all of which were located in southeastern Connecticut and attracted trips primarily from a small section of New
England. Cervo was thus concerned only with traveltimes of ninety minutes or less and has not eliminated the effect of competition between two or more facilities. Andrew Ungar (4) studied the effect of recreational facilities, socio-economic characteristics, and traveltime upon trips made to Indiana state parks, but Ungar was also concerned with several similar facilities and relatively small traveltimes. James H. Evans (5) did some similar work concerned with the prediction of trips to state parks in Georgia. Like Cervo and Ungar, however, Evans was concerned with several similar facilities, each attracting trips from a relatively small area. Furthermore, Evans was unable to reach any conclusions concerning the effect of traveltime since the origins of the trips in his study were unknown. J. S. Matthias and W. L. Grecco (6) have studied the effect of traveltime on recreational trips made to multi-purpose reservoirs in Indiana. Again, however, this study involved several competing facilities and small traveltimes. G. David Boggs (7) conducted a study of recreational travel patterns in southern Ontario as a part of the Ontario Joint Highway Research Programme. However, that study was primarily concerned with factors other than traveltime, such as resort facilities and resort-user characteristics.

The recreational facility used in this study was Six Flags Over Georgia, known also as Six Flags, a modern amusement park located on Interstate 20 approximately eleven
miles west of downtown Atlanta.

The park was opened in 1967 and is open week-ends from the first week-end after Easter through May and from Labor Day through the last week-end in November and is open daily from the first week in June through Labor Day. Approximately 1,600,000 persons visited Six Flags during 1968, the year for which data was used for this study. These persons, called "guests" by Six Flags personnel, came not only from the Atlanta area but also from throughout the southeastern United States and, to a lesser degree, from the entire country. Approximately one-half of the park's business in 1968 came from within Georgia.

Six Flags Over Georgia was chosen for this study because of its convenience to the writer and the availability of needed data. Also, it was important that the park attracted trips from relatively large distances and that no similar facility existed within several hundred miles of Atlanta. This minimizes the possibility of the presence of direct competition obscuring the effect of traveltime. Of course, the absence of a similar facility near Six Flags Over Georgia does not mean that Six Flags has no competition at all, since any form of recreation can be competitive with an amusement park.
CHAPTER II

HYPOTHEZIED MODEL

It was hypothesized that the number of trips from any area to Six Flags Over Georgia could be predicted if the population of that area, the traveltime from the area to Six Flags, and certain socio-economic information were known. As previously stated, the purpose of this study was to investigate the effect of traveltime. The writer's interest in any socio-economic data was limited to the possible use of such data to eliminate the effects of any factors that would obscure the effect of traveltime. Early observation of limited data indicated that income might be an important determinant of the number of trips from a particular area to Six Flags. Thus an adjustment factor based on per capita income was incorporated into the model.

The number of trips from any area to Six Flags was assumed to vary directly with the population of that area. In other words, all other things assumed equal, an area with twice the population of another area would be expected to have twice as many trips originating from it as would the second area. No such assumptions were made concerning the effects of traveltime and income. The model for predicting the number of trips from a given area to Six Flags can thus
be expressed as

\[ PT = P \times IF \times K \]

where

- \( PT \) = the predicted number of trips from the area
- \( P \) = the population of the area
- \( IF \) = an impedance factor indicative of the effect of the traveltime from the area to Six Flags
- \( K \) = an adjustment factor based on the area's per capita income

If the above model is appropriate, then with the use of appropriate factors based on traveltime and per capita income, the number of predicted trips from an area to Six Flags will approximate the number of reported trips from that area. Letting \( RT \) represent the reported trips from an area, the model then becomes

\[ RT \approx PT = P \times IF \times K, \text{ or} \]
\[ RT \approx P \times IF \times K, \text{ or equivalently} \]
\[ IF \approx RT/(P \times K) \]

This last relationship was the one used in this study to determine the effect of traveltime upon the number of trips made to Six Flags. As will be explained in a later chapter, the number of reported trips from a zone was used in this study to represent the number of actual trips from that zone.

In order to estimate the traveltime factors from the relationship given above, zones had to be created and certain data for each of the zones were needed, including:

1. the reported number of trips originating from each zone during the study period (1968),
2. the population of each zone during the study period,
3. the per capita income of each zone during the study period, and
4. the traveltime from each zone to Six Flags Over Georgia.

The model described above is similar in several respects to the Gravity Model of trip distribution used in transportation planning. In fact, this model was admittedly influenced by the writer's familiarity with the Gravity Model, and much of the terminology used in this report is similar to that used with the Gravity Model.

However, it is important to recognize that there are basic differences between the model used in this study and the Gravity Model. These differences arise from the different purposes of the two models. The Gravity Model distributes a given number of trips from a zone to other zones, based on a set of traveltime factors. The model formulated for this study predicts the number of trips made from a zone to a single location (Six Flags Over Georgia). In other words, while the Gravity Model uses traveltime to distribute trips, this study's model uses traveltime to predict the frequency of a particular type of trip.
CHAPTER III

PROCEDURE

The procedure used in this study to determine the effect of traveltime on trips attracted to Six Flags Over Georgia is documented in this chapter. This procedure was based on the model discussed in Chapter II.

Designation of Zones

In order to estimate the number of trips attracted to Six Flags from a particular area by the model described in the previous chapter and to compare this figure with the number of reported trips from that area, the areas to be used for analysis had to be defined. To accomplish this, the United States (excluding Alaska and Hawaii) was divided into zones. In all, 208 such zones were created, with no zone boundaries crossing county or state lines. The boundaries were so drawn in order to facilitate the acquisition of population and income data.

The counties (or states) were grouped in zones primarily according to approximate distances and traveltimes, i.e., neighboring counties which were approximately the same distance and traveltime from Six Flags Over Georgia were often placed in the same zone. The size of the zones varied with traveltime, with larger zones being utilized for areas
farther from Atlanta. Zone sizes varied from one county to six states. Also taken into consideration in the creation of zones was the character of the area. Thus large urban areas (particularly in Georgia and adjacent states) were often considered as individual zones. The size of such zones depended on the size of the particular urban area and varied from one county to four counties.

The judgment of the writer was necessarily used extensively in the creation of zones. The counties and states in each zone are indicated in Table 2, included in Appendix I.

Acquisition of Data

In the course of this study, much data became necessary. The methods used to obtain the required data are discussed in this section.

Determination of Reported Trips from Each Zone

Drivers of automobiles coming to Six Flags Over Georgia were given short questionnaires that were designed to obtain certain information for the management of Six Flags. Normally, Six Flags attempts to give a questionnaire to every vehicle at the park, but for various reasons this goal is not reached. In 1968 an estimated 250,000 questionnaires were distributed among the 338,476 cars at Six Flags. Of these, approximately 27,000 were returned. It was from these returned questionnaires that the origins of trips were determined.
One of the questions asked on the questionnaire was "What is your hometown?", and the answers to this question were summarized in weekly, monthly, and annual reports for 1968. The data from the annual summary were used in this study to determine the "reported trips" from each zone.

Each town listed in the summary was assigned to the proper zone. The 1968 Rand McNally Commercial Atlas and Marketing Guide (8) was used to locate towns in the correct zones. The number of reported trips from each zone was determined by summing the numbers of reported trips from the towns in the zone.

Some problems inevitably arose when following the above process. These were resolved either by referring to the weekly reports (from which the annual report used for this study was summarized) or by the writer's judgment. In almost all cases requiring judgment, very few trips (usually only one or two) were involved, and it is not likely that any significant effect on the conclusions of this study could have resulted from incorrect judgments in these situations.

The number of reported trips from each zone is shown in Table 5, included in Appendix II.

Estimation of Zone Populations

The population figures used in this study are estimates of populations as of January 1, 1968, and they were taken from the 1968 Editor and Publisher Market Guide. (9) The population of each zone was found by summing the popula-
tions of the counties (or states) in the zone.

These zone populations are indicated in Table 4, included in Appendix I.

Estimation of Per Capita Incomes

The total personal income for each zone was determined by adding the total personal incomes for each county (or state) in the zone. The source of these estimates, which were for the calendar year 1968, was the 1968 Editor and Publisher Market Guide (10), the same source used for population estimates. The per capita income for each zone was found by dividing its total personal income by its population.

The total personal income for each zone is shown in Table 4, included in Appendix I.

Estimation of Traveltimes

In order to estimate the traveltimes from the various zones to Six Flags Over Georgia, some average speeds were assumed. The type of roadway and its location greatly influence speeds, and therefore a single average speed for all roads was not used. For the purposes of this study, roads were placed in one of three categories, for each of which an average speed had been assumed. In estimating these average speeds, the Traffic Engineering Handbook (11) was used as a reference, particularly its Table 5.15. The three types of roads and the corresponding average speeds are shown in Table 1.
Table 1. Assumed Speeds Used in Traveltime Calculations

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<tr>
<th>Road Type</th>
<th>Description</th>
<th>Assumed Average Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Controlled-access freeways (urban and rural) and rural 4-lane roads</td>
<td>55 m.p.h.</td>
</tr>
<tr>
<td>B</td>
<td>2-lane rural roads</td>
<td>45 m.p.h.</td>
</tr>
<tr>
<td>C</td>
<td>All urban roads except controlled-access freeways</td>
<td>25 m.p.h.</td>
</tr>
</tbody>
</table>

For each zone a "centroid" of trip-making was approximated. It was from this point that all trips from the zone were assumed to originate, or to be "loaded" on the highway network. The Traffic Assignment Manual states that "the point of loading for each zone, defined as a centroid or loading point, should be located at the center of activity for the zone." (12) It further says that "the location of the centroid is determined to a large extent by judgment." (13) However, since for this study the traveltime from the zone centroid to only one destination (Six Flags) was needed, it was not necessary that the centroid be located at the "center of activity", but merely that it be placed so that its traveltime will be approximately equal to that of the center of activity. The writer's judgment was used extensively in locating zone centroids. After a zone centroid had been located within each zone, the traveltime to Six Flags Over Georgia could be determined. This was
done by manual calculation, using the assumed average
speeds discussed earlier. The mileage of each of the three
road types was estimated from road maps and a traveltime was
thus estimated for the route. In cases where the route
having the shortest traveltime was not readily apparent, two
or more routes were compared and the route with the smallest
traveltime value was selected.

The method described above for the estimation of
traveltimes is admittedly only a rough approximation, but in
the absence of any better method that was feasible, it was
considered sufficiently accurate for the purposes of this
study.

The calculated traveltimes are given in Table 4,
included in Appendix I.

**Method Used in Determining Effect of Traveltime**

As indicated in Chapter II, the effect of traveltime
on the number of trips made to Six Flags Over Georgia was to
be expressed in the form of an impedance factor approximately
equal to the ratio of (reported) vehicle-trips (from the
zone to Six Flags) to the zone population.

The form of the proposed impedance factor curve
(plotted against traveltime) was intended to be smooth and
decreasing with increasing traveltime values. As stated by
the Bureau of Public Roads, the curve should be smooth, if
possible, because
a. Smooth curves can be approximately defined in a mathematical expression; possibly, one that is not too complex.

b. If these curves can be approximated by a mathematical expression, meaningful comparisons can be made between these expressions for different . . . areas with various population and density characteristics.

c. These comparisons would eventually help quantify, with a mathematical function, the effect of spatial separation between zones on trip interchange. (14)

Although the above reasons were meant to apply to urban transportation studies, they are also applicable to this study.

The use of adjustment factors, to have been based on zonal per capita income, was also planned. It had been anticipated that these adjustment factors would have been used in this study to clarify the effect of traveltime, but attempts to ascertain a clear and logical relationship between these adjustment factors and trip-making to Six Flags were not successful. The procedure that the writer had planned to use to incorporate the effect of income involved first estimating the impedance factors without any adjustments for income. These estimates of impedance factors were then to be used in calculating income adjustment factors which would in turn be used to obtain another estimate of impedance factors. This process was to be repeated until, in the writer's judgment, the effects of income and traveltime had been sufficiently segregated.

Due to the large number of calculations required in
this study, an electronic computer was utilized frequently. Two programs were created by the writer and used frequently in the study. These will be referred to as the impedance factor and income factor programs. Only minimum information needed to understand the procedure used in this study is included in this section; a more complete description of the two programs can be found in Appendix III.

The impedance factor program was used primarily to compute the impedance factors for each traveltime that was designated for use. (In order to permit easier estimations of impedance factors, all possible traveltimes were not used. Instead, the traveltimes for the zones were rounded to the nearest of several values of traveltime used in the two computer programs, e.g., 30 minutes, 45 minutes, etc. A complete list of these values can be found in Table 3, included in Appendix I.)

The most important output of the impedance factor program was the adjusted impedance factors. These values were used in estimating the effect of traveltime and in calculating the income adjustment factors. These adjusted impedance factors were computed by multiplying the input impedance factors by the ratio of reported trips to predicted trips (as calculated using the input impedance factors) for zones with that traveltime, i.e.,

\[
\text{Adjusted Impedance} = \frac{\text{Input Impedance Factor} \times \text{Reported Trips}}{\text{Predicted Trips}}
\]
The other program used, the income factor program, was devised to aid in the creation of the income adjustment factors. These factors are simply the ratios of reported trips to predicted trips for given groups of zones. In this program, the zones were grouped according to per capita income and thus it was hoped that a relationship between per capita incomes and the computed adjustment factors could be ascertained. If so, the effect of income could at least be partially incorporated into the estimation of impedance factors and thus permit a clearer indication of the effect of traveltime.

In order to permit more detailed analysis when desired, the two programs performed similar operations for each of the 208 zones individually as they did for the larger groups of zones (grouped by travel times for the impedance factor program and by per capita incomes for the income factor program).

First Approximation of Impedance Factors

Following the procedure discussed, the first estimate of impedance factors was made with the impedance factor program, using no corrections for per capita incomes. The resulting adjusted impedance factors were then plotted on semi-log paper, i.e., a graph with the ordinate, or Y-axis, on a logarithmic scale. A "smooth line" (actually consisting of two straight lines) was drawn through these points, and this line was used to determine the impedance factors
to be used as input to the first income factor program run.

**Attempted Estimation of Income Adjustment Factors**

The estimated impedance factors were next used with the income factor program to calculate the income adjustment factors, and the resulting adjustment factors were plotted against per capita income on a rectilinear graph. Although there did appear to be some relationship between the adjustment factors and per capita income, the form of this relationship could not be determined because of the extreme and unaccountable variation exhibited by the adjustment factors. (These scattergrams are included in Chapter IV and Appendix II.) Therefore the effects of income could not be incorporated into the impedance factor calculations, as had originally been planned.

**Observation of Low Response from Georgia**

At this point it was decided to make closer observations of individual zones. The output of the impedance factor program was studied, and it was observed that reported trip rates of zones in states adjacent to Georgia were inexplicably higher than those of nearby zones in Georgia. Further investigation revealed that this was not only the case, but that there were actually more reported trips from Alabama than from Georgia.

This did not seem reasonable and created doubt concerning the reliability of the data. In order to determine whether the data that were being used (which were obtained
from the questionnaire given to vehicles coming to Six Flags) were reliable, they were compared with the results of a "parking lot survey" which was conducted routinely and in 1968 sampled about 60% of all cars at Six Flags. This parking lot survey recorded the states from which automobiles in the Six Flags parking lot had come, based on the vehicles' license tags. Although the parking lot survey data were not detailed enough for extensive use in this study, they had the advantage of being more nearly random than that of the questionnaires, since they were not dependent upon the cooperation of the vehicle occupants. It was therefore believed that the percentage of trips from Georgia could be more accurately estimated by the parking lot survey than by the questionnaire results.

It was found that only 21.8 per cent of the reported trips (based on the questionnaire responses) were from Georgia, yet 50.7 per cent of automobiles included in the parking lot surveys had Georgia license plates.

In order to determine whether a similar situation existed in other states, the number of reported trips from Georgia was assumed to be 21,555 instead of 5857. This was done in order to make the percentage of reported trips from Georgia 50.7, the percentage indicated by the parking lot survey. By doing this, the percentage of reported trips from other states would not be biased by a low response from Georgia. When this was done and the percentage of the
reported trips from each of the states adjacent to Georgia was calculated based on this enlarged number of total reported trips, these percentages gave reasonably good agreement with the parking lot survey percentages.

It was thus apparent that, for unknown reasons, persons who had come to Six Flags Over Georgia from places in Georgia were much less likely to return the questionnaires than were persons from other states. This tendency to not return the questionnaires did not appear to be present in other states and in many cases seemed to end suddenly at the Georgia boundary.

Since a lower response from some areas than from others could influence the estimation of the income adjustment factors, the zones were split into three groups (those in Georgia, those in Alabama, Tennessee, Mississippi, North Carolina, South Carolina, and Florida, and those in all other states), and separate adjustment factor calculations were made for these groups to determine if a clearer relationship existed between income level and reported trips than had been indicated by the first analysis. Georgia zones were considered separately because of the low response from Georgia. In addition, the remaining states were split into two groups, roughly according to whether they were in an area where a facility similar to Six Flags would be competitive. Thus any significant effect of competing facilities would be avoided in the group consisting of all
zones in Alabama, Tennessee, Mississippi, South Carolina, North Carolina, and Florida.

Adjustment for Low Georgia Response

The impedance factors which appeared particularly lower than would be indicated by the smooth line drawn were those corresponding to traveltimes of 150 minutes or less. It is significant that most zones with traveltimes to Six Flags of 150 minutes or less were in Georgia. Many zones with traveltimes somewhat greater than 150 minutes lay in neighboring states, particularly Tennessee, Alabama, and South Carolina, as well as in South Georgia.

Thus the lower impedance factors as computed and plotted were apparently caused by the low response from Georgia. By multiplying these factors by the ratio of corrected reported trips to reported trips, $21,555/5857 \approx 3.7$, it could be seen that they would then be roughly in line with the other impedance factors.

Estimation of Impedance Factor Function

A new line was drawn to represent the estimated relationship between impedance factors and traveltimes. This line was then expressed as a mathematical function. This line was estimated by the writer without the use of statistical regression techniques for reasons discussed later in this chapter.

Use of Final Estimates of Impedance Factors

The impedance factors were calculated from this
mathematical function and were then used to predict the number of trips to Six Flags from each of the 208 zones. In addition to the impedance factor program which permitted comparison of reported trips and predicted trips for individual zones as well as zones grouped by travel times, the income factor program was again used to calculate adjustment factors for each of the income levels, using these final impedance factor estimates. As had been done with the previously estimated impedance factors, the income adjustment factors were calculated using four different groups of zones:

1. all zones (1-208)
2. zones in Georgia (1-50)
3. zones in Alabama, Mississippi, Tennessee, North Carolina, South Carolina, and Florida (51-176)
4. zones in other states (177-208)

Adjustment for Questionnaire Response Percentage

Since all questionnaires given to drivers of vehicles at Six Flags Over Georgia were not completed and returned, the number of vehicle-trips indicated by the estimated impedance factors was lower than the actual number of such trips. For this reason, the distribution was modified so that all impedance factors were multiplied by the ratio of actual vehicle-trips (from all zones) to predicted vehicle-trips (from all zones). The new function thus obtained provided an estimate of the actual impedance factors effective in 1968 for Six Flags Over Georgia.
Reasons Statistical Techniques Not Used

Certain statistical techniques are often used to aid in defining the relationship between the dependent variable, such as impedance factors, and one or more independent variables, such as traveltime. In particular, the use of linear regression techniques might seem appropriate for this study because of the apparent exponential relationship between impedance factors and traveltimes since such a relationship indicates a linear relationship between the logarithm of the dependent variable and the independent variable. Regression methods might also have been useful in identifying the relationship between per capita income and any income adjustment factors that might have been used, had the employment of such adjustment factors been practical.

Regression methods were not used in this study, however, primarily because of the low response rate from within Georgia. In order to make the impedance factors for short traveltimes comparable to those of other traveltimes and thereby make any equation (relating impedance factors to traveltimes) meaningful, an adjustment for the low Georgia response would have been necessary. Such an adjustment, however, required a somewhat arbitrary change in the impedance factor values corresponding to low traveltimes, and it was believed that such manipulation of the data would make the use of linear regression meaningless and perhaps misleading as to the preciseness of the resulting equation.
In addition, the effects of inaccuracies in the data, normal trip interchanges between the various zones for purposes other than going to Six Flags, the inevitable inaccuracies in estimated travel times due to the assumed average speeds, and many other factors would cause the increased accuracy gained by using linear regression to be meaningless and possibly misleading to some persons.

Any equation, whether or not it was obtained by linear regression, could only be assumed to apply to Six Flags Over Georgia for 1968. Any other recreational facility or amusement park could not be expected to have the same impedance factors, nor could these factors be assumed to be applicable to Six Flags Over Georgia for any year other than 1968. Therefore, the form of the impedance factor curve was believed by this writer to be much more important than the parameters of the equation defining the curve, and thus even if it had been feasible, the use of linear regression would not have added significantly to the results of this study.
CHAPTER IV
EVALUATION OF RESULTS

The objective of this study was to determine the effect of traveltime on the number of trips made from a particular area to Six Flags Over Georgia. This effect was to be indicated by a set of impedance factors, approximately equal to the ratio of reported trips to total population for areas separated from Six Flags by various traveltimes.

As a first step, the ratio of vehicle-trips to population was calculated for each traveltime value used by the impedance factor program. The results of these calculations are indicated in Figure 1. The two straight lines drawn through the plotted points represent the smooth, decreasing function which was expected. It is interesting to note that the impedance factors decrease much more slowly when traveltimes are greater than fifteen hours than when they are less than fifteen hours. With the impedance factors from this smooth-line approximation being used, the average trip length of the predicted trips was 328.3 minutes, compared to an average trip length of reported trips of 318.3 minutes.

The values indicated by the two straight lines were then used as input impedance factors in the income
Figure 1. Initial Estimate of Impedance Factors
factor program in an effort to create income adjustment factors. When the values of average zonal per capita incomes (in hundred dollar increments) were plotted versus the corresponding adjustment factors, no clear relationship could be detected. (See Figure 2.) When the low questionnaire response rate from Georgia was observed, plots of adjustment factors versus income levels were made using data from three sub-groups of zones (those in Georgia, those in Alabama, Mississippi, Tennessee, North Carolina, South Carolina, and Florida, and those in other states) in order to determine if the relationship of the original factors (utilizing data from all 208 zones) to income had been obscured appreciably by zone locations. However, these efforts did not provide an improved understanding of the effect of income on trip-making to Six Flags. The appropriate scattergrams are included in Appendix II as Figures 5, 6, and 7.

After the adjustment for the low Georgia response was made (as described in Chapter III), a new approximation of the smooth impedance function was made, and this modified function is shown graphically in Figure 3.

In order to permit it to be expressed quantitatively, this relationship was converted to a mathematical expression, which is given below:

\[
\text{IF} = \begin{cases} 0.007 \left(e^{-0.007T}\right), & T < 930 \\ 0.0000125 \left(e^{-0.00025T}\right), & T \geq 930 \end{cases}
\]
Figure 2. Income Adjustment Factors Calculated with No Adjustment for Low Georgia Response
Figure 3. Final Estimate of Impedance Factors
where

\[
\begin{align*}
\text{IF} &= \text{impedance factor} \\
T &= \text{traveltime in minutes} \\
e &= \text{the base of natural logarithms} \approx 2.718
\end{align*}
\]

As mentioned previously, linear regression was not used in determining this relationship, and it is only an approximate expression of the effect of traveltime on the number of reported trips (adjusted for the low Georgia response).

Using this mathematical expression, a new set of impedance factors were computed and subsequently applied to the prediction of trips from each of the zones. A comparison of reported and predicted trips can be made by observing Table 5, included in Appendix II. Using these calculated impedance factors, the average length of the predicted trips was 263.7 minutes. No calculation was made of the average length of reported trips using an adjustment for the low Georgia response.

A new set of adjustment factors was calculated, using the modified impedance factor function, and then plotted. (See Figure 4.) In addition to this calculation, the same operation was performed using only data from the three subgroups of zones mentioned previously. These scattergrams are shown in Figures 8, 9, and 10 in Appendix II. As above, no improved understanding of the effect of income on trip-making to Six Flags could be gained from these efforts.
Figure 4. Income Adjustment Factors Calculated Using the Adjustment for the Low Georgia Response
The impedance factors that would be obtained from the relationships given earlier in this chapter would be based on reported trips, only adjusted for the unusually low questionnaire response from within Georgia. Since only a small percentage of the questionnaires distributed at Six Flags in 1968 were returned, another adjustment was necessary in order to permit the calculation of impedance factors that could be used in estimating the actual number of trips to Six Flags.

This adjustment was made by multiplying the coefficients of the first impedance factor function by a number approximately equal to the ratio of the number of vehicle-trips made to Six Flags in 1968 (338,476) to the number of predicted trips (32,953) based on the impedance factors computed from the final impedance factor function.

This resulted in the following impedance factor function, which yields impedance factors that are appropriate to use in estimating (by the model on page 6) the actual number of vehicle-trips from an area to Six Flags:

\[ IF = 0.072 \left( e^{-0.007T} \right), \quad T < 930 \]
\[ IF = 0.000129 \left( e^{-0.00025T} \right), \quad T \geq 930 \]

where

IF = impedance factor
T = traveltime in minutes
\( e \) = the base of natural logarithms \( \approx 2.718 \)
It is interesting to note that Matthias and Grecco (15) developed a model of the above form to predict trips to Indiana reservoirs, even though the situation studied in that research was not the same as that studied in this. Nevertheless, it is particularly noteworthy that they concluded that two separate exponential relationships should be used to predict recreational trips to Indiana reservoirs, one applicable to areas where the closest reservoir to the area is the one in question, and the other applicable to areas with an intervening reservoir. Although similar results were obtained in this study, this writer did not reach any conclusions concerning why two separate exponential relationships were applicable.
CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

From the research connected with this study, the conclusions listed below were reached by the writer:

1. The average number of trips made to Six Flags Over Georgia in 1968 decreased according to an exponential function as the traveltime to Six Flags Over Georgia increased.

2. There is reason to believe that when a certain value of traveltime has been exceeded, the effect of further increases in traveltime on the number of trips is much less pronounced, although this effect is still exponential. It thus appears that two separate exponential relationships describe the effect of traveltime.

3. The questionnaire results were biased by lower returns from persons who travelled short distances (generally, from within Georgia).

4. Although there appears to be a relationship between per capita income and recreational trips, efforts in this study to ascertain this relationship were unsuccessful. It is probable that other socio-economic factors had a significant influence on recreational trip-making and thus obscured the effect of per capita income from this research.
5. Although it would seem logical that the type and quality of facilities available at a recreational area would influence the number of trips made to that area, such influences were not considered in this study. Of course, since only one recreational area was studied, the effect of different facilities could not be determined.

Since this research was concerned with an area in which little work has been done, it is only a preliminary step to a full understanding of inter-city recreational trips, and it thus leaves many questions unanswered. The writer makes the following recommendations concerning further research in this area.

1. Since this study was only concerned with data for one year, further study is needed that will determine possible changes in the effect of traveltime over a period of several years.

2. Further research should be conducted to determine the effect of income and other socio-economic factors on inter-city recreational trip-making.

3. Additional study is needed to determine whether vehicle occupancy rates vary with traveltime or are independent of traveltime.

4. Additional investigation is needed to discover how the effect of traveltime varies with the day of the week, the time of year, and holidays.

5. Studies similar to this one should be conducted
in order to determine what differences, if any, in the effect of traveltime on recreational trip-making are encountered at other types of facilities. It is expected that trip-making to different types and sizes of recreation areas will be influenced differently by traveltime.

6. More research is needed to determine what caused the sharp break found in the impedance factor curve at approximately 930 minutes.
APPENDIX I

DATA
Table 2. Composition of Zones

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<th>Zone Number</th>
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Table 2. Composition of Zones (Continued)

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### Table 2. Composition of Zones (Continued)

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Table 2. Composition of Zones (Continued)

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Table 2. Composition of Zones (Continued)

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Table 2. Composition of Zones (Continued)

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Table 3. Values of Traveltime Used in Estimating Impedance Factors

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Table 4. Data Used in Estimating Impedance Factors

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APPENDIX II

RESULTS
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Figure 6. Income Adjustment Factors Calculated Using Zones 51-176 with No Adjustment for the Low Georgia Response
Figure 7. Income Adjustment Factors Calculated Using Zones 177-208 with No Adjustment for the Low Georgia Response
Figure 8. Income Adjustment Factors Calculated Using Zones 1-50, Adjusted for the Low Georgia Response
Figure 9. Income Adjustment Factors Calculated Using Zones 51-176, Adjusted for the Low Georgia Response
Figure 10. Income Adjustment Factors Calculated Using Zones 177-208, Adjusted for the Low Georgia Response
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Table 5. Comparison of Values of Reported Trips and Predicted Trips (Continued)

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<td>208</td>
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</table>

Note: The Predicted Trips in Table 5 were calculated with the use of impedance factors which were estimated based on an adjustment for the low Georgia response but no adjustment for the overall percentage response to the questionnaires.
APPENDIX III

DESCRIPTION OF COMPUTER PROGRAMS
Two computer programs were written specially for use in this research. These are referred to in this thesis as the impedance factor program and the income factor program. A brief description of these programs is included as well as a copy of the programs. The descriptions are meant primarily to supplement the main text of this report by providing a brief, informative outline of the programs. Those persons interested in greater detail are referred to the copies of the programs included in this Appendix. Both programs were written in ALGOL (programming language) for operation on the Burroughs B-5500 computer at the Georgia Institute of Technology.

**Impedance Factor Program**

This program performs the following operations:

1. For each zone, reads the zone number, the number of reported trips, the population, the total personal income, and the traveltime.
2. For each traveltime value used, reads the input impedance factors.
3. For each income level, reads the income adjustment factor.
4. For each zone, replaces the calculated value of traveltime (as read from the data cards) with the nearest value used in the program.
(5) For each zone, calculates the per capita income by dividing the total personal income by the population.

(6) For each zone, calculates the number of predicted trips by multiplying the zone population by the appropriate impedance factor and income adjustment factor.

(7) For each traveltime value used in the program, computes an adjusted impedance factor by multiplying the input impedance factor by the ratio of reported trips to predicted trips for zones with that traveltime.

(8) Computes the average length (in minutes) of reported trips and of predicted trips.

In order to accomplish the above operations, some "counter" variables are used in the impedance factor program. These include the number of reported trips from zones having various traveltimes, the number of predicted trips from zones having various traveltimes, certain variables used in calculating the average length of reported and predicted trips, and a variable (TOTALZONES) equal to the number of zones for which the above operations have been performed. This last variable is useful in determining whether any logic errors resulted in some zones being omitted from any calculations.

**Income Factor Program**

This program performs the following operations:
(1) For each zone, reads the zone number, the number of reported trips, the population, the total personal income, and the traveltime.

(2) For each traveltime value used, reads the input impedance factors.

(3) For each zone, replaces the calculated traveltime value (as read from the data cards) with the nearest value used in the program.

(4) For each zone, computes a predicted number of trips (without any adjustment for per capita income) by multiplying the zone population by the appropriate impedance factor.

(5) For each zone, calculates the per capita income by dividing the total personal income by the population.

(6) For each zone, calculates the ratio of reported trips to predicted trips, calculated in Step 4 above.

(7) For each income level, computes an adjustment factor by dividing the number of reported trips by the number of predicted trips computed in Step 4 above.

As in the impedance factor program, some "counter" variables are used in the income factor program. These include the number of reported trips from all zones in each income level, the number of predicted trips from all zones in each income level, two variables (TOTALZONES AND ZONESUSED) that indicate the number of zones for which various calculations have been made. These two variables are useful in determining
whether any logic error resulted in some zones being omitted from any calculations.
BEGIN

IF IN CUDIN (2*10)

IF OUT CUDOUT (2*15)

FORMAT IN FMT3 (I3*X6*X6*X6*X6*X6*X6) #

FORMAT OUT FMT3 (F9.7)

FORMAT OUT FMT4 (X5*"ACTUAL NO. OF TRIPS","X10,"PREDICTED NO. OF TRIPS","X10,"CAPITA INCORE"/)

FORMAT OUT FMT5 (F9.7)

FORMAT OUT FMT6 (X5*"TRAVEL TIME","X2","ACTUAL TRIPS","X3","PREDICTED TRIPS","X3","USED","X3","ADJUSTED IF/")

FORMAT OUT FMT7 (X5*"AVERAGE LENGTH OF ACTUAL TRIPS **","X2","F9.7")

FORMAT OUT FMT8 (X5*"AVERAGE LENGTH OF PREDICTED TRIPS **","X2","F9.7")

FORMAT OUT FMT9 (X5*"TOTAL NUMBER OF ZONES USED **","X2",")

FORMAT OUT FMT10 (F4.2)

FORMAT OUT FMT11 ("BELOW ARE LISTED THE INCOME LEVELS")

FORMAT OUT FMT12 ("AND THE K-FACTORS USED IN THIS RUN")

FORMAT OUT FMT13 ("PER CAPITA INCOME","X10","K-FACTORS")

FORMAT OUT FMT14 (X7,X7,X7,F4.2)

REAL ARRAY GHTJP, AVERAGE, HOFH, 10750, GH, TF, TFAU(12000), KIN [1010]

INTEGER ARRAY ZONE, TRIPS, INCOME, POP, 11250, GRTG[1000]

REAL AVGOD, TOTUM, AVGH, NUMCOMP

INTEGER J, K, TOTAL, N这场D ZONES, Z1

WRITE (CUDOUT!)
FOR I + 1 STEP 1 UNTIL 200 DU

READ (COUNI, FMT), (COUNI, FMT), (INCOME[1], TIME[1])

FOR J = 2, 3, 4, 5, 6, 7, 8, 10, 12, 14, 16, 18, 20,
    22, 24, 26, 28, 30, 32, 36, 40, 44, 48, 52, 56, 60, 64,
    68, 70, 74, 76, 80, 84, 90, 96, 104, 112, 120, 128, 136,
    144, 152, 160, 168, 176, 184, 192, 200 DU
READ (COUNI, FMT), (FMT, TRIP[K])
FOR K + 10 STEP 1 UNTIL 69 DU
READ (COUNI, FMT), (FMT, KTRIP[L]EVT[J, K])
TOTALZONES + 1
FOR I + 1 STEP 1 UNTIL 200 DU
BEGIN
IF TIME[I] < 7.5 THEN TIME[I] + 30
FOR Z = 45 STEP 15 UNTIL 105 DU
IF TIME[I] > 7.5 AND TIME[I] < 11.5 THEN
    TIME[I] = Z
IF TIME[I] > 11.5 AND TIME[I] < 14.0 THEN
    TIME[I] = 120
FOR Z = 150 STEP 30 UNTIL 399 DU
IF TIME[I] > 7.5 AND TIME[I] < 2.15 THEN
    TIME[I] = Z
IF TIME[I] > 2.15 AND TIME[I] < 4.30 THEN
    TIME[I] = 420
FOR Z = 440 STEP 60 UNTIL 1140 DU
IF TIME[I] > 2.15 AND TIME[I] < 4.30 THEN
    TIME[I] = Z
IF TIME[I] > 4.30 AND TIME[I] < 12.0 THEN
    TIME[I] = 120
FOR Z = 1200 STEP 150 UNTIL 3000 DU
IF TIME[I] > 4.30 AND TIME[I] < 12.0 THEN
    TIME[I] = Z
IF TIME[I] > 12.0 AND TIME[I] < 3000 THEN
    TIME[I] = 3000
END
FOR J = 2, 3, 4, 5, 6, 7, 8, 10, 12, 14, 16, 18, 20,
    22, 24, 26, 28, 30, 32, 36, 40, 44, 48, 52, 56, 60, 64,
    68, 70, 74, 76, 80, 84, 90, 96, 104, 112, 120, 128, 136,
    144, 152, 160, 168, 176, 184, 192, 200 DU
BEGIN
FOR I + 1 STEP 1 UNTIL 200 DU
BEGIN
AVGCOUNI[J] = 1000 × INCOME[J] / POP(J)
FOR J = 2, 3, 4, 5, 6, 7, 8, 10, 12, 14, 16, 18, 20,
    22, 24, 26, 28, 30, 32, 36, 40, 44, 48, 52, 56, 60, 64,
    68, 70, 74, 76, 80, 84, 90, 96, 104, 112, 120, 128, 136,
    144, 152, 160, 168, 176, 184, 192, 200 DU
FOR K + 10 STEP 1 UNTIL 69 DU
IF TIME[K] > 15.5 AND AVGINC[J] > 100 × K + .5 THEN
    AVGINC[J] = 100 × K + .5 THEN
BEGIN
TOTALZONES + 11
BEGIN
UTR[J] = UTR[J] + TRIP[J]
GMM[J] = GM(J) + GMMAP(J)
END BEGIN
END FOR J = 2, 3, 4, 5, 6, 7, 8, 10, 12, 14, 16, 18, 20,
```
BEGIN
    TOTIND + TOTIND + N1(J)
    TOTG + TOTG + N2(J)
    NUMIND + NUMIND + 1544 + G1(J)
    NUMERG + NUMERG + 1544 + G1(J)
    IF G1(J) = 0 THEN G4(J) + 1;
    TFAD(J) + TFAD(J) + G1(J)/G2(J)
END

AVGND + NUMFAND/TOTINT
AVGGM + NUMFGRM/N1M
WRITE (CUMNJ, FMT3)
FOR I + 1 STEP 1 UNTIL 208 UV
WRITE (CUMNJ, FMT4, TMEM(J), TRIPS(J), GMTHM(J), AVIGCHEM(J))
WRITE (CUMNJ, FMT5)
WRITE (CUMNJ, FMT6)
FOR J = 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20
   22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40
   41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58
   59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76
   77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94
   95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110
   111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124
   125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138
   139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152
   153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166
   167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180
   181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194
   195, 196, 197, 198, 199, 200
WRITE (CUMNJ, FMT6, UML(J), NUMERG(J), TFAD(J)), TFAD(J))
WRITE (CUMNJ, FMT7, AVGGM)
WRITE (CUMNJ, FMT8, AVGGM)
WRITE (CUMNJ, FMT9, FRAME(J))
WRITE (CUMNJ, FMT10)
WRITE (CUMNJ, FMT11)
WRITE (CUMNJ, FMT12)
WRITE (CUMNJ, FMT13)
FOR K = 10 STEP 1 UNTIL 84
WRITE (CUMNJ, FMT14, 1000 + K, FINC(0, K))
WRITE (CUMNJ, FMT15, TOTALZUMES)
END.

OUTPUT(W) IS SEGMENT NUMBER 0018, PART ADDRESS IS 0076
ALNCK CONTROL IS SEGMENT NUMBER 0019, PART ADDRESS IS 0076
INPUT(W) IS SEGMENT NUMBER 0020, PART ADDRESS IS 0102
ALGOL READ IS SEGMENT NUMBER 0023, PART ADDRESS IS 0014
ALGOL SELECT IS SEGMENT NUMBER 0025, PART ADDRESS IS 0017

NUMBER OF SYNTAX ERRORS DETECTED = 0, NUMBER OF SEQUENCE ERRORS DETECTED = 0
COMPILER TERMINAL PROCESSOR = 10 SECONDS; CPU = 17 SECONDS ELAPSED = 56 SECONDS;
PART SIZE = 945 TOTAL SEGMENT SIZE = 1000 WINDOWS, DISK SIZE = 53 SEGMENTS, PUH. SEG = 24
ESTIMATED COMMUTER STORAGE REQUIREMENT = 6750 WINDOWS.
```
BEGIN

FILE IN CODIN (2,10)
FILE OUT CODOUT T6 (2,15)
FORMAT IN FMT1 (I3,X6,14,X5,16,X3,X18,X22,X4)
FORMAT IN FMT2 (F9.7)
FORMAT OUT FMT3 (X11,'ACTUAL',X15,'PREDICTED',X4,'TRAVEL',X4)
"PER CAPITA",X6,'ZONE'
FORMAT OUT FMT4 ('ZONE',X7,'TRIPS',X8,'TRIPS',X7,'TIME',X7)
"INCOME",X7,'X',"FACTOR"
FORMAT OUT FMT5 (I3,X9,10,X8,10,X9,10,X9,F5.2)
FORMAT OUT FMT6 (X5,'INC0ME',X5,'ACTUAL',X5,'PREDICTED'
"X5','INCOME','LEVEL')
FORMAT OUT FMT7 (X5,'INCOME',X5,'TRIPS',X9,'TRIPS',X9,'FACTOR')
FORMAT OUT FMT8 (X8,X10,F9.7,X8,F7.2)
FORMAT OUT FMT9 ('TOTAL NUMBER OF ZONES USED =',X2,F13)
FORMAT OUT FMT10 ('ZONES USED IN INCOME PORTION =',X2,F13)
FORMAT OUT FMT11 ('THE TRAVEL-TIME FACTORS USED IN THIS RUN =')
FORMAT OUT FMT12 ('ARE GIVEN BELOW =')
FORMAT OUT FMT13 ('TRAVEL-TIME',X10,'TRAVEL-TIME FACTOR')
FORMAT OUT FMT14 (X3,X4,X20,F7.2)

REAL ARRAY GMTF, KFZONE, SVGINC, 1157501, TF16(200), GMFAP, KFLEVEL(10,16)
INTEGER ARRAY ZONE, TRIPS, TRIPSADD, TIME, INC0ME(1250), TRIPS(10,14)
INTEGR F, J, K, KFZONES, ZONEUSED = 81
FOR 1 + 1 STEP 1 UNTIL 203
READ (CDDIN, FMT1, ZONE11), TRIPS11, POP11,
INCOME11, TIME11
FOR I = 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 14, 16, 18, 20,
22, 24, 26, 28, 32, 36, 40, 44, 48, 52, 56, 60, 64,
68, 72, 76, 80, 84, 88, 92, 96, 100, 112, 120, 128, 136,
144, 152, 156, 160, 168, 176, 184, 192, 200, 208,DO
READ (CDDIN, FMT2, TF(J)),
TOTALZONES, ZONESUSED, 0
FOR I = 1 STEP 1 UNTIL 208 DO
BEGIN
IF TIME11 < 37.5 THEN TIME11 = 30
IF Z = 25 STEP 15 UNTIL 105 DO
IF TIME11 >= 27.5 AND TIME11 < 27.5 THEN
TIME11 = Z
END
FOR Z = 150 STEP 30 UNTIL 390 DO
IF TIME11 >= 112.5 AND TIME11 < 135 THEN
TIME11 = 120
FOR Z = 150 STEP 60 UNTIL 1140 DO
IF TIME11 >= 135 AND TIME11 < 150 THEN
TIME11 = 144
IF TIME11 >= 150 AND TIME11 < 165 THEN
TIME11 = 168
IF TIME11 >= 165 AND TIME11 < 180 THEN
TIME11 = 192
IF TIME11 >= 180 AND TIME11 < 202.5 THEN
TIME11 = 200
END
FOR Z = 10 STEP 1 UNTIL 43 DO
BEGIN
TRIPS11 =; 20)
FOR J = 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 14, 16, 18, 20,
22, 24, 26, 28, 32, 36, 40, 44, 48, 52, 56, 60, 64,
68, 72, 76, 80, 84, 88, 92, 96, 100, 112, 120, 128, 136,
144, 152, 156, 160, 168, 176, 184, 192, 200, 208
READ (CDDIN, FMT2, TF(J)),
TOTALZONES =; TOTALZONES + 1.
END
BEGIN
GMTRP11 = POP11 * TF(J)
TOTALZONES = TOTALZONES + 1.
END
BEGIN
AVGINCOME11 = INCOME11 / POP11
IF GMTRP11 = 0 THEN GMTRP11 = 1
ZONE11 = ZONE11 / GMTRP11
END
BEGIN
AVGINCOME11 = INCOME11 / POP11
IF GMTRP11 = 0 THEN GMTRP11 = 1
END
BEGIN
TRIPS11 = TRIPS11 + TRIPS11
GMTRP11 = GMTRP11 + GMTRP11
ZONESUSED = ZONESUSED + 1
END
END
END
WRITE (CDDOUT, FMT3);
WRITE (CDDOUT, FMT4);
WRITE (CDDOUT, FMT5, ZONE(1), TRIPS(1), GWTAPI(1),
      TIME(1), AVGTIME(1), KFZONE(1))
WRITE (CDDOUT, FMT6);
WRITE (CDDOUT, FMT7);
WRITE (CDDOUT, FMT8, 10000, TRIPS(10), GWTAPI(10),
      KFINGLEVEL(10));
WRITE (CDDOUT, FMT9);
WRITE (CDDOUT, FMT10);
WRITE (CDDOUT, FMT11);
WRITE (CDDOUT, FMT12);
WRITE (CDDOUT, FMT13) ________________________________________
FOR J = 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 16, 18, 20, 22, 24, 26, 28, 30, 32, 36, 40, 44, 48, 52, 56, 60, 64, 66, 72, 76, 80, 84, 88, 96, 100, 104, 108, 112, 116, 120, 128, 132, 136, 140, 144, 148, 152, 156, 160, 164, 168, 172, 176, 180, 184, 188, 192, 196, 200, 204
WRITE (CDDOUT, FMT14, 1500, TIME(I))
WRITE (CDDOUT, FMT15, TOTALZONES)
WRITE (CDDOUT, FMT16, 3000, ANNEXES)
END.

OUTPUT(1) IS SEGMENT NUMBER 0017, PRT ADDRESS IS 0010
INPUT(1) IS SEGMENT NUMBER 0011, PRT ADDRESS IS 0005
ALOG READ IS SEGMENT NUMBER 0019, PRT ADDRESS IS 0073
ALOG WRITE IS SEGMENT NUMBER 0025, PRT ADDRESS IS 0004
ALOG SELECT IS SEGMENT NUMBER 0027, PRT ADDRESS IS 0015

NUMBER OF SYNTAX FINDS DETECTED = 0, NUMBER OF SEQUENCE ERRORS DETECTED = 0
COMPILED PROGRAM SIZE = 10 SECONDS, TOTAL SEGMENT SIZE = 833 WORKS, DISK SIZE = 44 SEGS, TOTAL SEGMENT SIZE = 44 SEGS, DISK SIZE = 44 SEGS, ESTIMATED CORE STORAGE REQUIREMENT = 6570 WORKS.
REFERENCES CITED


10. Ibid.


15. Matthias and Grecco, p. 68.
OTHER REFERENCES

