1983

Analysis of factors affecting mode choice for the journey to work trip case study, Windsor, Ontario.

Patricia Catherine. Miskovsky-Janisse
University of Windsor

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ANALYSIS OF FACTORS AFFECTING MODE CHOICE FOR THE JOURNEY TO WORK TRIP - CASE STUDY WINDSOR, ONTARIO

by

Patricia Catherine Miskovsky-Janisse

A Thesis
submitted to the
Faculty of Graduate Studies and Research
through the Department of
Geography in Partial Fulfillment
of the requirements for the Degree
of Master of Arts at
the University of Windsor

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1983

ABSTRACT

ANALYSIS OF FACTORS AFFECTING MODE CHOICE FOR THE JOURNEY TO WORK TRIP - CASE STUDY, WINDSOR, ONTARIO

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Patricia Catherine Miskovsky-Janisse

This thesis focuses on one aspect of transportation, modal choice, in an attempt to provide some insight into the factors that characterize mode users for the journey to work trip. The analysis uses the City of Windsor as a case study. The units of analysis were by the sub-regions of planning districts.

All the basic data was provided by a questionnaire, specially designed for this research and from the City of Windsor Planning Department. Data were divided into three categories: socio-economic, perception and characteristics of the mode. Once the users were classified as a car or bus user, profiles were developed for each of the categories.

The results from the analysis characterized car users as: male head of household, combined household income of $25,000 or more; two car household, live in a single family home, high school/university education and consider convenience and reliability of the mode as important variables.

Bus users were characterized as: female head of household, low income (combined household income of less than $20,000), live in higher density areas than car users, live in duplexes and apartments, one car household, education high school or less and considered cost, convenience and reliability of the mode as important variables.

An important contribution of the thesis is that improvements to the existing public transportation system can be suggested through the aid of this research. The transportation planners can concentrate on improvements to the transportation system in the planning areas that exhibit the characteristics those of the bus user. The thesis provides the transportation planners with a reduced set of variables which can be used to make improvements to the system on a day to day basis.

ACKNOWLEDGEMENTS

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CHAPTER I

INTRODUCTION

In many respects transportation may be considered one of the major causes of present urban problems and also one of their symptoms. Although attempting to solve urban transportation problems may often be only a matter of tackling one of the symptoms of these urban ills, there is a strong case for solving transportation problems in their own right (Stopher and Meyburg, 1975,9).

The urban transportation planning process can usually be visualized as a three-stage program. The first stage is the making of an inventory of existing travel patterns throughout the whole urban area, together with inventories of land use, socio-economic characteristics of the population, and the existing facilities for travel. The second stage is made up of a set of forecasts -- first of land uses that should occur in the forecast period, and then of the travel demand that may be anticipated and the way this will occur throughout the region. The final stage comprises the detailing of a number of alternative strategies for providing transportation and changes in land uses, together with

evaluations and eventual selection of a particular form or policy for future planning (Stopher and Meyburg, 1975,60).

Because of the increasing complexity of deciding on investment priorities among transportation alternatives and between other urban and regional concerns, the accurate estimation and prediction of travel demand are becoming increasingly important as aids to the necessary decision making process. Intelligent evaluation of alternative possibilities in transportation planning requires that many factors other than purely technical ones be taken into account. The way a complex of transportation facilities of various modes will be used depends as much on the characteristics of the population and the geographical distribution of activities as on the characteristics of the network itself, (Hall and Surti 1973,47).

Within an urban area a great many people travel in pursuit of their daily activities. This large human movement is accomplished with the help of private automobiles, taxis, public transit and commuter trains. The basis on which people choose between the various means of transportation available in different parts of an urban area is of utmost importance to the transportation planner (Hill and Von Cube, 1963,78).

Planners must evaluate new alternatives which may have service attributes far different from the level of

service characteristics of existing technologies. The ultimate purpose of research is to provide insight into the main factors that jointly influence the use of public transportation systems and to develop techniques of analysis and prediction by which planning of future transit needs may be aided.

Scope of the Research

This thesis focuses on one aspect of transportation: mode choice. The research is carried out to determine what factors affect mode choice for the work trip, using Windsor, Ontario as a case study.

With increases in energy costs, and a decrease in public expenditure, it is important to design transportation systems to be both cost effective and efficient. For this thesis the journey to work trip was selected because it is the most frequent of trips, and the consumer's knowledge of the different modes available is greatest for this trip.

If planners understand the consumers' process in their mode choice for the work trip, they can "see" the transportation system from the travellers viewpoint. If planners understand what attracts a consumer to a particular mode a transportation planner can incorporate these variables into the transportation plans.

A transportation plan of the type presented is of assistance in estimating the patronage that may be attributed to new modes by extending present attitudes toward abstracted features of existing modes and projecting them to their new mode counterpart. In the same manner, a person relates past experience to analysis of future possibilities.

Problem Statement

The methods of analyzing and predicting modal choice should be applicable, as far as possible, to situations differing widely in the transportation alternatives that are available or proposed, and the demand that is to be satisfied. It is unrealistic to expect that a high degree of precision is attainable in predicting individual behaviour with respect to choice of modes and routes of travel, particularly in future or hypothetical situations. The variability and multi-dimensonality of choice are integral parts of the nature and heritage of individual consumers. However, recognition of patterns of travel independently to some extent of time and place provides the only solid foundation for long range planning (Hall and Surti, 1973,36).

Similarly, answers to the following questions that will be addressed in this research must be derived in order that transportation planning can be useful for the present and future needs of the city.

1. What are the socio-economic factors that characterize bus users and car users?
2. What perceptions do car and bus users have of their mode and what are they for the alternative mode?
3. What characteristics of the mode are considered important to bus and car user?

The answers to these questions could then give the transportation planners the direction needed to develop forecasting models and transportation planning.

Basic Assumptions and Methodology

There are three main travel decisions that an individual must make previous to their journey:

1. Decision whether or not to travel. (trip production)
2. Decision where to travel. (trip distribution)
3. Decision how to travel. (modal choice and route choice)

A basic assumption of this thesis is that both the decision to travel and where to travel have been selected. Trip production and trip distribution show the need to travel to work via some means of transportation. For this research, information on the decision of how to travel for the work trip was gained from data collected by means of a questionnaire, specifically designed for this research. (See Appendix A).

Most models of modal choice are macro-analytical in nature, focusing on the behaviour of large groups of travellers and have limited explanatory power. Transportation managers need to know more about the decision making process of individual travellers in selecting a mode for a particular trip if they are to develop strategies for influencing these decisions. Individual consumers are seen as trying to satisfy a particular travel need by first specifying the 'ideal' modal attributes required for this trip. Next, the perceived characteristics of a limited number of modes are evaluated against this 'ideal' solution and the consumer is assumed to select the mode which provides the best match. The model explicitly recognizes the impact of psychological variables on modal choice as well as the consumers need for information, if the individual is to evaluate realistically all alternatives (Lovelock, 1975,253).

Relevance of Research

A considerable amount of research has been carried out on the journey to and from work, (DeDonna, 1971), (Wilson, 1967), (Warner, 1962), (Lansing and Blood, 1964b). Since journey to work is frequent and relatively inflexible in origin and destination and in time of day, it constitutes a major problem in a transportation plan. Both DeDonna and Wilson investigated factors that influence travel choice and concluded that attributes such as comfort, convenience reliability and safety are significant in an important way

in the traveller's decision, particularly in choice of mode. The individual's perceptions of various subattributes may not be directly related to some measured characteristic of the transportation system.

The main problem is to understand how the consumer chooses a mode. Although travel behaviour in cities can be forecast, the basic behavioural processes of individuals which generate these specific patterns of movement in cities are still not understood. While the travel patterns of specific households are straightforward the complex chains of decision making which lead to those patterns are relatively unknown (Horton, 1972,415). From the understanding of this, accurate estimates of transportation market potential can be predicted and better transportation can be developed.

The intention of this thesis is to aid understanding of consumer behaviour with respect to transport mode choice in the City of Windsor for the journey to work trip. The information collected on mode choice might help urban transportation authorities with investment policies of for example the number of buses to buy next year and the development of better transportation planning through use of express bus lanes, mini buses, etc. wherever it is appropriate to implement.

Outline of Thesis

This thesis begins with a presentation of the evidence

supporting the assumption that understanding the factors that determine mode choice can lead to better transportation planning. This evidence is based on a review of state of the art literature on modal choice models and the various applications in metropolitan areas in Canada, Britain, Holland and the United States.

Chapter III outlines the methodology and the region of study, Windsor, Ontario stating the reasons why it was selected for the case study. Chapter IV analyzes the questionnaire data and establishes profiles characterizing car users and bus users. The profiles are discussed under three headings; socio-economic, characteristics of the mode and perception. The final chapter discusses the practical applications of the study to the improvement of the public transit system in the City of Windsor.

CHAPTER II
LITERATURE REVIEW

For the purpose of understanding the demand for personal travel, passenger transportation can be said to consist of three distinct types of elements:

1. The origins and destinations
2. The transportation system and
3. The passengers.

The potential origins and destinations of trips can be described in terms of their land use, population size, and type of economic activity. The transportation system can be defined by the level of service attributes of its various modes and routes. Socio-economic and behavioural charactersitics can describe the passengers.

Thus, travel involves the interaction of these three elements, each of which has its own properties. However, since it is the passenger himself who decides whether to travel, what mode and route to choose, where to go, when to go, and so on, estimates on future transportation demand clearly require an understanding of the basic mechanisms of consumer demand for transportation. Travel modes are not ends in themselves; it is the consumer's attitudes toward and desires for the various modes and alternative routes that define the trip.

Therefore the purpose of this chapter is to review the existing literature on modal choice research, and models

that are applicable to this research area.

Modal Choice Studies

Recent work in the area of mode choice has produced a number of studies concerned with those factors that determine mode choice for the journey to work (Lansing, 1964 a,b) (Wilson, 1967), (Surti, 1973), (Wigner, 1973), (Hill and Von Cube, 1963), (Spear, 1976), and (Lucaratti, 1977). The objective of these studies was to determine the major factors affecting the travel mode choice and to construct a reliable framework of references (modal split) necessary in travel movement forecasting for specific transportation planning purposes.

Mode choice is affected by motivation as well as by the perceived efficiency and attractiveness of the alternative modes. Mode attractiveness might include the passenger's perception of degree of comfort, convenience of access, safety, reliability, usefulness of travelling time, service frequency and traveller's itinerary (Heggie, 1976, 80). Value of time is usually derived empirically, by examining situations as to the traveller rationale in trading off time against cost. However, this tradeoff may exist in an abstract sense and the traveller does not always perceive the tradeoff. (Heggie, 1976, 82).

Basic studies of factors affecting people's choice of travel mode were carried out in Toronto in 1960-1961 by the

Traffic Research Corporation (TRC) for the Toronto Metro Planning Board. The approach taken by TRC was to first investigate a limited number of factors which it thought might influence the choice of mode of travel. The factors considered were length of trip, fare structure, population density, travel service characteristics, geographical location of a particular zone and economic motivation. The next step in the Toronto project was to conduct a test study on a zone basis. Factors included on a zone basis were population, total employment, labour force, number of households, area of all land other than vacant land, mass transit service index and economic status. From the preliminary work of analyzing the factors, it was disclosed that the following variables, ranked in order of their relative importance, influence modal choice:

1. Relative door to door time including time spent walking to and from transit stations and time spent waiting.
2. Household income
3. Degree of Central Business orientation.

John B. Lansing (1964) studied the journey to work trip in Ann Arbor, Michigan and concluded that three factors were the major determinants:

1. availability - availability of service, terminals and convenience of scheduling.
2. financial consideration - factors related to price of transportation and financial resources of the traveller.

3. quality of mode - quality of services and preferences.

A number of other studies investigated factors that influence travel choice and concluded that attributes such as comfort, convenience, reliability and safety play an important role in the traveller's decision, particularly in mode choice. Despite this recognition, relatively little work has been undertaken to incorporate these attributes in travel demand models.

Spear (1976) conducted his research in two major U.S. cities: Boston and Chicago. Only the choice of mode for the work trip was investigated. The transportation system characteristics (i.e. convenience etc.) were quantified by using sensitivity scaling techniques. The highest ranked items on the sensitivity scale were associated with reliability, accessibility and travel times as factors in determining mode choice. The next highest group associated the flexibility of the transportation system and the physical efforts required to make the trip. The lowest ranked were the amenities provided by the transportation (Spear, 1976, 8).

In 1969, a study was conducted in Rochester, New York using traveller's attitudes of comfort, convenience, self-esteem and personal safety (Hartgen and Tanner, 1971, 13). The research was conducted using attitudinal data to predict individual mode choice. Travel was viewed as human behaviour so therefore sociological and psychological

principles were applied. Six tests were used to emphasize the effect of attitudes on mode choice behaviour. The first four tests were used to examine the effect of clean buses, downtown terminal, zero fares and new vehicles respectively. Test results indicated increased usage because of each factor. The greatest increase of patronage resulted from zero fare. The last two tests (Test 5, Test 6) were intended to operate the model near its tolerable limits. These tests examined the influence of equal eccess and equal satisfaction. Increased transit mobility on equal access (Test 5) appeared as a stronger patronage stimulant than fare reduction (Test 3). Creating a more favourable attitude toward transit (Test 6) appears to be nearly as important as increasing transit accessibility (Test 5).

In Hill and Von Cube's (1963) work on forecasting travel mode choice using survey information from Toronto 1954, Washington 1955, Philadelphia 1960 and Washington D.C. 1961, it was concluded that travel mode choice behaviour for trips to work are related to four factors: time, cost, service and income. It was disclosed that high income is not necessarily a deterrent to transit usage provided the time, cost, and convenience are competitive between public transit and private automobile.

Koppleman and Pas examined the relationships between consumers' mode perceptions, feelings, preferences, and

choice as a basis for understanding consumer mode choice behaviour and developing strategies to modify this behaviour. A central hypothesis of this study is that individuals choose among alternatives based on their perceptions of these alternatives rather than an objectively measured characteristics. That is, perceptions of modal attributes (system characteristics) serve as mediating variables between objective measures and preferences. Because formation of perceptions is influenced by both measured (age, income) and unmeasured (experience, psychological make-up) individual characteristics, as well as by modal attributes, perceptions of alternatives differ among individuals. The respondents indicated a high degree of sensitivity to major increase in gasoline prices (fewer car trips, more walk trips) but little sensitivity toward lower bus fares. On the other hand they expressed a positive reaction toward improved bus service (decreased headways).

In Vickerman's (1972) study the individual travel behaviour is assumed to be influenced by three main factors or groups of factors, socio-economic, locational and level of service. This implies that the amount of travel generated by the individual will depend on his or her own socio-economic status (income, occupation, age and sex) and that of the individuals household (overall household income, household size).

It is generally agreed that the choice of travel mode contributed to and evolved from a decentralized form. Gauthier and Mitchelson's (1981) research in Ottawa-Hull, examined the attitudes respondents had toward the characteristics of their travel mode choice. To offer a simple example, a consumer may be more than willing to forego the five minutes of travel time involved in an increase from two to seven minutes in exchange for a savings of 50 cents in out-of-pocket costs. However the same consumer may be totally unwilling to forego the five minutes increment from 10 to 15 minutes for the same 50 cents saving. In the former case cost is more important than time and in the latter case time is more important.

Economists hypothesize that among the alternatives available an individual chooses the mode of travel with the lowest cost. The theory suggests that the major determinants of choice of mode are:

1. out-of-pocket money costs of the modes
2. door-to-door travel times of the modes
3. value of travel time per hour for the person making the trip.

Early studies of travel behaviour in Metro Toronto and Region and in Winnipeg support this type of theory. The proportion of trips made by public transit was higher when the relative out-of-pocket cost and travel times were

more favourable for transit and when the average income of the trip makers was lower. The fact that people place values on in-vehicle travel time explains why traffic congestion is an important concern of urban transportation policy.

Car users infer that the value they place on the savings in travel time by car is greater than the extra out-of-pocket expense. On the other hand bus users place less value on the time travel savings by the car than on the extra money costs.

Beesley (1973), and Quarmby (1971) have concluded that on average people at each income level actually value in-vehicles travel time per hour during the journey to work at 20 to 50 percent of their hourly wage rate. People value walking and waiting time at two to three times as much as in-vehicle time.

Windsor has been the subject of many transportation studies, the most recent, entitled Windsor Urban Transportation Study - Report on Phase III, dated January 11, 1980 by DelCan Consultants. The results from this report will be used to complement this research. Similarly, the results from a report by B.G. Hutchinson entitled The Use of Census Journey to Work Data in Ontario Municipalities will be used in the analysis of the Windsor situation.

The Windsor Transportation report sets out to address the issues of Transportation, Land Use, Economics, and the Environment. The goals and objectives of this study are set out below:

Transportation Goal - provide a transportation plan which will accommodate the study area present and future needs for the movement of people and goods relative to the growth of the community.

Objectives

1. provide solutions to the traffic deficiencies
2. provide an overall acceptable level of service
3. be flexible to accommodate changes
4. facilitate a balance of public and private transportation services
5. minimize road-rail conflict

Land Use Goal - the transportation plan should be integrated with the Official Plan and a mutually supportive relationship between the two should be encouraged.

Objectives

1. support the Official Plan
2. encourage establishment of industries in locations where they best can be serviced with the least disadvantage to the social, physical or natural environment, and promote and maintain development of suitable parkland, recreational areas and open space.
3. minimize the intrusive effects of transportation facilities
4. improve transportation services to special institutions and the central area
5. improve and provide adequate accessibility to neighbourhood centres and community facilities
6. limit the disruption to established communities.

Economic Goal - should contribute to the economic progress of the study area.

Objectives

1. can be implemented within the financial capabilities

of the City, recognizing the financial support from senior governments.
2. will reduce travel time and delay through the study area and thus contribute to a minimization of user costs

Environment Goal - Minimize the impact of vehicular traffic on the physical environment.

Objectives

1. minimize the effects of air, noise and visual pollution.

These goals and objectives are key in the implementation of the transportation plan in Windsor.

Hutchinson's report describes some detailed trip distribution analyses of the 1971 census journey to work data for the fifteen Ontario census areas of which Windsor is one of the areas. A detailed review of the commuting patterns of the households in the census tracts of the Windsor Census Metropolitan Area are analyzed. Each census tract were reviewed under five broad categories:

1. Multi-community composition of census area.
2. Topographic and man made features.
3. The time and sequence of development of an area.
4. Socio-economic factors.
5. The domination of large employment concentrations.

The principal determinants of residential zone commuting clusters of trip linkages in Windsor were socio-economic factors, the timing of development and to a lesser extent the magnitude of employment in census tract 25 (South Walkerville Planning District, Chrysler Centre).

This thesis concerns itself with the variables that affect mode choice. In the Windsor transportation study (Transit Windsor Survey) the following factors were considered important in an individual's decision of mode choice:

1. Auto Ownership - The data indicates that although vehicle ownership varies over the city, in most areas an average of 1.5 cars is available per household. These autos are generally used before public transit is considered an alternative.

Area	Vehicle/Dwelling Unit
Forest Glade	1.47
South Windsor	1.76
West Windsor	1.12
Riverside	1.44

2. Income

   As income rises, generally travel via auto is preferred over travel by transit. In part, this factor is linked with auto ownership. Windsor has an above average industrial wage rate and can be expected to exhibit above average auto usage.

3. Travel Time

   Most often modal split analysis is related to travel time on the cost differences between auto and by transit. Transit travel times in many cities with extensive express bus networks usually average 1.25 to 2 times travel time by auto. Travel time ratios in Windsor for many of the origin-destination pairs would equal to 2.0. This is partly because many of the major destination areas are easily accessible via the major arterial network.

4. Availability of Parking

   Auto users usually have a lower perceived auto operating cost, but are aware of the parking cost as it is paid monthly or daily. Where parking is free, there is a greater incentive to drive to work. Windsor has a large number of employers providing lots and a generous off-street parking supply in many areas in the city.

5. Trip Purpose

This purpose affects travel mode choice. Transit, if convenient, is usually preferred for the work trip over shopping and business trips.

6. Shift Work

The great amount of shift work in Windsor encourages the formation of carpools and vanpools as the employees leave and arrive at precise times. Often the late evening shift changes when transit may not be operating at full service.

7. Accessibility to Major Employment Centres

Employment centres are easily accessible from most parts of the city via the major arterial road network. (DelCan, 1980, 9-11).

Modal Choice Models

Numerous sources of research concerning disaggregate travel demand models are available. Warner (1962) was the first to use disaggregate data in mode choice modeling when he developed a probabalistic binary mode choice model. Since then, experience has been gained in disaggregate modeling of mode choice and other travel choices. In a number of studies DeDonna (1971), Reichman and Stopher (1971), Ben Akwa (1973), and Watson (1973) all suggest that disaggregate travel demand modeling is a feasible modeling approach.

The earliest models for the prediction of modal choice utilized aggregated data for zones and districts. In 1969 Haney concluded that modal choice was a function of four groups of variables: transportation systems

characteristics, community characteristics, trip characteristics and trip maker characteristics (Lovelock, 1975, 257).

The disaggregate modal split models predict the probability than an individual will choose a given transport mode for a given trip. There are certain advantages with the disaggregate model:

1. Disaggregate models focus on the basic travel decision making unit, the indiviudal.
2. The precise value of different system characteristics facing each individual of the sample can be used to calibrate the disaggregate models.
3. The stochastic character of these models is consistent with modern theories of human discrimination and choice.
4. Binary disaggregate models provide information on the value people attach to some attitudes towards the transport modes (F.X. DeDonna, 1971, 31).

Disaggregate behavioural models which characterize journey decisions in terms of a cost and time trade-offs enable the 'price' of time to be calculated from the relationship between the coefficients (Heggie, 1976, 5). Once individual variations in consumer characteristics are recognized and key points in the modal choice decision process are identified, opportunities for influencing such decisions and developing a product to better satisfy consumer needs may become clearer.

Summary

There is strong evidence to suggest that the choice of mode depends on three types of variables: socio-economic, perception, and characteristics of the mode. This evidence comes in part from interview or questionnaire answers to questions related to actual choice of mode travel. Modal choice is the consequence of the type and extent of the transportation facilities available in an area. Journey to work trips are due to various social and economic characteristics of the population of the area.

Since there is strong evidence that the variables of socio-economic, perception and characteristics of the mode, determine mode choice this research will develop profiles for car users and bus users for each of the variables.

CHAPTER III

METHODOLOGY

Social and economic characteristics in addition to the modal characteristics of journey time, cost, comfort, convenience, reliability and route choice, are all interrelated in the mode choice decision for the traveller.

The modes considered for this study are public transit and the private automobile. Public transit is characterized by fixed routes and schedules, while the private automobile may be used flexibly whenever desired by the traveller. Many factors affect the individuals decision of modal choice for a work trip, but all these factors operate simultaneously. Whether a person decides to take a trip depends upon a wide variety of personal characteristics of the traveller at a given time. Each characteristic can be shown to have some discernible impact on travel.

Region of Study

The region under study is the City of Windsor, Ontario. Windsor is a medium size municipality with a population of 192,083 (1981). The major transportation modes available for those taking the journey to work trip: the private automobile and public transit. Windsor was chosen as the study area because it is generally believed that the city has serious transportation problems (Windsor Urban Transportation Study, 1980).

The City was analyzed by the sub-regions of planning districts (see Figure 1) in an effort to define the variables that characterize a modal user. The study area was limited to Windsor so as to include only the area which makes the largest contribution to the journey to work traffic in the Windsor Census Metropolitan Area.

Windsor is made up of various socio-economic groups and through the analysis of this research, it is hoped that definite patterns of mode choice emerge due to income, population density, car ownership and other variables to be explained.

Data

The data considered for this study were derived from a household sample of the Windsor population undertaken in July of 1979, by the author. The method of collection of the data (study variables) was through a questionnaire. The transportation questionnaire can be located in Appendix A.

A random sample was taken from the Greater Windsor City Directory 1978 selecting every 150th name, generating a list of 550 housholds.

A return addressed postage guaranteed envelope containing a questionnaire was delievered to 550 households in the City of Windsor, in July of 1979. Within two

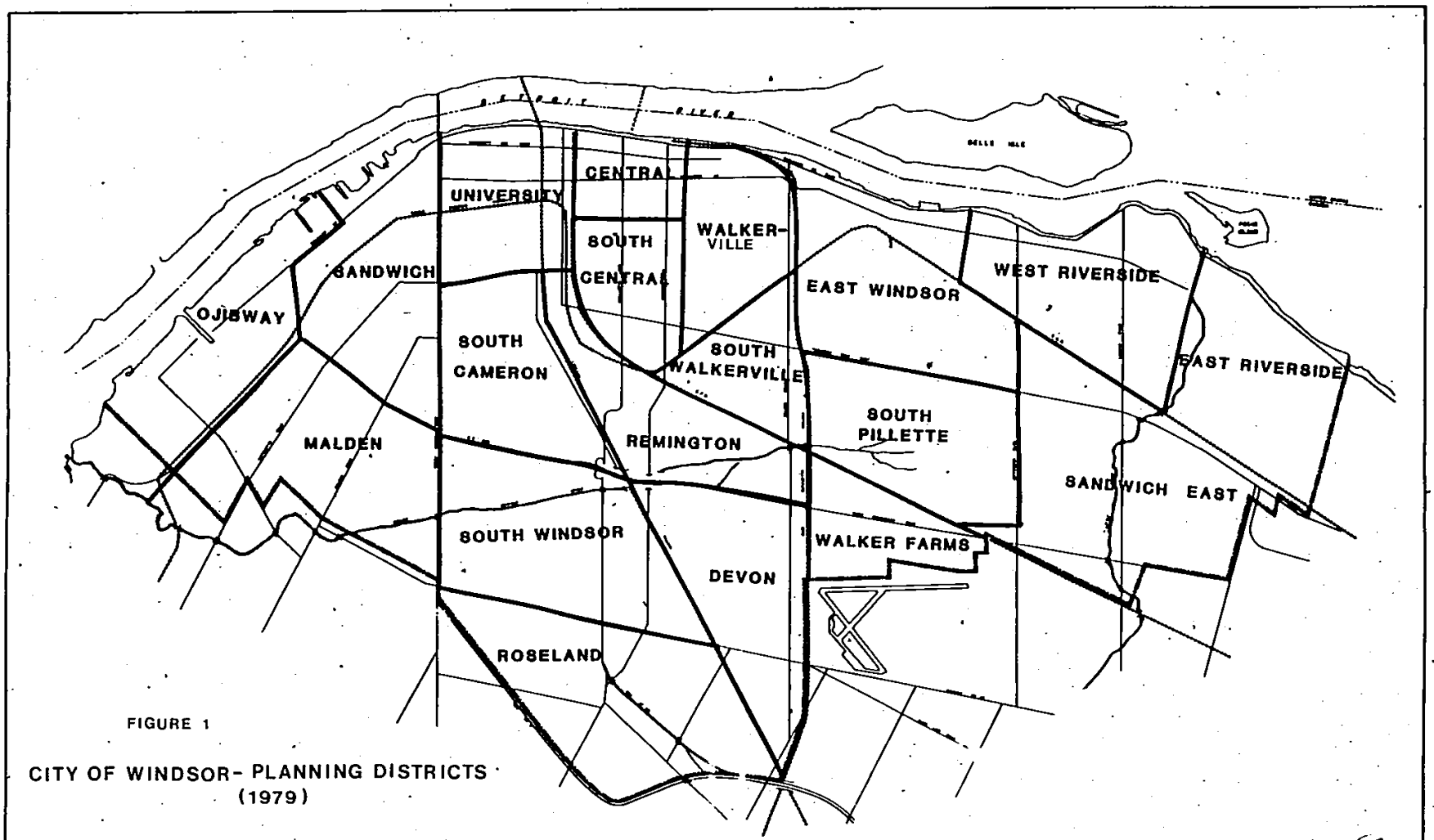


FIGURE 1

CITY OF WINDSOR- PLANNING DISTRICTS
(1979)

months 158 households responded to the questionnaire which represented a sample of approximately one household in 400 in the City of Windsor.

The locations of 158 households are found on Figure 2. There are 149 car users and nine bus user households in this sample.

The distinction between car users and bus users was based on percent usage. If an individual used the car 51 percent or more of the time for their journey to work trip, they were classified as car users. The same procedure was used for bus users, 51% or more.

The households are randomly distributed throughout the city, modal split of 5.7 percent in the sample compares favourable with that for the City of Windsor 5.7 percent (Windsor Urban Transportation Study).

The data were used to demonstrate some of the practical considerations in the application of behaviour modes. Consumer travel behaviour as determined from the questionnaire was analyzed in light of behavioural theory, and modal split predicted on the basis of expressed preferences for modal characteristics.

Data from statistics Canada and from the Windsor Planning Department on the planning districts were used to supplement the data from the questionnaire.

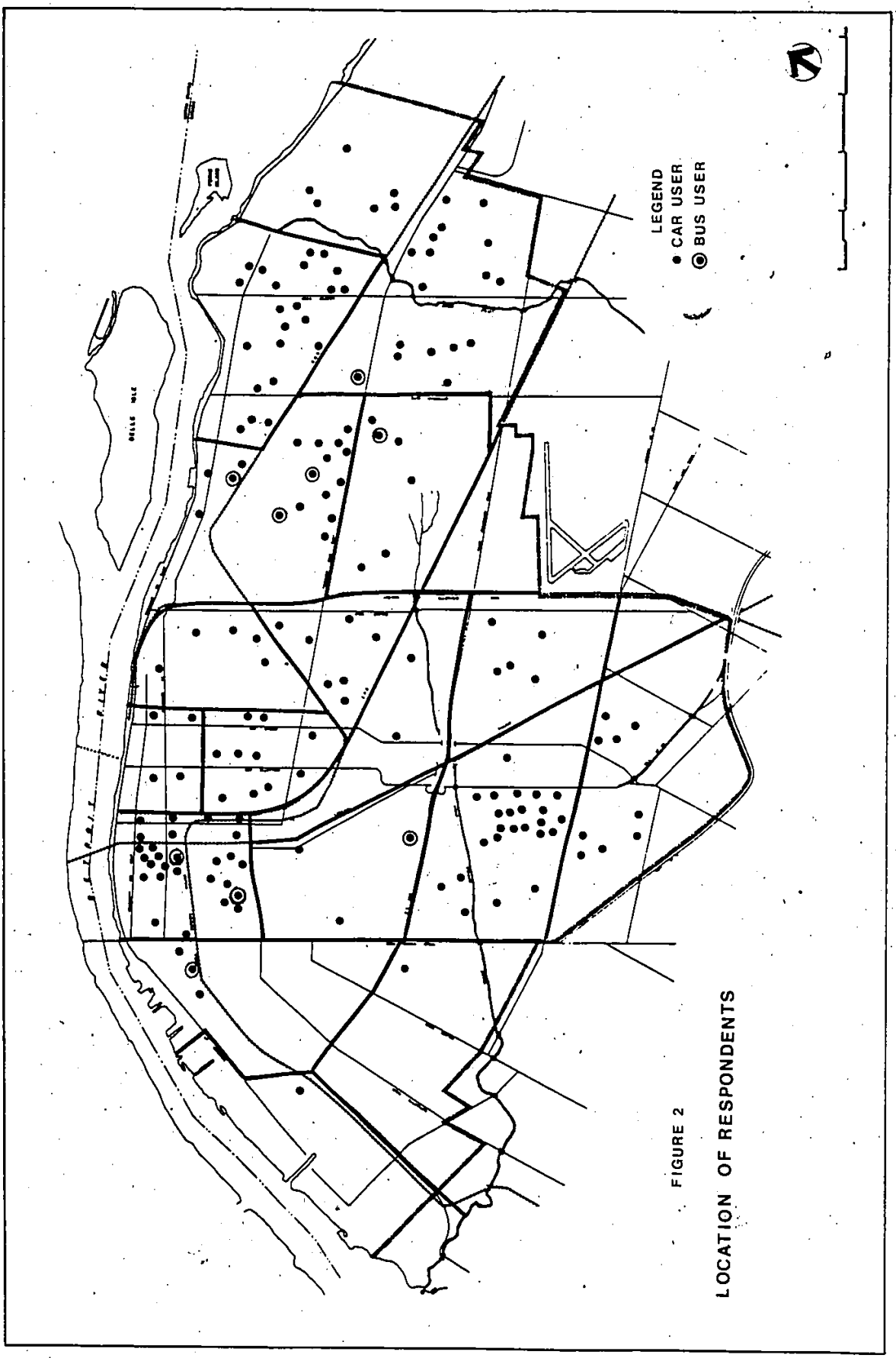


FIGURE 2

LOCATION OF RESPONDENTS

Profile of Users and Testing Procedure

For the analysis of the thesis, the respondents were divided into two groups - car users and bus users. As discussed, to determine which group a respondent best belonged was done by percentage use of the mode. If the mode was used for 51% or more of the time for the journey to work trip, then the respondent was classified as a car user or a bus user.

As a check to determine if the respondent fitted into the category, two additional variables were used to classify the respondents. They were:

- distance to work
- travel time to work

It was determined that a car user lives an average of 9.0 kilometers (5.6 miles) from place of work, taking an average of 15 minutes to travel to work. The bus user lives closer to work, an average of 4.5 kilometers (2.8 miles) but the journey to work is much longer, an average of 19 minutes.

After separating the two groups a profile of bus users and car users was devised. If the characteristics of car users and bus users are known, better transportation plans can be created by improving bus service in the planning districts that have the bus user characteristics.

CHAPTER IV

ANALYSIS OF DATA

The analysis of data will be discussed under the two profiles of car user and bus user. The profiles will be discussed under three sub-sections:

- socio-economic
- perception
- characteristics of the mode

The data collected on the car user and bus user are recorded in Appendix B and C, respectively.

SOCIO-ECONOMIC

Car User Profile

From the questionnaire it was determined that 149 cases, used the car for travel to and from work. The characteristics of the respondents are summarized in the following section.

The head of the household was responsible for completing the questionnaire. The head of the household was used because of the greatest freedom of choice in their travel mode compared to the other members of the household. Eighty-six percent of the respondents were male and fourteen percent female.

Combined household income is a major factor that distinguishes car users from bus users. Over seventy-three percent of the car users have a combined household income of $20,000 and over. Over one-third had a combined

household income of $30,000 and over. In 1976, the average income for a Windsor household was $23,137 (Windsor Municipal Housing Statement, 1981). Only 35.8 percent of Windsor households earned $25,000 or more, whereas the sampled population has 49.6 percent earning $25,000 or more. This sample represents car users only, whereas the statistics represents all households. There is a possible over-representation of high income earners of the sampled population.

The respondents held jobs from the various industrial groups of manufacturing, primary, construction, community, business and personal service etc. Auto related jobs represented the largest percent (30%) of the sampled population. In 1979 when this survey was conducted 27.3 percent of the industrial labour force was in manufacturing. These employees usually work on a two or three shift day and therefore the workers cannot rely on the transit system in the early morning (before 6:00 a.m.) and late at night (after 12:30 a.m.) because the bus service is not operating at those hours. This is one reason the large majority of respondents are car users.

The sampled population of car users shows a large percentage (43%) have two people working in a household. This statistic supports the combined household income statistic of 49.6 percent earning $25,000 or more per annum.

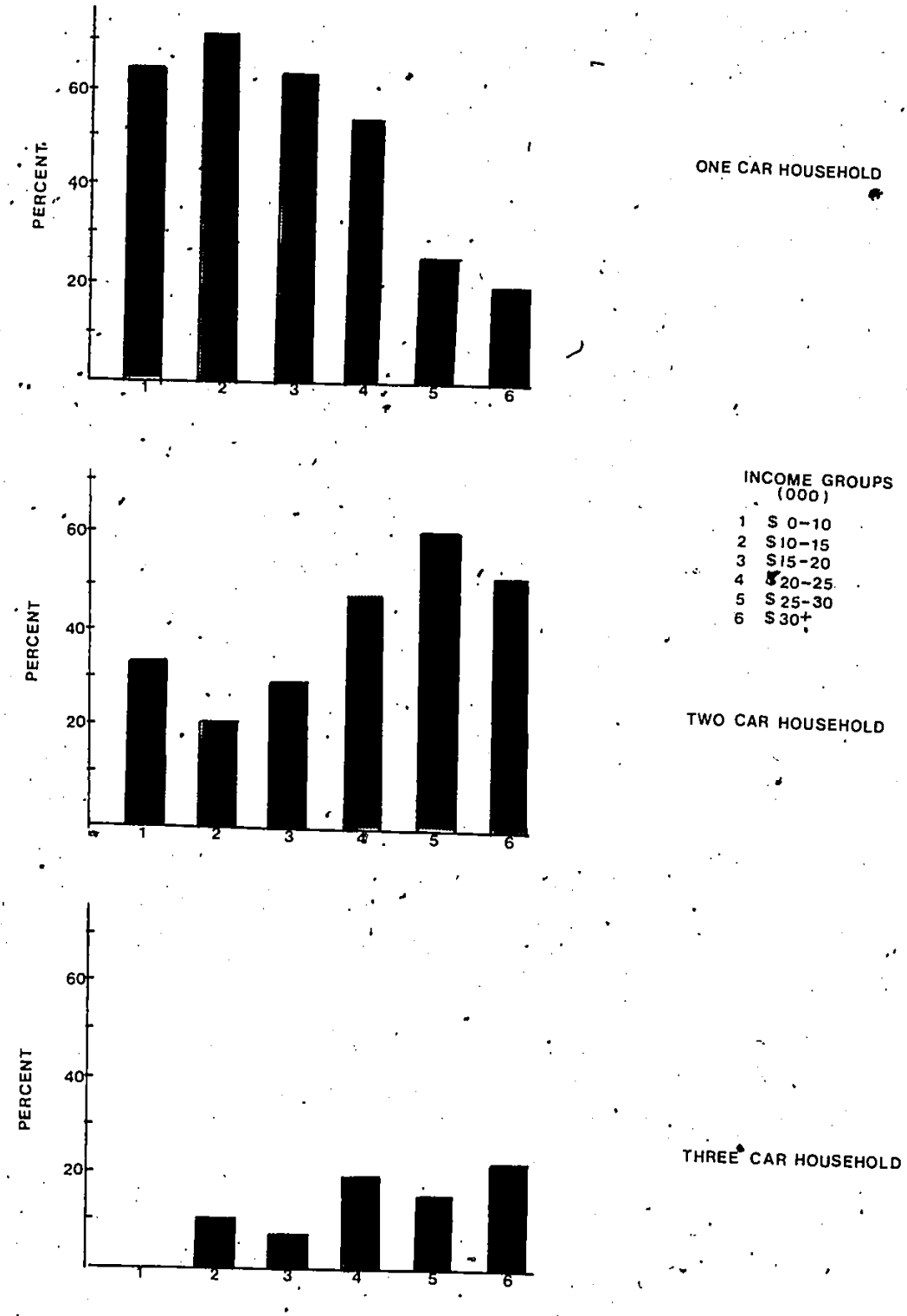
Another statistic related to income is car ownership and the number of cars per household. From the questionnaire it was determined that a large percentage (45%) own two cars. Twelve percent of the car users own three cars and 5.4 percent own four cars. The statistics show 61.1% of the car users own two or more cars. From the Windsor Urban Transportation Study it was determined that in most areas an average of 1.5 cars are available per household. South Windsor ranked first in number of vehicles per household (1.76). South Windsor households also have the highest average household income ($35,555) (Windsor Municipal Housing Statement, 1981) of the Planning Districts. This suggests that as income rises so does the number of cars per household. (See Figure 3).

Single family houses (89.7%) are the predominant type of housing for car users. Only 6.2 percent live in duplexes, 2.7 percent live in row housing and 1.4 percent live in apartments. For the City of Windsor, 68.7 percent (1981) of the dwellings are single family houses and 19.7 percent are apartments. From the sampled population, the car users reflect an over-representation of single family houses (89.7%). But the Windsor statistic accounts for car, bus and other mode users.

The majority of car users are married (88.4%). The remaining 11.6 percent are single. In 1981 of the Windsor population, in the 15 years of age and over category, 62.9

FIGURE 3

NUMBER OF CARS PER HOUSEHOLD BY COMBINED HOUSEHOLD INCOME



percent were married, 37.1 percent single (single, divorced, widowed).

Almost one-third of the car users have some university/college training. Fifty-five percent have high school education and 12.4% have public school education. Education is interrelated with income in that the higher education one has the higher the income (See Figure 4).

Ninety percent of the sampled users have a driver's license. There are 83.1 percent of the households with two or more persons with a driver's license. This is consistent with the number of cars per household of 60 percent having two or more cars per household. In addition 61.1 percent of households have two or more persons working. Therefore the car users with two workers may require more than one car to provide the second worker with a car for travel to and from work.

The following is a general profile of the socio-economic characteristics of the head of the household car user;

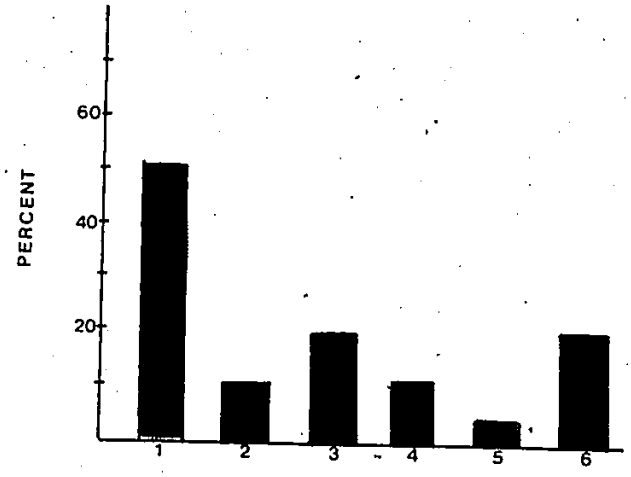
-Male
-Combined household income of $25,000 or more
-Two cars per household
-Single family house
-Married
-Education High School/University

Bus User Profile

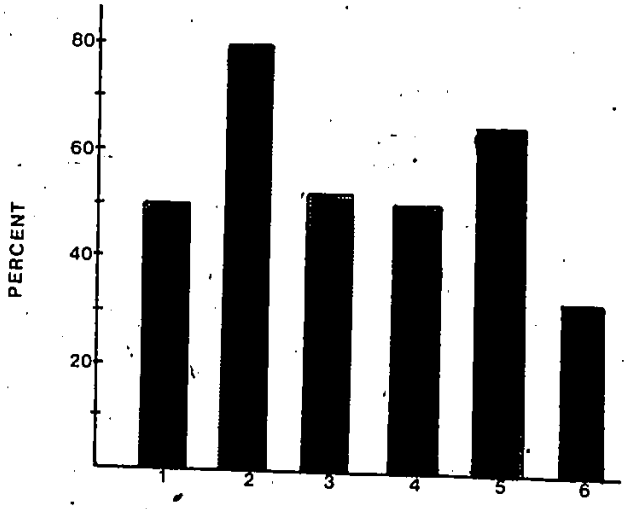
Fifty-six percent of the bus users were female heads

FIGURE 4

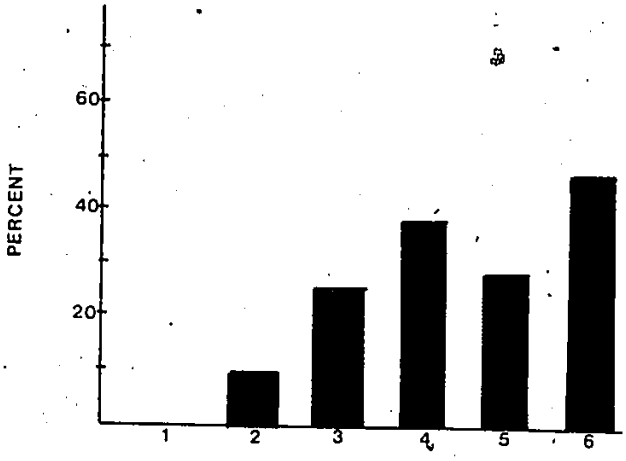
YEARS OF EDUCATION BY COMBINED HOUSEHOLD INCOME



PUBLIC SCHOOL



HIGH SCHOOL



UNIVERSITY

of household. There are more female heads in the bus user category than in the car user category. This may be reflecting the fact that female heads usually are the only income earners in the household and therefore cannot afford the luxery of driving a car to work

Over 87 percent of bus users have a combined household income of less than $20,000. Seventy five percent of cases have income levels between $10,000 and $20,000. This statistic is in contrast to car users whose combined income (household) for over seventy percent is $20,000 or greater.

Combined household income is related to the number of persons working per household and in the case of bus users 45 percent have only one worker per household. One worker per household creates an income per household considerably less than the two persons working household which is the case for car users in this research.

Similarly, car ownership is a component of income in that the greater the disposable income available to a household, the greater the chances are of owning a car. For bus users one-third do not own a car. This is compared to the car users 2 percent.

The location of the bus users can be found on Figure 2. The bus users are found in the following planning districts:

-University
-South Cameron
-Sandwich
-East Windsor
-South Pillette
-and Sandwich East

All the households in the planning districts with the exception of South Cameron and Sandwich East earn less than the Windsor average household income of $23,137 (1976). Therefore low income is an important factor in the profile of a bus user.

Just over 50 percent of bus users live in single family houses, 22.2 percent live in duplexes and 22.2 percent live in apartments. Bus users have a high percent of people living in duplexes (22.2%) when compared to the Windsor average (4.8%). More bus users live in apartments than car users, 22.2 percent to 2 percent, respectively.

Education is also related to income in that a higher education might promote a higher income. The majority of bus users have a high school education or less. Two-thirds received a high school education and 22.2 percent had a public school education. Bus users on average are less educated than car users in this research. Car users have almost one-third of the respondents receiving some college or university training compared to 11.1 percent for bus users.

The majority of bus users come from one income households

of which 44.4 percent have a single marital status.

Almost ninety percent of bus users have drivers licenses. The fact that they have drivers licenses yet choose to use the bus might be regarded as a purely economic decision in their mode choice for the journey to and from work.

In sum the socio-economic characteristics of a bus user are:

-Female Head of the Household
-Combined household income of $20,000 or less
-One car per household
-Housing - duplexes and apartments
-Marital status - single
-Education - high school or less

PERCEPTION

Car User

The average car user from this research perceives the cost of travel to and from work for one week to be $5.85 (1979). Therefore the average cost for the work trip per annum is $292.50, assuming 50 work weeks. According to the Ontario Motor League, in 1979 the average car (8 cylinder) travelled 24,000 kilometers (15,000 miles) in a medium size city (100,000 - 300,000 population) at a cost of $2,936. This figure includes the following costs:

-insurance
-maintenance
-gas and oil
-tires

-depreciation
-snow tires
-licenses

For travel by car and transit for the work trip represents 38% of all trips in the City of Windsor (Windsor Urban Transportation Study, 1980). Thirty-eight percent of $2,396 is $910.48. The car users estimated $617.98 less than the average cost of owning a car for the journey to and from work. The car users do not perceive the real costs of owning a car therefore on can suggest that cost is not an important factor but one's discounted perception of it is important. Furthermore, it is likely that even if their perception were closer to the facts the cost would not be a major determinant of modal choice.

The majority (78.8%) of car users state that the journey to work takes less than 20 minutes. Of the five time categories (0-10,11-20,21-30,31-40 and more than 40 minutes) the largest percent (50%) were in the 11-20 minute category. The average length of time was 15 minutes and the average trip length was 9.0 kilometers (5.6 miles). Hutchinson's analysis showed that in Windsor, the average trip length was 7.9 kilometers (4.9 miles) in 1976. Therefore the car population is representative of a typical car user in the City of Windsor.

As stated previously the perception of the alternative mode is important in determining if it is indeed a viable alternative to the respondent. The respondents were asked

how long it would take to travel to work by bus. The time categories were the same as for the car and the largest percent of respondents (38.3%) stated, that for the same trip, it would take 40 minutes or more to get to work. Over one third stated the trip by bus would take between 31-40 minutes. Therefore, over seventy percent stated that the trip which takes an average of fifteen minutes by car takes 31 minutes or more to travel by bus.

Over 40 percent of car users live within one block of a bus stop. Although the majority (88.5%) of bus stops do not have shelters, the location is convenient for most of the car users. The reason they do not use the bus is possibly because of their perception and knowledge of the bus schedule. The morning rush hour service stated by the largest percent of car users (44.7%) is every 15 minutes and the evening rush hour service is also every 15 minutes. Of the respondents 59.7 percent stated that they have to wait more than 10 minutes for a bus, taking less than five minutes to walk to the bus stop. This potential consumption of time shapes part of the perception of the car user with respect to transit service.

As an example from the respondents of the East Riverside Planning District, over 83 percent state that the morning rush hour service is every 30 minutes, and in fact it is every 30 minutes. The respondents perception is correct yet all the respondents in East Riverside (18) are

car users, preferring to use a mode which will take less time to arrive at the place of work.

Similarly when asked if the urban transportation system of Windsor needed improvement over seventy percent stated yes. Some of the problems with the system were:

-fare too high
-poor service for shift workers
-too many transfers
-service not convenient

Bus User

In 1979 the adult bus fare was 40 cents per trip, thereby costing $4.00 per week to travel to and from work for bus users. This would be the economical way to travel to and from work compared to the car's weekly expense of $18.21 (Ontario Motor League, 1979).

Two-thirds of the bus users take 11 to 30 minutes to travel to work. The average trip length for the bus users was 4.5 kilometers (2.8 miles) and the average trip time was 19 minutes. The average bus trip takes four minutes longer but the bus trip is only covering half the distance, 4.5 kilometers (2.8 miles) to 9.0 kilometers (5.6 miles), respectively.

Almost ninety-percent of the bus users have a bus stop within one block from their home. In contrast, car users had less than 50 percent of the respondents living within

a block of a bus stop. The location of the bus stop is convenient for bus users therefore it is possibly one reason why they are bus users.

The combination of the time it takes to walk to the bus stop, length of time waiting for the bus and the presence of shelter are all questions of perception. The majority of bus users take less than five minutes to travel to the bus stop and the majority (55.5%) wait less than 10 minutes for a bus. One hundred percent of the bus users have no bus shelters at their bus stop. A bus shelter, including a place to sit, would provide protection during inclement weather and would make the walking to and waiting for the bus more bearable. Although the majority of car users (62.8%) live less than five minutes from the bus stop, 60 percent responded that they had to wait ten minutes or more for a bus. The real time may not be ten minutes but the car users perceive it as such and that is the important factor. Related to this is the dependability of bus schedules so that bus riders could reduce waiting time by synchronizing their arrival at the stop with that of the bus.

Morning and afternoon rush hour transit service provides a 30 minute headway for 88.9% and 100% of the respondents, respectively for bus users. The bus users are located in the planning districts of more frequent transit service when compared to the planning districts of Roseland, South Windsor, Malden, and Objibway. Transit service during the morning

and afternoon rush hours for the aforementioned planning districts are from 60 to 120 minutes. Limited frequency could pose a problem to the people in these areas who wish to take the bus to work.

Figure 5 illustrates the level of peak hour service of transit in the City of Windsor in 1979. A good level of service is assumed to have a bus every 15 to 30 minutes, average service is 30 to 60 minutes and poor service is 60 minutes or more. The good bus service forms a linear pattern along the northern portion of the city. Similarly, the planning districts that have a good level of peak hour service coincides with the planning districts of higher densities (See Figure 6). Therefore the bus users are located in the planning districts with a better level of bus service.

The majority of bus users stated that Windsor has an urban transportation problem. The bus users provided some solutions to the problems which are:

-Faster buses
-Decrease headways
-More shelters
-More buses

In sum, bus users perceive the bus as an economical means of transportation when compared to the cost of owning a car for the journey to and from work, convenient in the location to a bus stop and good bus service. Bus

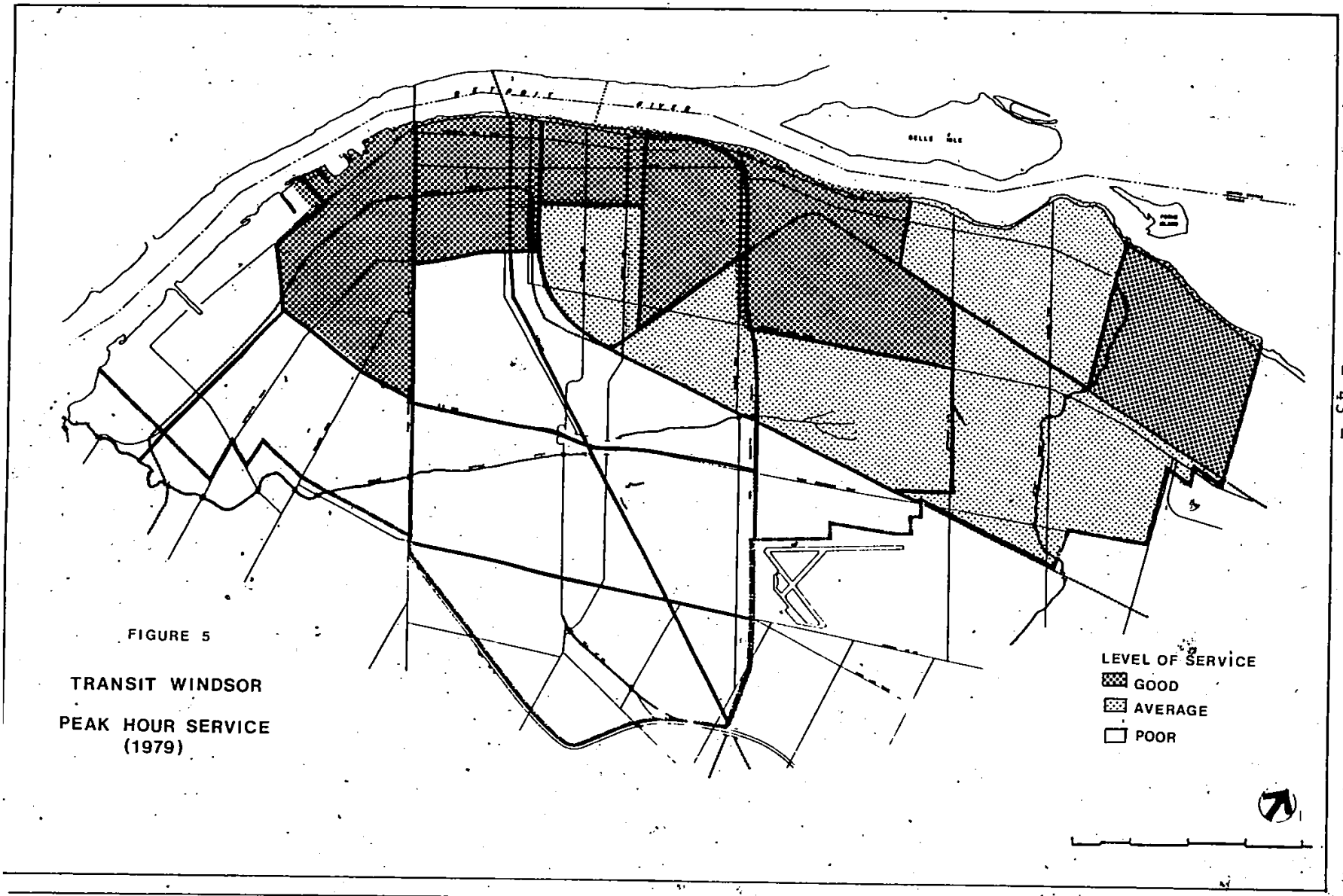


FIGURE 5

TRANSIT WINDSOR

PEAK HOUR SERVICE
(1979)

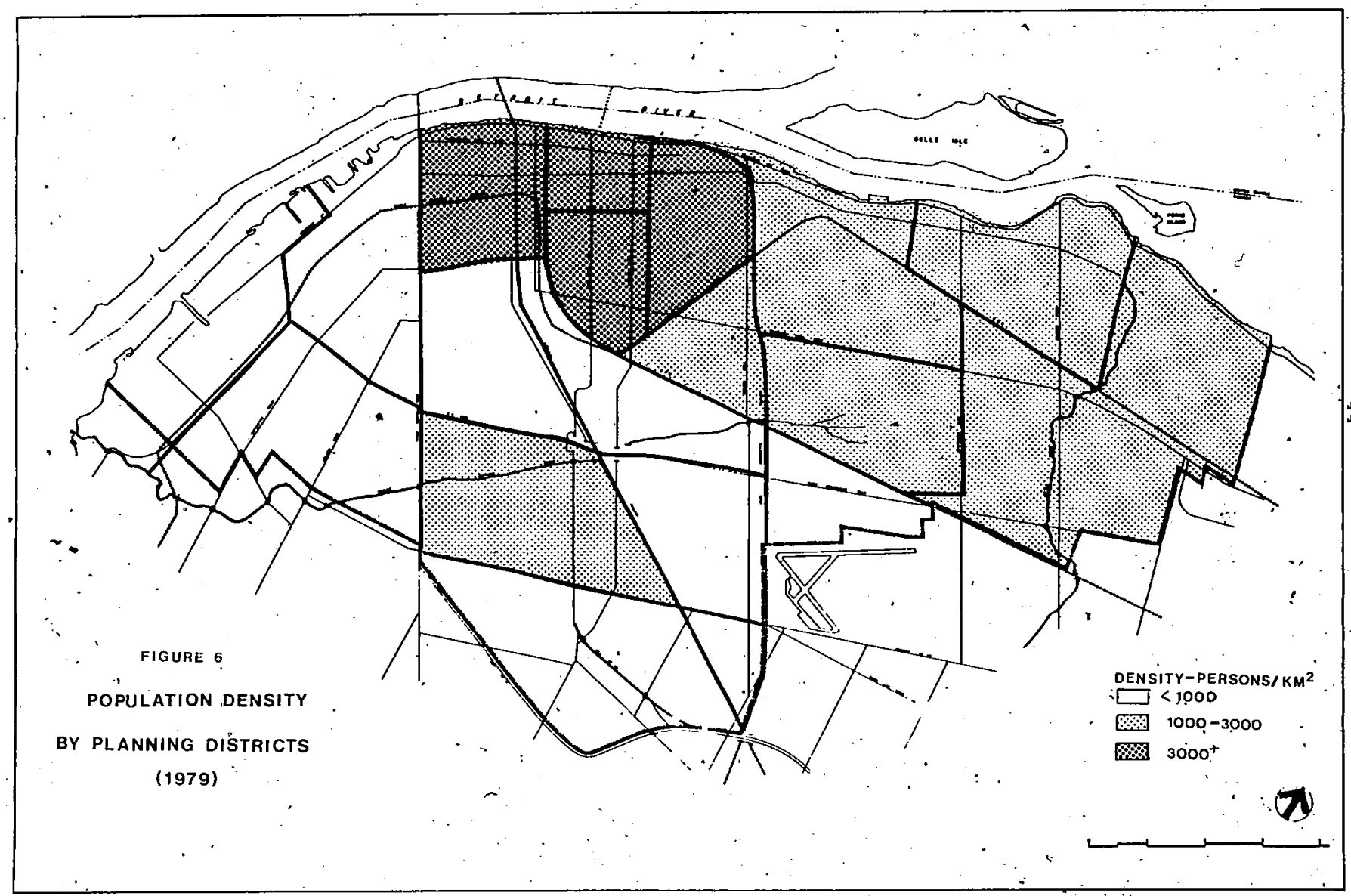


FIGURE 6

POPULATION DENSITY

BY PLANNING DISTRICTS

(1979)

users have a better level of service than the majority of car users. Although the bus users are satisfied with the level of service they receive, they have suggested a few improvements which if implemented might attract some car users to transit for the journey to work trip.

CHARACTERISTICS OF THE MODE

Car User

Question fourteen directly asked the car users why they used the car to get to and from work. The respondents were asked to rank their answers in order of importance. The top three answers were assumed to be important variables and were recorded as such. Therefore the percent is greater than 100 because some respondents gave more than one answer.

The first and foremost reason the car is selected was for its convenience. Convenience is a term that each individual respondent defines differently and therefore even though this statistic ranked first in importance (67.1%) it will be taken out for the purpose of this analysis.

The seven remaining factors have equal weight when the convenience variable is taken out. The factors of the "bus being uncomfortable," "too long to wait for bus", "too many transfers in the journey to and from work" are all ranked between 15 and 18 percent. The factors of "need it for business" and "run erands after work" also ranked at 15 percent.

There are no strong reasons why the respondents use their car other than the fact it is convenient, and most of the separate variables above could fit under the umbrella term of "convenience".

When asked what factors were considered the most and least important in the kind of transportation the respondents used to travel to work, the respondents were asked to rank the variables on a Guttman scale. A ranking of one, two or three was considered an important factor and a ranking of four, five, six or seven was assumed to be not important.

Reliability was ranked by 96.4 percent of the car users as an important factor in deciding to take the car for the journey to and from work. Reliability can be defined as the mode's ability to be available at anytime to depart to or from work in this case, the car is accessible at anytime and does not have to adhere to any schedules. Another important factor is convenience of the mode (93.5%). Speed is ranked as moderately important by 62.1 percent of the respondents.

Comfort and cost of the mode were ranked at 50 percent, neither being an important nor unimportant factor.

Reliability of the mode is important when considering the need for the user to run errands on their journey to or from work or both. Over 60 percent of the car users ran errands during their trip to and from work. The

majority (40.8%) only ran errands once in a while. Twenty-seven percent ran errands three times a week; while only 14 percent ran errands daily. The fact that errands are required makes the car a basic necessity to the car users. It is important to the car users to have a mode available to them that is reliable for these errands. This involves a time cost factor viz-a-viz the use of mass transit transfers to accomplish multiple errands to or from work.

Only 28.6 percent of the car users need their car for business. The remaining 70 percent use their car because of its reliability, convenience and necessity of the car when the need to run errands occurs.

Car users are posed with additional problems, when compared to bus users, in their need to park the car after they get to work. For 86.5 percent of the car users, parking is available free of charge. In the Windsor Urban Transportation Study (1980), it states that, where parking is available free of cost in company or subsidized locations, there is a great incentive to drive as the parking cost is not a deterrent. Windsor has a large number of employer provided lots and a generous on-street parking supply in many areas of the city.

Of the 13.5 percent that pay for parking, the average rate of parking per day is 57 cents. The majority of car users park in parking lots (87.4%), with only 7.7 percent

parking on the street where there are no meters.

From the Windsor Urban Transportation Study, it was disclosed that the great amount of shift work in Windsor encourages the formulation of carpools and vanpools, as the employees leave and arrive at precise times. Often the late evening shift change occurs when the transit system may not be operating at full service. From the questionnaire it was determined that twelve percent of the respondents were in carpools. The largest percent (44.4%) of the carpools had one other person in their car pool and an additional one third had two other persons in their car pool.

In sum, the profile of car users might suggest areas of potential bus users in the future. Some of the more important factors that could affect modal split in Windsor that were derived from this research are:

1. Income: As income levels rise, generally travel via car is preferred over travel by transit. Income is linked to car ownership.

2. Auto Ownership: The Transit Windsor survey indicated that in most areas in Windsor there are an average of 1:5 cars per household. In this research it was determined that 60 percent of the car user households owned two or more cars.

3. Travel Time: Most often modal split analysis is related to travel time on cost differences between travel by auto and by transit. This research indicates that the perceived difference between travel to work by auto and by transit is 2.0. That means transit takes twice as long for the same trip taken by car.

4. Reliable: The most important factor to car users was reliability of the mode (car). If Transit Windsor can

persuade car users of the reliability of transit then there might be a change in the modal split.

Bus User

Within the decision to be a car user or a bus user the respondent must indicate what characteristics are important for the respondent to select the mode.

For bus users, question twenty-two specifically asked what the reasons were for taking the bus to and from work. The number one answer was, more economical. As shown previously, the cost of taking the car to work for one week would allow a bus user to take the bus for a month for the same cost. Cost is a very important factor to bus users. One-third of the bus users do not own a car and therefore for this study the only alternative mode is the bus. These respondents are captive riders.

There are two other reasons why bus users use the bus, and they are negative reasons against the car:

-road congested
-no parking available at work

Bus users ranked the modal variables of comfort, convenience, cost, reliability and speed all as important variables in the selection of the bus for the journey to work. One hundred percent of the bus users ranked convenience and reliability of the mode as very important variables. Eighty-eight percent thought cost was important and seventy-

five percent ranked comfort and speed as important.

Car users also ranked convenience and reliability of the mode as important, but they considered comfort, cost and speed as unimportant factors.

Over one half of the bus users do not run errands to or from work. This may be a question of convenience or cost. To carry any large parcels or to get off the bus in mid trip would be both an inconvenience and extra cost to pay another fare to get back on the bus to complete your journey to or from work. For those bus users that run errands to or from work, 50 percent only do them once in a while. Once in a while is less than weekly, where as the majority of car users (59.2%) run errands weekly.

In sum, the profile of a bus user might suggest areas of potential bus users in the future. Some of the more important factors that could affect modal split in Windsor for bus users are:

-more economical than car
-areas of better service find more transit users

Summary

This research suggests that certain factors characterize bus users and car users. The most predominant set factors that characterize users are the socio-economic factors.

Income was determined to differentiate most clearly

between bus users and car users. Over 73 percent of the car users have combined household incomes of $20,000 or more. Whereas 87 percent of bus users, from this research have combined household incomes of less than $20,000 per annum.

As stated previously, income is related to car ownership. Of the bus users in this sample, one third do not own cars and only two percent of the car users are without a car. The fact of not owning a car limits for this study the choice of mode for the journey to work trip. Similarly, 45 percent of the car users owned two or more cars where only 16.7 percent of bus users owned two cars.

Also related to income is housing. More bus users live in apartments and duplexes than car users. Less than eight percent of car users live in apartments and duplexes, whereas bus users have 45 percent. Housing is related to the amount of disposable income available for housing but it can also be a fact of location and personal preference. However apartments and duplexes are usually in areas of higher density. The planning districts with higher densities are University and East Windsor having population densities of 3571.06 and 3138.47 persons per square kilometer, respectively. Both the University and the East Windsor planning districts have bus users in them, possibly suggesting that higher density areas are provided with better bus service. Morning rush hour service in these two planning districts is every 30 minutes. This is a good service, when compared

to the service in the Roseland planning district of every two hours. The population density of this district is 892.78 persons per square kilometer, almost one fifth less the density of the other two districts. This may have an impact on the use of the bus in the Roseland planning district.

Education was another factor that differentiated car users and bus users. Car users had an average from this research more university education 32.1 percent compared to the bus users 11.1 percent.

It was discovered that more female heads of households are bus users (55.5%) than car users. This statistic is consistent with the income and housing results with 87.5% making less than $20,000 per annum and living in high density. Buses are more convenient and affordable for these users.

If a transportation planner knew the socio-economic characteristics of the households of the municipality, the households might be characterized as car or bus users. If they are bus users improvements in service could be planned for those areas in preference to those which can be characterized as car users districts.

In the second section, Characteristics of the Mode the car and bus users had similar characteristics or attributes that were important. Both convenience and

reliability of the mode scored high with both users. The only difference in characteristics of a user is that bus users are concerned with cost. Over 87 percent of bus users considered cost an an important factor. This is a significant statistic in which one can examine the characteristics of the user. Cost of the mode was related to the amount of disposable income available for travel to work.. It was found that bus users make less combined household income than car users. Therefore, cost of the mode can be an important factor in characterizing bus and car users.

Both car and bus users were asked what was the reason for selecting a particular mode for the journey to work trip and each user gave a different answer. The car user overwhelmingly had selected convenience as the reason they were car users. Convenience can mean ability to be flexible in arrival and departure times, ability to run errands either to or from work, and as many interpretations as there are respondents. Whereas the bus user from this research stated the number one reason they used the bus was that it is more economical. This fact concurs with the cost factor of the previous paragraph.

More care users run errands to and from work than bus users, but not a significant number. Over 60 percent of car users run errands compared to 44.4 percent of bus users. Running errands is not a significant factor in characterizing car users and bus users.

Perception in relation to transportation has never been investigated in the City of Windsor. Perception is involved when the respondent estimates time, cost and distance to work. Car users travel an average of 9.0 kilometers (5.6 miles) to work, taking an average of 15 minutes. Bus users travel half the distance 4.6 kilometers (2.83 miles) but taking longer to get to work (19 minutes). From this, one could possibly suggest that bus users live closer to their place to work than car users.

The real cost of owning and operating a car for the car user is something they do not perceive. From the survey the average cost of using the car for the journey to work was $5.85 a week. The real costs are $18.21 (C.A.A.) for the work trip. Cost is not an important factor to car users when considering choice of mode because they under estimate the true costs by almost $13.00 a week or $650 a year, assuming 50 work weeks. Bus users have a more realistic view on cost because they work on a user pay basis. It costs $4.00 a week to travel to and from work for a bus user, which is a savings of $14.21 per week or $710.50 per year for not using the car. This makes the bus the more economical mode using cost as the only factor.

Bus users stated that it took less than 30 minutes to travel to work. When car users were asked the same question, they responded that if they took the bus it would

take 30 minutes or more. The car users average time for the journey to work is 15 minutes and their perception of the alternative mode, the bus, is that it will take twice as long.

Perception of the bus service by car users provides some insight into why they are car users. The majority (88.9%) of bus users perceive their bus stop to be within a block of their home. Car users (74.8%) state the bus stop is within two blocks. Associated with distance to the bus stop is the majority (88.9%) of bus users take less than 5 minutes to travel to the bus stop. Car users state 62.8% take less than 5 minutes to walk to the bus stop.

Perception of available bus service during the morning rush hour, 44.7% of bus users had a 15 minute headway and 55.3 percent have a 30 minute or more headway. Eighty-nine percent of the car users had a 30 minute or less headway. Indeed using perception alone, the bus users have a better service. But through improvement of the car users perception of bus service they could increase the modal split. This issue will be discussed in the next chapter.

CHAPTER V

RECOMMENDATIONS

Improvements to the existing public transportation system can be suggested through the aid of this research analysis. The transit planners can concentrate on improvements to the system in the planning districts that characterize those of the bus user. An example of how a transit planner can make improvements is explained in the following section.

Walkerville planning district has been selected as the case study. This research suggested that bus users are found in areas of higher density. Walkerville has the highest population density of all the planning districts in Windsor. Bus users are characterized as having combined household incomes of less than $20,000 per annum. Although the households of the Walkerville planning district (of this research) make slightly more, $22,500, they do make less than the City of Windsor average, $23,137 (1976).

Bus users are characterized of having some high school education and the respondents of this planning district also have some high school education. The average distance to work from the survey was 5.3 kilometers (3.3 miles) — which is just slightly more than the bus users average distance of 4.5 kilometers (2.8 miles). Presently, this district is served by four bus routes operating at a 15 to 30 minute headway at rush hour. The potential for bus users in this district are possible because of

the similar characteristics to the bus user profile. Car users in this district take an average of 10 minutes to travel to work and state the alternative mode, the bus, would take 3 times as long, 30 minutes. Improvements can be made in the transportation system by informing the potential bus users of the available modal alterantive to the car. More time and effort can be made in this district because of its potential.

Similarly, to determine which planning districts are potential bus user districts a checklist similar to Figure 7 can be used. Selecting three characteristics that characterize bus users - combined households income of less than $25,000 per annum, travel less than eight kilometers (5 miles) to work and live in planning districts of high density the following planning districts can be classified as bus user districts:

1. University
2. Central
3. South Central
4. Walkerville

The planning districts of East Windsor and South Pillette fulfil two of the characteristics but are medium density districts. However, these two districts have potential to be bus user districts. The remaining planning districts only fulfil one characteristic and therefore no improvements to the present transit system are likely to create new users.

FIGURE 7

BUS USER CHARACTERISTICS BY PLANNING DISTRICTS

Planning Districts	Household Income <25,000	Travel to work <8 kilometers (5 miles)	Population Density
Objibway	✓		low
Sandwich	✓		low
Malden	✓		low
University	✓	✓	high
South Cameron		✓	low
South Windsor			medium
Roseland			low
Central	✓	✓	high
South Central	✓	✓	high
Remington	✓		low
Devon	✓		low
Walkerville	✓	✓	high
South Walkerville		✓	medium
East Windsor	✓	✓	medium
South Pillette	✓	✓	medium
Walker Farms	✓		low
West Riverside			medium
Sandwich East			medium
East [illegible]or			medium

This research provides transportation planners a reduced set of variables to consider in their effort to make improvements to the transportation system. In the Windsor situation a concentrated effort could be made around the Central Business District and to the east in the planning districts of University, Central, South Central, Walkerville, East Windsor and South Pillette in an effort to increase transit patronage. (See Figure 8).

This thesis attempted only to disclose those factors that characterized bus users and car users for the journey to work trip. There is a need for additional research in the following areas:

1. Value of time research to determine at what point a car user will change to the bus for transportation to work.
2. More studies analyzing the community planning aspects on co-ordinating land uses to transportation planning in an effort to plan a more effective and energy efficient community.
3. Transportation data collected on the disaggregated level to better understand the consumers behavioural patterns in relation to modal choice.
4. The development of models for all trip purposes.
5. The weights consumers attach to these modal attributes.
6. How people perceive the service characteristics of the modes.
7. The degree to which consumers are aware of the available modal alternatives.
8. The determination of how the consumer's use of a particular mode bias his perception of the level of service offered by the other modes.

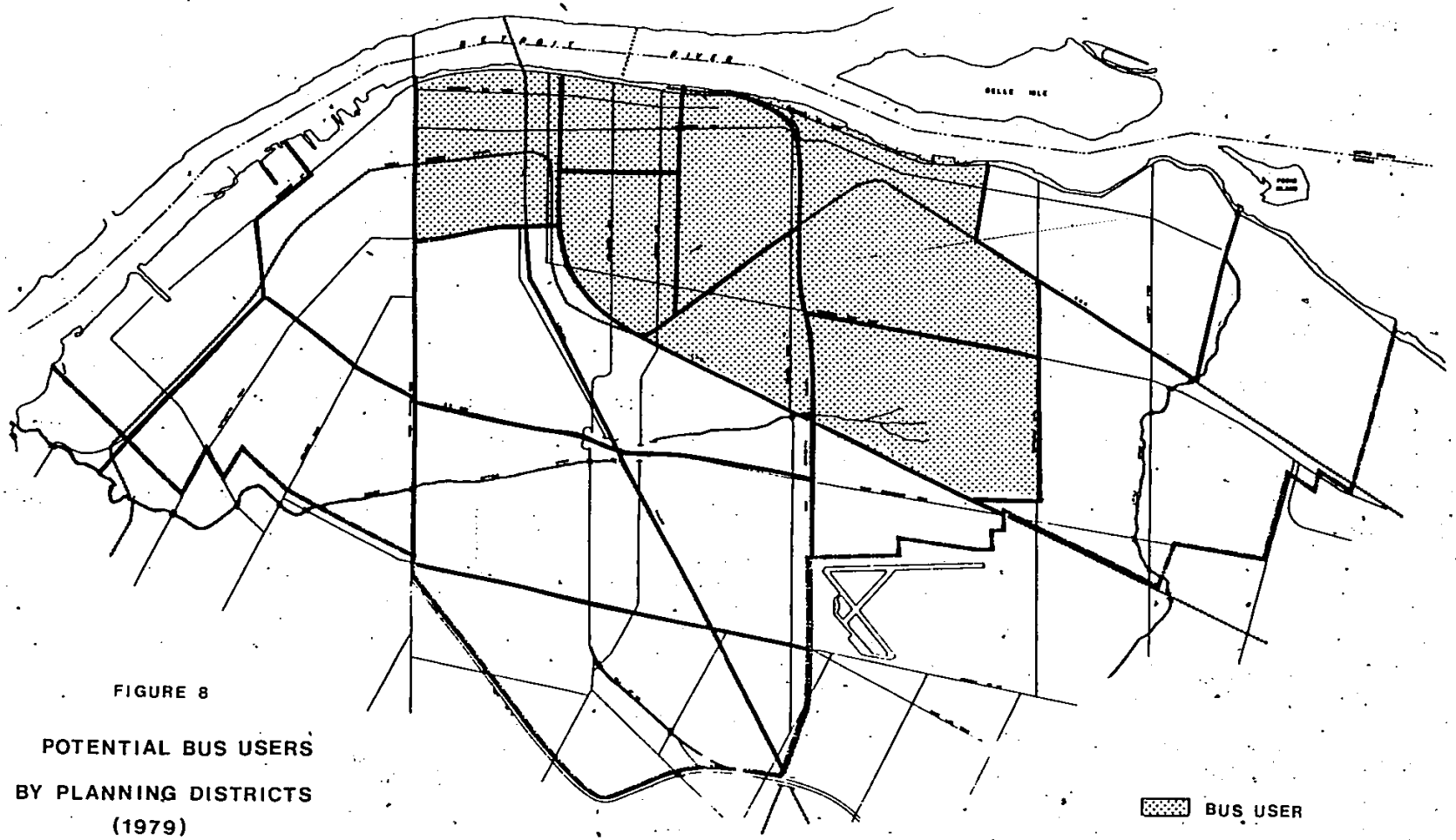


FIGURE 8

POTENTIAL BUS USERS

BY PLANNING DISTRICTS

(1979)

9. The determination of how the consumer's use of a service attributes of radically new modes.

10. More research is needed to understand the influence of socio-economic parameters on individual attitudes and sensitivities of transportation stimuli.

In conclusion transportation planners must be able to identify the impacts of a particular policy change on the comparative levels of satisfaction trip makers derive from their travel alternatives.

APPENDIX A

TRANSPORTATION QUESTIONNAIRE

Transportation Questionnaire

Office Use Only

Address_____ Census Tract _____

Case Number_____ Pop. Density _____

Instructions

Please have the head of the household fill out this questionnaire.

---

1. Do you have a driver's license?

   Yes____ No____

2. How many people in your household have driver's license?

   circle one 1 2 3 4 5 5+

3. Do you own a car?

   Yes____ No____

4. How may cars are there in your household?

   circle one 1 2 3 4 5 5+

5. How many persons in your household work?

   circle one 1 2 3 4 5 5+

6. How many miles is it to your place of work?

   _____Miles

7. What percent do you use the following forms of transportation to get to work?

   Car_____% Bus_____% Other_____%
   specify

8. What factors do you consider most and least important in the kind of transportation you use to travel to work?

	Very Important						Not Importar
comfort	____	____	____	____	____	____	____
convenience	____	____	____	____	____	____	____
cost	____	____	____	____	____	____	____
reliability	____	____	____	____	____	____	____
speed	____	____	____	____	____	____	____

9. Do you come to work in a car pool?

Yes____ No____

if yes other than yourself, how many people are in the car pool.

circle one 1 2 3 4 5

10. Is there a parking space available to you at your place of work free of charge?

Yes____ No____

if no

Is there a charge for parking?

Yes____ No____

if yes

What is the charge per day? $_____/day

11. Where do you park?

Street(no meters)___ Street(meters)___ Parking Lot___

Other (specify)_____

12. Do you run errands on your journey to or from work?

Yes____ No____

if yes how frequently?

Daily____

Three Times a Week___

Weekly____

Once in a while_____

13. Do you need your car as part of your job?

Yes____ No____

14. What are some reasons you use your car to get to work? (if there is more than one reason please number them from the most important to the least important)

_____do not use car to get to work
_____journey to work by bus is too long
_____no bus service available
_____too long to wait for bus
_____journey to work would include transfers
_____use car to run errands before and after work
_____need it for business
_____bus uncomfortable
_____convenient
_____other (specify)_____

15. How much does it cost you to travel to work by car for one week?

$_____/week

16. How long would it take you to travel to work by car? (door to door)

_____0-10 minutes
_____11-20 minutes
_____21-30 minutes
_____31-40 minutes
_____40+ minutes

17. How long would it take you to travel to work by bus?

_____0-10 minutes
_____11-20 minutes
_____21-30 minutes
_____31-40 minutes
_____40+ minutes

18. How far is it to the nearest bus stop from your home?

within one block_____ 3-5 blocks_____
1-2 blocks _____ more than 5 blocks_____

19. Is there a bus shelter at the stop you use?

Yes_____ No____

20. How long would it take you to walk to the bus stop?

less than 5 minutes_____
5-10 minutes_____
over 10 minutes_____

21. How many minutes would you have to wait for a bus?

less than 3 minutes_____
3-5 minutes_____
5-10 minutes_____
over 10 minutes_____

22. What are some reasons you travel to work by bus?(answer same as q.14

_____do not travel to work by bus
_____more economical
_____roads congested
_____journey to work too long by car
_____car being serviced
_____do not own a car
_____husband or wife use car to travel to work
_____wife uses car for shopping/recreation/social trips
_____no parking available at work
_____other (specify)_____

23. What is the frequency of bus service in your area from 7:00 a.m. to 9:00 a.m.

bus every 15 minutes_____
30 minutes_____
60 minutes_____

24. What is the frequency of bus service near your place of work from 4:00 p.m. to 6:00 p.m.

bus every 15 minutes_____
30 minutes_____
60 minutes_____

25. Sex. Female_____ Male_____

26. Number of people living at this address.
circle one 1 2 3 4 5 5+

27. Marital Status. Single_____ Married_____
Divorced_____ Separated_____

28. Housing Type. Single Family_____ Duplex_____
Row_____Apartment_____

29. What are the ages of all the members of the household.
less than 16_____ 45-64_____
16-24_____ 65+_____
25-44_____

30. Combined Household Income .
0-9,999_____
10,000-14,999_____
15,000-19,999_____
20,000-24,999_____
25,000-29,999_____
30,000+ _____

31. Number of years of education of the head of the household?
circle one 1 2 3 4 5 6 7 8 9 10 1 12 13 14 14+

32. Do you think there is any need for improvement with the urban transportation system in the city of Windsor?
Yes_____ No_____

if yes please comment on what improvements you would like to see.

_____
_____
_____
_____
_____

Thank You For Your Time And Co-Operation

APPENDIX B

CAR USER DATA

Transportation Questionnaire

Office Use Only

Address _____ Census Tract ____

Case Number _____ Pop. Density ____

Instructions

Please have the head of the household fill out this questionnaire.

1. Do you have a driver's license?

   Yes 144 No 5

2. How many people in your household have driver's license?

   circle one 25 (1) 79 (2) 32 (3) 12 (4) 1 (5) Ø (5+)

3. Do you own a car?

   Yes 146 No 3

4. How may cars are there in your household?

   circle one 59 (1) 67 (2) 20 (3) 3 (4) Ø (5) Ø (5+)

5. How many persons in your household work?

   circle one 58 (1) 64 (2) 18 (3) 8 (4) 1 (5) Ø (5+)

6. How many miles is it to your place of work?

   5.6 Miles (average)

7. What percent do you use the following forms of transportation to get to work?

   Car _____% Bus _____% Other _____% (specify)

8. What factors do you consider most and least important in the kind of transportation you use to travel to work?

	Very Important					Not Importar
comfort	56	___	___	___	___	69 ___
convenience	129	___	___	___	___	9 ___
cost	70	___	___	___	___	58 ___
reliability	135	___	___	___	___	5 ___
speed	82	___	___	___	___	50 ___

9. Do you come to work in a car pool?

Yes 18 No 131

if yes other than yourself, how many people are in the car pool.

	8	6	2	1	1
circle one	1	2	3	4	5

10. Is there a parking space available to you at your place of work free of charge?

Yes 128 No 20

if no

Is there a charge for parking?

Yes 15 No 32

if yes

What is the charge per day? $ _____/day

Less than = $0.50	More than $0.50
7	5

11. Where do you park?

Street(no meters) 11 Street(meters) 1 Parking Lot 125

Other (specify) Garage 1 Private Lot 5

12. Do you run errands on your journey to or from work?

Yes 92 No 57

if yes how frequently?

Daily 13

Three Times a Week 25

Weekly 17

Once in a while 38

13. Do you need your car as part of your job?

Yes 42 No 105

14. What are some reasons you use your car to get to work? (if there is more than one reason please number them from the most important to the least important)

____ do not use car to get to work
42 journey to work by bus is too long
35 no bus service available
35 too long to wait for bus
38 journey to work would include transfers
34 use car to run errands before and after work
35 need it for business
10 bus uncomfortable
100 convenient
____ other (specify)_____

15. How much does it cost you to travel to work by car for one week?

$_____/week

less than $5.00	58
$5.00 - $10.00	52
more than $10.00	26

16. How long would it take you to travel to work by car? (door to door)

42 0-10 minutes
73 11-20 minutes
26 21-30 minutes
4 31-40 minutes
1 40+ minutes

17. How long would it take you to travel to work by bus?

1 0-10 minutes
11 11-20 minutes
20 21-30 minutes
39 31-40 minutes
44 40+ minutes

18. How far is it to the nearest bus stop from your home?

within one block 61 3-5 blocks 29
1-2 blocks 43 more than 5 blocks 6

19. Is there a bus shelter at the stop you use?

Yes 15 No 116

20. How long would it take you to walk to the bus stop?

less than 5 minutes 86
5-10 minutes 35
over 10 minutes 16

21. How many minutes would you have to wait for a bus?

less than 3 minutes 3
3-5 minutes 9
5-10 minutes 34
over 10 minutes 68

22. What are some reasons you travel to work by bus?(answer same as q.14

_____do not travel to work by bus
_____more economical
_____roads congested
_____journey to work too long by car
_____car being serviced
_____do not own a car
_____husband or wife use car to travel to work
_____wife uses car for shopping/recreation/social trips
_____no parking available at work
_____other (specify)_____

23. What is the frequency of bus service in your area from 7:00 a.m. to 9:00 a.m.

bus every 15 minutes 51
30 minutes 32
60 minutes 31

24. What is the frequency of bus service near your place of work from 4:00 p.m. to 6:00 p.m.

bus every 15 minutes 47
30 minutes 26
60 minutes 21

25. Sex. Female 20 Male 126

26. Number of people living at this address.
circle one 1 (4) 2 (31) 3 (35) 4 (49) 5 (16) 5+ (11)

27. Marital Status. Single 13 Married 129
Divorced 4 Separated Ø

28. Housing Type. Single Family 131 Duplex 9
Row 4 Apartment 2

29. What are the ages of all the members of the household.
less than 16 45-64
16-24 65+
25-44

30. Combined Household Income
0-9,999 2
10,000-14,999 10
15,000-19,999 22
20,000-24,999 30
25,000-29,999 20
30,000+ 43

31. Number of years of education of the head of the household?
circle one 1 2 3 4 5 6 7 8 (17) 9 10 11 12 13 (76) 14 14+ (44)

32. Do you think there is any need for improvement with the urban transportation system in the city of Windsor?
Yes 89 No 38

if yes please comment on what improvements you would like to see.

Better information 1	Decrease fares 5
Shetlers 6	Mini bus/jitneys 10
Poor Service for Factory Workers 3	Decrease headway 15
Better schedules/routes/service 21	Express buses 5
More buses 8	Transfer co-ordination 3

Thank You For Your Time And Co-Operation

APPENDIX C

BUS USER DATA

Transportation Questionnaire

Office Use Only

Address _____ Census Tract _____

Case Number _____ Pop. Density _____

Instructions

Please have the head of the household fill out this questionnaire.

---

1. Do you have a driver's license?

   Yes 8 No 1

2. How many people in your household have driver's license?

   circle one 3 1 4 2 Ø 3 1 4 Ø 5 Ø 5+

3. Do you own a car?

   Yes 6 No 3

4. How may cars are there in your household?

   circle one 4 1 1 2 Ø 3 Ø 4 Ø 5 Ø 5+

5. How many persons in your household work?

   circle one 4 1 3 2 2 3 Ø 4 Ø 5 Ø 5+

6. How many miles is it to your place of work?

   2.83 Miles (average)

7. What percent do you use the following forms of transportation to get to work?

   Car _____ % Bus _____ % Other _____ % (specify)

8. What factors do you consider most and least important in the kind of transportation you use to travel to work?

	Very Important						Not Importar
comfort	6	___	___	___	___	2	___
convenience	8	___	___	___	___	Ø	___
cost	7	___	___	___	___	1	___
reliability	8	___	___	___	___	Ø	___
speed	6	___	___	___	___	2	___

9. Do you come to work in a car pool?

Yes____ No____

if yes other than yourself, how many people are in the car pool.

circle one 1 2 3 4 5

10. Is there a parking space available to you at your place of work free of charge?

Yes____ No____

if no

Is there a charge for parking?

Yes____ No____

if yes

What is the charge per day? $_____/day

11. Where do you park?

Street(no meters)___ Street(meters)___ Parking Lot___

Other (specify)_____

12. Do you run errands on your journey to or from work?

Yes 4 No 5

if yes how frequently?

Daily 1

Three Times a Week Ø

Weekly 1

Once in a while 2

13. Do you need your car as part of your job?

Yes____ No____

14. What are some reasons you use your car to get to work? (if there is more than one reason please number them from the most important to the least important)

_____do not use car to get to work
_____journey to work by bus is too long
_____no bus service available
_____too long to wait for bus
_____journey to work would include transfers
_____use car to run errands before and after work
_____need it for business
_____bus uncomfortable
_____convenient
_____other (specify)_____

15. How much does it cost you to travel to work by car for one week?

$_____/week

16. How long would it take you to travel to work by car? (door to door)

_____0-10 minutes
_____11-20 minutes
_____21-30 minutes
_____31-40 minutes
_____40+ minutes

17. How long would it take you to travel to work by bus?

__2__0-10 minutes
__3__11-20 minutes
__3__21-30 minutes
__Ø__31-40 minutes
__1__40+ minutes

18. How far is it to the nearest bus stop from your home?

within one block 8 3-5 blocks 1
1-2 blocks Ø more than 5 blocks Ø

19. Is there a bus shelter at the stop you use?

Yes Ø No 9

20. How long would it take you to walk to the bus stop?

less than 5 minutes 8
5-10 minutes 1
over 10 minutes Ø

21. How many minutes would you have to wait for a bus?

less than 3 minutes Ø
3-5 minutes 4
5-10 minutes 1
over 10 minutes 4

22. What are some reasons you travel to work by bus?(answer same as q.14

Ø do not travel to work by bus
4 more economical
3 roads congested
Ø journey to work too long by car
Ø car being serviced
3 do not own a car
Ø husband or wife use car to travel to work
Ø wife uses car for shopping/recreation/social trips
2 no parking available at work
Ø other (specify)_____

23. What is the frequency of bus service in your area from 7:00 a.m. to 9:00 a.m.

bus every 15 minutes 5
30 minutes 3
60 minutes 1

24. What is the frequency of bus service near your place of work from 4:00 p.m. to 6:00 p.m.

bus every 15 minutes 5
30 minutes 4
60 minutes Ø

25. Sex. Female 5 Male 4

26. Number of people living at this address.
circle one 1 2 3 4 5 5+

27. Marital Status. Single 2 Married 5
Divorced 1 Separated 1

28. Housing Type. Single Family 5 Duplex 2
Row Ø Apartment 2

29. What are the ages of all the members of the household.
less than 16 45-64
16-24 65+
25-44

30. Combined Household Income
0-9,999 1
10,000-14,999 3
15,000-19,999 3
20,000-24,999 1
25,000-29,999 Ø
30,000+ Ø

31. Number of years of education of the head of the household?
circle one 1 2 3 4 5 6 7 8 9 10 11 12 13 14 14+
2 6 1

32. Do you think there is any need for improvement with the urban transportation system in the city of Windsor?
Yes 6 No 2

if yes please comment on what improvements you would like to see.

Faster buses/better routes/adherence to schedule 4
Bus more frequent/increase headway 1
Shelters 1
More buses 1

Thank You For Your Time And Co-Operation

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VITA AUCTORIS

Born: May 30, 1954 in Windsor, Ontario

Education: 1968 - 1973 High School
Vincent Massey Secondary School
Windsor, Ontario

Academic History

1973 - 1976 University of Windsor, Windsor, Ontario
Degree: Honours Bachelor of Arts in Geography, 1976.

1976 - 1983 University of Windsor, Windsor, Ontario
Degree: Master of Arts in Geography, 1983.

Professional History

1980 - 1982 Ministry of Municipal Affairs and Housing

Position: Urban Planner