Suburban Transport Behavior as a Factor in Congestion

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Suburban congestion is among the most pressing transportation problems in large urban metropolises. One of the major causes of this problem is the changing transport behavior of people, created by a series of complex social, economic, technological, and cultural changes. Rapidly developing suburbs are a focal point for congestion in part because they are at the forefront of these changes. A conceptual framework has been established for identifying the channels through which various phenomena affect individuals and households, their orientation in life, and the decision-making process that results in manifest transport behavior. Several national trends in household structure, location patterns, incomes, life-styles, social values, and norms, as well as in technology, are identified in this paper, and their effect on transport behavior is explored. To explore differences in demographics, household structure and commuting patterns among the central cities and growing and stable suburbs, a cluster analysis was performed using data from several suburbs and the central city of Chicago. Cluster results suggest that growing suburbs appear to be quite different from other areas in dimensions related to life-styles and transport behavior. Based on these results, useful solutions to the suburban congestion problem must be based on a more fundamental understanding of the underlying life-styles and transport behavior of suburban residents.

Suburban traffic congestion is one of the most pressing transportation problems in large urban metropolises. Suburbs are growing rapidly—many faster than the nationwide average growth rates. This growth is in many dimensions: housing and residents, office space and jobs, and both vertical and horizontal sprawl. As a consequence, traffic density has increased in the suburbs, in some locations to intolerable levels.

Intuitively, some of the factors behind suburban congestion are as follows: (a) the recent addition of large numbers of suburban jobs that resulted in large numbers of trips destined to those areas, (b) the attractiveness and relative affordability of housing, (c) the often inadequate roadway infrastructure (i.e., infrastructure not designed to carry heavy traffic), and (d) the absence of (effective) public transportation.

An associated factor behind the suburban congestion problem is the accelerated growth in automobile ownership and use in recent years. Sprawling development in the suburbs, along with the inability of transit to provide a reasonable level of service in low-density areas, has given consumers incentives to own more automobiles. However, the growth in automobile ownership may not be explained by these factors alone.

We believe there are complex social, economic, technological, and cultural factors that are changing people's transport behavior—in particular, automobile ownership and usage. Society evolves over time, demographics change, new social values and norms are established, the economy changes, and new technologies become available. All of these changes change transport behavior.

Rapidly developing suburbs are a focal point for congestion in part because they are at the forefront of these changes. To deal with suburban congestion, we must understand not only the trends in transport behavior but also the demographic, social, and economic trends underlying them.

Some recent major changes are briefly listed below.

- *Social changes:* decreasing household size, increasing numbers of working women, the returning young adult phenomenon, and the increasing proportion of never-married people;
- *Economic changes:* increasing incomes for certain classes (i.e., upper middle class) and household types (i.e., multiple worker), decreasing amounts of savings, decreasing operating costs of automobiles, declining heavy industry, and rapid increase of service and high-technology industries;
- *Locational changes:* suburban sprawl and rapidly increasing numbers of both residents and jobs, relocation of companies from central city to suburbs, and "leapfrogging" of new developments to suburban hinterlands—trends generating many trip attractions accessible only by automobile; and
- *Technological changes:* telecommunications enabling companies to create satellite operations or move to low-density locations; many technological advances making automobiles more functional, safer, more comfortable, and far more fuel efficient; cellular telephones helping make travel time productive; technology and retailing trends making many activities easily accessible or directly available to drivers from their cars; and technology enabling the retailing and entertainment industries to become more efficient and attractive.

In this paper we (a) present a conceptual model linking these trends to suburban travel; (b) review aggregate statistics that confirm these relationships; and (c) present our analysis of suburban attributes, showing important travel-related differences among a sample of suburbs.

CONCEPTUALIZATION

To understand all these elements and dimensions, we need a broad framework describing the underlying process generating people's transport behavior. This framework identifies the channels through which various phenomena affect individuals and households and their orientation in life and decision-making processes that result in manifest transport behavior.

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Although individuals can be viewed independently, with their own unique aspirations, goals, and idiosyncratic personalities, as long as they belong to households, their behavior is constrained to conform to certain role assignments defined to meet household as well as individual goals with reasonable efficiency. Therefore, it is important to recognize the effects of changing household characteristics while also trying to account for the personal attributes of each individual in the household.

Figure 1 presents our conceptual model founded upon work by Hartgen and Tanner (*1*), Field et al. (*1*), Ben-Akiva and Lerman (*2*), and Salomon (*3,4*).

Travel or *transport behavior* results from the household's transport-related decisions (*2,5*). These decisions may be classified into long- and short-term decisions. Long-term transport behavior decisions include mobility choices, such as residential location, employment location, automobile ownership, and mode to work. Short-term decisions include travel choices, such as frequency, mode, destination, route, and time of day for individual trips.

The model suggests that there is a set of activity opportunities, defined by location and activity attributes, with certain time and money requirements and constraints (e.g., food store closes at 9 p.m.). The activity locations are connected by the transportation system, which has distinct characteristics (e.g., network structure, modes, performance, and costs to the traveler) and policies.

This is the abstracted environment for each household comprising one or more individuals. The personal and joint needs of individuals create the set of household needs. Some needs must be fulfilled (i.e., maintenance), whereas some others may or may not be fulfilled (i.e., recreational activities). When the needs that can be fulfilled and the activities that will meet those needs have been identified, the adopted activity sequence for each individual determines the chosen activity sequence for all household members, which will result in the fulfillment of needs. This is a dynamic process characterized by much variation around a stable activity pattern, as well as longer-term changes in that stable pattern, both driven by exogenous and endogenous factors.

The activity sequence for individuals and households is the result of a series of long- and short-term decisions. Each individual has a set of values and a distinct personality. These elements interact imperfectly with the surrounding world, generating a *life-style*. Life-style is a construct used by Salomon (*3,4*) and others to describe the outcome of the choice process of people. Life-style, according to Salomon, is the orientation of an individual in life through three major decisions: the decision to form a household, the decision to participate in the labor force, and decisions about spending free

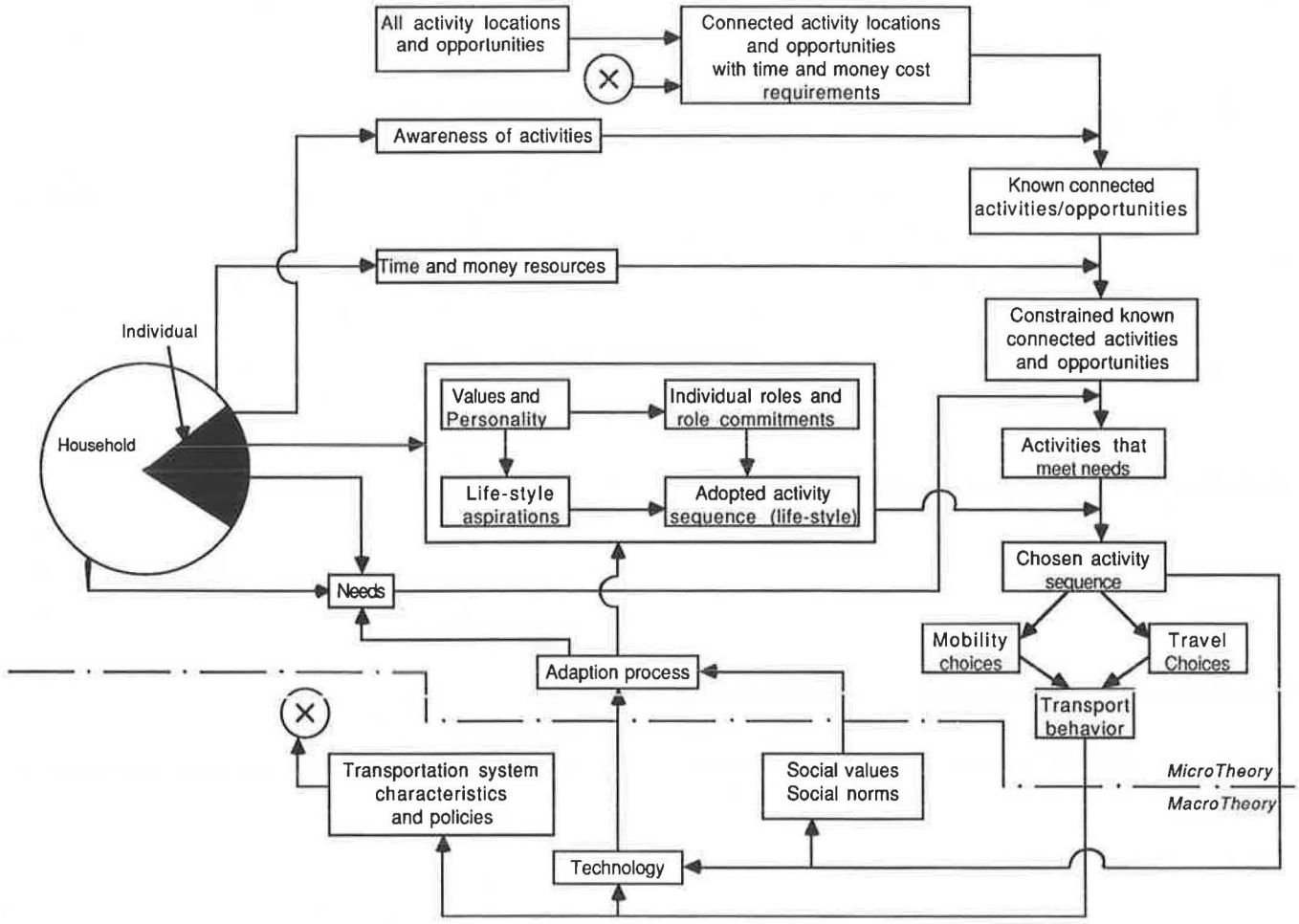

FIGURE 1 Conceptual model of transport behavior.

time (leisure). Many more detailed components that are complements or parts of this broad definition (e.g., preference for suburban living, degree of career orientation, preference for specific types of automobiles, and preference for specific art expressions and types of entertainment) have been attributed to life-style. Life-style is important because it underlies the decision-making process of individuals. Certainly, the chosen life-style for each individual is not a line between the times T and $T + t$; it is rather a corridor in which individuals make decisions and perform activities that broadly fulfill their life-style aspirations.

Another important element for each individual household member is that of role and role commitments (e.g., provision of shelter and food gathering). A broad range of factors, including social norms and economic demands, influences the role of household members. There are short- and long-term role commitments. Over time, roles change for members of a household as it evolves through life-cycle stages (*6*).

All of these result in the activity sequence for the individual household member. This sequence allows the needs of the household to be fulfilled and the life-style aspirations of the individual to be achieved. The chosen activity sequence then serves as the input for mobility and travel choices of household members, choices that define the transport behavior.

The sum of the chosen activity sequence and the transport behavior across individuals in the population feeds back the social values and norms as well as the technology and the transportation system and policies to the household. This dynamic interaction creates the new environment in which individuals live. A complicated adaptation process then takes place, and the household needs and the standards and aspirations for each individual are adjusted. Adaptation is a dynamic process of reacting to perceived imbalances through changes in activity patterns, within the limitations of household role requirements and resources and transportation-connected activity locations (*1*).

The critical elements of this framework are the individual and household *needs* as well as the *life-styles* of the individual household members. There are some basic needs and life-styles that can be found in most individuals at most places (i.e., work, shelter, family formation, transportation). Many factors (e.g., culture, environment, and technology) shape and differentiate needs and life-styles across individuals, households, or places.

The model in Figure 1 suggests that people's transport behavior is affected by factors such as

- Household structure;
- Availability, cost of activities;
- Life-style;
- Transportation system characteristics, policies;
- Location patterns;
- Personal/household income;
- Social values, norms; and
- Technology.

None of these factors logically can be considered to be exogenous (i.e., as a conceptual starting point for understanding and anticipating the others). They must be viewed as an interconnected system within which relationships are driven by a variety of processes at the levels of individuals, households, groups, communities, and society that lead to short-term, homeostatic equilibria and longer-term drift.

TRENDS AFFECTING CHANGES IN TRANSPORT BEHAVIOR

All factors listed above are time variant; we should expect changes in people's transport behavior as both individuals and society, and the factors that affect them, change. For example, moving to a low-density residential area (i.e., suburb), getting a promotion (which typically leads to a higher income), graduating from school or college, or opening a new expressway facility all can be expected to affect individual or household automobile ownership and trip patterns.

Many changes have taken place since 1975 that have given a new shape to the factors affecting transport behavior. Below we discuss some of these changes and their expected effect on transport behavior.

Household Structure

The three major components of household structure are its size, the age of its members, and the number of workers. All three have changed dramatically; household size has decreased while both age and the number of workers per household have increased.

Decreasing household size (Figure 2) can be attributed to the lower fertility rate, the increasing number of single-parent households, and the increasing number of unmarried people (and cohabitation of unmarried couples). This trend is very important because smaller households forego some economies of scale; since the total population continues to grow, and thus the number of households is increasing, more travel may be required to meet these households' needs.

Another major demographic change is the *aging of the population*: the median age of the population has been increasing consistently over the years 1970 through 1984 (Figure 3). This translates into more people being eligible to drive, more people at an age of high-activity participation and mobility (i.e.,

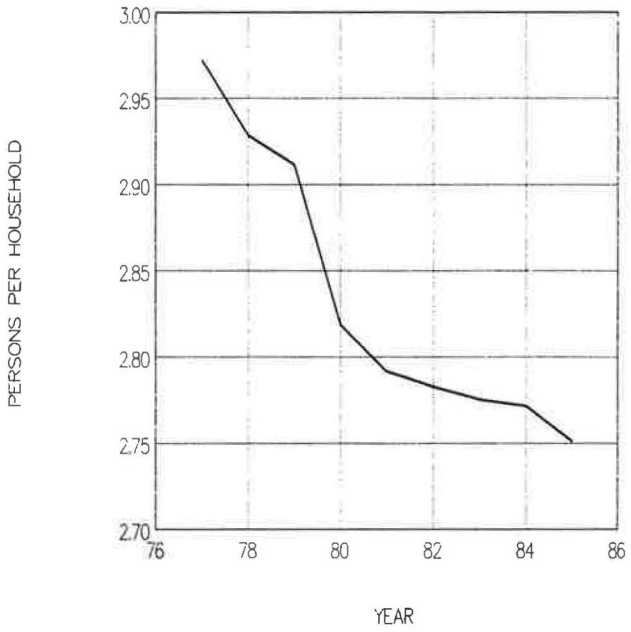

FIGURE 2 Trend in household size (*18*).

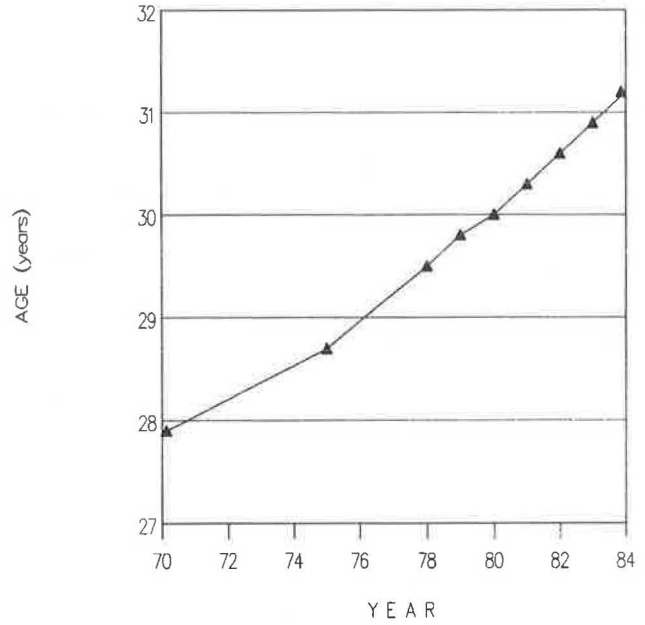

FIGURE 3 Trend in median population age (*18*).

between 20 and 60), and probably more people at an age that enables them to work and earn an income. These effects of population aging clearly increase the demand for both travel and automobiles. Furthermore, Wachs (*7*) points out that the senior citizens of today increasingly are people who grew up in the suburban automobile era. When they reach 65, it is unrealistic to expect them to give up their cars and the associated mobility benefits or to move to the central city where transit is better and vehicular travel needs are less.

The number of workers per household has increased as a result of the *increasing size of the labor force* (Figure 4), which may be attributed to three factors. First, people born in the baby-boom era are presently at their work age (25 to 40 years old), so there exists a large supply of labor. Second, women participate in the job market almost on an equal basis with men, further increasing the supply of labor. Third, one salary often is not enough in multiperson households to cover the basic household needs, enjoy the plethora of consuming opportunities, or improve the standard of living. Therefore, there are real incentives for more members of the household to seek employment. In addition, because of low salaries, high costs, and employment uncertainty, more people hold more than one job.

Personal or Household Income

Income is the resource pool from which the cost of activity participation and purchases are covered. Knapp (*8*) suggests that household income has decreased over recent years (Figure 5). According to him, the reasons for the decreases in income are excess labor supply, the decline of heavy industry, and the expansion of low-paying positions in the service and entertainment industries.

Our interpretation of the distribution of household income over recent years is that it remains rather stable, affected slightly by recession or international crises. Hence, increasing automobile ownership (Figure 6) is an unexpected outcome not only since automobiles are expensive but also because automobile availability in the United States was the highest in the world in the early 1970s. This suggests the existence of powerful factors boosting automobile ownership despite the relative stability in income.

Social Values and Norms

Social values and norms influence choices about life-styles and ways households operationalize them. Three manifesta-

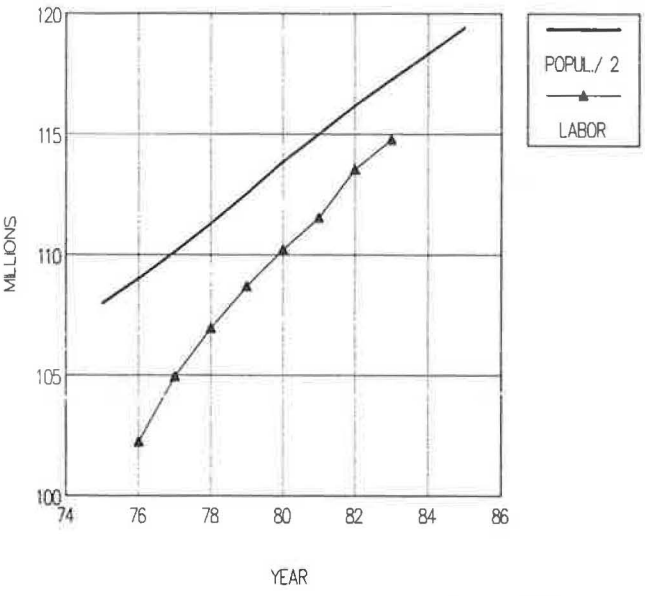

FIGURE 4 Trend in labor force compared to population (*18*).

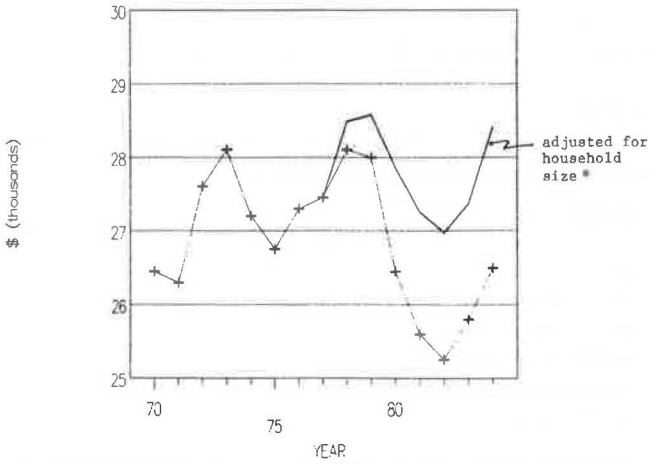

FIGURE 5 Trend in median household income in constant 1984 dollars (*8*).

(*) The adjustment is basic and reflects the logic that, on the average, smaller households have fewer breadwinners and therefore less income. The factor by which incomes after 1977 were multiplied is: household size in 1977 divided by household size in year being adjusted.

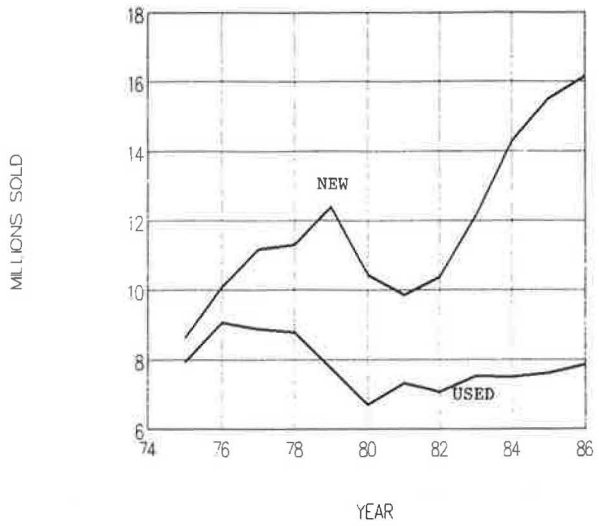

FIGURE 6 Trend in sales of new and used automobiles (*19*, *20*).

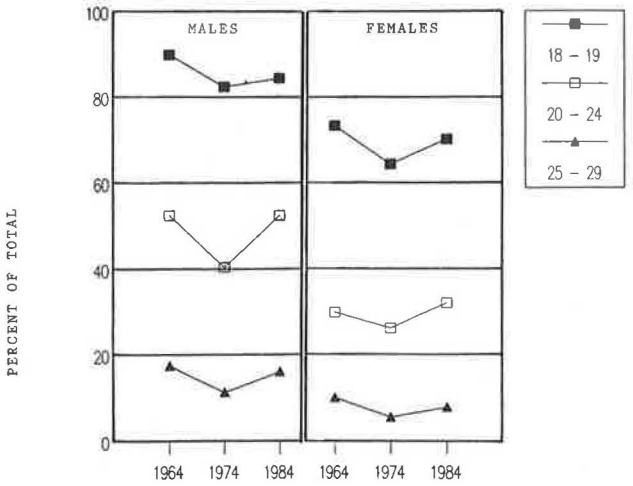

FIGURE 8 Young adults remaining in parental households (*10*).

tions of values related to household behavior for which data are available are the increasing number of never-married people, the returning young adult phenomenon, and the (apparently) increasing social value of the automobile.

There has been a significant increasing trend in the number of *unmarried people* (Figure 7). An important aspect of this trend is the implication of altered attitudes toward life (*9*). Specifically, unmarried people do not usually accumulate money while waiting to marry; instead, they develop a fully independent life and proceed with major purchases such as real estate and automobiles. Furthermore, they are relatively more active (i.e., frequent dining out) and more mobile (locally and regionally). This social phenomenon may result in an increasing demand for both automobiles and travel.

A growing American phenomenon is the pattern of "mature" children returning to the parental household after completing their education. Figure 8 provides evidence for this phenomenon: irrespective of gender and age group, the number of *returning young adults* (RYAs) has grown considerably between 1974 and 1984.

Schnaiberg and Goldenberg (*10*) believe that a strong cause of the RYA phenomenon may be the changing opportunity structure; an increasing number of children have problems meeting their parents' expectations and moving into adult roles. There is also more intense competition for career-entry positions. Even after entry into a career track, young adults find much less stability in career employment than in the past.

Figure 9 illustrates graphically that the RYA phenomenon tends to increase household automobile ownership. On the *y*-axis we have two scenarios: the single-household case in which the young adult stays at the parental nest (RYA) and the two-household case in which the young adult establishes his/her own independent household. The *x*-axis shows the number of cars potentially owned by all households in the scenarios. Rays from the origin show the loci of constant average household automobile ownership.

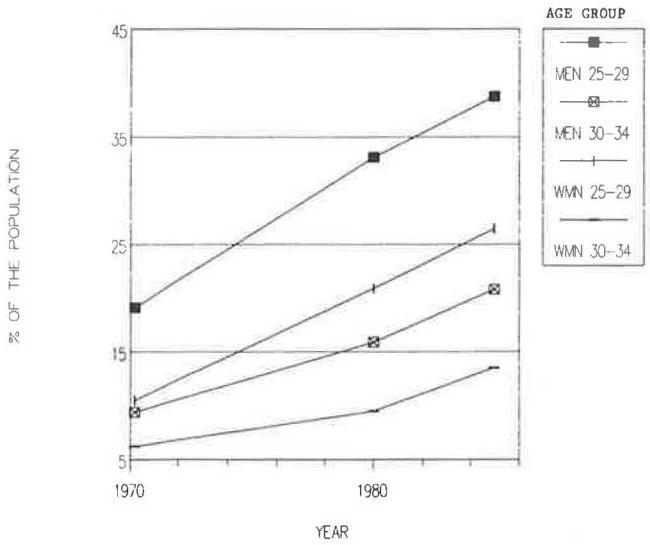

FIGURE 7 Unmarried people as a percentage of the population (*9*, *18*).

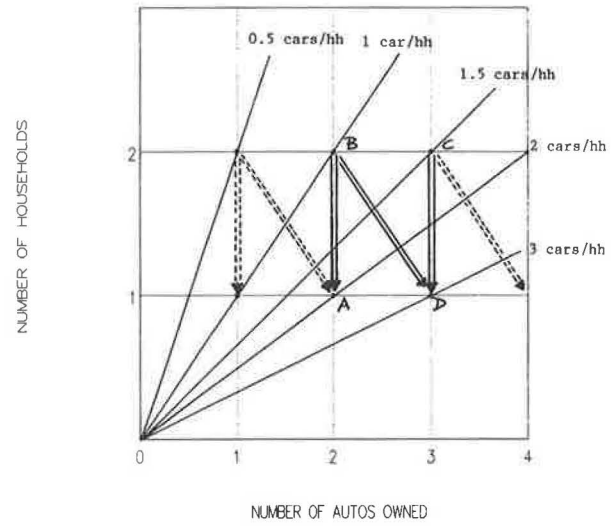

FIGURE 9 Effect of returning young adults on household automobile ownership.

If parents and a young adult live together in one household owning two cars, the average automobile ownership then is two cars per household (Point A in Figure 9). Should the young adult establish an independent household without acquiring an automobile, automobile ownership drops to one car per household, since the two cars are now divided over two households (Point B). If the young adult acquires a car, automobile ownership increases to 1.5 (Point C).

If the young adult returns to the parental household and no cars are added, automobile ownership increases (or returns) to 2.0 (Point A again). Adding a vehicle to sustain the travel needs of the RYA increases automobile ownership to 3.0 (Point D). Figure 9 suggests that, with or without the addition of more cars, the RYA phenomenon, shown as jumps from two to one household, can increase automobile ownership.

Figure 10 shows clearly that the trend is toward multiple automobile ownership (i.e., the top curve shows the rapidly increasing number of households owning at least one automobile). Most significant is the increase in households owning three or more automobiles. These data may suggest that the value of owning and using automobiles exceeds the value of the transportation produced. The automobile may be viewed as an office, a storage unit, a home away from home, a means and place of recreation, and a social instrument of increasing significance; people increasingly define themselves by the number and types of automobiles they own. As a result, automobile mobility may have social status value beyond that reflected in travel forecasting models.

Life-Style

Of particular interest to us is the life-style of suburban residents, especially residents of rapidly growing suburbs. There we notice a strong career orientation, a preference to more and rather distinctive automobiles, more outgoing attitudes, greater participation in exercise or athletic activities, a more active participation of children in various out-of-school activities (e.g., sports leagues and extra tutoring on computers), and a tendency for more comparative shopping in various suburban malls (*11–13*). Later in this paper we try to establish the case that the life-styles of residents of growing suburbs are different from the life-styles of residents of stable suburbs and the central city, which may help us understand one source of suburban congestion.

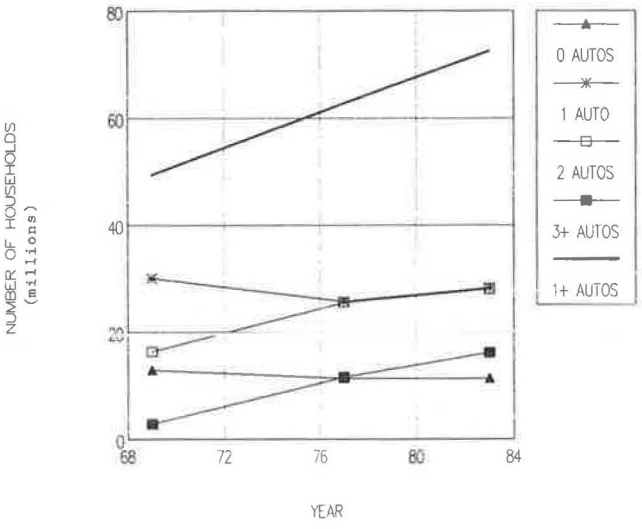

FIGURE 10 Trend toward multiple automobile ownership (*14*).

Availability and Cost of Activities

The more outgoing style of certain categories of people (i.e., the suburban middle class) has been captured by entrepreneurs. Businesses have responded and encouraged social needs and activities by offering more, diverse, and better goods, services, and prices. The mushrooming suburban malls, fitness centers, and food and entertainment facilities are examples of this trend. Suburbs are becoming satellite urban centers, which, as a result, increases the density (i.e., availability) of activities and reduces the distance (i.e., accessibility improves) from neighboring residences. Thus, the supply side of the activity market is supporting travel-increasing trends on the demand side.

Location Patterns

The exodus to the suburbs is a factor that needs no further proof. It started early and quietly by residents in the 1950s and earlier, was accelerated by retailers in the 1960s, and hit record levels when a broad spectrum of businesses followed since the 1970s. By 1980 58 percent of residents (49 percent in 1960) and 48 percent of jobs (32 percent in 1960) in urban areas were in the suburbs.

Technology

Two technological trends affecting transportation systems are important to this discussion. First, automobiles and automobile-related services have changed. The oil crises and competition from Japanese automobile makers led to highly fuel-efficient vehicles with reduced maintenance needs and many on-board amenities at very competitive prices. Furthermore, several industries responded by offering even more amenities or services to motorists: cellular phones, banking, food purchasing, express automobile care, and so on. As a result, automobiles became cheaper and more attractive overall.

A second significant change has been the introduction of telecommunication, computers, and automation into the retail, service, and entertainment industries. Telecommunication systems have helped businesses to create satellite operations or to relocate to suburban locations, where they typically find more floor and parking space at lower prices, resulting in increasing suburban employment.

Small, low-priced computers have made businesses less dependent on centralized locations and have facilitated retail automation, which has cut labor costs, permitting the use of low-skill labor and supporting both product differentiation and multisite businesses. The diversity of small retail and service businesses spread over the landscape, particularly in the suburbs, encourages a dispersed travel pattern for both comparative shopping and purchasing. Moreover, technology has enabled financial institutions and retailers to offer widely

accepted credit accounts to millions of customers, further attracting them to a wide variety of shopping and entertainment activities.

Transportation System Characteristics and Policies

A major trend in the supply of transportation over the past decade has been greatly reduced spending on freeway infrastructure. Most of the urban freeway system planned in the 1950s currently is in place. At present, there are two critical problems regarding existing freeways. First, certain segments supply less capacity than needed for providing acceptable levels of service, and second, the orientation of the urban freeway system—aiming to serve commuting from the suburbs to the central city—is obsolete in the sense that the bulk of the demand currently is intersuburban (*14*).

Transit has not filled the gap because available technology cannot provide quality service in low-density markets at reasonable costs. Conventional transit gains efficiency through economies of density (i.e., more riders using the same vehicles in the same corridors); the increasingly suburban trip set is dispersed, omnidirectional, and distributed more uniformly over time. Worse yet, conventional transit must compete for space on congested streets with the automobile.

In addition, urban population has been shifting from places with the most public transportation to places with the least; this is true on both a macro and micro scale (*15*). Transit infrastructure and services have not been able to follow this trend in either scale. As a result, public transportation increasingly is not an option for urban residents.

Increasing highway congestion has led to the introduction of both market and policy incentives to get people to rideshare or vanpool instead of driving alone. Such measures have not reduced the share of the automobile mode to work, and there are indications that public transportation has become the loser because people who drive to work have invited colleagues who rode transit to benefit from ridesharing incentives.

DIFFERENCES BETWEEN CITIES AND SUBURBS

Do the macroscopic trends described above, and other factors, tell us anything about *suburban* congestion? To answer this question, we must determine the extent to which suburbs, or certain classes of suburbs, are substantially different from other parts of urban areas in socioeconomic and cultural characteristics.

Typically and historically, a suburb has been defined as an urban area where the ratio of employment to residents is below 1. That is, suburbs have been viewed primarily as places of *residence*. For example, in 1980 the employment-to-residents ratio for Manhattan was 2.50; for Washington, D.C., it was 2.00; for Fairfax County, Virginia, it was 0.54; and for the Midwestern suburbs in standard metropolitan statistical areas it was 0.86 (*16*). Because of the rapid growth of jobs in developing suburbs, however, this definition may no longer be valid; there are some developing suburbs with heavy concentrations of office malls and light manufacturing.

Such a simplistic, historically based definition of suburbs tends to homogenize the variety of suburban settlements. To develop a better understanding of variations in suburban demographics and economies, we might classify suburbs according to employment and residential density; employment and population growth rates; and/or other socioeconomic indicators, such as average income, household size, and so on. We propose a simpler and more practical classification in two categories: *stable* and *growing* suburbs.

Stable suburbs are largely fully developed, with little unused land and no, slow, or even negative growth. Typically, but not necessarily, they are attached geographically to the central city and have many commonalities with central city neighborhoods, especially in large metropolitan areas. These similarities may include density, household size and income, lifestyle, occupations, and so on. Stable suburbs usually are well connected to the central city by public transit. Urban highway networks were designed primarily to accommodate the commuting needs of nearby suburban residents who work in the central city. Thus, one would expect stable suburbs to be highly dependent on the central city (i.e., a large number of residents of stable suburbs work in the central city).

Growing suburbs may be defined as the portion of the suburban area that currently exhibits a substantial growth in both resident population and employment. We are particularly interested in growing suburbs because they seem to be the focal point for suburban congestion, perhaps in part because they are on the advancing wave of the kinds of the socioeconomic changes identified above. To test the notion that there are important transportation-related differences between growing suburbs and the rest of urban areas, we conducted an exploratory cluster analysis.

A cluster analysis is a statistical tool designed to identify homogeneous groups from a population by grouping population elements according to their similarity over a specified set of variables. The cluster items were 29 northwest suburbs of the Chicago metropolitan area, each with a population of 25,000 or more, as well as the city of Chicago. These suburbs were chosen to avoid strong cultural and economic dissimilarities among them. The socioeconomic and transport-related characteristics used as variables for clustering communities into groups were the following:

- Median population age,
- Percent of workers who work in the central city,
- Population density,
- Percent of workers commuting by car (solo drivers and carpoolers),
- Average number of persons per household,
- Average number of workers per household,
- Population growth index,
- Employment-to-residents ratio, and
- Median household income.

These variables include major socioeconomic, demographic, and transportation-specific measures, which were readily available. A major missing variable is the number of automobiles per household, which was not included in the 1980 Census of Transportation (community-level printouts). The life-cycle stage and life-style variables also are missing. Instead, surrogate variables such as household structure, income, education, and occupation are used. Finally, the distance to the central business district was excluded because it resulted in biased solutions by immediately separating suburbs in stable inner-ring suburbs and growing outer-ring suburbs.

A hierarchical cluster analysis generates 1 to $n - 1$ clusters, where n is the number of items to be clustered. The objective is to identify a few meaningful clusters containing highly similar items. A useful visual product of the cluster analysis is the dendrogram, in which items are grouped together according to the degree of similarity. The higher the similarity, the shorter the distance between clustered items. SPSS-X reports this in a dendrogram with a rescaled distance index between clustered items ranging from 0 to 25 (*17*).

Figure 11 shows the city of Chicago and the 29 suburbs of our sample. The shaded suburbs belong to the stable suburb cluster that resulted from the analysis. All suburbs in the data set, as well as Chicago, are listed in Table 1 in descending order with respect to their population growth between the two most recent censuses.

Figure 12 presents scatter plots of all the communities in our data set for each of the variables tested. The filled squares represent growing suburbs, whereas the empty ones represent stable suburbs as they resulted from the cluster analysis; the asterisk represents the city of Chicago.

Figure 12 indicates that larger households and a noticeably younger population reside in growing suburbs. Household income is lowest for households in Chicago, whereas there are no strong differences in household income between stable and growing suburbs, although the variance seems to be less for growing suburbs than for stable ones. Residential density appears to be a key differentiating measure. Typically, the density in growing suburbs is low, whereas stable suburbs are about twice as dense. A few stable suburbs and the central city are in another class, with densities well above 10,000 residents per square mile.

The dependency of the stable suburbs on the central city, reflected by the percent of residents working in the central city, is clear; a much smaller proportion of the residents of growing suburbs work in the central city. Nearly 50 percent of the central city residents *do not* work in the central city, which leads to a significant amount of reverse commuting. Finally, as expected, growing suburbs exhibit the lowest share of use of public transportation (and the highest use of private automobiles) for the work trip, whereas stable suburbs have a transit share that is twice as high.

More than a dozen alternative specifications (i.e., alternative sets of variables for grouping suburbs) were tested in the cluster analysis. The dendrogram described next was consistently the result from most of the specifications. Two major clusters of suburbs can be identified in Figure 13. The top area contains stable suburbs, whereas the bottom contains growing suburbs.

Evanston, Cicero, and Oak Park initially form a separate cluster, probably owing to the distinct low use of automobiles for the work trip; all are well served by rapid transit to the Chicago Loop. In later stages they are combined with the

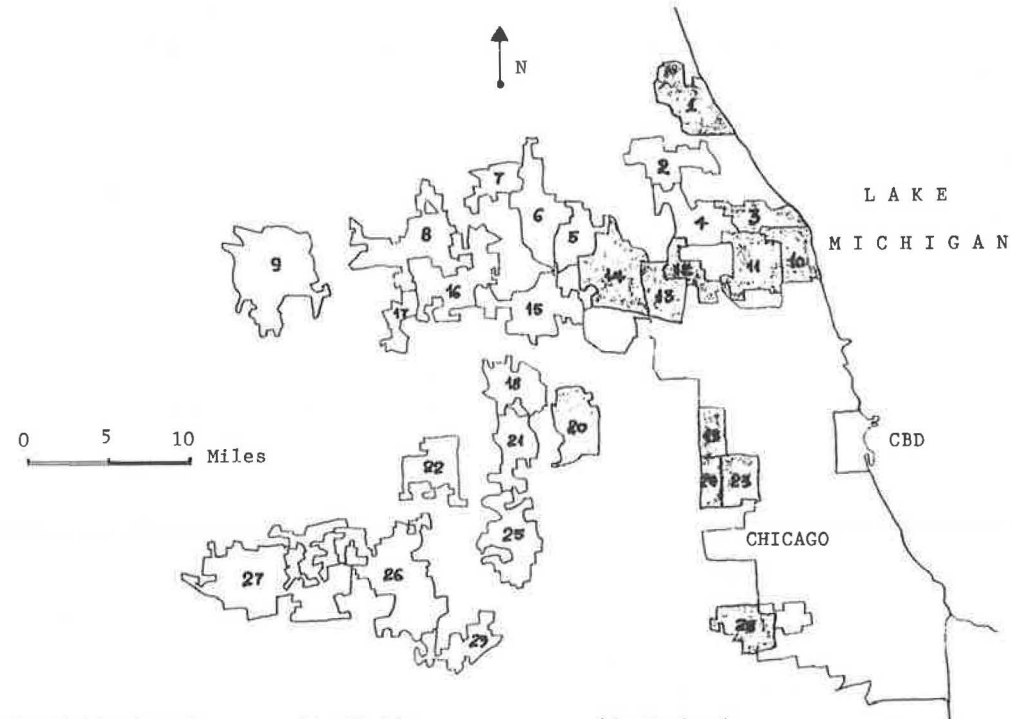

FIGURE 11 Northwest Chicago metropolitan area and suburbs used in analysis set.

TABLE 1 SELECTED CHICAGO METROPOLITAN AREA COMMUNITIES WITH A POPULATION OF 25,000 (IN 1980) OR MORE LISTED ACCORDING TO THEIR POPULATION GROWTH BETWEEN 1970 AND 1980 (*18*)

CHICAGO METRO AREA COMMUNITIES	POPULATION CHANGE (%) 1970-1980
BOLINGBROOK	387.0
SCHAUMBURG	187.7
HANOVER PARK	145.8
NAPERVILLE	85.7
HOFFMAN ESTATES	67.6
MOUNT PROSPECT	50.4
ELK GROVE VILLAGE	42.1
WHEATON	38.2
DOWNERS GROVE	30.8
GLENVIEW	28.9
PALATINE	23.5
ADDISON	21.6
NORTHBROOK	21.1
ELGIN	14.6
LOMBARD	9.6
AURORA	9.3
ARLINGTON HEIGHTS	1.6
OAK LAWN	0.5
NILES	-3.4
ELMHURST	-4.6
HIGHLAND PARK	-5.1
DES PLAINES	-6.4
EVANSTON	-8.0
CICERO	-8.7
PARK RIDGE	-9.2
BERWYN	-10.8
C H I C A G O	-10.8
SKOKIE	-11.8
WILMETTE	-12.2
OAK PARK	-12.2

stable suburb cluster. Interestingly, Chicago is placed in the cluster containing Evanston, Cicero, and Oak Park. The four communities were clustered together, resulting in a distance of 6 units. Eventually, the cluster containing Chicago, Evanston, Cicero, and Oak Park agglomerates with the cluster of other (nine) stable suburbs, but the distance increases to 12. All growing suburbs constitute a rather tight cluster; 15 out of 17 communities form a cluster with a distance equal to 8 (i.e., they are highly similar).

The two final clusters developed have properties that support our expectations. This outcome is consistent among all the specifications we tested. The results portrayed in this dendrogram support both hypotheses—that is, the central city is largely dissimilar to the suburbs, and the suburbs also split in two distinct clusters that we call stable and growing suburbs, respectively. Table 2 shows the resulting groups of suburbs, and Table 3 presents average values for the various characteristics for each cluster of suburbs and the central city. Large differences exist across all examined characteristics among the central city, the stable suburbs, and the growing suburbs. Seventeen growing suburbs had an average population growth rate of roughly 70 percent in 10 years. This figure becomes more significant when compared to the negative average growth of 12 stable suburbs and the central city.

Larger households and younger people reside in growing suburbs, earning incomes comparable to those earned in households in the stable suburbs. Furthermore, the standard deviation of median household income is smaller for growing suburbs compared to that for stable suburbs ($4,690 versus $6,192). This suggests that older, stable suburbs might further be classified into two categories: one with a majority of blue-collar and lower-income residents (e.g., Cicero, Berwyn) and the other with a majority of white-collar/managerial/professional residents (e.g., Wilmette, Highland Park).

The density of growing suburbs ranges between 2,000 and 4,000 residents per square mile, whereas the density for stable suburbs varies greatly between 3,000 and 12,000 residents per square mile. Growing suburbs demonstrate a much lower dependency on the central city, where only 17 percent of their residents are employed, whereas twice this number of residents of stable suburbs work in the central city.

Finally, the share of public transportation for the trip to work is very low in growing suburbs (8.7 percent) because of the lack of efficient transit services, the lesser number of people who work in the central city, and (perhaps) the distinct life-style that favors ownership and use of automobiles.

Thus, the cluster analysis reinforces our belief that growing suburbs differ from the stable ones and the central city. Differences in demographics, household structure and characteristics, and commuting patterns were observed, all of which suggest that differences in life-styles and in transport behavior are likely to exist.

It seems reasonable to argue that congestion in growing suburbs is related, at least in part, to fundamental differences between growing suburbs and other parts of metropolitan areas. While we need to examine these factors in much more detail to confirm this observation, it appears that treating the growth in suburban travel demand as merely the result of more people and jobs is insufficient. Understanding the effects of social and cultural variables is probably critical to the development of infrastructure, service, and policy responses if they are to produce lasting benefits.

CONCLUSIONS

Some of the potential causes of suburban congestion associated with the behavior of people are explored in this paper. We believe that a series of major demographic, social, economic, and cultural trends are leading to changes in people's transport behavior and that the most active locus of these changes is in rapidly developing suburbs. From our conceptual model of transport behavior, we conclude that factors such as household structure, location patterns, availability and cost of activities, personal or household income, life-style, social values and norms, technology, and transportation systems characteristics and policies have a potentially significant effect on people's transport behavior.

The first part of our analysis shows that several of these factors have changed in important ways over the past 10 to 20 years. We have experienced decreasing household size and aging of the population; increasing numbers of returning young adults and of never-married people; reorientation of industry from heavy manufacturing to services, entertainment, and high technology; widespread introduction of computers and telecommunications systems; and relocation and expansion of

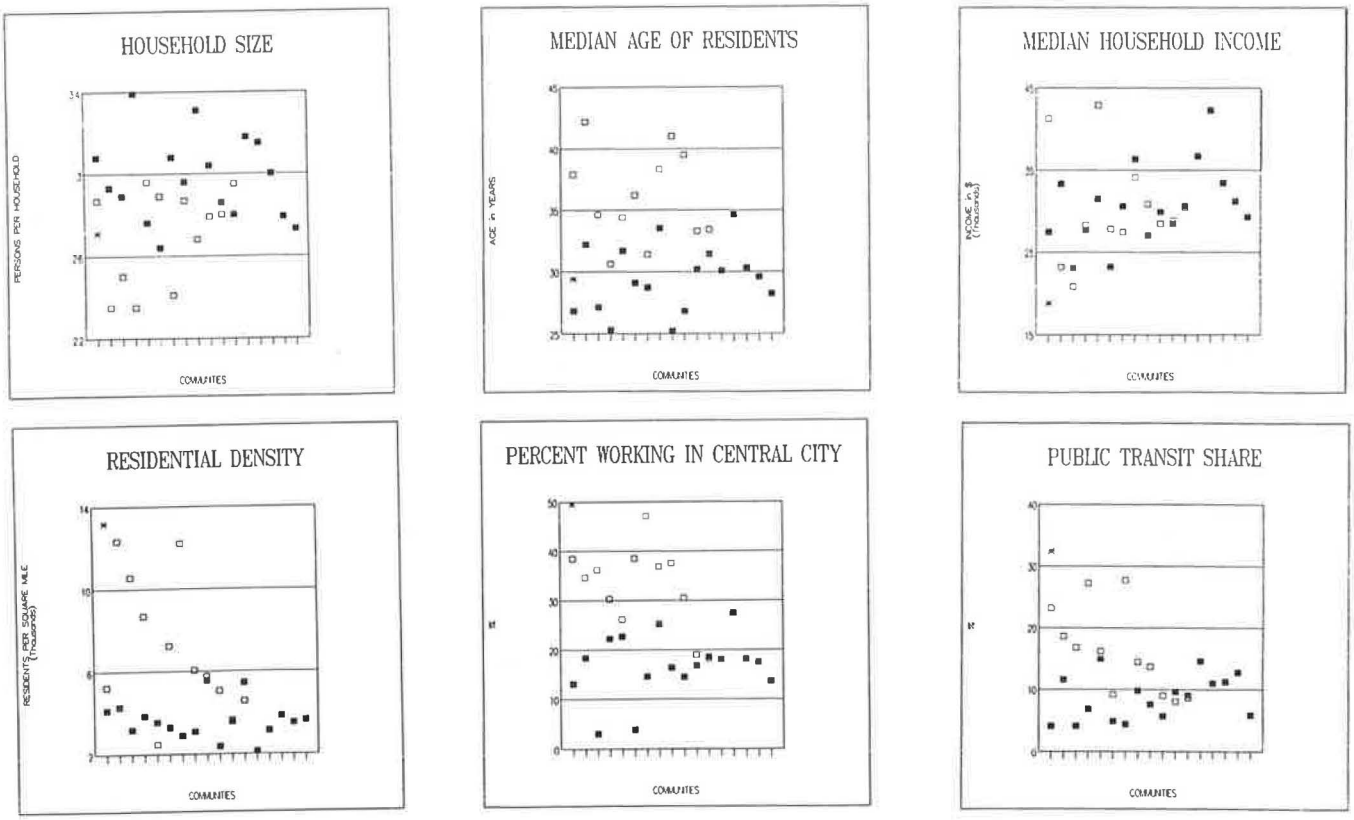

FIGURE 12 Distribution of communities with respect to socioeconomic and transport-related characteristics. (■) Growing suburbs, (□) stable suburbs, (*) city of Chicago.

FIGURE 13 Distinct clusters of growing and stable suburbs.

TABLE 2 CLUSTERED SUBURBS

Stable Suburbs	*Growing Suburbs*
Evanston	Addison
Oak Park	Elk Grove Village
Des Planes	Hoffman Estates
Elmhurst	Bolingbrook
Highland Park	Hanover Park
Park Ridge	Mount Prospect
Skokie	Schaumburg
Niles	Glenview
Oak Lawn	Northbrook
Cicero	Downers Grove
Wilmette	Wheaton
Berwyn	Arlington Heights
	Lombard
	Palatine
	Naperville
	Aurora
	Elgin

TABLE 3 AVERAGE VALUES OF CHARACTERISTICS OF CLUSTERED URBAN SUBSETS

URBAN CLUSTER / CHARACTERISTICS	SUBURBS		CENTRAL CITY
	GROWING	STABLE	(CHICAGO)
Population Growth Rate	68.60	-7.70	-10.80
Household Size	2.98	2.70	2.71
Median Age (yrs)	29.50	36.10	29.40
Median Household Income ($)	30,696	30,361	18,774
Residential Density (res/sq.mi)	3,606	6,975	13,174
% Employed In Central City	16.70	32.80	49.50
% Using Public Transportation	8.70	16.10	32.40

residences, retailers, and businesses to the suburbs. A major center for these changes has been rapidly growing suburbs of large urban areas.

Cluster analysis was employed to identify whether growing suburbs are different from stable suburbs and the central city. The results suggest that larger families with young children and/or young adults tend to reside in growing suburbs. The presence of children as well as the younger population results in a relatively more active society, while high income relaxes the constraints on activity participation.

The growing suburbs we examined appear to form a relatively homogeneous group with a distinct life-style (as implied by surrogate variables and indices), fewer constraints, and plenty of opportunities. As a result, we expect that they display a rather "growing suburb-specific" transport behavior that involves the ownership of several automobiles as well as high values associated with owning and using automobiles as an element of their suburban life-style.

What we actually observe is the tip of an iceberg. The driving forces behind suburban congestion are the household structure and economics, which, along with the distinct suburban life-style, determine the needs, activities, preferences, and choices of suburban households and individuals. There will be no realistic solutions to the suburban congestion problem until the underlying fundamentals are fully explored and understood. To achieve this understanding we must conduct a disaggregate analysis. The results of the work presented here provide a strong incentive for such a study, which is already under way.

The outcomes of our understanding suburban transport behavior may be new approaches to transportation planning (i.e., different techniques for stable and growing areas), improved automobile ownership and trip generation models, ideas for land use planning (i.e., to attract particular types of residents or developments), and new perspectives on policy-sensitive characteristics of individuals and households, all of which may provide better tools for managing suburban congestion.

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