SPATIAL ANALYSIS OF URBAN INTER - RESIDENTIAL SOCIAL TRIP FLOWS

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This is to certify that the

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ABSTRACT

SPATIAL ANALYSIS OF URBAN INTER-
RESIDENTIAL SOCIAL TRIP FLOWS

By

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This study concerns the spatial and related dimensions of inter-residential social travel in an urban area. Aggregate cross-sectional transportation data from an origin-destination study provided by the Lansing Tri-County Regional Planning Commission are examined first. These data are supplemented by more detailed longitudinal data on individuals' recurrent social travel behavior gathered from a field interview of a neighborhood in the East Lansing area. The study attempts 1) to provide a basic understanding of the temporal, demographic and socio-economic structure of social trips, 2) to identify desire lines of movement and to delimit, for social interaction comprehension, the socially cohesive neighborhoods of the study area, and 3) to explain, to a degree, why spatial patterns are formed as they are by testing two hypotheses concerning the social and physical distance between social contacts.

Social trips, when compared to all trips, display marked differences in both diurnal and weekday distributions. The sequencing and linking of social trips also differs from that of total trips in that social trips are primarily from home to another residence and back home again, but may involve more than one social stop. Definite variations in social trip making are shown to be related to the trip maker's socio-economic and demographic attributes. Income, household

size, and age are shown to be highly correlated (negatively) with social trip making. The minimum inter-residential separation of occupational classes shows that Lansing's residential structure is at least similar to concepts of classical urban rent theory. But, there is apparently little, if any, relationship of this inter-residential separation to the distance people travel on social trips.

More importantly, this study reveals that social trips differ substantially from other types of trips in their spatial patterns. At several levels of analysis, it is demonstrated that the individual is constrained in his social interaction by distance and status barriers. When frequency of interaction between traffic districts is compared with distance separating the districts, strong distance decay effects are observed at short distances. Once the interaction is carried on beyond the immediate neighborhood, an individual's social communications network is the prime determinant of interaction, and the distance decay is much more gentle.

Urban social interaction patterns are computer generated and interpreted. Flow maps display several prominent linkages among portions of the study area. Factor analysis of two origin-destination matrices elucidate socially organized areas within the larger study area that are internally similar in their social interaction. The factors are interpreted spatially by mapping factor scores for census tracts and traffic districts. Both flow maps and factor analyses show the decreasing social importance of areas with increasing distance from one another. The decreasing importance is not regular, but distorted by variation in the "status plane."

Frederick Paul Stutz

A neighborhood analysis permits the exposure of the two components thought to be the essence of social interaction. One is the neighborhood component, which is basically a distance decay factor, and the other is the social network component, which is basically a status factor. These are defined and evaluated to determine the extent to which social trips are affected by these two aspects of interpersonal social relations.

Due to the voluntary and substitutional nature of social trips, variations in individuals' personalities and attitudes make social trip frequency and patterns of social ties difficult to predict. A partial explanation of how and why individuals select social trip ends is forwarded through a behavioral model. But until these factors of personality and attitude can be measured, a certain random element must be assumed when analyzing social trips. The random element is based not only on these factors of personality and attitude, but also on the individual's unique social communication network, each of which is not completely determined by distance and status considerations.

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CHAPTER I

INTRODUCTION

Researchers are becoming interested, with increasing intensity, in travel patterns and studies of migration of human populations. Regions with large and growing urban populations have naturally caused interest in travel within and between cities, and these populous regions have served well as the primary study areas for analysis of movement patterns. Closely related to these studies of movement patterns have been studies of urban growth and market structure. This paper deals with the spatial patterns of urban social travel and their relationship to urban social structure.

In geography, a relatively large proportion of research has been conducted on two types of trips, the shopping trip and the work trip.[1] These two types of trips are similar in that they are both non-discretionary. That is, people must perform work and shopping activities and they must perform them with a certain degree of regularity. The destinations are limited to those commercial and industrial land uses adapted for the particular trip type, and each trip deals with a person to activity connection.

The social trip is another type of trip that generates urban patterns, but it has received little attention from researchers. The

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[1]For shopping travel patterns see, for example, Garrison, et al., 1959; Berry, 1962; Garrison and Worrall, 1966; Nystuen, 1967; Marble, 1967, 1968; Horton, 1968; and Yuill, 1968. For work trip travel patterns, see Taaffe, Garner and Yeates, 1963; Lonsdale, 1966; and Wheeler, 1967, 1969. The treatment of these types of trips has been, by no means, limited to geographers (Voorhees, Sharpe, and Stegmaier, 1955; Kain, 1962; Lapin, 1964; Mayer and Goldstein, 1964; Keefer, 1966; and Bucklin, 1967).

trip for social interaction is quite different from the work trip or the shopping trip in several ways. First, the social trip is concerned primarily with person to person connections, while the other two trips are not. Second, the social trip is discretionary in nature, and is more personalized than the two previously mentioned trips because the trip maker becomes socially involved at the trip destination. Third, he also has a wide degree of choice in where to travel. Many other types of activities can be substituted for the social interaction trip. Among them are recreation, going for a ride, or simply relaxing and watching television. These latter activities may not involve a trip at all. The activity that is chosen, whether social or otherwise, depends basically upon an individual's preferences, income, and his leisure time availability. A trip that is discretionary in nature, rather than a matter of necessity, may exhibit a much wider variability in trip generation from household to household because of these preferences.

The volume of research outside geography on urban social interaction patterns is small. Although a number of geographic studies have been done on recreation, another leisure time activity, it is surprising that no research analyzes specifically social trips.

A distinction will be made not only between social and recreational trips, but also between certain types of social travel. There are many types of social interaction that may take place at a variety of land uses. In this study, only trips made to residential land uses for the social purpose of visiting friends, neighbors, or relatives are considered. Some theory on social interaction exists in the sociological literature of the neighborhood, and it will be subsequently reviewed where relevant, but this literature often lacks the spatial

element of special interest to geographers, and points up the need for spatial studies.

Objectives of Study and Methods Employed

The general purpose of this study is to examine the spatial and related dimensions of inter-residential social travel in an urban context. Three primary objectives underlie this analysis. The first is to gain a fundamental understanding of the nature of social trips. A need for this is seen by the shortage of basic knowledge, especially of the spatial characteristics, but also of the non-spatial characteristics, of urban social interaction. The analysis of social interaction is an underdeveloped area of research compared with the research produced on other types of trips. To meet this first objective the paper will describe the general temporal, demographic, and socio-economic structure of social trips based on aggregate data from a metropolitan area transportation survey.

Specifically, graphs of the diurnal distribution of social trips are analyzed. A matrix of transition probabilities is generated and analyzed to study the linking characteristics of social trips. A least squares method with addition of variables is employed in the multi-stop social journey analysis. A relative social trip frequency ratio is constructed to analyze variations in trip making by individuals with various socio-economic and demographic characteristics. Social trip generation is explained statistically by methods of multiple regression. The patterns of income and social trips are visually examined by the use of computer generated isoline maps.

A second objective, involving the spatial component of interaction, is to identify desire lines of movement and to delimitate, for social interaction comprehension, the socially cohesive neighborhoods of the study area. To accomplish this, the study 1) presents and analyzes computer generated flow maps of social interaction and 2) uses factor analysis to determine the degree to which social interaction is similar among different parts of the city. This objective stems from the need to know how the urban areas function socially, especially in view of the likelihood that social travel may be a basis for the understanding of the areal distribution of urban social structure. Since choice of residence via the market place is eventually reflected in spatial structure, the relationship between social interaction patterns and the choice of a residence is a key consideration. Operationally, this means that this objective is concerned with metropolitan area interaction and social interaction systems of a recurrent nature, exhibiting tendencies to cluster into spatial patterns. This objective is met by not only using factor analysis to identify areal dimensions of social interaction and computer plotting of social trips by categories of income and race, but also by mapping factor scores.

The third objective is to explain, at least in part, why spatial patterns of social interaction are formed as they are. This approach would define aspects of urban social interaction patterns which have predictive significance for urban social structure in metropolitan areas other than only the present study area. In an effort to explain the patterns, this paper generates two hypotheses and tests them with data from a metropolitan area transportation survey, as well as with data gathered from field interviews, and constructs a

model to predict social interaction flow systems. The two hypotheses tested deal with 1) the distance decay concept and distance sensitivity of different status groups and 2) the social class segregation hypothesis which suggests that interaction will be most frequent among individuals of similar socio-economic status.

Methods employed to meet this third objective include constructing a scatter diagram and running a regression analysis with data transformations to show the relationship between the frequency of social trips between areal units and the distance between these areal units. The format of the transportation problem of linear programming is employed to compute the inter-residential separation of classes of individuals, as this inter-residential separation is thought to be related to trip length. Further, factor scores are mapped, income standard deviations from areas loading highly on factors are computed, and variables suggestive of class rank are correlated with factor scores. Lastly, the distance decay and social class hypotheses are tested on the neighborhood level of analysis in an effort to examine relationships that are hidden at the city level. Data on a neighborhood were gathered from direct field interviews.

The Data and Study Area

The extensive work in urban transportation and land use planning during the past decade has been, to a large degree, the source of and stimulus for present work on travel patterns. At the same time, it can be said that much of the current work on urban travel activities is limited to the analytical approach that has evolved in transportation studies due to the type of data available from the transportation

surveys. The analytical approach might be characterized as cross-sectional, aggregative, phenomonological, and predictive.

Metropolitan transportation survey data are very welcomed, however, by the individual researcher such as the geographer, and it is these type of data that have been used primarily in this study. The data supplied by the transportation planning studies permit the researcher to process large amounts of information, with the aid of computers, that would otherwise be unattainable to him because of the time and cost constraints of obtaining it. These data then, permit the individual researcher to get a broad picture of the phenomena he studies and also to have sufficient data to produce statistically significant results. The data for this research endeavor have been obtained from the Tri-County Regional Planning Commission of Lansing, Michigan, and are based on The 1965 Home Interview Survey of over 4500 households, representing a 5 percent sample of the population.

The major purpose of the Home Interview Survey was to obtain information necessary to adequately plan for improved or new transport facilities to accommodate present and future travel needs in Clinton, Eaton, and Ingham counties. In preparation for the Home Interview Survey, the sample households and group quarters to be interviewed were selected. The household portion of the sample consisted of single, two, and multiple family housing units. The group quarters sample consisted of university dormitories, fraternities, sororities, cooperatives, and religious units. The households were chosen by systematically sampling the meter address records of the power companies which supply electrical power to the residents of the five township area of the Tri-County Region. These sources included Michigan State

University, Lansing Board of Water and Light, and Consumers Power Company.

Five percent of the region's approximately 90,000 households and 2½ percent of the group quarters residents were selected as the sample. These percentages yielded approximately 4500 household interviews and 500 group quarters interviews. The basis for these percentages was that, according to the transportation consultant, Alan M. Voorhees and Associates, they would yield sufficient data to facilitate the necessary statistical expansions and analyses for the region as a whole. The smaller group quarters percentage was chosen because residents are more similar than those living in households. For example, the residents in group quarters are, in most cases, similar in age, daily schedules, income, and car ownership. These characteristics vary considerably among normal household residents, however.

In the selection of a systematic sample such as that used, the sample rate was based on the estimated total universe and the total number of samples desired. In order to obtain a 5 percent household and 2½ percent group quarters sampling rate, it was necessary to oversample to allow for such circumstances as vacant houses, refusals, and unusable interviews. Therefore, a household sampling rate of one in every thirteen was used, yielding 6933 samples. A group quarters sampling rate of one in every twenty-six was employed, providing 600 samples.

Since travel varies by day of week and by week of year, the interviewing period was spread over as long a period as practicable — the months of April, May, and June, 1965, and over all seven days of

the week. Each household interviewed received a letter from the Governor of Michigan, and a brochure explaining the Home Interview Survey. In addition, the various news media were used in informing as many residents in the region as possible about the Home Interview Survey.

The three counties of Ingham, Clinton, and Eaton, in which data were gathered, contain some 1700 square miles and a population of 356,000 people, with Lansing-East Lansing as the nodal center of the area. The Tri-County region comprises seventy-eight local units of government, but the five townships in which Lansing-East Lansing are located -- Delhi, Delta, DeWitt, Lansing, and Meridian -- contain two-thirds of the region's population, and it is with these five townships that the study will deal (Figure 1).

Lansing and East Lansing contain a composite of functions and facilities, among them being automobile manufacturing and related manufacturing plants, the many offices of state government, Michigan State University, and principal shopping and commercial centers, each of which generates a large amount of traffic.

The data for all trip types in the Tri-County were made available to the researcher on magnetic tape and consist of 44,860 records (trips). The data which provide a detailed trip-by-trip account of all auto-driver and passenger trips made by each member of the interviewed household five years of age and older for a selected day include the trip purposes as well as the zones and land uses of the origin and destination of each trip. In addition, each record (trip) contains demographic and socio-economic information on the individual and the household of which he is a member, and additional information on the

Figure 1. Five Township Study Area. Base Map Source: Tri-County Regional Planning Commission, Lansing, Michigan.

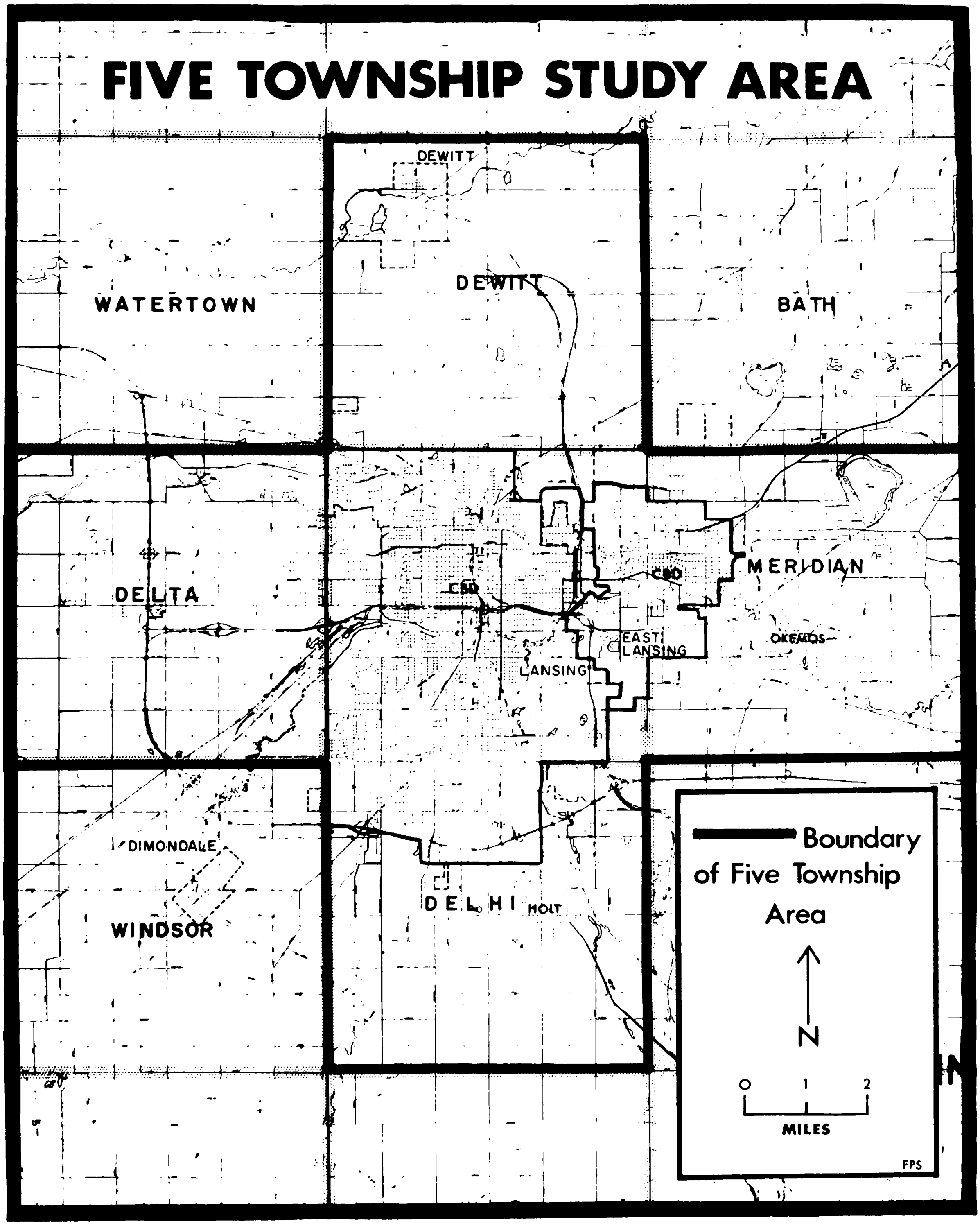
FIVE TOWNSHIP STUDY AREA
DEWITT
WATERTOWN
DEWITT
BATH
DELTA
CBD
CBD
MERIDIAN
EAST LANSING
OKEMOS
LANSING
DIMONDALE
WINDSOR
DELHI
HOLT
Boundary of Five Township Area
N
0
1
2
MILES
FPS

FIGURE 1

trip, such as transportation mode and the time of day at which the trip took place. Variables and the format under which they appear on tape are given in Appendix A. The records for each person are arranged sequentially for the 24-hour period, and are further ordered by survey, household, and person number.

Portions of the analysis concerning only social trips were undertaken on the computer by first sorting out only social trips. This was accomplished by sorting out all trips with purpose at destination as social-eat meal, as these two activities were combined into one trip purpose in an effort to limit the "purpose" variable to a one-column field. These trips were then further sorted according to land use at the trip destination, which in this case was residential. This sort also eliminated trips made to restaurants to eat, thus omitting commercial eat-meal trips. This subset of total trips yielded approximately 1900 records, or approximately 7 percent of all trips made. These were expanded to 63,000 trips for most of the social trip analyses.[1]

It should be pointed out that this data set contains only information on out-of-home activities which required the use of a car, taxi, bus, or truck. The only walking trips included in the data are walking trips to work. No bicycle trips were recorded. These limitations prevent a thorough examination of school children's and teenagers' travel patterns. Also missing were the walking mode social trips which may occur on a visit to the next door neighbors. Nevertheless, vehicular social travel is an important factor of urban interpersonal

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[1]Each trip may be multiplied by an expansion factor which is dependent on sample size and which expands the data to 100 percent.

interaction, and research on social ties on a macro-scale should help considerably the understanding of urban functional association.

Some information basic to geographical analysis of social interaction patterns can be obtained only through talking to the individuals directly involved in the interaction. Therefore, in addition to the basic data tape, a micro-geographic area within the metropolitan area was surveyed. In preference to using the random sampling method, fifty detailed household interviews were gathered at all of the responding households on the streets in this neighborhood. A questionnaire was designed and used to record the home interview data. (See Appendix B.) In most cases, the persons interviewed were pleasant and cooperative. Although some refused to answer certain questions, such as income and location of their friends, very few refused to respond to the entire interview.

The purpose of the field interview was to secure specific types of information, such as longitudinal data on social decision patterns, not available from the data tape, and to become familiar with different individual attitudes and preferences for social travel.

Related Literature

Many studies show a distance decay function for most human spatial interaction. The best summaries of that literature can be found in a review article by Carrothers (1956), in Isard's book on regional methods (1960), and in Olsson's monograph (1965). Diffusion research and the construction of mean information fields (Hagerstrand, 1967) and potential surfaces (Warntz, 1964; Neft, 1966) are based on the effects of distance on interaction. Planners have also shown intra-urban trips to decline in frequency with distance inputs (Schneider, 1959; Harris, 1964; and Boyce, 1965). Much non-travel literature that lies outside geography and regional science treats the effect of distance on friendship and interpersonal relations.

The diminuation in the probability of social communication and friendship with increasing distance has received attention from sociologists. For example, Katz and Hill (1958) have shown that, at least at the city scale, the greater the amount of potential courtship interaction, which varies inversely with distance, the greater the probability of marriage. Distance has traditionally (Bossard, 1932) and more recently (Morrill and Pitts, 1967 [geographers]) proven to be a significant variable in mate selection. Ramsøy (1966) found that the probability of marriage varies directly with the degree of similarity of occupational status of the two parties involved, and inversely with the distance between their residences.

Several studies have included the concept of social accessibility, or functional distance, as a determinant of social interaction, especially at the micro-level. Functional distance reflects the actual pattern of routes of interaction, and may include barriers to person movement such as permanent laundry lines, or hedges. Similarly, common sidewalks or an apartment location near a staircase have been shown to promote social relations (Festinger, et al., 1950). At this micro-scale, much shorter distances have been shown to be important in the formation of friendships and social relations.

Studies by Caplow and Foreman (1950) and by Festinger, et al. (1950) have revealed the importance of distance in personal contacts in college married student housing units. As expected, an individual's acquaintanceship field grew as a function of the duration in the housing complex. At all scales, including the neighborhood scale, results of questions asking individuals to name the person or persons that they interact with most frequently reveal the overwhelming influence of propinquity on social relations (Boult and Janson, 1956).

Study of social interaction in a dormitory showed that students are friends with others who are near to them, not only in proximity, but also in college class (peership) (Priest and Sawyer, 1967). By tracing individual pairs through time, it was shown that, between roommates and others living close to one another, attraction changes less when it is initially high. Between individuals more spatially separated, attraction changes less when it is initially low (Newcomb, 1956). Thus, attraction is more stable when it is in balance with proximity. This study has also shown that the perception of distance by individuals tends to vary much as a matter of intervening distance, so that, similar to distance decay rates for mean information fields (Marble and Nystuen, 1963), the distance traveled to friends depends on the density of potential acquaintances.

Accepted ecological theory suggests that spatial distances between spatial clusters of people of the same occupational class are closely related to their social distances (Duncan and Duncan, 1955). With respect to mate selection, as well as other types of social interaction, the probability of interaction has been generally shown to vary directly with degree of similarity in occupational class. Sophisticated methods for measuring the social distances between social status categories using occupational data exist (Beshers and Laumann, 1967). In Beshers and Laumann's study, the social distance to the highest and lowest occupational classes was the greatest and an overall hierarchal effect of social stratification was shown. In another study, Laumann (1966) showed that comparable occupational class is the main factor in predicting with whom individuals will engage in social relations.

Studies of neighborhood social relations have been performed, and they generally point to urban social distance. The reduction in cost of movement and reduced choice of contacts in a neighborhood result in greater reciprocation and clique formation than would take place otherwise (Frankenberg, 1966). Nelson (1966) has shown greater geographical immobility of those belonging to well-connected cliques, such as might be found in a stable neighborhood, than of those belonging to less well-connected cliques.

A study by Foley (1952) shows that many individuals do not interact locally and do not consider the local neighborhood to be a social community. This suggests that urbanites are mobile, anonymous, and lacking identity with their local area. In light of the theory on urban structure, it would seem that residents of predominantly lower socio-economic neighborhoods should be the most tightly knit groups spatially, exhibiting relatively low spatial mobility. The higher socio-economic groups should display spatially dispersed patterns.

And yet, Smith, et al. (1954) have shown for Lansing, Michigan, that the degree of local intimacy varies directly with income, and not inversely, as suggested above. The reasons given are that the lower social groups' mobility for social interaction is greater because of greater residential mobility. The wealthier have greater residential tenure, and tend to increase friendships the longer they stay.

Somewhat contrary to Smith, et al., Priest and Sawyer (1967) have indicated that a person's quota of friends is filled after a certain time, and that increases in length of time in a neighborhood or on a college campus may not increase one's number of social contacts. However, Festinger, et al., (1950) have documented the increasing spread of an individual's acquaintanceship field as a function of the amount of time spent in a housing development. Greer (1956) pointed out the distorting effects that relatives have on the usual distance decay relationship, showing individuals to travel longer than average distances to interact with relatives.

Newcomb (1956), the social psychologist, has argued that the object of similar attitudes must be valued by both the sender and receiver and of common relevance to them. This is most often accomplished when both parties are of the same status. As a result of interaction and communication, individuals tend to become more similar to each other with respect to important and relevant objects. This increased communication will also be followed by an increase in positive attraction between the two individuals, regardless of the content of the communication. Also, Putnam (1966) has argued that influence on voters is mediated primarily through numerous personal contacts among members of the community, and is not due to the activity of the political party in the area. The extensive literature in the area of personal influence points out the social and psychological processes assumed by this theory (Katz and Lazarsfeld, 1955).

Reasons why similarity of status is a predominant condition of friendship have been advanced. Cox (1968, 1969) has argued that social relations are associated with an exchange between the participating individuals. This exchange of payoffs is used by the persons concerned to evaluate the costs and rewards, or the expectancies of cost and rewards, likely to be associated with a renewal of the contact at a future time. Williams (1956) has noted that repeated contacts and sustained friendships must result from a mutual evaluation of high rewards, as opposed to high net costs. Location is seen by Cox (1969) to affect this social interaction in two ways: 1) the distance decay or gravity component -- the process of interacting with a person as a function of distance and intervening distance -- and 2) the network biased or diffusional component -- in a topological sense, the degree to which individuals have connections with each other, independent of least cost considerations. Thibaut and Kelley (1959) have stated that rewards must be maintained above the available alternative contact level in order for social interaction to be maintained; and Beshers and Laumann (1967) have indicated that this is most easily done if the parties are of the same socio-economic group.

The social and psychological studies reviewed above were performed, in most cases, on a small number of individuals, using their complete social activities over long periods of time. It is surprising that there are few studies of social travel in the urban setting. With the lack of literature on social travel, one must turn to studies of other types of trips for insights into the nature of social travel.

Oi and Shuldiner (1962), Shuldiner (1962), and Fisher and Sosslau (1966) have established that the frequency of all trip making varies closely with such aspects as household size and car ownership. Some research has shown, however, that, contrary to widely held ideas, the location of the individual within the spatial system does not have a great effect on the frequency of trip making. Garrison (1956) has shown that the frequency of shopping trips was distributed among households without any relationship to the type of road service locally available, and that the frequency of shopping was independent of distance from the shopping center, although the place visited was a function of distance. Oi and Shuldiner (1962) have also found that if household size and car ownership are controlled, the location effect on trip frequency is negligible.

Other studies by Marble (1959) and Stowers (1962) have shown that socio-economic status is positively related to gross trip frequency. This relationship of increased trip making with higher status may, of course, be due primarily to the fact that higher status groups have access to more autos on the average and, therefore, have more of an opportunity to travel. However, Walker (1966) has shown that households in which the head of the household is a professional averaged approximately seven trips per day, whereas households in which the head is a laborer averaged approximately five trips per day, even though the number of people in the family and the number of cars owned per family were held constant.

Although most of the above findings have been made for trips without regard for trip type, some guidelines concerning social travel may be extracted from the Chicago Metropolitan Planning Reports. Sato (1966), for example, showed that in Chicago the number of social-recreation trips made by the family varied closely with the income of the family, as measured by the number of autos owned. Weekend trips were not used in the analysis. This represents a severe limitation to the findings, especially with respect to social travel, since it is expected that a high degree of social interaction takes place on the weekends, and that social travel during the week is severely limited because of work, school, and other obligatory activities.

In summary, one evident research requirement needed in order to become acquainted with social trips is the exploration of variations in social trip periodicities and generation rates under differing circumstances. Circumstances may be exogenous to the individual, including factors such as day of week, time of day, or location in the urban setting. They may also include endogenous factors of the individual trip maker. These include his various socio-economic, demographic, and personal characteristics. Next, it would seem that from the literature, two basic factors tend to have a bearing on social relations. One is distance between the two potential social contacts, and the other is the status similarity of the two social contacts. These two factors, then will be principle considerations in this study. Specifically, it is hypothesized that the frequency of social interaction between the two interacting individuals will be inversely related to distance, and directly related to similarity of status. Social trips, as studied here, are a single subset of social interaction as a whole and, therefore, the degree to which social trips can be shown to exhibit similar characteristics of interaction, in general, remains to be seen. In addition, the treatment of these hypotheses will examine an area of transportation research that has not been previously investigated.

Organization of Study

The remainder of the study is divided into five chapters. In the following chapter, Chapter II, an exploration is made into the general nature of social trips. It is necessary to have a grasp of the nature of social trips in order to undertake later portions of the analysis. In the first section of this rather lengthy chapter, the diurnal and weekly distribution of social trips is compared and contrasted to the distribution of total trips. In the following section, the linkage of social trips is considered. The first part of the trip linkage analysis examines the degree to which various trip purposes are linked to one another on multi-stop trips from home. Social trips, as they are linked to all other trip purposes, are compared to the pattern for all trips. The second part of the trip linkage analysis is concerned with the extent to which individuals with certain household characteristics tend to make multi-stop social journeys.

The next section of Chapter II concerns the socio-economic and demographic structure of social trips. The relative frequency of social trips by age, income, household size, sex, and race reveals important variations. Next, social trip generation is explained in a statistical sense by 1) regressing the relative frequency of social trips with socio-economic variables, each of which has been broken into several data intervals, and 2) regressing the relative frequency of social trips with socio-economic variables aggregated on the census tract level. Computer maps are then presented showing the areal distribution of income and relative social trip frequency by census tracts. Areal similarities in the patterns are given.

Chapter III is divided into two sections. The first section studies the diminuation of social interaction with increasing distance between pairs of contacts. A scatter diagram is constructed and the frequency of social trips between traffic districts is regressed with distance between traffic districts in the study area. In the second section of this chapter, social trip length by occupational class is computed. An attempt is made to explain mean social trip length for different occupational classes by comparing these with the mean inter-residential separation of the classes. For this analysis the mean inter-residential separation of each occupational class is computed by employing the transportation problem of linear programming.

Chapter IV analyzes urban social interaction patterns by constructing and interpreting maps from information on origins and destinations of social trips. An effort is made to elucidate social linkages in the urban area and the degree to which these linkages are related to distance and status effects. The first section of this chapter describes the computer generation of flow maps and the second identifies desire lines of movement. In the third section discrete cohesive social areas of the larger study area are identified. This is accomplished by factor analyzing an origin-destination matrix of social trips to reveal portions of the study area with similar patterns of social trips. Two factor analyses are presented, one on the census tract level and another on the traffic district level of analysis.

In Chapter V, the scale of the study is reduced to a single neighborhood. In this chapter the distance and status hypotheses are tested to provide a keener knowledge of the social interaction process. This is made possible by specific types of information on recurrent visiting patterns of the respondents. This information was gathered from direct field interviews. This rather brief chapter examines the social linkages of the neighborhood in question to other neighborhoods, and shows the status similarity between pairs of social contacts. This chapter also brings to light what the author believes to be a neighborhood component and a social network component of social trips.

Ths sixth, and final chapter, summarizes the findings from earlier chapters, and also provides supplementary explanations for the observed distance and status relationships. Two models are then presented. The first model is a behavioral model that formalizes the elements involved in an individual's choice to make a social trip. The second model is a predictive model that gives a method by which patterns of social travel may be simulated and predicted for future periods. Empirical verification of the models is suggested as a problem for future research.

CHAPTER II

THE NATURE OF SOCIAL TRIPS

Temporal Distribution

One manner in which social trips differ from trips made for other purposes is in their temporal distribution throughout the day and week. The distribution of all weekday urban travel throughout the twenty-four hour day peaks in the early morning and in the late afternoon. This bimodal distribution is a familiar phenomenon to the commuter and the transportation planner. The hourly distribution of all weekday trips for the study area is shown in Figure 2. Each datum point on the graph represents the percent frequency of all trip starts for that sixty-minute period interval, compared to all trips for the twenty-four hour period. The first peak, between 7 and 8 a.m. represents the morning rush hour, involving trips to work and to school. After this peak there is a rapid decline in frequency of trip starts. A subsidiary peak is shown between 12 noon and 1 p.m.. At this time there is a large number of trips to eat-meal, some of which are to home from work and back to work. A large proportion of this noon activity consists of people making social stops, however.

A second depression is seen in the afternoon at approximately 2-3 p.m., followed by a sharp rise to the evening rush hour peak between 4 and 6 p.m.. This peak is not as sharp, even though higher in amplitude than the other peaks, because it extends over a longer period of time, due to people getting off work over a two-hour interval.

For this graph, the datum point for trip starts from 4-5 p.m. and

DISTRIBUTION OF ALL WEEKDAY TRIPS BY HOUR OF DAY

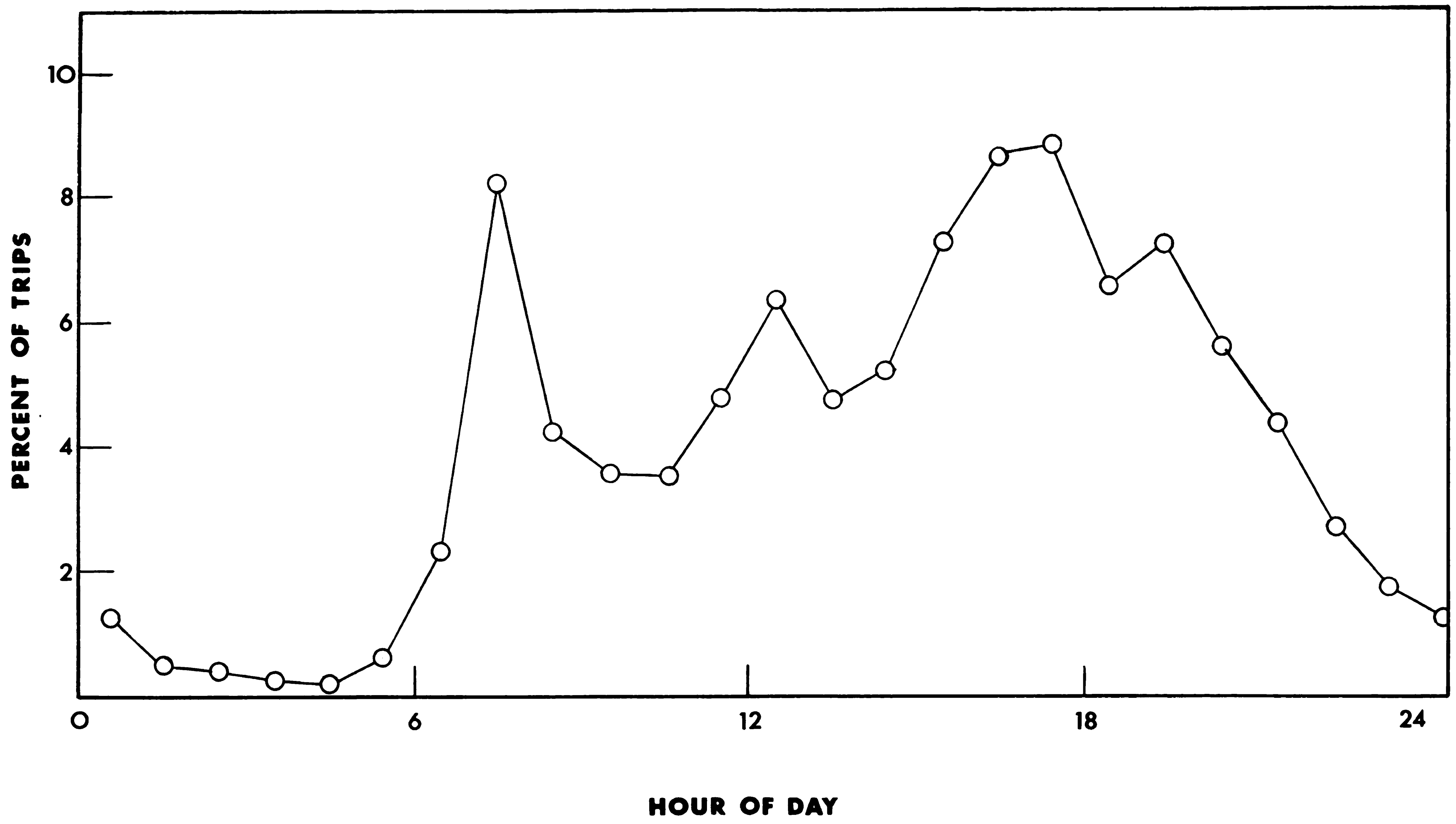

FIGURE 2

the datum point for starts from 5-6 p.m. show approximately the same frequencies -- 9½ percent. If trips were graphed by minute intervals, a sharper peak would be present near 5 p.m.. Trips decline in number sharply after the evening rush hour, although there is a subsidiary peak occurring near 7-8 p.m.. This is due to individuals engaging in activities after their evening meal, such as going riding or shopping, or to a social engagement. A sharp tapering off is seen after this evening peak.

In contrast to the daily pattern of total trips, social travel reaches its major peak during the evening between 7 and 8 p.m. (Figure 3). Social trip distribution also has a secondary peak during midday. During the late morning hours, there is a rapid increase in the frequency of social trips until a peak is reached between 12 noon and 1 p.m.. The noontime peak is followed by a gradual decline in number of social trips, reaching a depression between 3 and 4 p.m.. A smooth increase up to the evening peak at 7-8 p.m. is seen. The most rapid hourly change is the sudden decrease in trips following the evening peak. Nearly a third of all social trips in the Lansing study area take place between 6 and 9 p.m..

A marked contrast is seen by examing the distribution of social trips for weekday compared to weekend (Figure 4). The distribution of social trips for weekday is similar to that for total social trips, but with more pronounced peaks and troughs. The two peaks are higher, basically because people have leisure time over the noonhour and after work, and thus these periods are heavily used for social trips. The distribution of social trips on the weekend shows an increase in frequency during the late morning, reaching a peak between 11 a.m. and 12 noon.

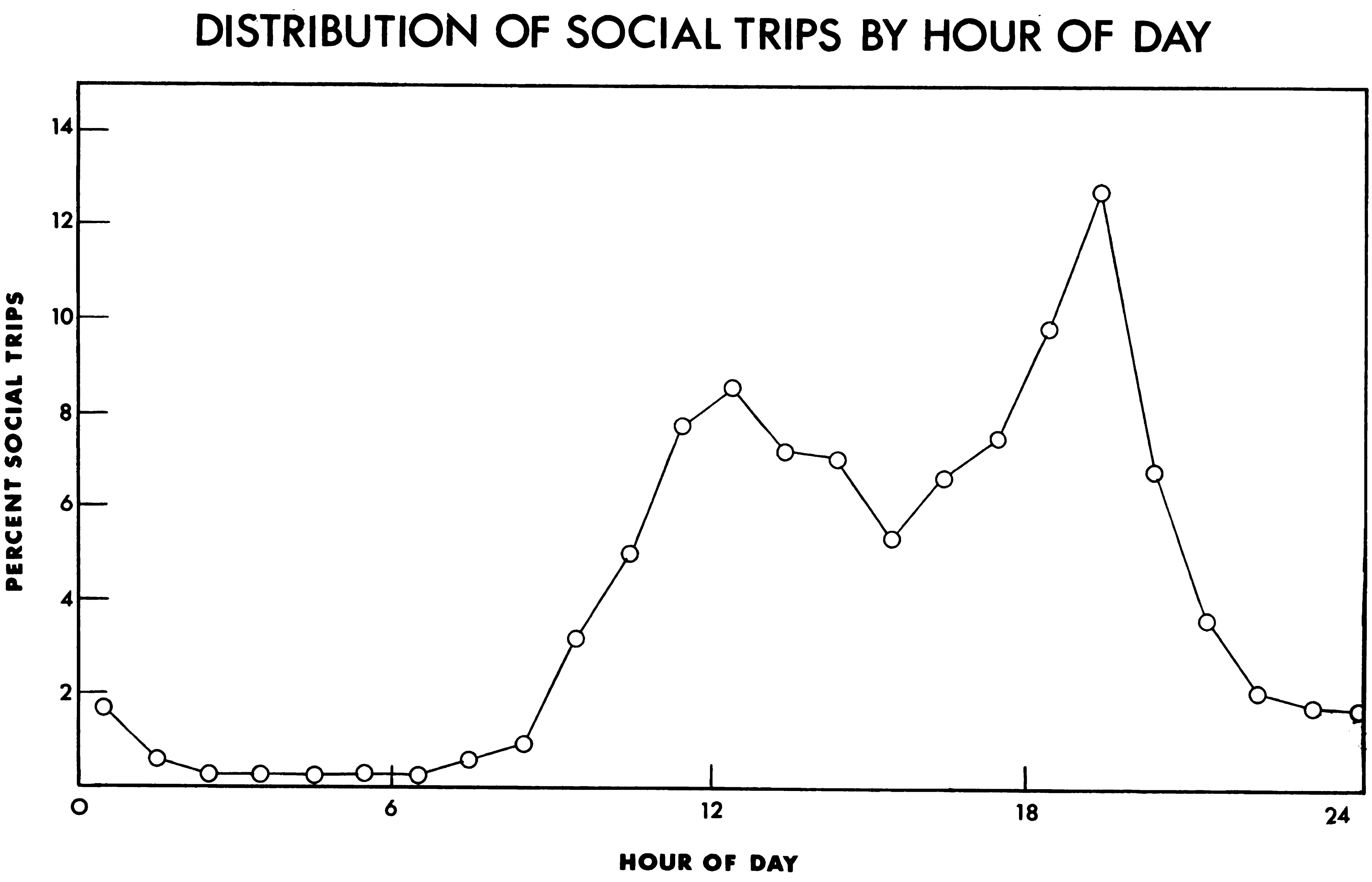
DISTRIBUTION OF SOCIAL TRIPS BY HOUR OF DAY
PERCENT SOCIAL TRIPS
14
12
10
8
6
4
2
O
6
12
18
24
HOUR OF DAY

FIGURE 3

HOURLY DISTRIBUTION OF SOCIAL TRIPS BY DAY OF WEEK

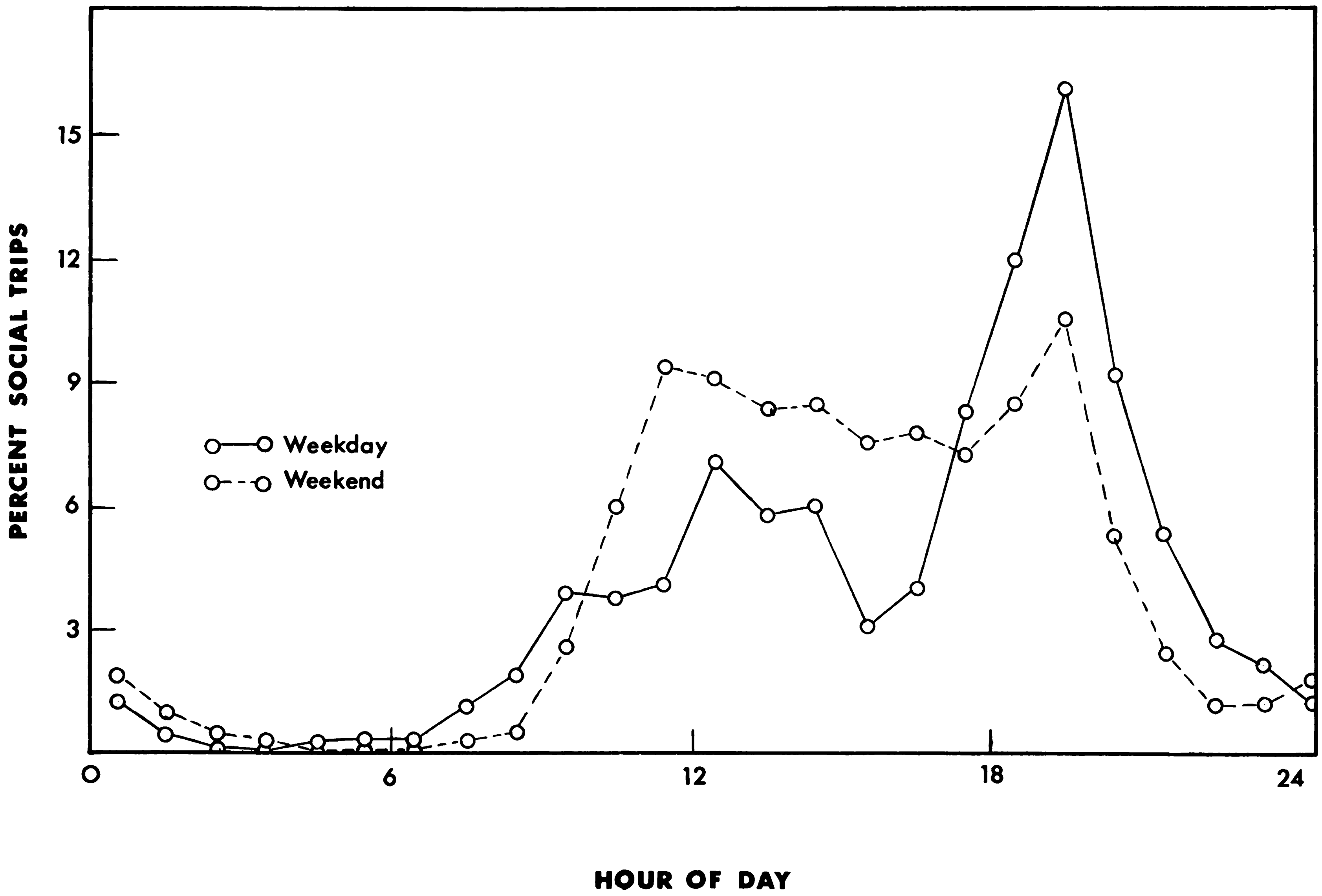

FIGURE 4

There is a sustained high hourly frequency of social trips throughout the day, with only a slight depression in the late afternoon. Between 7 and 8 p.m. there is another peak approximately equal in amplitude to the first, after which there is a rapid decline in frequency of social trips. The basic difference between the two frequency distributions is that weekend social trips remain at a high frequency from approximately noon to 8 p.m., whereas the weekday social trips show two sharp peaks, one at noon and one at 8 p.m..

Another difference in temporal distribution between social trips and total trips is in the number of trips made for each day of the week. Fifty-three percent of total trips in the study area occur on weekdays, but only 37 percent of the social trips occur during the five weekdays. Twenty-eight percent of social trips take place on Saturday, with Sunday having 35 percent of the trips. Therefore, nearly two-thirds of social travel occurs during weekends.

The sequencing of social trips throughout the day, as they are linked with other trip purposes on the same journey from home, reveals interesting distinctions. The following section will deal with the linkage of social trips to other trips.

Linkage of Social Trips

Over a twenty-four hour day, most travel by residents of the urban area is home-based. That is, residents typically start from home in the morning, return to and leave from home a number of times, and end up there at night. Each journey is composed of two or more trips in the conventional sense, as used in the origin-destination studies of urban travel. For example, the Tri-County Regional Planning Commission (1965) defines a trip as one-way travel from one point to another, covering two or more blocks, for a particular purpose. Thus, round trips to and from work, to and from shopping, and to and from a friend's residence represent at least two trips in each case, one to travel to the place of work, shop, or socializing, and one for the return trip home. If there are only two trips in a journey, from home to an activity and back home again, then no activity linkages occur on the journey. Complex journeys of more than two trips obviously involve sequencing or linking of activities.

Combining several trips for the same or different purposes on a single journey away from the home is efficient behavior, and has received attention in the literature, primarily with respect to shopping trips (Garrison, et al., 1955; Marble, 1964; and Nystuen, 1967). But the linking of activities occurs actually somewhat infrequently. Usually a person leaves home for a single activity and returns home when it is done. Only about 25 percent of all trips in a metropolitan area recorded in home survey studies are not home-based.

This section is divided into two parts. The first part will examine the degree to which various trip purposes are linked to one another. Social trips, as they are linked to all other types of trips and also to social trips, will then be compared to the pattern for all trips. The second stage of the analysis will be concerned with the extent to which individuals in certain household types tend to make multi-purpose social journeys.

Linking Trip Purposes

The first stage of the analysis uses a transition probability matrix to analyze social trips made by residents as linked to all other trip purposes. This approach has been used previously, specifically for shopping trips (Marble, 1964; Thomas, Horton and Dickey, 1966; and Shuldiner and Horton, 1967). Groups of highly linked trip purposes, as revealed by transition probabilities, are identified.

The basic input into the trip linkage analysis is a data matrix giving all trips originating and ending at various trip purposes or activities in the Five-Township area for an average weekday and an average weekend day, yielding a total of 1,151,769 trips. The probability p_{ij} of a trip going from any origin activity i, labeled on the rows, to each destination activity j, labeled on the columns, was then computed by the expression $p_{ij} = f_{ij} / \sum_{j=1}^{11} f_{ij}$, where f_{ij} is the frequency of the ij^{th} cell. p_{ij} is the ij^{th} entry of the matrix, and is the probability of a trip maker moving from state i to state j. Row i of this matrix gives the probability vector for a trip starting at activity i ending at all other activities m. Column j of the matrix gives the probability vector for trips from m activities ending at activity j, although for the columns, values must be normalized for probabilities to sum to unity. Thus the transition probabilities of moves between states can be shown.

The transition matrix of trip purposes for all trips in the Five-Township Area is shown in Table 1. The first eleven columns and rows show the trip purposes and associated probabilities for all trip purposes in the original data. The next two columns and rows give the probabilities, respectively, for total trips, as defined above, and social trips. Similarly, Table 2 and Table 3 display probabilities for trip purposes, respectively, for weekday and weekend trips. For example, in Table 1, the probability that an individual will move to home given

TABLE 1

TRIP PURPOSE MATRIX OF TRANSITION
PROBABILITIES FOR TOTAL TRIPS*

From \ To	1. WOK	2. PER	3. MED	4. SCH	5. SOE	6. CGM	7. SHP	8. REC	9. HOM	10. BUS	11. SEV	12. TOT	13. SOC
1. WOK	.01	.03	.01	.00	.13	.01	.04	.01	.65	.07	.05	.07	.02
2. PER	.02	.13	.01	.01	.09	.00	.13	.02	.54	.02	.04	.06	.03
3. MED	.01	.08	.01	.01	.08	.00	.18	.02	.57	.02	.02	.01	.00
4. SCH	.01	.02	.01	.03	.06	.02	.03	.02	.79	.00	.02	.02	.01
5. SOE	.01	.02	.00	.01	.13	.00	.06	.03	.65	.06	.04	.16	.20
6. CGM	.11	.06	.00	.21	.12	.01	.06	.06	.34	.00	.03	.00	.00
7. SHP	.00	.04	.00	.00	.08	.00	.16	.01	.66	.01	.03	.11	.06
8. REC	.00	.01	.00	.00	.09	.00	.02	.04	.80	.01	.03	.07	.05
9. HOM	.17	.10	.01	.08	.24	.00	.14	.14	.00	.03	.10	.38	.57
10. BUS	.02	.02	.00	.00	.07	.00	.03	.01	.41	.41	.03	.12	.05
11. SEV	.07	.06	.00	.01	.08	.00	.07	.03	.51	.02	.14	.00	.00
12. TOT	.07	.06	.01	.02	.16	.00	.11	.07	.38	.12	.00		
13. SOC	.01	.02	.00	.01	.14	.00	.02	.01	.77	.02	.00		

*All entries not identical are significantly different at P = .01.

DEFINITIONS OF ABBREVIATIONS USED IN TABLES 1, 2, AND 3.

1. WOK . . . Work
2. PER . . . Personal Business
3. MED . . . Medical-Dental
4. SCH . . . School
5. SOE . . . Social-Eat Meal
6. CGM . . . Change Mode
7. SHP . . . Shop
8. REC . . . Recreation-Ride
9. HOM . . . Home
10. BUS . . . Business
11. SEV . . . Serve Passenger
12. TOT . . . Total
13. SOC . . . Social

TABLE 2

TRIP PURPOSE MATRIX OF TRANSITION PROBABILITIES FOR WEEKDAY TRIPS*

From \ To	1. WOK	2. PER	3. MED	4. SCH	5. SOE	6. CGM	7. SHP	8. REC	9. HOM	10. BUS	11. SEV	12. TOT	13. SOC
1. WOK	.00	.03	.01	.00	.14	.00	.04	.01	.65	.07	.05	.09	.03
2. PER	.02	.13	.01	.01	.08	.00	.12	.00	.56	.03	.04	.05	.04
3. MED	.01	.07	.01	.01	.08	.00	.16	.02	.59	.02	.02	.01	.00
4. SCH	.01	.02	.01	.03	.06	.02	.03	.02	.79	.00	.02	.04	.02
5. SOE	.01	.02	.00	.01	.11	.00	.06	.03	.59	.11	.05	.11	.13
6. CGM	.01	.07	.00	.24	.08	.01	.07	.07	.32	.00	.04	.00	.01
7. SHP	.00	.04	.00	.00	.07	.00	.16	.01	.65	.01	.04	.10	.09
8. REC	.01	.01	.00	.01	.07	.00	.02	.04	.79	.01	.03	.06	.05
9. HOM	.21	.10	.01	.11	.16	.00	.14	.12	.00	.03	.11	.39	.53
10. BUS	.02	.02	.00	.00	.07	.00	.03	.01	.41	.41	.04	.16	.10
11. SEV	.09	.05	.00	.01	.08	.00	.07	.02	.50	.02	.15	.00	.00
12. TOT	.09	.06	.01	.04	.11	.00	.10	.06	.37	.16	.00		
13. SOC	.02	.03	.00	.02	.08	.00	.05	.01	.76	.03	.00		

*All entries not identical are significantly different at P = .01.

TABLE 3

TRIP PURPOSE MATRIX OF TRANSITION PROBABILITIES FOR WEEKEND TRIPS*

From \ To	1. WOK	2. PER	3. MED	4. SCH	5. SOE	6. CGM	7. SHP	8. REC	9. HOM	10. BUS	11. SEV	12. TOT	13. SOC
1. WOK	.01	.03	.00	.00	.12	.01	.05	.01	.67	.06	.05		.01
2. PER	.01	.12	.01	.00	.10	.00	.16	.03	.51	.01	.04		.02
3. MED	.00	.16	.00	.00	.05	.00	.37	.00	.41	.00	.00		.00
4. SCH	.00	.00	.00	.00	.09	.00	.00	.00	.91	.00	.00		.00
5. SOE	.00	.01	.00	.00	.15	.00	.05	.03	.72	.01	.03		.24
6. CGM	.14	.00	.00	.00	.35	.00	.00	.00	.51	.00	.00		.00
7. SHP	.00	.02	.00	.00	.09	.00	.17	.02	.66	.07	.03		.05
8. REC	.00	.01	.00	.00	.10	.00	.02	.04	.80	.00	.02		.06
9. HOM	.08	.10	.01	.01	.40	.00	.14	.17	.01	.02	.08		.60
10. BUS	.02	.01	.00	.00	.09	.00	.02	.00	.44	.41	.02		.02
11. SEV	.02	.07	.00	.00	.12	.00	.09	.04	.54	.01	.11		.00
12. TOT													
13. SOC	.00	.01	.00	.00	.17	.00	.10	.02	.79	.01	.00		

*All entries not identical are significantly different at P = .01.

that he is at work is 0.65.

Trip purpose categories used in the Tri-County data are, with minor exceptions, typical of metropolitan surveys and have generally accepted interpretations. One exception is that social trips are paired with eat-meal trips in the Tri-County data, while social trips are usually paired with recreational trips. A description of the trip purposes used by the Tri-County and in this section is given in Appendix C.

By examining column nine of Table 1 it can be seen that the majority of all trips, regardless of origin, have home as the destination. For trips leaving from home, there is an expected probability of 0.24 that an individual is making a social-eat meal trip. Work trips, shopping trips, and recreation and ride, in that order, are the next most frequently chosen trip purposes as one leaves home.

From school, by far the most frequent destination is home. Social-eat meal is the next most frequent trip destination from school. Individuals leaving from work are most often returning home, as shown by a transition probability of $p = 0.65$. The next most frequent trip destination from work is social-eat meal, with a probability of $p = 0.13$. This reflects, to a degree, trips made by individuals going to lunch from work. Trip destinations highly linked with personal business, other than home, are personal business, and shopping, and latter of which is essentially a form of personal business. Since a medical or dental trip is also a type of personal business and frequently requires the individual to go to a commercial district of the city (where personal business can also be undertaken), the fact that it is linked to personal business is explainable. The shopping trip is most heavily linked to itself, showing the presence of multi-stop shopping trips. Medical-dental, personal business, and shopping are highly linked with one another. These three trip purposes are somewhat strongly linked to social-eat meal as well. Apparently, individuals are apt to end their personal business with a meal or snack, therefore, raising the probabilities in the social-eat meal column. Individuals are not as likely to begin personal business after a social-eat meal trip, however.

Other than with home, change mode is linked to work and school, meaning that these two purposes have a noticeable share of mass transit users. Serve passenger is highly linked to itself, however. Recreation and ride is overwhelmingly linked to home, as this trip purpose is, along with the social trip, an individualistic type of activity that most often occurs as a single trip from home. The next most highly linked trip purpose with recreation and ride is social-eat meal.

The probability of an individual returning home after a business purpose is the second lowest in column nine. Equal to this probability is the business trip linked to itself, showing the presence of individuals who make business their mode of work. Examples are individuals who are traveling salesmen, telephone repairmen, vending machine operators, and parcel postmen. The column entitled "total" in Table 1 shows that individuals,on the whole, travel most often to home, next most often for social-eat meal, and then for shopping, business, work, and recreation and ride, in that order.

An examination of the transition probabilities for weekday, as seen in Table 2, shows that work is more highly linked than in Table 1 to social-eat meal, showing the enlarged relative frequency of the trip to eat from work over the lunch break. Social-eat meal for the weekday, as opposed to the entire week, is more highly linked with business, as individuals return to work or to business activity after the lunch period. This table shows, as is expected, that trip linkages from home to work are more frequent on weekdays than on all days. Trips to and from business and work show higher probabilities for weekdays than for all days of the week.

For weekend trips alone, as seen in Table 3, the probability of going from social-eat meal to social-eat meal is higher than for weekday trips alone. This is due, in part, to the fact that by far the largest portion of multi-stop social journeys occur on the weekend when individuals have time to make more than one social engagement. Trips from home to social-eat meal in Table 3 show a substantially higher probability, p = 0.40, than trips from home to social-eat meal for weekday, p = 0.16, displaying, as previously shown, that 67 percent of social trips occur on the weekend.

The linkage of social trips to trips for other purposes, although generated separately, is also shown in Tables 1, 2, and 3. As can be seen from the last two columns of Table 1, 57 percent of all social trips have residential origins, or home as the purpose at origin. This value is substantially higher than the comparable value for total trips, of which only 38 percent have residential origins. It can be seen that 20 percent of all social trips have a previous social trip occurring just before them, suggesting the importance of multiple-stop social journeys. Only 16 percent of total trips have social-eat meal as the purpose at the origin.

Another striking difference between social trips and all trips is the fact that another 10 percent of social trips start from work or business origins, whereas 25 percent of total trips start from these origins. Another 6 percent of social trips start from shopping origins, whereas almost twice this amount of total trips begin from shopping origins. Social trips, as linked to other trip purposes at the latter's destination, differ substantially, therefore, from total trips with respect to basic linkage pattern. Social trips occur primarily from home to another residence and back home again, with a relatively low probability that an individual travels to a social stop on a journey with most other activities.

By examining the last two rows of Table 1 one can see the ways in which individuals select trip purposes from social trips, as compared to selecting trip purposes from total trips. Total trips may be considered the same as an average trip in this discussion. The entries in the last two rows of Table 1 indicate the probability of an individual making a stop at the purpose labeled on the columns. The basic difference is that individuals usually go home after a social trip, $p = 0.77$, whereas after an average trip the probability is 0.38 that an individual will go home. The probability of returning home from all trips (or from an average trip), $p = 0.38$, is seemingly low. However, it is low because this value also includes trips made from home, constituting well over a third of all trips made, none of which have home as the destination.

In every category, except social, the probability of an individual stopping at a particular trip purpose after a social contact has been made is much lower than for total trips. This indicates, once again, the high likelihood that individuals return primarily to home after a social contact has been made, but may also travel to other social contacts, rather than to other types of trip purposes. One of the reasons for this relationship is the fact that the largest number of social trips occur in the evening hours. After their completion, few other types of spatial opportunities are available to individuals and home is the most logical destination.

Columns and rows twelve and thirteen in Table 2 and Table 3 show similar types of information for weekday and weekend trips as Table 1 did for total trips. The basic difference between all trip purposes linked to social trips for weekdays compared to weekend days is the fact that during the week there is a higher probability that an individual will go from a work or business trip purpose to a social trip purpose. These former purposes include not only work and business purposes, but also personal business, medical-dental, and shopping purposes. The probabilities for these activities for weekday, as shown in Table 2, are significantly higher, in general, than are the probabilities for these activities for the weekend, shown in Table 3.

Another basic difference is the fact that on a weekday, individuals tend to link their social-eat meal trips with social trips somewhat less often than on the weekend, as shown by a probability of $p = 0.13$ compared to $p = 0.24$. Similar relationships are shown by the activities individuals choose after leaving a social contact. These relationships are shown in the last row of Table 2 and Table 3. Comparing these probabilities, one can see that, as expected, after a social stop has been made on a weekday, one is most likely to choose activities characteristic of weekdays.

Due to the restricted number of hours of leisure time on a weekday for most individuals, social stops are linked to each other only eight times out of one hundred on the weekday, as opposed to seventeen times out of one hundred on the weekend. Similarly, due to the fact that fewer types of activities are available on the weekend, especially on Sunday the probability is higher that an individual will return home after a social stop on the weekend, as shown by a probability of p = 0.79, compared to only p = 0.76 on a weekday.

A general relationship for all social trips, including weekday and weekend travel, is that there exists a much higher probability tha an individual will go home from a social trip than go from home to a social trip. P = 0.77, in the last row of Table 1, means that, when a social trips are considered, there is a strong probability that an individual will go home after the trip. This approaches the highest probability of homeward travel of the analysis, with only recreation and ride being slightly higher.

<u>Multi-stop Social Journeys</u>

In the previous section of this chapter, it was shown that socia trips are linked to other trip purposes on a journey from home somewha less frequently than the average. If an individual does link a socia trip with another trip purpose, or another social trip, he has made what may be called a multi-stop social journey. This portion of the social trip linkage analysis will examine the extent to which differen individuals tend to make these multi-stop social journeys. The purpos is to determine to what degree people in different income, race, and a groups link trips on social journeys, and under what conditions of location and household size this linking occurs.

In this analysis, a multi-stop social journey is defined as a journey or series of stops during which there was at least one social stop. The method used to determine if a multi-stop social journey occurred was to isolate individuals in the survey data and examine their sequencing of trips. The sort sequence for the data was by survey number, household number, person number, and trip number. Identification of multi-stop social journeys was accomplished by matching, simultaneously, the person number with the household number. When the household number changed, or when a person number changed, a different person's trips were being recorded, and a break in the sequence of trips occurred.

When a sequence of matches occurred between person number and household number, then a person made more than one trip in a sequence. By checking the purpose at origin, one could determine whether a multi-stop trip was made. For example, the purpose at origin of the first trip that a person made for the day in question would be coded as nine, home. The trip was made from home to another purpose. If the purpose at the destination was social, then this was one leg of a social journey from home. If the second trip that was made was from a social stop to another social stop, then this person was regarded as linking social stops on the same journey away from home. In this case, two stops were made. Observations which included other stops linked to social stops at the origin, although few in number, were included in this analysis; yet each destination used in the analysis was a social stop.

Frequencies of stops on social journeys were divided into four categories. A frequency of one indicated a single stop on a social journey from home. A frequency of two indicated that an individual made a total of two stops on the same social journey. Similarly, a frequency of three and four indicated that three stops and four stops were made, respectively, on the same social journey.

The number of stops on a social journey away from home was then considered to be the focus of attention and treated as the dependen variable. It was regressed with variables that were thought by the author to have some bearing on the linking of stops on a social jou These included the individual's income, household size, age, sex, ra and location in the urban area. Variables and their associated code used in this analysis are shown in Table 4. For the last variable, location, a simple code was constructed, with a value of one indicat that the individual was a city dweller and a value of two indicating that the individual lived in a suburb outside the city limits. Alth there are seventeen census tracts out of sixty classified as suburba less than one-seventh of the population in the Five-Township Area resides in those tracts.

A regression analysis with stepwise addition of variables was performed. The results of the regression with addition of variables although displaying generally weak relationships, are shown in Table A minimum significance of P = 0.15, rather than P = 0.05, was origin used in order to exclude only very weak relationships, and thereby g a more complete picture of the role that the independent variables p in explaining the dependent variable. The intention was to later ru the regression with a minimum significance of P = 0.05, but all vari entered into the regression in the initial run with the least signif having P = 0.05. The most significant variable was suburban, with household size, age, income, race and sex explaining lesser amounts variation. A negative relationship was shown for the suburban varia meaning that people in the city make more stops on social journeys t people in the suburbs. A possible explanation is that people in the live in more dense areas and are closer to a larger portion of peopl

TABLE 4

REGRESSION WITH SETPWISE ADDITION OF VARIABLES
FOR MULTI-STOP SOCIAL JOURNEYS

Variable	Name	Code Values
X (1)	TRIPSTOP	Number of Stops
X (2)	INCOME	8 Income Intervals (1 = Low, 8 = High)
X (3)	HHSIZE	Actual Size
X (4)	AGE	Actual Age
X (5)	SEX	1 = Male, 2 = Female
X (6)	RACE	1 = White, 2 = Non-White
X (7)	SUBURBAN	1 = City, 2 = Suburb

Step	Variable	R^2	Increase	Sign	P	Variables Not Included
1	X (7)	0.243	0.243	–	<.01	X (2), X (3), X (4), X (5), X (6)
2	X (3)	0.268	0.025	–	<.01	X (2), X (4), X (5), X (6)
3	X (4)	0.280	0.012	–	<.01	X (2), X (5), X (6)
4	X (2)	0.285	0.005	+	<.01	X (5), X (6)
5	X (6)	0.289	0.004	+	.02	X (5)
6	X (5)	0.291	0.002	+	.05	

and, therefore, must spend a smaller amount of time and travel cost in stopping in more than one place.

The next strongest relationship (the variable which contributes most to the remaining unexplained variation in the dependent variable after the first regression) is between the number of stops on a social journey and household size, although it adds only 2½ percent. It sho a negative relationship. This may be due to the fact that smaller households, consisting of single individuals and couples, are mobile, with the ability to make many trips from home. They, therefore, have capacity to make a larger number of stops on social trips, compared t larger families who have children. The next most important relations again negative, is with age, indicating that younger individuals tenc to link social trips more than older individuals. In a later section it will be shown that age is negatively related to social trips. Thi fact may also be important in explaining why younger individuals make more multi-stop social journeys.

Income was the next variable to enter the analysis and it was th last variable to be significant at the $P = 0.01$ level. The last two variables entering the regression, race and sex, show weak positive relationships, meaning that non-whites and females (white and non-whi are more apt to link social stops than are whites and males. Analysi of variance for overall regression was significant at less than P = C due primarily to the large sample size of 1822 observations. However only 26 percent of the total variation was explained, giving generall weak relationships. If parsimony was a criterion, only the first one or two variables would remain.

Another regression was run with the presence of a multi-stop soc journey coded as a value of two and the presence of a single stop on a social journey coded as a value of one. The results of the analysis did not improve the amount of variation explained in the previous analysis, however. These results suggest that the social trip is an individualistic and a complex trip and does not correspond well to linking characteristics of other trips. This may be due to the variability of individuals' preferences for and attitudes concerning social interaction, something on which data do not exist at present. If this is true, socio-economic and demographic variables may not be adequate predictors of social trip generation. The next two sections of this chapter are undertaken in order to determine to what degree variables on which data are available can help explain social trip generation.

Socio-Economic and Demographic Structure of Social Trips

The distribution of social trips by age presents some important variations. Figure 5 shows the distribution of social trip frequency by five-year age intervals. The trip frequency metric on the y-axis is the ratio of an age interval's percent of social trips to the age interval's percent of total population. A value above +1.0 indicates that an age interval makes more than an average portion of social trips. Those below +1.0 are age groups making less than an average share of social trips. The first three age intervals have a below average amount of social trips. It is expected that a large percentage of social trips made by individuals of these age intervals are not vehicular and, therefore, not included in the data, making the frequencies in Figure 5 for these age categories small.

Figure 5 shows that the frequency of social trips peaks at age

SOCIAL TRIP FREQUENCY BY AGE

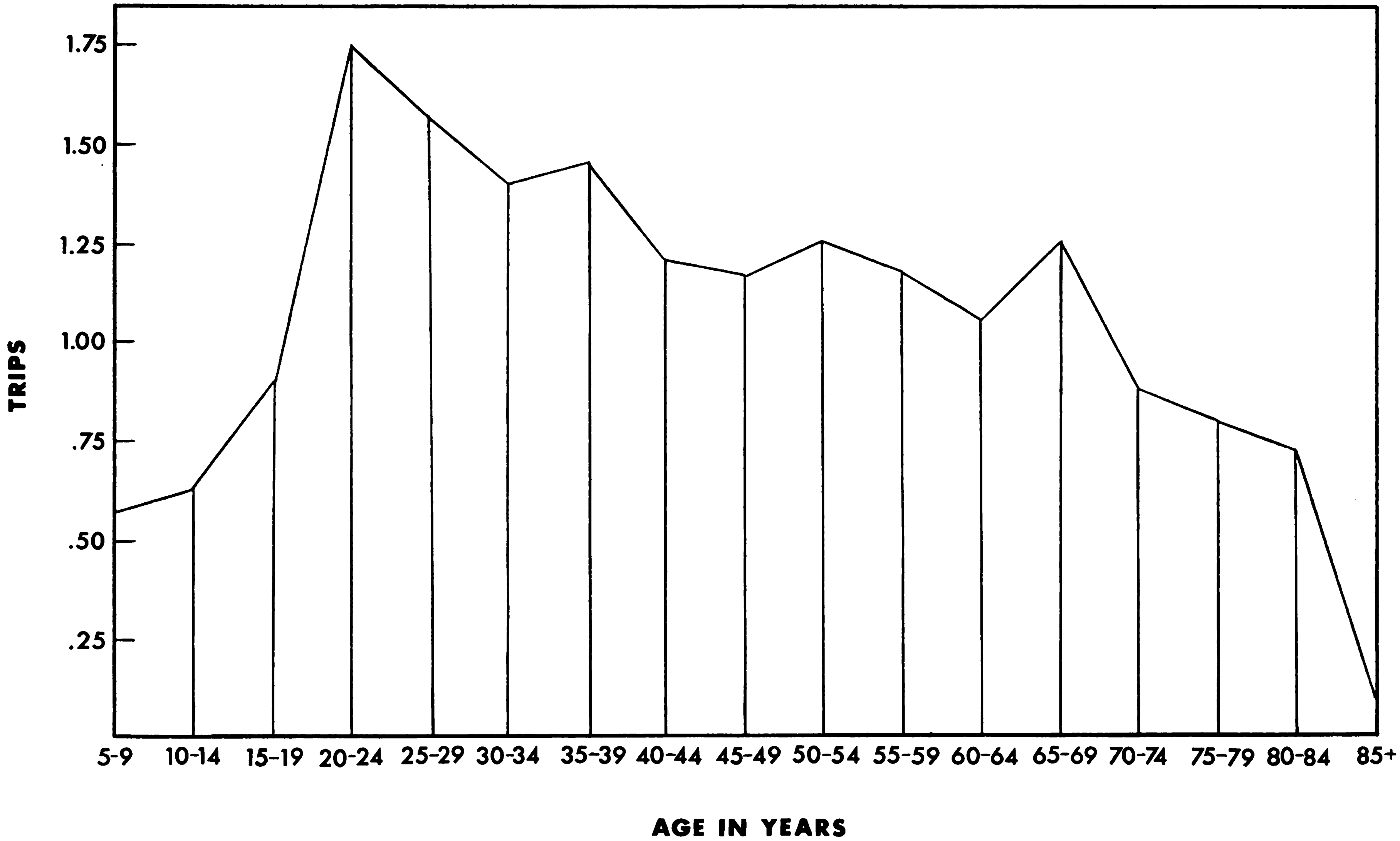

FIGURE 5

twenty to twenty-four, and generally declines thereafter, with several smaller peaks occurring in the late thirties and the early fifties. The peak in social trips at age twenty to twenty-four is, perhaps, due to the large emphasis placed on social activities by members of this age group. It is between ages twenty and twenty-four that most individuals pursue a marriage partner, for example. After age twenty-four many individuals are married and total social activity declines. The two previous age categories reflect the presence of many non-drivers and even fewer car owners. These effects help make the twenty to twenty-four age group have the highest relative frequency of social trips. A definite increase in social trip frequency is shown for individuals between sixty-five and sixty-nine, after which there is a rapid decline in number of social trips with age. This latter age group represents recently retired individuals. It is possible that these people use their increased leisure time for social visiting purposes, making trips primarily to visit relatives. In sum, social trips make up a relatively large share of trips for those individuals in the twenty to forty age group. But after the late thirties, the social trip purpose is decreasingly selected, except for the first few years of retirement.

The relative frequency of social trips by income, occupation, household size, sex, and race also reveal interesting variations. Table 5 gives the relative social trip frequency for these variables by various data intervals. In this table, each value represents the ratio of the percent of social trips made by persons in a data interval to the percent total trips made by persons in that interval, as computed from the 1,151,769 expanded trips on the tape. This ratio is referred to, henceforth, as the relative social trip frequency. A relative social trip frequency larger than unity indicates that persons in the interval

TABLE 5

RELATIVE SOCIAL TRIP FREQUENCY BY DATA CATEGORY

Code	Income (dollars)	Relative Social Trip Frequency (RSTF)	Code	Occupational Class	Relative Social Trip Frequency (RSTF)
1	0	1.46	1	Professionals and Technical Workers	0.86
2	1- 2,999	1.18			
3	3,000- 4,999	1.15	2	Managers	0.80
4	5,000- 6,999	1.00	3	Sales Workers	0.94
5	7,000- 9,999	1.12	4	Clerical and Kindred Workers	1.21
6	10,000-14,999	0.94			
7	15,000-24,999	0.76	5	Craftsmen and Foremen	1.06
8	25,000+	0.62	6	Operatives	1.23
			7	Service Workers	0.90
			8	Laborers	0.69
			90	Not in Labor Force	1.10

Code	Sex	RSTF	Code	Race	RSTF
1	Male	0.85	1	White	0.98
2	Female	1.17	2	Non-White	1.26

Table 5 (cont'd.)

Code	Household Size	RSTF
1	1	1.23
2	2	1.26
3	3	1.14
4	4	1.02
5	5	0.80
6	6	0.62
7	7	0.98
8	8	0.40
9	9	0.97
10	10+	0.96

Code	Mode	RSTF
1	Auto Driver	0.91
2	Auto Passenger	1.27
3	Bus Passenger	0.18
4	School Bus Passenger	0.16
5	Taxi	0.90
6	Truck	0.69

made more than an average portion of social trips. In Table 5
values for the eight income intervals tend to decline with inc
income. The two middle intervals are the only data units not
to this pattern, while the two extreme intervals have, by far,
strongest patterns. Apparently low income families make a dis
tionately large share of social trips, perhaps substituting th
other leisure time activities which require monetary cost. In
social activity is a cheap method of entertainment, compared t
natives such as going to a movie or to the country club.

The distribution of relative social trip frequency by occ
shows extremes of the occupational ranking to have smaller tha
relative frequencies, while the middle categories, clerical, c
and operatives, or about 59 percent of all those in the labor
have higher than average relative frequencies. Approximately
of all trips are taken by those not in the labor force. Fifty
percent of social trips are made by these individuals, includi
unemployed, and housewives, however. No doubt the presence of
number of females in this latter group, as well as in clerica
helps explain the higher relative social trip frequencies of t
groups.

As can be seen from the variable, sex, females make more
an average share of social trips, accounting for approximately
percent of all social trips made. Non-whites make more social
compared to total trips than do whites, the former correspondi
lower income groups. The distribution of relative social trip
by household size shows generally that smaller households make
social trips relative to total trips than do larger families.

small families seek more out-of-the-home activities to occupy leisure time, whereas larger families function more as a unit within the family more often than interacting with another fa

The distribution of social trips by mode of travel shows trips are made most often by auto, as opposed to mass transit This may be due partially to the fact that, as shown by the h distribution in Figure 2, most social trips take place in the Since auto provides door-to-door service as well as being a c and convenient mode of transportation, the auto is highly pre People tend to travel in groups of two or more on social trip than singly, as is shown by a higher relative frequency of au as compared to auto driver trips. The auto is efficient for more individuals as only one set of fixed and operating costs Relationships between variables and social trips have been su and these variables will now be used to explain social trip f

Explaining Social Trip Frequency

A difficulty arose when the author tried to explain the of social trips. No data unit on which to form variability o trips existed that could easily be compared with variables su income, age, sex, race and location. Social trips were sorte all trips, but each had a frequency of one, with a variance o Therefore, trips could not be treated as observations. Since were recorded for each respondent for only one day, treating as observations was infeasible. Two methods were used to exp trips, however.

Data Interval Method

One method is to explain the variation of social trips with socio-economic variables by correlating the relative frequency of social tri for each data interval of a variable with the corresponding interval's rank for that variable. For example, if the variable, income, was selected, then the rank of the data interval, \$0.00-\$3,000.00, is correlated with the corresponding relative trip frequency value for that income interval. Such data for income and household size used to explain relative social trip frequency are shown in Table 5. This met is limited to the simple two-variable case, as data intervals between variables are not comparable (income \$0.00 to \$3,000.00 compared to a household size of five, for example). One is also restricted to a relatively few number of observations, depending on the number of data intervals for a variable.

The correlation between relative social trip frequency and income yielded a simple correlation of r = -0.94 (P<.01, N = 8), suggesting t lower income individuals make a larger proportion of social trips comp to all trips than do higher income individuals. This relationship is especially important because it is contrary to the only previous trip study remotely related to the study here. Findings for Chicago have shown, as discussed above, that higher income individuals make more social-recreation trips than do lower income individuals (Sato, 1965). Apparently lower class people substitute for non-home recreation and entertainment the less expensive, in-the-home activities of visiting friends, as was previously suggested.

The data points in the diagram of age and relative social trip frequency, Figure 5, form a generally negative slope. By omitting all

individuals twenty years of age and younger, the majority
non-drivers, age of individuals and vehicular social trip
highly correlated (r = −0.87, P<.01, N = 14).

Another variable, suggested in the last section as be
in predicting the number of social trips made by individua
household size. The ten classes of household size used in
Interview Survey and shown in Table 5 were correlated with
frequency of social trips made for each household size cla
was, as expected, a negative correlation (r = −0.58, P =
showing that larger families substitute more in-the-home a
social travel than do smaller families.

These three regressions were conducted individually b
did not exist on a small level of aggregation which could
into a common regression problem. The separate regression
tant relationships to exist between social trips and incom
household size and, therefore, constitute significant find

Areal Aggregation Method

The second method for explaining social trip frequenc
common data base on which all variables can be aggregated.
unit provided the necessary data unit of analysis. In thi
variables can be entered into the same regression, but res
weakened because of the heterogeneity of a large data unit
degrees of freedom. Nevertheless, this type of analysis w

The only common unit on which data were gathered and
contained on each record of data was the census tract. Si
tracts were demarcated in the Five-Township Area and these

the regression analysis. Since the census tract level of analysis is a rather gross level of data aggregation, with approximately 4000 persons per tract, the population of each is somewhat heterogeneous in socio-economic and demographic characteristics, yielding large sample variability.

Nonetheless, the relative frequency of social trips for each census tract was computed by dividing the percent of social trips for a tract by the percent of all trips for that tract. Social trip frequency was considered the dependent variable and it was regressed with median family income, average age, average household size, population density, and automobile ownership for each tract. In this regression, income and social trip frequency had a simple correlation of $r = -0.23$ ($P = .08$, $N = 60$). The other variables entered in the analysis were not significant at the $P = .10$ level. The multiple correlation coefficient for the regression was $R = 0.27$, explaining only $7\frac{1}{2}$ percent of the total variation. It is surprising that any relationship at this heterogeneous census tract level is significant. This regression points out a definite negative relationship between social trip frequency and income.

Frequently, urban planners find that the best estimator of total trip generation in an area is the population of that area. Some form of population measurement is almost always present in their trip generation equations, and is highly correlated with the number of trips produced (Chicago Area Transportation Study, 1960). The frequency of social trips per census tract for the study area was regressed with two measures of population, the tract's household population and the tract's group quarters population. The equation is

$$Y = 519 + 0.24 \text{ HH POP} + 0.03 \text{ GQ POP}.$$

The resulting multiple correlation coefficient was R = +0.52 (P = .01, yielding a multiple coefficient of determination of 0.26, with a standa error of the mean of 0.46. Again, the variability and uniqueness of the social trip is shown.

The correlations between income and social trip frequency can be shown, to some degree, by mapping the patterns. Figure 6 shows a computer map of the distribution of income by census tract for the Five-Township Area, and Figure 7 shows relative social trip frequency by census tract for Lansing and East Lansing. The computer program SYMAP (1969) was used to construct these maps.

For each figure, contour lines emerge from a data plane at selecte levels which are determined from the scale of the map and the range of data. For Figures 6 and 7 the values for data points (census tracts) have been divided into quintiles. Dark shading indicates higher values For both figures the approximate locations of Lansing's and East Lansing's CBD (Central Business District) are shown as reference points

Several areas of noticeably low and high income can be seen in Figure 6. The downtown section, near the CBD, lies in the lowest quintile of income. This section comprises the largest portion of Negroes in the city. Michigan State University's campus, south of the East Lansing CBD, also lies in the lowest quintile of income, basically due to the large proportion of student and unemployed individuals livir here. To the southwest of the Lansing CBD is one of the highest income areas of the city. This is the Lansing Country Club-Pleasant Grove neighborhood. The westernmost township, Delta Township, has an area of high income in the western two-thirds, with somewhat less average income in its eastern portion. Some of the residents in the western

Figure 6. Distribution of Income by Census Tract for the Five-Township Area.

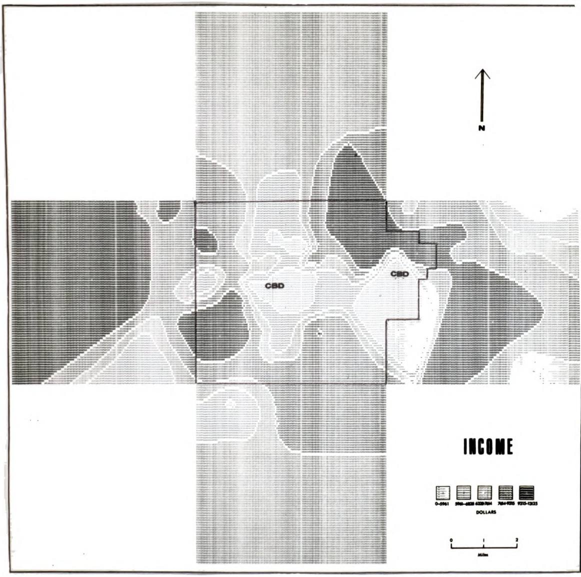
N
CBD
CBD
INCOME
0-5961
7614-9215
9215-13125
DOLLARS
0
1
2
Miles

FIGURE 6

Figure 7. Relative Social Trip Frequency by Census Tract for Lansing—East Lansing.

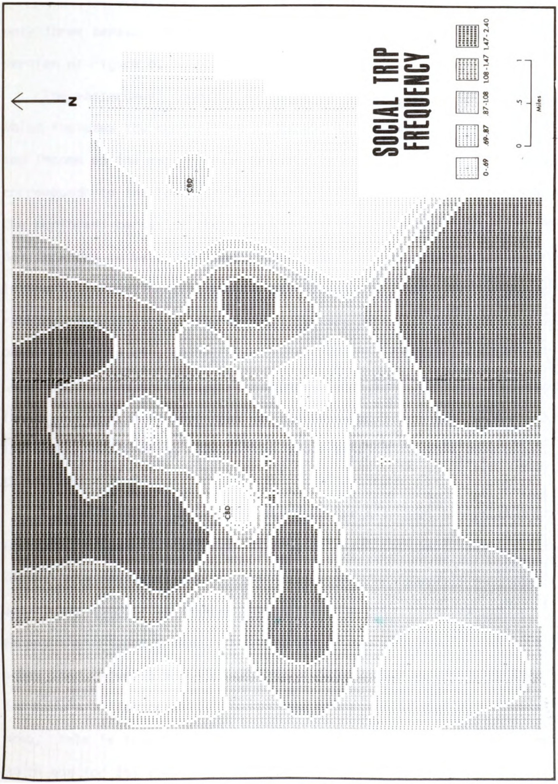
SOCIAL TRIP FREQUENCY
0-.69
.69-.87
.87-1.08
1.08-1.47
1.47-2.40
0
.5
1
Miles
N
CBD
CBD

FIGURE 7

part of Delta Township are well-to-do farmers who raise the median income of the area. Delta Township's data for this map are given by only three census tracts, accounting for the lack of detail in this portion of Figure 6.

The easternmost township of the study area is Meridian Township, which includes the communities of Okemos and Haslett. The portion of low income on the map in this township in the extreme northwest corner corresponds to the Towar Gardens suburb (also shown in Figures 12 and 14). The northeast corner of the township includes Lake Lansing and Haslett and is shown to be a low income area also. A continuous area of high income is present in the eastern and central portions of this township, running generally north and south. The northern end begins in eastern Dewitt Township and, moving south, includes the Groesbeck area of Lansing, and the Whitehills and adjacent Strathmore-Avendale neighborhoods. The high income area continues to the southeast, including Okemos and the Indian Hills area. The latter place names are shown on Figures 12 and 14.

Figure 7 shows the spatial distribution of relative social trip frequency by census tract for Lansing and East Lansing. Since relative social trip frequency and income, as measured by census tracts, are negatively correlated ($r = -0.24$), it can be said, in a figurative sense, that Figure 6 and 7 correlate at -0.24. Figure 7 is on a larger scale than Figure 6 and the outline of Figure 7 is shown on Figure 6. For Figure 7, low relative frequencies characterize the East Lansing area. This is true for both the high income residential areas to the north and for the low income student housing areas to the south, the latter being deficient in vehicular trips. In the city of Lansing, no obvious relationship can be seen between relative social trip frequency and income, although in the lower income central portion of Lansing the majority of tracts have above average relative frequencies.

CHAPTER III

SOCIAL TRIP DISTANCE SENSITIVITY

An important consideration in a study of spatial human interaction is the friction of distance experienced by individuals. Although it is presumed that social travel will exhibit a distance decay function similar to that found for most other human spatial interaction, the degree to which this is true remains to be tested. Few studies have examined distance decay changes with occupation (Wheeler, 1969), and none have done it for social travel. This chapter is divided into two parts. The first section will examine the diminuation of social interaction with increasing distance. The second section will examine social trip length by occupational status.

Distance Decay of Social Trips

In order to test the distance decay concept and the effect of distance on social interaction, an analysis was performed with social trips between traffic districts. A traffic district is somewhat smaller than a census tract. There are eighty in the study area. Measurement was made on the traffic district level in order to gain a finer discrimination of distance than could be obtained at the census tract level.

The first stage of the analysis was to tabulate the frequency of unexpanded trips between and within cell districts. Inter-district airline distances were then computed between each of the eighty traffic districts. Distances were measured from the center of each district and were measured to the nearest one-fifth mile. Trips with their origin and destination in the same traffic district were assigned a value according to the distance between traffic zones that they connected.[1] If trips remained within a zone, they were assigned a distance of one-fifth mile, or the approximate radius of an average size traffic zone. Forty-four units of distance were used, each unit one-fifth mile larger than the previous one. The frequency of trips between each district was then entered into the appropriate cell of a table, from one to forty-four, depending on the distance between the two districts.

An idea of the nature of the distance decay relationship can be gained by plotting the values on a graph, Figure 8. On the y-axis is frequency of social trips and on the x-axis is distance. The scatter of points on the graph shows two interesting elements: 1) the decline of points is not smooth, and a somewhat large variation about a least squares line exists; and 2) the least squares line is not linear, but concave outward. In the simple regression with frequency of trips as the dependent variable and distance traveled as the independent variable, a correlation of $r = -0.66$ ($P < .01$, $N = 44$) was found, explaining 43 percent of the total variation in trip frequency. Distance, therefore, has a relatively strong negative effect on social interaction.

It was expected that a moving mean transformation to smooth the data may improve the relationship, since the distance units (one-fifth mile), as well as the traffic district level of analysis, are arbitrarily chosen data units. Therefore, it was felt that the use of a moving

[1]Traffic zones are smaller than traffic districts, and there are approximately 300 traffic zones in the study area. Trip data have been summarized on this basis (traffic zone) for some sections of the analysis, including the next section of this chapter. Traffic zone boundary determinants include major roads, political boundaries, land use homogeneity, census tract boundaries, natural features such as rivers, and minimum and maximum land area limitations. The 300 traffic zones are condensed into eighty traffic districts, using the applicable traffic zone determinants to delineate the districts.

SOCIAL TRIP FREQUENCY BY DISTANCE

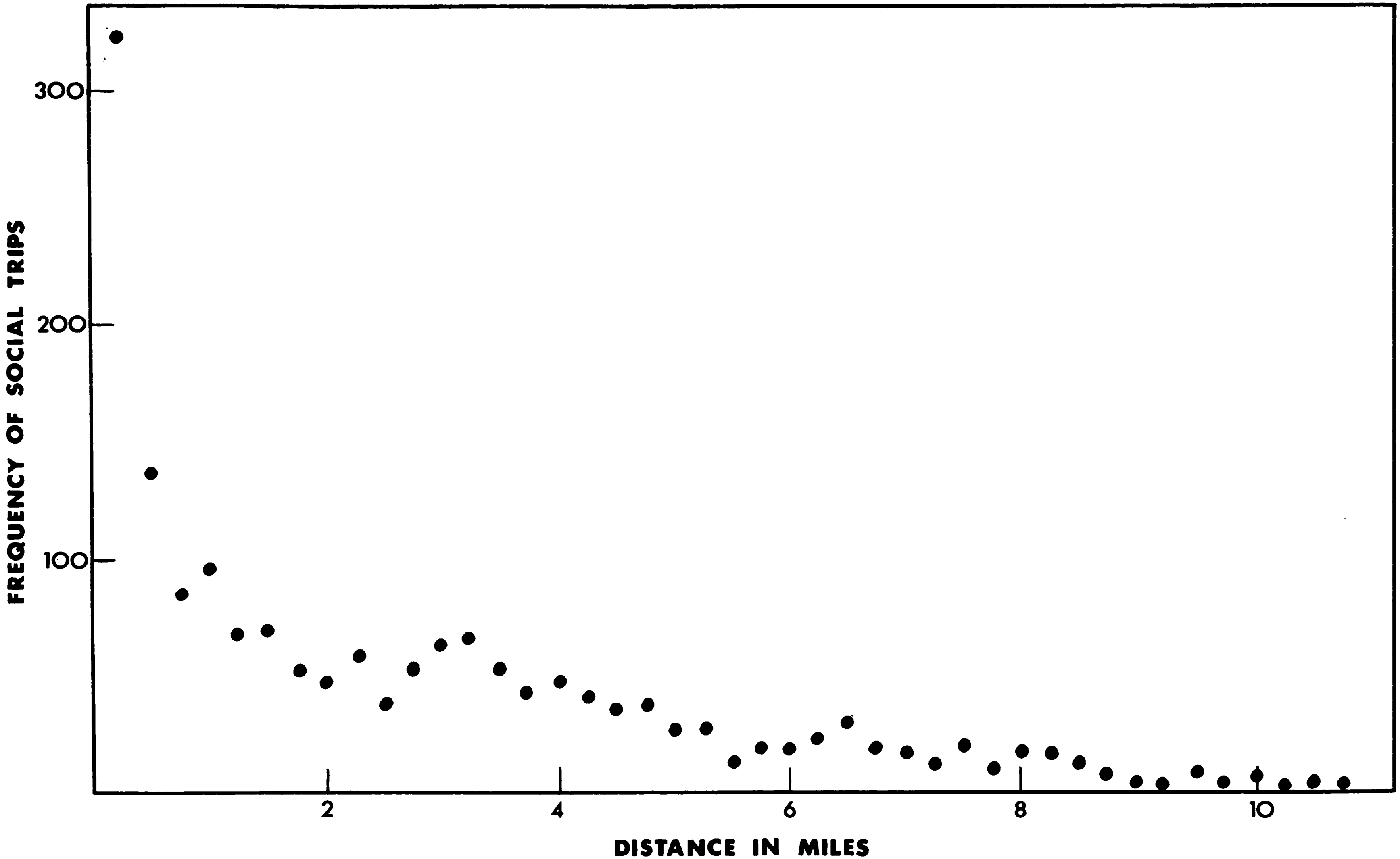

FIGURE 8

mean on the trip frequency data would not be harmful on theoretical grounds. Three-point moving means of the original trip frequencies were computed, and the resulting data points were regressed with distance. The correlation of this run was $r = -0.78$ ($P < .01$, $N = 44$); the initial relationship was improved by 28 percent. This correlation is still significant at the $P = .01$ level, even though the number of degrees of freedom are reduced to one-third the original amount because of the use of the moving mean. The use of the moving mean suggests that if a larger sample was available, local variations in the data may well be reduced, resulting in stronger relationships than can be shown here in the simple regression with untransformed frequencies.

The concavity of the scatter plot was due primarily to the steep negative sloping of the graph for the short distances, especially for distances less than one mile. Large frequencies at the short distances added an upper tail to the scatter of points. A noticeable flattening out of the graph was observed, beginning approximately one mile from the origin. It was thought that a logarithmic transformation of distance would help straighten the scatter of points, and thus improve the statistical relationship and explained variation.

Therefore, the logarithm of the distance was computed and regressed with social trip frequencies. A strong correlation resulted ($r = -0.84$, $P < .01$, $N = 44$), explaining 71 percent of the total variation in the frequency of social trips. By transforming the raw distance units to log distance units, an extra 38 percent of the variation over the initial run was explained, showing the non-linearity of the distance - frequency relationship for this data. A higher correlation with the log transformation suggests that human behavior does not vary linearly with distance, but maybe more closely approximated by raising distance to a power.

Next, both transformed variables, the moving mean of frequencies, and the log of distance units, were entered into the same regression. The strength of the relationship rose still further ($r = -0.93$, $P < .01$, $N = 44$), explaining 86 percent of the total variation in the data. This was a total improvement of 43 percent over the original analysis which used raw variables. Figure 9 shows the relationships between the two transformed variables. Results for the four distance decay problems are summarized in Table 6.

The negative curvilinear relationship between frequency of social trips and distance is explainable in the light of present theory. The steep upper tail of the scatter of points shows a sharp distance decay, as individuals most often interact with people living very near them. The upper tail could be interpreted as a neighborhood component of social interaction. These social contacts live in the same neighborhood as or very near to the trip maker. After a point, the graph levels off substantially, meaning that after a certain threshold of distance is reached, which is probably dependent on the population density, people interact over longer distances and the frequency of social trips tapers off much more slowly. The contacts several blocks to a mile and more away represent individuals who have come into social contact with people through their unique set of activities. These activities include work, school and clubs, to mention a few. These social contacts might be called a social network component of social interaction. People are not as sensitive to distance for this component, thus causing the distance decay curve to be flatter at longer distances.

A possible explanation for the flattening of the scatter, beginning at distances of several blocks to a mile, is that people make a small

TRIP FREQUENCY BY DISTANCE WITH DATA TRANSFORMED

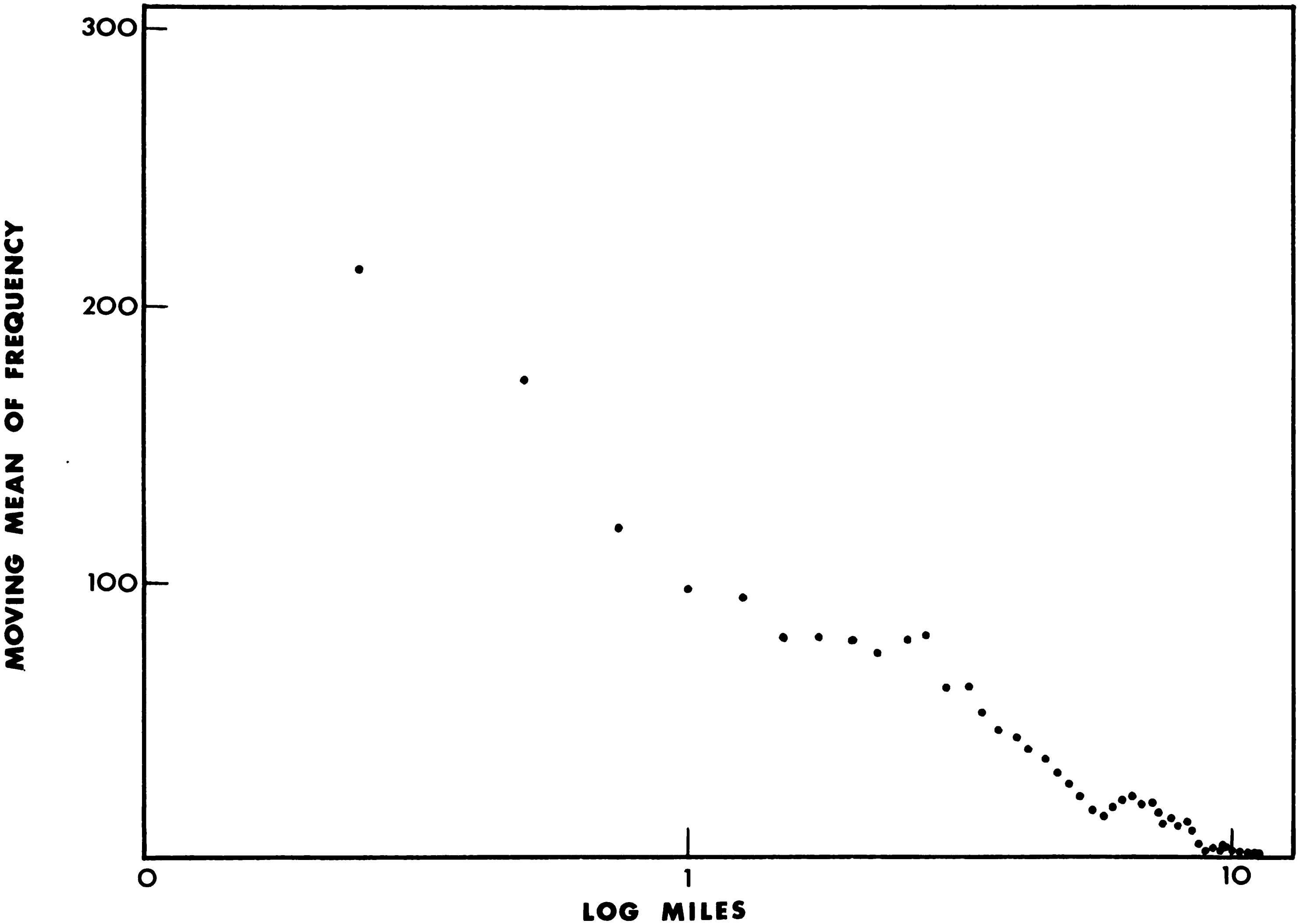

FIGURE 9

TABLE 6

DISTANCE DECAY ANALYSIS FOR SOCIAL TRIPS

	Distance			Logarithm Distance		
	r	r^2	r^2 increase	r	r^2	r^2 increase
Frequency of Social Trips	−0.66	0.43	0.43	−0.84	0.71	0.38
Moving Mean of Frequency	−0.78	0.61	0.28	−0.93	0.86	0.43

All r's significant at P = .01.

number of social trips compared to other types of trips and regard social trips as a luxury. Individuals are willing to travel the necessary distance, up to a point, to interact with whom they choose, rather than travel to the nearest person available. This is because individuals become personally involved at the destination, and expect a certain amount of personal, psychological rewards there. They are willing to travel extra distance for larger rewards at the destination, making them less distance sensitive for social trips than they might be for other types of trips. It is thought, therefore, that the upper tail of the scatter of social interaction with distance represents a neighborhood component and that the lower tail represents a social network component of social interaction. Reasons for the shape of each have been forwarded, perhaps lending explanation to the social trip distance decay phenomenon, rather than merely describing rates of decline, as is often done for other distance decay relationships. Arguments have been made for explaining such relationships in science (Kuhn, 1962). These two aspects of social interaction — the neighborhood and social interaction components — will be examined further in Chapter V when the study of a particular neighborhood in the study area is undertaken.

Social Trip Length and Occupational Status

In this section of Chapter III, mean social trip length is considered. It is hypothesized that the mean social trip length is greater for individuals of high occupational status than it is for those of low occupational status. By considering social trip length for different occupational classes, one is confronted with the questions of 1) whether a difference exists in social interaction distance sensitivity for different classes of people, and 2) whether varying social classes exhibit different inter-residential separation. Either of these two factors could have an influence on the groups' mean social trip lengths.

The mean social trip length for social classes gives some answers to the above questions. However, spatial opportunities for social interaction vary from urban area to urban area, depending on the associated urban spatial distribution of individuals. In order to measure an occupational class's social interaction distance sensitivity, it is necessary to compare the mean length of social trips for the class to a comparable measure of the class's inter-residential separation.

An attempt will be made below to explain mean social trip length for different occupational classes by comparing it with the mean inter-residential separation of the class. If the residential structure of the study area approximates classical residential rent theory, then the mean length of social trips should increase with an increase in occupational status, _ceteris paribus_.

Urban rent theory assumes a declining rent gradient away from the CBD. A household with a given preference for space is seen as attempting to maximize the utility of its income by locating a certain distance from the CBD, trading off transport inputs for savings in location rent, thus facilitating the consumption of more space. Therefore, population density declines with increasing distance from the CBD, and households identical in all respects will live at increasing distances from the CBD as a function of their income. The Lansing area is clearly not a model example of urban rent theory, as East Lansing provides a subsidiary nucleus. Nevertheless, it is hypothesized that the minimum inter-residential separation between individuals of an occupational group will rise as the status of the group rises. If this relationship holds, then the mean social trip length may well increase as occupational status increases.

The minimum inter-residential separation between individuals of eight occupational classes is computed below. Two basic data inputs were necessary for this analysis. One was a 300 X 300 matrix of inter-traffic zone distances. The other was a 400 X 8 matrix of the frequency of individuals in each of eight occupational classes for each traffic zone. Each data input was computer-generated and punched on cards.

The linear programming model used to solve the transportation problem of optimum allocation of transported goods from m supply places to n demand points is used to give a measure of minimum inter-residential separation of a given occupation. The output of the model is the shortest possible aggregate distance for all individuals X^k of occupational class k from the residences of k, S_i^k (supply places), to residences of k, D_j^k (demand points), as computed between zones. A unique feature of the application of the linear programming model of transportation to this problem is that every household of a particular social type acts both as a supply and demand unit, so that the total supply of a zone equals the total demand of the same zone. The supply of one zone cannot be used to fill the demand of the same zone, however, or the shipments effectively would be zero. This means that the results will be aggregated on the zone level, which is a small enough unit of analysis to give comparable results, but more important, it is the same data unit on which trip length was computed. Associated with the movement of individuals between zones is a cost, C_{ij}, of travel from i to j, which is considered to be a linear function of distance in this analysis.

In the objective function of the linear programming model, total cost, Z^k, of moving all individuals of occupational class k is minimized. The objective function is expressed as

$$Z^k = \sum_{i-1}^{m} \sum_{j-1}^{n} X_{ij}^k C_{ij}, \text{ where } (m = n)$$

subject to the constraints that total supply from residences and total demand at residences equal the number of individuals shipped. This is written

$$\sum_{j-1}^{n} X_{ij}^k = S_j \quad (i = 1,2,...m),$$

and

$$\sum_{i-1}^{m} X_{ij}^k = D_j \quad (j = 1,2,...n),$$

respectively. Or, total individuals moving from residences is the same as the total amount demanded at residences,

$$\sum_{i-1}^{m} S_i^k = \sum_{j-1}^{n} D_j^k.$$

Finally, movements cannot be zero or negative, or the solution would be mathematically trivial:

$$X_{ij} \geq 0.$$

The average minimum inter-residential separation, MIS, for occupational class k is

$$MIS^k = \frac{Z^k}{\sum X_{ij}^k}$$

The data described above were organized into eight matrices, using the Tucker Format. Row one of a matrix gives the destinations and row n of the matrix gives the demands for each destination. Column one of the matrix gives the origins and column n of the matrix gives the supply at each origin. The cells of the remaining n-2 X m-2 square matrix contained costs (inter-zone distances) between each pair of supply and demand points. Each of the eight matrices was then used as input into the eight linear programming problems.

MIS values for each occupation are shown in Table 7. High values of MIS for the highly ranked occupational groups indicate that these groups have greater mean separation of residences between individuals of that group. Low values for low occupational status groups suggest residential concentration of these groups. As can be observed, however, the relationship is not a perfect one. Nevertheless, the assumption of residential location of urban land rent theory, as measured by MIS for individuals of occupational classes, at least, generally seems to hold for the Lansing area.

The mean social trip distance by occupational class is shown in Table 8. An examination of the distances for the occupational ranking shows a general decrease in distance with an increase in status. The two extreme classes, the lower being laborers, (a mean social trip distance of only 1.70 miles), and the upper being professionals (a mean social trip distance of 2.49 miles), are the only exceptions to the general relationship. If these two extreme cases are omitted, a perfect negative relationship exists between the occupational status and associated mean distance traveled for social contacts. Whether or not the two extreme cases are omitted, no support can be given to the hypothesis that lower status individuals make shorter average social trips. Lower status individuals are apparently not more distance sensitive than other individuals, and may even be less sensitive. In fact, the findings lend support to the Smith (1956) hypothesis that lower income individuals travel farther for social contacts due to the presence of generally shorter residential tenure. Individuals at the

TABLE 7

AVERAGE MINIMUM SEPARATION DISTANCE BY OCCUPATIONAL CLASS

Occupational Class	Distance (miles)
Laborers	1.03
Service Workers	1.35
Operatives	1.63
Craftsmen and Foremen	1.40
Clerical and Kindred Workers	1.53
Sales Workers	1.68
Managers	2.11
Professionals and Technical Workers	2.01

TABLE 8

MEAN SOCIAL TRIP DISTANCE BY OCCUPATIONAL CLASS

Occupational Class	Distance (miles)
Laborers	1.70
Service Workers	3.05
Operatives	2.93
Craftsmen and Foremen	2.85
Clerical and Kindred Workers	2.61
Sales Workers	2.43
Managers	2.29
Professionals and Technical Workers	2.49

upper end of the occupational ranking may well live in more stable neighborhoods, a factor which would promote more friendships in the local area.

Apparently there is little relationship between the MIS of a class and the class's mean distance of vehicular social trips. This may be different for non-vehicular social trips, which are, obviously, more important in densely populated areas. These findings show that inter-residential distances between people of the same occupation are rather small compared to home-work distances (Wheeler, 1967, 1968). Yet, because social interaction is so personal, individuals prefer to travel the necessary distance, whatever it might be, to see a good friend, rather than going to the closest person. Therefore, because individuals expect rewards from a person or group that they become personally involved with at the destination, they are willing to travel to the individual's location, and the MIS seems to have little relevance. This idea, discussed in the previous section of this chapter, is discussed further in Chapter VI.

CHAPTER IV

URBAN SOCIAL INTERACTION PATTERNS

This stage of the analysis will attempt to answer the question of the extent to which urban social interaction patterns exist and can be identified in the study area. This question is actually part of a larger question of whether there is a direct connection between social structure and social interaction within an urban area. If social trips among residents in the Lansing area are plotted, with a straight line linking the origin and destination of each trip, one can identify portions of the study area that are functionally related, socially. This mapping will show if "social areas" do indeed exist, and also if different neighborhoods are linked to one another. If this linkage occurs, the channels (desire lines) of interaction between neighborhoods will be shown.

This chapter is divided into three sections. The first deals with the method of constructing flow maps of social trips. The second uses these flow maps to help determine the extent to which parts of the study area are functionally tied to one another. The constructed flow maps of social trips are examined in this section. In the third section, an attempt is made to identify discrete cohesive social areas in the larger study area. To accomplish this, an origin-destination matrix of social trips is factor analyzed to reveal portions of the study area with similar patterns of social trip origins and destinations.

Generating Flow Maps

Social trips are displayed graphically in Figures 10A, 10B, 11A, and 11B. These maps were constructed by the calcomp plotter, using the program, MAPIT (Kern, 1969). There were two basic data inputs involved in the program. One was the "individual's" deck which consisted of cards, each representing one social trip made by an individual. Each card contained coordinates of the trip-maker's residence, or the origin of the trip, and the identification number of the traffic zone of destination. Therefore, origin and destination information necessary for mapping trips was available. The individual's deck was punched directly from the tape. The second data input was the city deck, which consisted of cards, each of which included the identification number of the zone, as well as the zone's associated coordinates and its size. Therefore, the individual's deck supplied the points of origin of trips and the identification number of the points of destination. The program then located the destinations by finding coordinates in the city deck corresponding to the identification numbers. The coordinates for the traffic zones of destination for the study area that were necessary for the city deck were coded and punched with the geodigitizer.

The process requires the use of a base map with the locations of data points on it. In this case, data points were considered to be centers of traffic zones. A map such as this, with the locations of all traffic zones, did not exist because of the large variation in the size of traffic zones in the Tri-County area. Such a map was constructed for the Five-Township area, however, by manually transferring the locations of the traffic zones from a series of smaller size maps of

Figure 10B. Social Trip Flow Map for Households with Less Than Median Income.

Figure 10A. Social Trip Flow Map for Households with Greater Than Median Income.

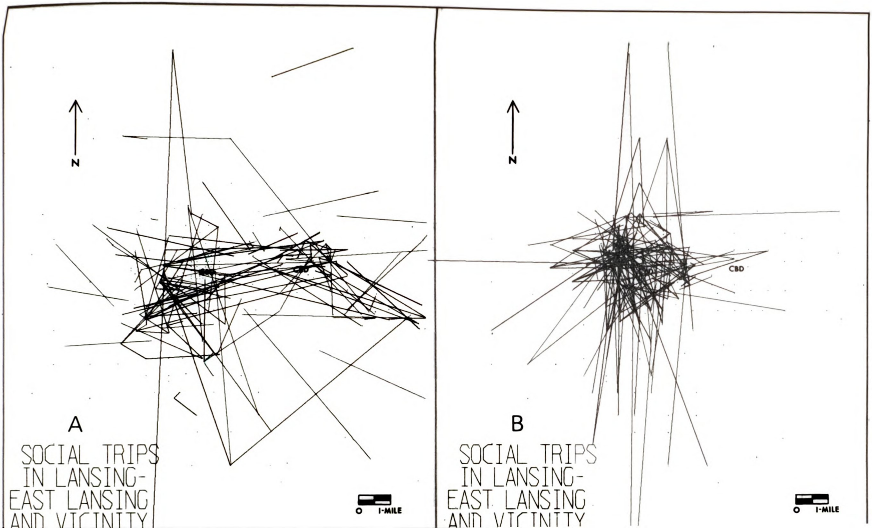
N
A
SOCIAL TRIPS
IN LANSING-
EAST LANSING
AND VICINITY
0 1-MILE
N
CBD
B
SOCIAL TRIPS
IN LANSING-
EAST LANSING
AND VICINITY
0 1-MILE

Figure 11B. Social Trip Flow Map for Michigan State University Students.

Figure 11A. Social Trip Flow Map for Non-Whites.

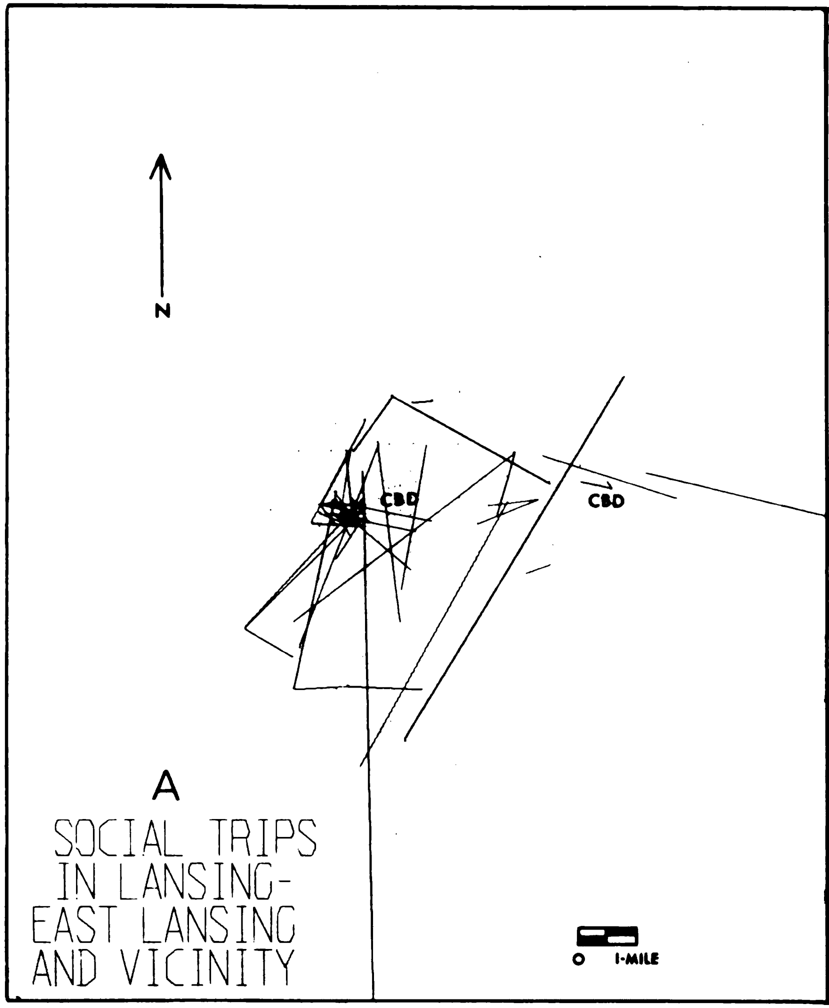

FIGURE 11A

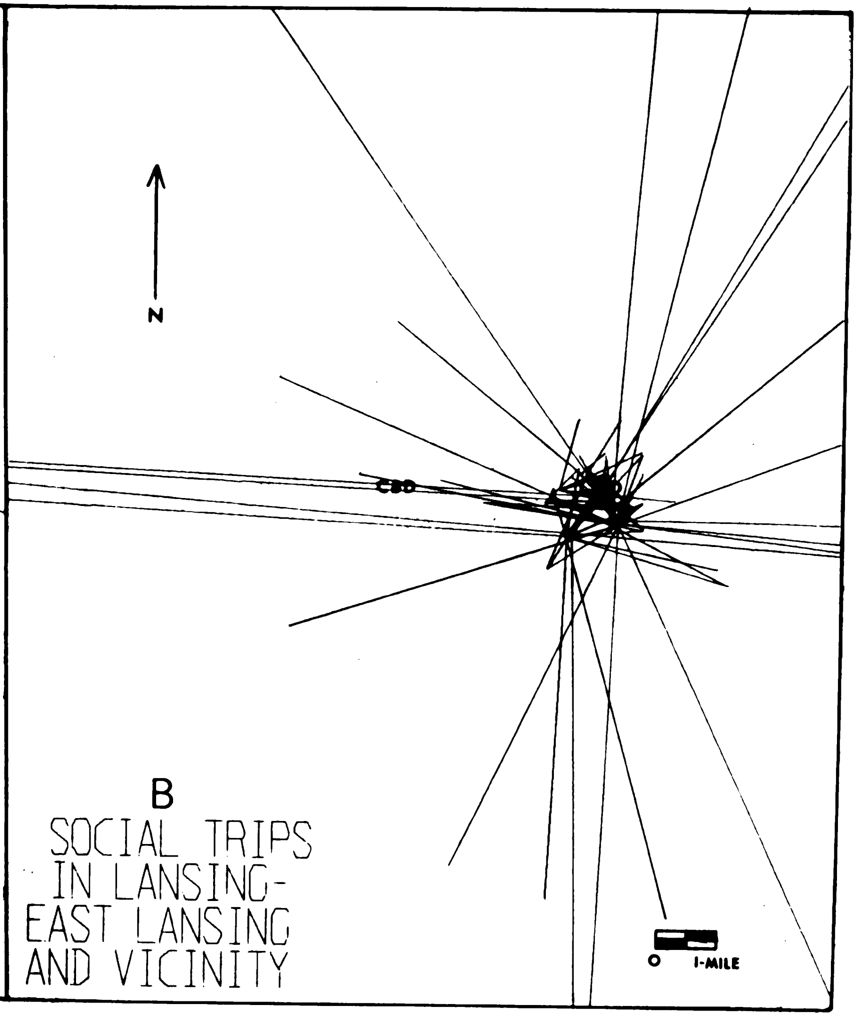

FIGURE 11B

varying scales to a large base map. This was necessary so that the coordinates of the 300 traffic zones varied linearly with distance. After this mapping was completed, the actual digitizing was done.

The digitizer's scale, however, was different than the scale used in the individual deck. It also had the coordinates (0, 0) in the southwest corner. The coordinate system used for residences by the Tri-County Planning Commission, however, had the coordinates (8965, 3995) in the southwest corner of the study area. Thus the two coordinates systems were incompatible. The scaled coordinates yielded by the digitizer could produce a map directly from the information (such maps were produced by SYMAP, using the digitizer's coordinates), but data on origin and destination from the individual's deck could not be plotted directly. In order for maps to be constructed showing trips (desire lines), the coordinate location data of the trip maker's residence and the location of the traffic zones were made compatible by a preprocessing program to properly scale the traffic zone coordinates.[1] The plotter then connected all origin-destination pairs for each card of data.

Social Trip Flows

Trips composed of the origin-destination data described above were mapped for high and low income groups, non-whites, and students attending

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[1]A similar technical problem as the one described above arose when maps were constructed on the line printer (Figures 6, 7, and 13). The program SYMAP requires a coordinate system with the location (0, 0) at the northwest corner of the map, making values on the y-axis increase southward. The resulting map is in the fourth quadrant of the Cartesian coordinate plane. This is in opposite fashion to most scaling procedures, including the digitizer. In order to avert this peculiarity of SYMAP, and properly generate coordinates needed for data points (census tract centers) and map boundaries, coordinates were generated by the digitizer; then all y-values were expressed as minus their original numerical value, transforming the map to the fourth quadrant, required by SYMAP.

Michigan State University. These are shown in Figures 10A, 10B, 11A, and 11B, respectively. Figure 10B shows the unexpanded social trips for less-than-median income residents, excluding individuals living in group quarters (much of East Lansing). A large cluster of trips is centered on Lansing, especially just west of the CBD. Several long trips are shown to the north and south of Lansing, but most trips are somewhat short and without directional bias. East Lansing, which is east of the main cluster, has noticeably few trips.

In contrast to the general pattern of social trips for less-than-median income individuals is the pattern for trips of high income individuals, Figure 10A. Instead of a single cluster of trips centered on the CBD of Lansing, two principle clusters of trip origins and destinations are present in the mapped patterns for the high income tracts. One cluster is in southwest Lansing. This cluster corresponds to the Lansing Country Club--Pleasant Grove area shown to have high income in Figure 6.

The second principle cluster, shown in Figure 10A, is in northern East Lansing and includes the areas of Glencairn, Whitehills, Strathmore and Avendale, with a subsidiary cluster in the community of Okemos to the east. Northern East Lansing and Okemos show social interaction to be high within themselves, and also between each other. Social interaction appears to be relatively high between the area of northern East Lansing just mentioned, and the Lansing Country Club--Pleasant Grove area of southwest Lansing. It is interesting to note that more trips flow between this southwest area of Lansing and East Lansing than originate and end in the area between them. This flow constitutes a significant linkage pattern.

To some degree, then, social ties can be shown between these two high income areas, even though they are spatially separated. This pattern shows the social connectivity of areas of like socio-economic characteristics. It is expected that more linkages could be shown between neighborhoods if the map were enlarged in scale in several areas, since the small scale tends to underestimate local movement on these maps. Local interaction is shown by either a short line or no line at all if the destination is within the traffic zone of trip origin. If two or more social trips have origins from the same block and destinations to the same zone, these trips appear as a single line. More linkages could be shown between neighborhoods if the sample had been larger. Approximately one social trip in twenty is shown for an average weekday and an average weekend day (two days). Because the sample is so small and few of the actual existing social ties are recorded, patterns are somewhat obscured.

The non-white social trips shown in Figure 11A show an even more spatially restricted pattern than do the low income trips, and this pattern bespeaks the segregation of and housing discrimination against the non-white in Lansing. Several non-white trips are shown to go out of the study area (external trips), but the large majority are in a very concentrated cluster just west of the Lansing CBD. Two changes in recent decades, as pointed out by Meyer (1970), have restricted the non-white's spatial growth and account for the cluster of social trips.

(1) The rapid growth of the Negro population fostered increased housing discrimination as whites attempted to segregate blacks.
(2) Negro migrants settled and concentrated in areas where blacks already lived ... By World War II traditional Negro residential patterns were well established. The rapid increase in black migrants brought about rigid boundaries which imposed an involuntary choice of housing on the Negro. Increasing

> segregation was manipulated by the prejudices of white home owners and particularly the real estate agencies. Ghetto concentrations were attained by 1950 in west-central Lansing.

Social trips made by students of Michigan State University living on campus in dormitories and by students living in fraternity and sorority houses are shown in Figure 11B. Two basic patterns of trips are shown. One pattern shows a dispersion of external trips and trips to the cities of Lansing and East Lansing, as opposed to the clustered trips on the East Lansing campus. Most of these dispersed trips occur on the weekend and the largest portion of them represent trips made to the students' home residences or to visit relatives.

The other pattern shows a cluster of student social trips among nodal centers on campus and points just north of campus. These latter trips nearly obliterate the CBD label on Figure 11B. Some patterns on campus can be identified. It appears that the south complex, including the dormitories of Wonders, Holden and Wilson, is highly linked to the complex of dormitories on north campus, as well as to areas just north of campus. A heavy concentration of trips is visible among the east complex of Fee, Akers and Hubbard, the dormitories at the Bogue entrance, the Brody complex to the extreme northwest, the student ghetto (the student apartment district just north of campus), and also fraternity and sorority houses north of campus.[1] The area just north of campus appears to be the most heavily saturated with social trips, perhaps due to the unrestricted use of automobiles in this area,

---

[1]The term "student ghetto" is used somewhat differently than originally used by Horvath (1969). He used it to include not only the student apartment district just north of campus, but also the area including fraternities and sororities. He has recently substituted the term "youth ghetto" for student ghetto.

something not true of the Michigan State University campus, at least for weekdays.

Except for the dispersed component, the student social interaction pattern shows a slight resemblance to the non-white pattern shown in Figure 11A because of the concentration of trips in a small area of land. Both areas have a high population density. Both non-whites and students are segregated in their own ways. The non-white is segregated due to discrimination and economic constraints which limit him to particular areas of the city. The students are segregated due to the housing availability and restriction of autos on campus. This compels them to live, for the most part, within walking distance of campus, unless economies can be gained by living off campus, at home for example, and using the commuter parking lot.

In summary, all four maps show the importance of two aspects of social interaction: 1) the presence of neighborhood linkages is consistent with the socio-economic status concept, and 2) the presence of many short and few long social trips is consistent with the distance decay concept. Not all linkages, especially the local ones, have been shown, however, due to some shortcomings of flow maps outlined above. In order to make stronger statements concerning areas which are similar to one another socially, another method will be used.

Identifying Social Areas

In order to determine what spatial association exists, with regard to social interaction, between parts of the study area, three factor analyses were performed on origin-destination matrices composed of social trips flowing between areal units. The first analysis was carried out on the census tract level, and the last two were carried out on the traffic district level. In each case it was anticipated that contiguous areal units, showing the effect of distance, and units similar in status, would have similar social interaction patterns.

In each of the factor analyses, fundamental patterns emerged from a factored matrix, revealing areas with similar patterns of social trip origins and destinations. Thus, the underlying social structure of the study area can be shown. The first matrix was constructed by frequency counting the number of trips flowing between each pair of census tracts, and weighting each trip by its associated expansion factor. This yielded 63,200 total social trips. The origin-destination matrix for the traffic district used in the last two factor analyses was constructed in a similar fashion. Cell ij of each matrix gives the number of trips flowing from areal unit i to j. Due to the small sample size of social trips and the variability of the data, however, a large portion of cells of both matrices had 0 entries.[1]

Each census tract of the 60 X 60 matrix and each district of the 80 X 80 matrix of social trips was considered a variable. Then symmetrical matrices of social trips were constructed by combining origins and destinations. Correlation matrices were then constructed. The matrices were then factored and rotated by the varimax method to produce maximum clustering, but with orthogonality. The third factor analysis also included an oblique rotation. The factor analysis of census tracts is discussed first.

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[1]The Tri-County Regional Planning Commission used a 5 percent sample for households and a 2½ percent sample for group quarters. Social trips comprise approximately 7 percent of all trips made. Therefore, only approximately three trips (social trips) out of 100 (total trips) are used in the analysis. Interviewed individuals give information on trips made for only a single day. Therefore, because of the cross-sectional nature of the data most interviewed households are not recorded as making a social trip at all.

Factor Analysis of Census Tracts

In the principal axis analysis, twenty-one factors had eigenvalues greater than 1.0, and eleven greater than 2.0. A varimax rotation analysis followed, with rotation terminated by the Kiel-Wrigley criterion.[1] This produced six factors which explained 38.7 percent of the total variance. Only two factors explained more than 6.5 percent, and only thirteen of the sixty communalities were greater than 0.50. These results indicate that, at the census tract level at least, one should not expect to find large areas of the city highly similar to one another in the spatial extent of their social interaction. The relatively low amount of explained variation is, to a large degree, due to the variation in frequency of social trips from household to household, and the discretionary and substitutional nature of social trips. It is also due to missing data, however, which cause zero entries in the origin-destination matrix, resulting in low correlations between variables.[2]

Social interaction, at least from this analysis, displays less similarity between areas than has been shown to exist for work-trips, for example (Wheeler, 1969). But because there is no precedent for studies of social trips and for methods of identification of social areas employed here, one cannot interpret the above results as especially

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[1]The principal axis solution is rotated until a factor is encountered on which fewer than k variables, $1 \leq k \leq 9$, have their highest loading (Williams, 1967). k was set equal to 9.

[2]Because the sample was so small (three social trips out of 100 total trips) and represented trips for only two "average" days, some of the 3600 cells of the census tract origin-destination matrix were zero.

weak. In fact, if the study area were a uniform plane, with the population being spread evenly and being homogeneous in all respects (status, preferences, etc.), then the only restriction to interaction would be distance. But since it would be a uniform restriction (because the population is uniform), interaction would also be evenly spread (or randomly spread, depending on the time interval and amount of data), and no clustering of variables (areal units) would occur. Each variable would be a factor and could explain only 1/N of the total variation.

Therefore, the similarity of areal units shown above is due to non-uniformities in the plane (physical barriers, for example), and to non-uniformities in the population (social barriers, for example). Little is known about the extent of non-uniformities in the urban area, or the difference in uniformities between urban areas. Therefore, a metric which can be used to compare results for the factor analysis of an origin-destination matrix of social trips does not really exist.

By examining factor scores, one can see the degree to which census tracts enter a factor pattern. Portions of the study area clearly display social cohesion. These patterns are mapped and discussed below. Census tracts with high standard scores for each of the first five factors are shown in Figure 12. Each set of mapped factor scores, or social areas, as they will be referred to, is shaded and a number indicating the order of entry of the factor in the analysis has been placed within the boundaries of the tracts which enter highly on the factor. Tracts with similar factor scores enter the factor in a similar way. Those tracts entering the most heavily on the factor are the key elements of the factor, and are parts of the area which have

Figure 12. Lansing—East Lansing Social Areas. Base Map Source: Tri-County Regional Planning Commission, Lansing, Michigan.

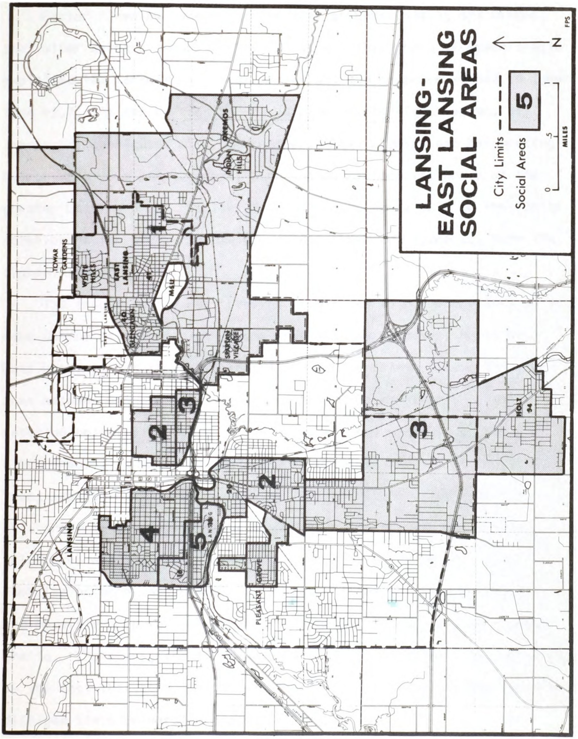
LANSING-
EAST LANSING
SOCIAL AREAS
City Limits
Social Areas
5
N
0
.5
1
MILES
FPS
TOWAR GARDENS
WHITE HILLS
EAST LANSING
MSU
GLENCAIRN
SPARTAN VILLAGE
OKEMOS
INDIAN HILLS
HOLT
LANSING
PLEASANT GROVE
1
2
3
4
5

FIGURE 12

the most similar profile of social interaction. These tracts are the ones which have been mapped.

Factor I can be labeled as the city of East Lansing and Okemos, the latter being a suburb of East Lansing. This group of seven tracts explained the largest amount of variation, and no score mapped is lower than +1.7. As can be seen by the mapping of the first factor, all tracts are contiguous with one another. East Lansing and neighboring Okemos are, to a large degree, high income residential areas of the greater Lansing area. Similarity of income plays a role in the social cohesion of the area. Tracts 40 and 41, shown in Figure 12, have the highest factor scores.

The tracts in the East Lansing area which do not share this pattern make up the relatively low income area of Towar Gardens, north of East Lansing, and the north campus of Michigan State University (the area between Grand River Avenue and the Red Cedar River). A tract entering relatively highly on Factor I, yet not contiguous with the other tracts, is the tract in the north-central portion of the study area, labeled "2." After examining the individual trips made from this tract to the East Lansing area, it was found that the average trip-maker was eighteen years old, lived in a building for three families or more, was unemployed (a category which included student), and made his trip to such areas as University Village or the student ghetto. Therefore, the linkage of this tract to Factor I is explained by the fact that this low income tract provides cheap housing for many Michigan State University students.

All scores for Factor I have been computer mapped for Lansing and East Lansing and are shown in Figure 13. Darkly shaded areas indicate

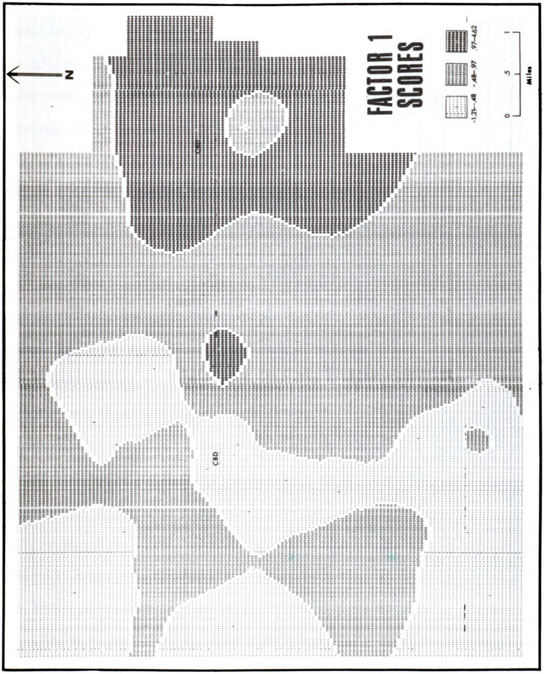

FIGURE 13

tracts with high scores and lightly shaded areas indicate tracts with low scores. East Lansing is darkly shaded, as expected. The low income tract in the central portion of Figure 13 also shows up as the only outlying tract entering the Factor I pattern; and Michigan State University is clearly shown to have a low score. By mapping all scores for the East Lansing factor, one can see 1) the decreasing importance, socially, of areas with increasing distance from East Lansing, and 2) residuals to the distance/interaction pattern which occur in areas of especially high or low status or income. For example, notice that the low income CBD area of Lansing is closer to East Lansing than the high income Pleasant Grove area, yet the former has lower scores, while the latter has higher scores.

In order to further test the degree to which socio-economic status is related to factor scores, median family income of the tracts and an index of occupational status of the tracts is regressed with the scores for Factor I. The index of occupational status, S, where $1 \leq S \leq 8$, for a census tract was computed from the data by multiplying the status-rank of an occupational group (1-professionals, 8-laborers) by the frequency of individuals of that occupation living in the tract, summing for all groups, and dividing by the population of the tract.

As expected, scores for Factor I, when correlated with income, showed a positive, though weak relationship. Scores correlated with the index of occupational status showed a stronger correlation ($r = 0.24$, $P = .06$, $N = 60$). Factor scores in this case are related to the status of a social area. On the other hand, the relatively low physical connectivity of East Lansing to Lansing has probably also been important in segregating East Lansing, socially. Figure 12 shows the boundary between East Lansing and Lansing as a dashed line. Only a few major road arteries connect the two cities, and these include Grand River and Michigan Avenues. East Lansing and Lansing are separated, to a large degree, by undeveloped land to the north and south, and by the presence of an interstate highway. These physical barriers, as well as information barriers created by lack of knowledge or indifference on the part of East Lansing residents as to what or who exists in Lansing, have also added to the social separation of the two areas.

Factor II, shown in Figure 12, can be interpreted as being characteristic of south-central Lansing, although one outlying tract, also labeled 2 and located in the central portion of Figure 12, is included in the pattern. Factor II is the factor most unlike Factor I. It has a tract entering strongly on it that also entered strongly on Factor I. Five contiguous tracts for Factor II are mapped in south-central Lansing, and tract 20 has the highest score (5.23). Factor scores for Factor II were also correlated with income and the status index. Although the correlations were negative, they were not significant. No significant relationship could be found between population density and scores for Factor I or II.

Factor III can be labeled as southwest Lansing and Holt. It includes a sector running from the south-central portion of Lansing, beginning at Holmes Road and extending into and including the northern portion of Delhi Township, encompassing the community of Holt. A tract also entering highly on this factor is just east of the Lansing CBD, and represents the only tract not contiguous with the others. This latter tract is labeled with a 3, as is the main cluster of Factor III.

The highest factor score for Factor III is tract 54, which is the city of Holt.

The scores for Factor IV show a somewhat fragmented pattern in west-central Lansing. Many census tracts enter into the pattern, but few are strong. The strongest nucleus of Factor IV, northeast of the Lansing CBD, including six of the strongest of the factor scores, has been mapped in Figure 12.

Factor V is interpreted as the non-white sector west of downtown Lansing, and includes tracts 16 and 18. Tract 18 has the largest Negro population in the study area and the highest factor score of the analysis (6.70). The segregation and cohesion of this area, socially, is reflected by this high score.

Factor VI, although unmapped, can be identified from the factor scores as being characteristic of Delhi Township, excluding Holt (Figure 1), and consists of four contiguous census tracts comprising a large area of land.

Factor Analysis of Traffic Districts

In an effort to improve the explained variation and to reduce the level of data aggregation, thereby identifying perhaps smaller, yet more numerous social areas, another origin-destination matrix of social trips was constructed for the traffic districts in the study area.[1] The traffic district level of analysis is a smaller level of

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[1]Because the traffic district of an individual's location and his trip destination are not given in the data, a transfer was made by taking the traffic zone of origin and the traffic zone of destination and referring to a table showing the zones contained within each district.

data aggregation, and there are approximately eighty districts in the study area, compared to sixty census tracts. The traffic zone (300 in study area) level was not used because of no available program to factor analyze a 300 X 300 matrix, and because of the even larger number of zero entries in a matrix of this size. Furthermore, urban transport surveys usually find the best predictive results by using the traffic district level, as opposed to the census tract or traffic zone level of data aggregation. Since the expansion factor expands the data to the census tract level, the expansion factors were not used for the traffic district factor analysis. The raw data, comprising a 5 percent sample, were used instead.

In the principal axis analysis, twenty-three factors had eigenvalues greater than 1.0, and thirteen factors had eigenvalues greater than 2.0. A varimax rotation was completed next, with rotation terminated by the Keil-Wrigley criterion, producing seven factors. Factor I explained only 7.5 percent of the total variance. Factor II explained 7.2 percent, and the seven factors together explained 42 percent of the total variance. Therefore, this second analysis improved on the previous one only slightly with respect to explained variation.

Factor scores for the varimax rotation analysis on the district level, as they formed units of social cohesion, showed similarities in spatial extent to the set of factors for the census tract analysis, although the factors entered the analysis in somewhat different order. The factors of this analysis were even more similar in spatial extent to a third set of factors which are discussed below.

A third factor analysis was undertaken to determine whether the explained variation and factor structure would be improved over that in the two previous varimax rotations by relaxing a perhaps unrealistic assumption concerning orthogonality of the factors. The traffic district origin–destination matrix of social trips was factor analyzed and two types of oblique rotations were used, the quartimin and the covarimin rotations.

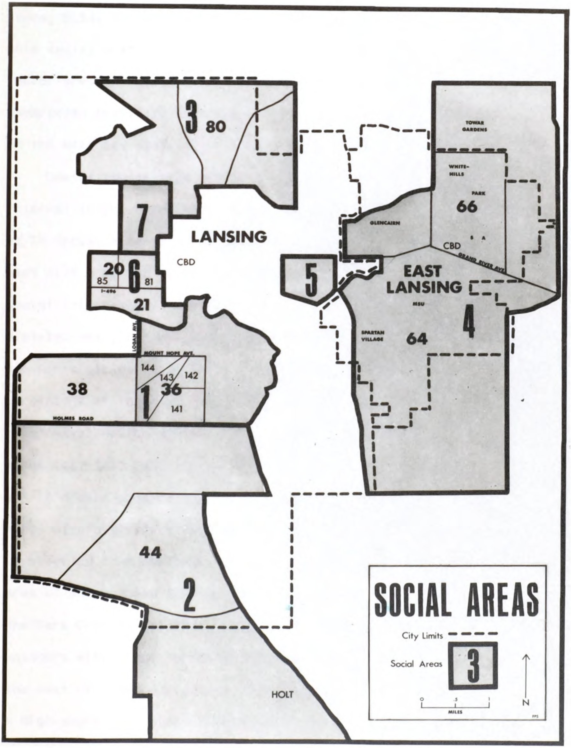
With the varimax method of rotation, the criterion is to distribute variances among loadings so as to accentuate high and low values. The quartimin analysis is a procedure which minimizes the cross products of the square of the factor loading. The varimax method does not disturb the orthogonality of the factors, but the quartimin method does not observe this restriction, and its use often results in correlated factors. This criterion tends to place high loadings opposite low loadings, on pairs of factors. In the orthogonal rotations the whole factor structure is moved around the origin at once, to best fit the configuration of clusters of interrelated variables. In oblique rotations, however, the factors are rotated individually to fit each cluster. The relationship between the resulting factors then expresses the relationships between the clusters of variables.

The rationale for oblique rotations has been proposed on several grounds (Cattell, 1965; Rummel, 1967). An important one is that correlations between factors are given by oblique rotations, and these correlations give information as to the actual independence or dependence of the data. In social science especially, it is an oversimplification to think that independence is the rule in nature. It should not be a necessary requirement to restrict the analysis to orthogonality, as the varimax method does. Clusters of variables are often, to some degree, dependent on one another, and oblique rotations take this dependence into account in their resulting factor loadings and correlations between factors. The most distinct factor structure resulted with the quartimin rotation discussed below.

With the quartimin solution, the first seven factors explained just over 47 percent of the total variation.[1] The first factor explained 9.2 percent of the variation, and represents a small improvement over the varimax analysis. The highest correlation among factors is -0.19 between Factor I and Factor II. Only two other correlations in the inter-correlation matrix are greater than $|0.09|$.

Although the basic dimensions which were found for factor scores in the census tract analysis were visible in this analysis, the spatial patterns are slightly varied and factors take a somewhat different order of entry in the unrotated analysis. This order has been preserved in the oblique rotation, even though explained variation by the factors in the oblique analysis is not monotonically decreasing from Factor I to Factor II. The spatial patterns of factor scores are somewhat clearer, however. The seven factors from the quartimin analysis have been mapped, and are shown in Figure 14. Similar to the varimax analysis of census tracts, social areas emerge from the mapped scores. Each factor or social area is shaded, and a large number indicating the order of entry of the factor in the unrotated analysis has been placed within the boundaries of the traffic districts which enter highly on the factor. Sets of medium-sized and small numbers refer to specific traffic districts and traffic zones, respectively. These districts and zones have also been outlined.

[1]Because of the large number of inter-correlations (2520) and factor loadings (504), tables for each have been omitted.



LANSING
CBD
EAST LANSING
MSU
SPARTAN VILLAGE
GLENCAIRN
TOWAR GARDENS
WHITEHILLS
PARK
GRAND RIVER AVE.
LOGAN AVE.
MOUNT HOPE AVE.
HOLMES ROAD
I-496
HOLT
SOCIAL AREAS
City Limits
Social Areas
MILES
N

FIGURE 14

Factor I, explaining 9.2 percent of the variation, can be interpreted as south-central Lansing, a high income area. The highest factor score, 5.24, is for district 38, located in the western portion of this social area. All of the seven districts entering highly on this factor are contiguous with one another. This social area is well demarcated spatially with Grand River on the north, undeveloped land on the east and west, and a lower income area to the south.

One of the traffic districts showing a very large number of internal trips, compared to others in the study area, is district 38 in Social Area 1. This district is composed of three traffic zones, each with a median family income of over $12,000 per year. Many more social trips existed within this district than flowed between the district and other areas adjacent to it which have lower income. Another district in Social Area 1, district 36, also has a high percentage of internal trips as shown by its diagonal entry in the origin-destination matrix. This district is composed of traffic zones 141, 142, 143, and 144.

A closer examination of the social ties between the traffic zones within district 36 shows interesting results. This district is bisected from northeast to southwest by Washington Park and an area of undeveloped land to the southwest, both of which have the New York Central Railroad tracks as a boundary to the north. A boundary effect due to these landscape features can be noticed. To the east of this undeveloped land are zones 141 and 142. There is a high degree of interaction between these two zones. Zone 143 is the area of primarily undeveloped land. To the north lies zone 144. This zone shows no ties to zones 141 and 142 which lie to the southeast of the barrier. It is more highly tied to the zone to the west of it outside district 36, even though the latter has a much higher median family income.

Factor II, explaining 8.3 percent of the variation, occupies an area in southwest Lansing and the adjacent suburb. The social area begins on the north at Holmes Road, the latter separating Factor I from Factor II. The social area continues southward, extending beyond the community of Holt. This factor could be referred to as southwest Lansing-Holt. There are six districts entering heavily on Factor II. The strongest of these is district 44, which has a factor score of 5.46. These six traffic districts are contiguous with one another, and there are no outlying districts on this factor. As previously mentioned, the correlation between Factor I and Factor II is -0.19.

Factor III explained 5.9 percent of the variance. Factor scores for Factor III can be interpreted as northwest Lansing, bounded by Sheridan Road to the north and Willow Road to the south, Wood Road to the east, and Grand River and the Chesapeake and Ohio Railroad tracks to the west. It includes eight districts, with district 80 having the highest score (4.54). There were two outlying districts in south-central Lansing also entering this factor.

Factor IV, explaining 6.6 percent of the variance, may be identified as East Lansing and suburban Okemos adjacent to it on the east, although only East Lansing is shown on Figure 14. This factor includes six districts, with district 66 having the highest score (6.75). It is located in the center of East Lansing, just north of the CBD. This district is bordered by Lake Lansing Road on the north, Grand River Avenue on the south, and Abbott and Hagadorn roads on the west and east, respectively. District 66 is a heterogeneous district socio-economically, and includes the low income areas of the student ghetto just north of Grand River Avenue, medium income neighborhoods of Strathmore and Avendale (labeled on Figure 14 with an S and A, respectively), and the high income neighborhood of Whitehills. All three display somewhat high intra-neighborhood interaction, making the combined interaction for the district extremely high, even though inter-neighborhood interaction is low.

Towar Gardens, not entering the census tract analysis on the East Lansing factor, is included on this factor, as is all of Michigan State University, district 64, also not included in the census tract analysis. Michigan State University campus (labeled on Figure 14 as MSU) is only one traffic district and it enters the East Lansing Factor. However, the campus is divided into two census tracts, one of which entered and one of which did not enter the East Lansing Factor. Michigan State University campus showed high internal interaction, as can be seen in Figure 11B, depicting social trips of university students.

Factor V can be identified as a single traffic district, district 61. It has a score of 4.68. It alone accounts for 5.6 percent of total variation. Its high degree of internal cohesion may be due, in part, to its physical setting. A physical barrier is noticed to the south and east in the form of the Interstate Highways and the Red Cedar River. Beyond these is undeveloped land. To the north is Michigan Avenue. This district is a low income area and lies on the border between Lansing and East Lansing.

Factor VI can be identified as the primarily non-white sector of

Lansing, and comprises districts 20 and 21 (Figure 14). District 20 has a score of 6.1, the second highest of the analysis. The housing discrimination against and social segregation of these people is clearly evident. A large amount of internal interaction was seen in district 20, especially for traffic zones 81 and 85. Zone 81 has the largest proportion of non-whites in the entire Tri-County Region. From field observation, zone 85 appears to be a high income enclave of primarily whites which have their neighborhood bounded on the north and west by undeveloped land, and on the south and east by non-white neighborhoods. This isolation affects internal interaction in a positive way. Zone 85 also shows a component of non-white diffusion into the neighborhood from areas east and south. There was a disproportionately large number of social trips made within traffic district 20 and within district 21, compared to the trips flowing between districts 20 and 21, both of which comprise the major portion of census tract 18. The reason for this phenomenon may be the presence of Interstate 496, paralleled by two major arteries, which separates the two traffic districts from one another. Only two streets traverse Interstate 496 west of Logan Avenue.

To curb barrier effects imposed by expressways and major arterials, and the noise and air pollution concomitant with the system, public action has been taken to halt new facilities in many areas (Nashville, Tennessee, for example). A measure milder than blocking highways from traversing a neighborhood is to erect elevated sidewalks over the street to permit non-vehicular interaction to continue between two parts of a neighborhood bisected by a highway. Such sidewalks can be seen in the study area in the 1200 block of East Mount Hope Avenue

(Social Area 1), and on Saginaw Avenue near East Lansing City Park, labeled "park" in Figure 14 (Social Area 4).

The seventh and final factor, explaining 6.3 percent of the variance, can be identified as two contiguous districts in west-central Lansing. The highest score on this factor is 6.58. Even though Factors V and VI are contiguous with one another and represent a section of continuous high density land occupance, these two factors are correlated at only 0.08, and probably do not correlate better because of the segregation of whites and non-whites.

The oblique analysis resulted in clearer patterns for the traffic districts than did the varimax analysis for the districts or census tracts. The former produced overall higher factor scores, and mildly improved explained variation. Both analyses showed that distance had a strong effect on interaction, as there were few areas entering highly on factors that were spatially removed from the principle clusters of traffic districts. Distinct similarities can be seen between the traffic district and census tract analyses with regard to the areal interpretation of factors.

A comparison of the social areas for the census and traffic district analyses shows a similar overall pattern with few differences. Since traffic district boundaries do not coincide with census tract boundaries, a clear delimitation among all social areas cannot be explicitly given. Nevertheless, Social Area 1, East Lansing and Okemos, for the tract level analysis, is clearly Social Area 4 of the district analysis (Figures 12 and 14). The non-white area of Lansing, Social Area 5 of the tract analysis, also appears distinctly as Social Area 6 of the district analysis. Social Area 2 of the tract analysis, south-central Lansing, can be seen to occupy much the same area as Social Area 1 in the district analysis. They both have identical north and south boundaries. Social Area 3 on the tract level, southwest Lansing-Holt, is Social Area 2 on the district level, and includes a portion of south Lansing and the area of land extending south to include Holt. Social Area 4 in the tract analysis, west-central Lansing, overlaps and includes a larger area than Social Area 7 of the district analysis. In addition, the district analysis produced another social area, north-central Lansing, Social Area 3, that was not included on the tract level.

In order to further gauge the role of status on interaction, census tract and traffic district social areas are analyzed for similarity. This was accomplished by selecting, for each social area, the areal units with the highest factor scores and analyzing the variation of their associated median family incomes. The measure of variation used was the standard deviation of each set of incomes. The standard deviation for the six areal units with the highest scores in each of the social areas was compared to the standard deviation of median incomes for sextiles and septiles of all tracts and districts, respectively, in the study area.

The degree to which similarity of status as measured by income is important in the social interaction and cohesion of social areas is shown by this comparison. If the factors and their associated social areas are more internally similar than the entire area is to itself (the average), then the standard deviations of the social areas should be smaller than the standard deviations of the sextiles and septiles. Standard deviations of income for the tracts and districts are expressed as a percent of the average standard deviation for the study area. A

ratio greater than one indicates a higher variability of income within the social area than within the study area, taken as an average. A ratio less than one shows the social area to have more income homogeneity than the study area as a whole. The ratios for census tracts and traffic districts are shown in Table 9.

This table shows that all but one social area in each analysis have a smaller amount of variability of income within them than average. The only social area not consistent with this pattern is the East Lansing-Okemos Social Area. The reason for the relatively high ratio in this area is that most of the census tracts and traffic districts in this social area are unusually high with respect to income, compared to Lansing, as East Lansing and Okemos contain some of the most exclusive residential areas of the metropolitan area. Yet, meshed within these high income neighborhoods is Michigan State University, with its associated low income student body housed in dormitories, married student housing, and off-campus apartments. For example, the average yearly income for the tract in which Spartan Village and the south complex of dormitories are located is only $4,673, while that of the Glencairn tract is $11,666. The tract north of Grand River Avenue containing fraternities, sororities, and the student ghetto has an average income of $4,800, as compared to the census tract including Okemos, which has a median family income of $12,300. These extreme values for areal units raise the ratio above unity.

In this analysis, income is a poor indicator of status, as most of the students are not in the labor force, and if they are, it is usually part-time work. Therefore, their income does not reflect their status. The status of students is not too unlike that of the inhabitants of the

TABLE 9

INCOME STANDARD DEVIATION RATIOS FOR SOCIAL AREAS

Census Tract Analysis		
Social Area (Factor)	Name	Ratio
Social Area 1	East Lansing and Okemos	1.17
Social Area 2	South-Central Lansing	0.63
Social Area 3	Southwest Lansing-Holt	0.65
Social Area 4	West-Central Lansing	0.62
Social Area 5	Downtown Lansing (Non-White)	0.96
Social Area 6	Delhi Township	0.56

Traffic District Analysis		
Social Area (Factor)	Name	Ratio
Social Area 1	South-Central Lansing	0.49
Social Area 2	Southwest Lansing-Holt	0.81
Social Area 3	Northwest Lansing	0.36
Social Area 4	East Lansing and Okemos	1.27
Social Area 5	Traffic District 61	0.65
Social Area 6	Downtown Lansing (Non-White)	0.47
Social Area 7	West-Central Lansing	0.83

surrounding area, and these students also make a sizeable portion of trips to a number of areas of East Lansing and Okemos. When the two student tracts are excluded, the ratio falls well below unity.

CHAPTER V

NEIGHBORHOOD ANALYSIS

A specific neighborhood in the study area is examined in an effort to determine the degree to which social status and distance affect social interaction. Several aspects of social interaction within an urban context can be more precisely analyzed at this level because of specific types of information that were attained from direct field interviews and not available from the data tape. The questionnaire used to record the survey information is contained in Appendix B. As can be seen from this questionnaire, the neighborhood data are longitudinal and express recurrent visiting patterns of the respondents, in contrast to the cross-sectional, aggregate data previously used.

The neighborhood examined is the Indian Hills Estates neighborhood, an upper income subdivision in the community of Okemos (Figure 12). The neighborhood is well demarcated by natural boundaries. On the east is the Red Cedar River, to the north is a golf course, to the west lies undeveloped land, and to the south is an arterial street.

Distance and Status

Preliminary findings can be gained from the interview data. One hundred and seventeen social ties, displaying recurrent social travel, were recorded from fifty households, representing over 432 social trips per month. These social trips were plotted on a map. An examination of the mapped patterns of social trips showed the presence of a social neighborhood, as evidenced by the cluster of of social trip destinations remaining within the neighborhood. Social interaction by the residents of this neighborhood is by no means confined to the immediate area, however. Lines of interaction exist outside the neighborhood. Principle clusters of social trip destinations occur in the high income neighborhoods of Glencairn (East Lansing) and Tacoma Hills (Okemos). Each of the two latter neighborhoods has high median family income and each constitutes an important social linkage for the Indian Hills neighborhood. These linkage patterns are consistent with the status hypothesis, because they show that neighborhoods of similar socio-economic level, as measured by income, are functionally tied, even though intervening opportunities exist.

One of the differences between this survey data and the data previously used, is that occupational information was gathered not only on the interviewed household but also on the household with which it interacted. It is, therefore, possible to test the precise extent to which individuals have social contacts with those of similar socio-economic status (as measured by occupation).

Twenty-four of the fifty interviewed households had professionals or technical-workers as heads of the household, while another thirteen had managers or officials as household heads. A cursory examination of Table 10, the matrix of social ties according to occupational class, shows a hierarchal effect of social interaction. Row i of the matrix shows the ways that the ith occupational class distributes its social contacts. Column j of the matrix shows the ways that occupational class j was selected for social contacts. The professional-technical group chose professional-technical households as social contacts much more frequently than they chose any other class.

TABLE 10

MATRIX OF SOCIAL TIES BY OCCUPATIONAL CLASS

		1	2	3	4	5	6	7	8	9
1. Professional technical	1	36	10	2	0	1	0	1	0	2
2. Manager, official	2	8	16	1	0	0	0	0	0	3
3. Sales worker	3	5	4	4	1	0	0	0	0	2
4. Clerical worker	4	1	2	1	2	1	0	0	0	1
5. Craftsman, foreman	5	0	0	0	0	1	0	0	0	2
6. Operative	6	0	0	0	0	0	0	0	0	0
7. Service worker	7	0	0	0	0	0	0	0	0	0
8. Laborer	8	0	0	0	0	0	0	0	0	0
9. Retired	9	2	3	1	1	0	0	0	0	3

Similar behavior exists for other occupational classes. In general, social interaction decreases away from the diagonal, although only the first two occupations are well represented by the data. An exception to this relationship is column 9, which is the retired category. The largest portion of trips made by and to these people are associated with relatives. These retired people are not grouped according to occupational class. They are probably mixed in thier former occupational composition.

When the frequencies of social ties are arrayed by the distances that they occur from the interviewed household, a strong distance effect is observed. Twenty-eight percent of the social trips are within two blocks of the origin, and 50 percent are within one mile. For this interviewed neighborhood, only 14 percent of the trip ends are over eight miles away.

Origin of Social Ties

One of the questions asked of each respondent was how the social tie was established between the two households. Another question was the inter-residential distance between the household under question and that of its social tie. Several categories of social ties are discernible from the responses to the question of how the friendship was established. These categories included neighbor, former neighbor old friend or relative, through children, club, work-business, or church.

The distance decay component and the social network component of social interaction, as pointed out by Cox (1969), and elaborated on in Chapter III, can be seen in the data regarding social ties.

To a large degree, social ties at short distances are immediate neighborhood contacts, and are due primarily to propinquity factors. Social ties at short distances are not limited to nearness factors alone, but also extend to social network factors, the latter of which appear to be somewhat frictionless. Social ties at more distant locations are due to the individual's unique set of activities, producing a status dependent social network.

Out of the thirty-three ties recorded within two blocks of the respondent (including distance categories of next door, same block, and next block), only three were to relatives, four to business associates, two to church acquaintances, and four to club acquaintances. The remaining twenty were due to propinquity factors. Common responses included such statements as "they are neighbors, they baby sit for us," or "our children play together." The relatively high degree of local friendship in this neighborhood is, in part, due to the uniformity of status and the general social stability of the neighborhood fostering friendships among those with increased residential tenure in the neighborhood. Very low income neighborhoods with a high degree of renters and residential mobility could not be expected to demonstrate an equal amount of stability or local friendship (Smith, et al., 1954; Nelson, 1966).

For this neighborhood, and as has been stated previously for the study area as a whole, the network component is seen to be the dominating social force at longer distances, while propinquity is the dominating social force at shorter distances. In the case of strong ties such as relatives, the friction of distance is reduced.

This is, no doubt, due to the greater rewards being experienced by the respondents as they interact with relatives, making perceived costs of interaction less. Of the sixteen contacts beyond eight miles, nine are relatives, three are church acquaintances, and three are business associates.

In order to determine quantitatively the relationship between the origin of social ties and the residential separation of the trip maker and the social contact, a factor analysis is performed. The origins of social ties are treated as variables, and the inter-residential distances between the interviewed households and their social contacts are considered as observations. Correlations between each variable over distance are obtained and factor analyzed. Two factors have eigenvalues greater than 1.0. The first explains 35.6 percent and the second explains 34.0 percent of the variation. The factor loadings for these two factors are shown in Table 11.

Neighbor, children, and club load heavily on Factor I. Factor I describes the distance decay or propinquity dimension of social ties which occurs within the immediate neighborhood. Social ties established through work, business, church, former neighbor and old friend or relative load highly on Factor II. Since the type of social ties associated with the second factor relates largely to status similarity, and is not closely constrained by distance, Factor II is unmistakably the network component of social interaction.

Similar relationships can be shown another way. When the data matrix is transposed, and observations are analyzed for patterns of similarity with respect to social tie origins, two patterns emerge (Table 12). In this Q-mode factor analysis the original observations

TABLE 11

R–MODE NEIGHBORHOOD VARIMAX ROTATION ANALYSIS

Variable	Factor Loadings	
	Factor I	Factor II
1. Neighbor	0.6756	–0.3554
2. Children	0.8713	–0.0455
3. Club	0.6642	0.3321
4. Work–Business	0.0027	0.9172
5. Church	–0.5502	0.6231
6. Former Neighbor	0.1394	0.7774
7. Old Friend–Relative	–0.7135	0.3845
Percent of Total Variance	35.6	34.0

TABLE 12

TWO-FACTOR Q-MODE NEIGHBORHOOD VARIMAX ROTATION ANALYSIS

Observations	Factor Loadings	
	Factor I	Factor II
1. Next Door	0.2494	0.8458
2. Same Block	-0.1341	0.8713
3. Next Block	0.5606	0.7035
4. 1 Mile	0.8597	0.1485
5. 2-3 Miles	0.8790	-0.2650
6. 4-8 Miles	0.9867	0.0580
7. 8+ Miles	0.3607	-0.6123
Percent of Total Variance	44.0	33.8

include distance categories of next door, same block, next block, one mile, two to three miles, four to eight miles, and over eight miles. These distances are considered as variables and are first correlated with one another, based on the number of social contacts occurring for each category of social ties. Social ties are considered as observations for this analysis. The matrix is then factored, and rotated by the varimax method.

In Table 12, two factors have been interpreted and they together explain 77.8 percent of the variation. Table 12 shows that two ranges of distances are similar to one another with respect to social ties. One range of distance is about one mile and more (observations 4, 5, 6, and 7), These observations load heavily on Factor I. This factor can be labeled as the social network component of social interaction. Distances for social interaction close to home load highly on Factor II. This factor can be labeled as the neighborhood component of social interaction. When a third factor is extracted, distances beyond eight miles are shown to be unique in their similarity of social ties. The factor loadings are shown in Table 13. The first two factors may be interpreted in the same fashion as above. The third factor appears to be a factor typical of social travel to visit relatives.

In sum, the neighborhood analysis shows many of the same relationships that were shown to exist for the study area as a whole. With the longitudinal type of data that were gathered, reflecting individuals' long run social visiting behavior, a type of data was available that was not available from the Tri-County. This longitudinal aspect of the data, as well as the fact that data were collected on the occupational status of the household that was visited, made it possible for the study 1) to examine the social linkages of the Indian Hills neighborhood

TABLE 13

THREE-FACTOR Q-MODE NEIGHBORHOOD VARIMAX ROTATION ANALYSIS

	Factor Loadings		
Observations	Factor I	Factor II	Factor III
1. Next Door	0.2079	0.9304	-0.1242
2. Same Block	-0.1488	0.9395	-0.1710
3. Next Block	0.6684	0.5800	-0.2141
4. 1 Mile	0.9777	-0.0284	-0.1568
5. 2-3 Miles	0.6530	-0.0310	0.3956
6. 4-8 Miles	0.9223	0.1005	0.4445
7. 8+ Miles	-0.0332	-0.1629	0.9676
Percent of Total Variance	39.23	30.33	23.11

to other neighborhoods, 2) to show the status similarity between pairs of social contacts, and 3) to show the presence of a neighborhood component and a social network component of social trips. The linkage analysis shows Indian Hills to be highly linked to high income parts of Okemos and East Lansing. On an individual basis, results show that an individual of a given occupational group has more social contacts with those of the same or similar status individuals than with those of differing status. The neighborhood analysis shows that distance and occupational class are important determinants of social travel. Based on an analysis of social tie origins, the neighborhood analysis shows a distance component and a social network component, the latter of which is related to status.

CHAPTER VI

CONCLUSIONS AND SUGGESTIONS FOR FUTURE RESEARCH

Discussion

Findings from this study show that social trips, when compared to all trips, display marked differences in both diurnal and weekday distributions. Social trips tend to occur most often when individuals have time available for such activities, as is evidenced by the large number of social trips made over the noonhour and in the evening. The sequencing and linking of social trips also differs from that of total trips in that social trips are primarily from home to another residence and back home again, but may involve more than one social stop. A relatively low probability exists that an individual will travel to a social stop on a journey involving trips primarily for purposes other than social. Both the temporal distribution and the linking of social trips are found to be different for the weekday, as opposed to the weekend, and are shown to be due primarily to differences in individuals' activity sets during these periods.

Although young, well-to-do city dwellers with small families are more likely to link social stops on the same journey from home, it was determined at an early stage in the analysis that the social trip has an individual nature and is a complex trip, not corresponding well to linking or household generation relationships of other trips. These ideas were further shown when only a small degree of social trip predictability was found at the census tract level of analysis. However, definite variations in social trip making were shown to be related to personal, socio-economic, and demographic attributes, including age, income, household size, race, and sex. In separate analyses, income, household size, and age were shown to be highly correlated with social trip making.

It was hypothesized that distance and status are important considerations in social interaction. It is demonstrated in the analysis that the individual is constrained in his social interaction by status and distance barriers. When frequency of interaction between districts is compared with distance separating the two districts, a strong distance decay relationship is found, and this relationship is strengthened by data transformations. The neighborhood component (distance) and the social network component (status) of social interaction are identified and used to interpret the scatter of data points on the distance/frequency graph.

Even though it is shown that the minimum inter-residential separation between individuals is at least similar to concepts in classical urban rent theory, there is apparently little, if any, relationship of this to the distance people travel on social trips. However, the amount of actual socializing unaccounted for by considering only vehicular trips is not known. From the neighborhood analysis, it would appear that the interaction unaccounted for may be substantial, especially in densely populated areas. One cannot, though, assume the same degree of local friendship to be present in all neighborhoods, because of variations in neighborhood social stability and residential tenure. These latter considerations could well have had an important bearing on the lack of association between the inter-residential separation of an occupational class and the social trip length of that

class.

In later portions of the analysis, urban social interaction patterns are generated and interpreted. Flow maps display several prominant linkages among portions of the study area. Although the flow maps used provide a visual vehicle from which generalizations concerning linkages could be made, the flow maps are regarded only as a generalized tool to display social linkages. The flow maps did display, however, the socio-economic effects on social linkages and the distance decay relationship by the presence of many short and few long social trips. Other methods are utilized to make more definite statements of social cohesion.

The factor analysis of two origin-destination matrices elucidates socially organized urban areas that are internally similar in their social interaction. The factor analysis shows the decreasing importance, socially, of areas with increasing distance from one another. Yet this decreasing importance is not regular, but distorted by variations in the "status plane." Although limited results are obtained by correlating factor scores with measures of status, a certain degree of income homogeneity is found for the social areas.

The neighborhood analysis, undertaken to examine many of the above relationships with somewhat more scrutiny, shows similar status and distance relationships on social interaction, as found in earlier chapters. The neighborhood analysis also brings to light two components of social interaction. The neighborhood component, basically a distance decay factor, and the social network component, basically a status factor, are revealed by a factor analysis for social ties by distance, lending credibility to the two hypotheses of this paper.

Some explanation for the distance decay relationships of social interaction is evident. Individuals' behavior is usually regulated by the principle of least effort. Few people travel farther than necessary to attain a certain goal, except for the pleasure of traveling itself. In a probabilistic sense, individuals living longer distances from one another have a smaller chance to have unplanned contact. Also, with small distance increments in all directions from an individual's residence, the area that an individual can contact people, or his potential social contact field, increases substantially (3.14 times the square of the distance [radius] from home), and again, the unplanned chance for two individuals to meet is reduced. This makes the local neighborhood the most likely place for an unplanned contact to occur.

Some explanation may be advanced concerning the status relationship as well. At least two forces are at work in fostering association by status: 1) a voluntary force, and 2) an involuntary force. The voluntary force is demonstrated when the individual chooses to interact with people of status similar to himself, because he gets larger rewards from doing so. In interacting with those of the same status, he feels comfortable. If he interacts with those of higher status, he may feel uneasy to the point of inferiority, depending on his perception of the situation. If the individual interacts with people of lower status, he may not gain the satisfaction that he might otherwise obtain, had he interacted with a person of his own status. He will also have certain things in common with individuals because of similar socio-economic situations, including, perhaps, personal attitudes and preferences. The fact that people tend to maintain social relations with those people from whom they receive the highest rewards is based on association by status.

The involuntary force is environmental. It is demonstrated by the fact that individuals, with their associated activity and opportunity sets, are usually juxtaposed in an environment of similar socio-economic status individuals. People tend to have social contact with those whom they have business, personal business, or church contacts. The people in an individual's immediate environment have more than an average chance of sharing a similar status level. With the involuntary force, both parties have an even stronger common denominator of experience and conversation than they did in the previous example of a voluntary force.

Due to the discretionary and substitutional nature of social trips, variations in individuals' personalities have important effects on social trip frequency. People make social trips depending on whether or not they enjoy and are rewarded by social interaction. If an individual is an introvert, he may prefer to be alone or with his family. If he is an extrovert, he may enjoy being with others for the rewards that he gains from them, rather than undertaking activities alone. These variations in individual personalities and attitudes are presently unmeasured, making social trip variation difficult to predict, and even more difficult to explain. However, several postulations can be made as to how people behave socially, but the verification of such ideas must be left for future research.

Suggestions for Future Research

The purpose of this part of the study is to suggest the direction for future research by formalizing relationships previously discussed

in the paper and in the literature into two models of urban social travel behavior. The first model is a theoretical model that formalizes the elements involved in an individual's choice to make a social trip.

Social interaction occurs after the choice is made to make a social trip. The social trip patterns of origins and destinations created by an aggregate of social trips are seen as having some degree of predictable order. The second model, then, is an operational model and proposes a simple method by which observed patterns of social travel may be explained and future patterns predicted in an urban area. Empirical verification of the models is seen as a problem for future research.

A Model of the Choice for Social Travel

There are many aspects of movement systems that pose complex problems of definition, prediction, and causation to the geographer, and many of them are in the area of human behavior. Much of the research in this paper, as well as in most social science research fields, has focused on description and prediction of what people do, and this is certainly a necessary step in understanding movement systems. Little attention, however, has been devoted to why people travel. Future research should examine this question. The framework set forth below is merely a guideline toward the development and testing of a plausible conceptual model of the decision to make a social trip. A model of the choice to make a social trip may take the form:

$$aNB_{ij} = bR_j - (cC_i\ D_{ij} - dK_i\ DU_j - eO_{i,j,k}),$$

where

NB_{ij} = total net benefits gained by i on a social visit to j

R_j = expected rewards at j

C_i = travel cost per mile for i

D_{ij} = distance from i to j

K_i = transaction cost per time unit for i

DU_j = duration time spent at j

$O_{i,j,k}$ = opportunity cost, forgone, for i by interacting with j instead of k

a,b,c,d,e = subjective weights placed on each parameter by i

As can be seen in the equation, the right side is composed of two parts, the positive and negative values associated with the interaction of i with j. These are R_j, the expected rewards that the individual i receives by interacting with j, and D, K, and O, the costs of interacting at j. A large volume of literature recognizes the time and other associated costs necessary to maintain social ties at a distance, and some of this literature has been reviewed previously.

In order for interaction to occur, the net benefits, NB_{ij}, of interaction for i with j must be positive. In order for net benefits to be positive, rewards, R, must be greater than total costs.

The expected rewards at j, R_j, are based on the social distance between the individuals involved. Rewards are also seen to vary according to the similarity of preferences and attitudes between i and j, and the length of time two individuals have known each other. In many cases, if the two individuals are relatives, rewards may be greater. Many other factors have a bearing on rewards. Ethnic and cultural similarity are important for some individuals, especially if they are in a minority group and are in a strange environment (foreign country, for example). The psychological rewards that are expected from interaction may be higher than anticipated. On the other hand, they may not be as high as anticipated and will, in either case, affect individual i's subsequent evaluation of the rewards at j. The present evaluation of rewards is based on feedback from previous experiences.

On the debit side are all the costs associated with interaction. The first cost is the cost of overcoming distance between i and j. This travel cost is expressed as the cost per mile of travel, multiplied by the distance, D, to j. The cost per mile of travel is dependent on such things as the individual's time cost, the operating cost of his vehicle, and other associated costs, such as discomfort and inconvenience costs. These may be, to a large degree, dependent upon the transport network and service levels between i and j. As individuals become more spatially separated and the negative values get larger, the rewards, alternatively, must be proportionately greater in order for net benefits to be positive.

The value, K_i, represents the individual's time cost spent for social interaction. It is called the transaction time. The individual's time cost, including travel time, is seen as being by far the most important cost of the equation. Each individual has a subjective evaluation of the worth of his own leisure time, and this is seen as being dependent on 1) his availability of leisure time, and 2) his ability to use the leisure time. This is partly dependent upon the range of alternatives available for using his leisure time, including not only the range of spatial opportunities in an area, but also the

individual's own resources and resourcefulness. For example, an individual who works eight to ten hours per day for five to six days a week may regard his leisure time as rather precious. Thus this element of the equation becomes large and overshadows rewards gained from interacting with others, leaving total net benefits negative. Rewards higher than social interaction might be attained by playing with his children. The alternatives an individual has are also seen as being important in the individual's evaluation of his time cost. If one knows many people, interaction with a single one may occur less often than if he knows only two people in town. The individual's time costs are multiplied by the expected duration of the individual's visit with j.

The last element of the total costs involved in social interaction is the perceived opportunity costs, $O_{i,k,j}$, or the opportunity individual i loses because he chose social interaction with j, as opposed to another type of activity at k. In this case, k may be the individual's home location, where he may enjoy activities such as gardening, or relaxing and watching television, for example. Or k may be any other location that may take an individual's time, such as shopping, going for a ride, or hitting golf balls. It may also take the form of social interaction with someone else.

Small case letters a, b, c, d, and e are subjective weights that the individual assigns to each of the elements of the equation. These weights are assigned partially by the individual's preferences for social activity, and partially on the basis of the individual's aquisition of information on rewards, various costs, and distances involved in the interaction.

In order for interaction to occur, NB_{ij}, the net benefits of interaction for i with j, must be positive. In order for net benefits to be positive, rewards must be greater than total costs. If costs are greater than rewards, individual i will stay home, or undertake some other types of out-of-the-home activities besides interaction with j. If the function is positive, individual i may interact with j, but will do so only if there are no other activities yielding higher net benefits for the time period under question. If there are other activities, these too will have associated costs and rewards. The activity with the highest net benefit for that time period will be the one chosen.

In order for a model such as the one presented here to be tested in the future, information on individual's preferences and subjective evaluations is necessary. It is expected that one would find some degree of order in the way people select options and evaluate social alternatives, rather than finding each individual as being unique in his social selection behavior. Methodology for finding space preference structures from data which describe spatial choices, such as the method of paired comparisons, developed in psychology by Guttman (1946), David (1963), and Kruskal (1964), could be developed for the urban area in a manner similar to presently existing methods for rural travel. The present methods use computer algorithms for searching and ordering the spatial relationship of people to alternatives and techniques of multi-dimensional scaling. Rushton (1969 a, b) has used these methods to predict an individual's maximum grocery purchase towns.

A Predictive Model of Social Interaction Patterns

The decision to make social trips is a common phenomenon, and results in recurrent spatial distribution of trips for a household or neighborhood in a defined study area. By using the regularities of distance and status from previous stages of the analysis, a model is set forth which would generate the dominant household social interaction patterns of a metropolitan area. Given social patterns for a neighborhood (or a traffic zone), the model would ideally be able to generate, within certain bounds of error, the same social patterns in simulated form. The model could then predict future social patterns for the study area, zone by zone, when given inputs of population and land use projections existing for these future periods. Such data exist in the Tri-County area for the year 1990.

To meet the objective of assigning social trip ends to an urban area from zone i to all zones j, probabilities can be assigned to the traffic zones of the urban area in accordance with the likelihood for individuals from zone i to make a social trip to zone j. This likelihood, as revealed by individual travel behavior, has been derived through a simple distance decay function in Hagerstrand (1967) spatial diffusion models, but will be dependent on two variables in this model. One is the time distance from i to j, which will include consideration of barrier effects and quality of network. The other is the social distance of zone i to zone j, expressing the social affinity between two zones, as measured by the status index of the zones. The zone probabilities will then be constructed of these two elements. The distance element will best evaluate the rapid decline in interaction with distance from the zone i, and reflects the neighborhood component of social interaction, defined and discussed in two previous chapters. The social distance element of the zone probabilities, or the degree to which individuals have connections with each other, independent of least travel cost considerations, reflects the individual's status-dependent social network component of social interaction.

Zone probabilities can be generated by using the concept of a potential surface. The probabilities that zone i will interact with zone j are:

$$ {}_iP_j = C \left(\frac{p_i \cdot p_j \, (8 - |S_i - S_j|)}{\log d_{ij}} \right) $$

where

${}_iP_j$ = probability that social trip from zone i will flow to zone j

p_i = population of zone i

p_j = population of zone j

S_i = status index of zone i

S_j = status index of zone j

C = empirically derived constant

d = time distance between k and j,

and

$$ \sum_{j}^{300} {}_iP_j = C \left(\sum_{j-1}^{300} \frac{p_i \cdot p_j \, (8 - |S_i - S_j|)}{\log d_{ij}} \right) = 1.[1] $$

The shorter in time and social distance one zone is from another, the higher is the probability of interaction between the two zones.

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[1]The equation assumes 300 traffic zones and 8 occupational classes.

Zone i under question would receive the largest probability. Each iteration of the model would simulate one trip between zone i and any other zone j. Preferably, there would be a large number of trips to simulate from the same zone to all others for the model to be effective. The larger the number of trips (or the longer the time period), the better is the simulation with a stochastic model.

Each trip destination is selected by choosing a random number corresponding to one of the zones j. The range of values assigned to a zone, and therefore, the chance that it will receive a trip, will be dependent on its associated probability. After many simulated trips, patterns of social trips will begin to be visible. If the model has properly weighted the two components, the actual location for social trip ends should be randomly distributed about the predicted location. Checking the sensitivity of the patterns due to a change in variable weights is the most important aspect of running the model, and should be used to redefine and recalibrate the model. Examining the sensitivity of the patterns due to a change in variables is the only aspect of the model that will tell us if we have properly evaluated human social behavior.

Studies dealing with the effect of distance and status on interpersonal social relations are in general agreement. A large body of literature at the group quarters, neighborhood, and city levels has found social and spatial distance to be important influences on pairs of social contacts. This study has shown that these relationships are also significant factors with regard to vehicular social trips. Earlier findings have generally dealt with a relatively small and detailed subset of individuals. For example, marriage partners, occupants of a boarding house, or a married housing unit, residents of a neighborhood, or inhabitants of a small town have been the subjects of research. This study is somewhat different in that it has shown similar results for a medium sized American city, with a broad range of individuals. This was made possible by using a vast amount of data that was gathered originally for other purposes.

Yet, due to the voluntary and substitutional nature of social trips, variations in individuals' personalities and attitudes make social trip frequency and patterns of social ties difficult to predict. An explanation of how and why individuals select social trip ends has been forwarded. More research is needed in this area. But until these factors of personality and attitude can be measured, a certain random element must be assumed when analyzing social trips. The random element is based not only on these factors of personality and attitude, but also on the individual's unique social communication network and his search behavior, each of which is not completely determined by distance and status considerations.

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APPENDICIES

APPENDIX A

FORMAT OF HOME SURVEY TRIP TAPE RECORD

Column Number	Description of Data	Codes
<u>Identification Data</u>		
1–2	Survey Number	Cols. 1–2 contain the following codes: 02–Trip made by household resident 22–Trip made by group quarters resident
3–7	Household Number	Actual number in cols. 3–6; col. 7 contains the following codes: 1–A 2–B 3–C 0–No letter given
<u>Location Data</u>		
8–10	Census Tract Number of Residence	Col. 8 contains following codes: 0–Ingham County 2–Eaton County 1,4–Clinton County Cols. 9–10 contain actual census tract number assigned by the Bureau of the Census for the tracted area; for the untracted area the accompanying "Jurisdiction Code List" applies.
11–12	Governmental Unit of Residence	See "Jurisdiction Code List."
13–15	Traffic Zone of Residence	Code must be "001–411."
16–23	Grid Coordinates of Residence	Actual coordinates coded.
<u>Household Data</u>		
24	Number of Cars Owned	Actual number.

25	Actual or Estimated	Col. 25 contains the following codes: Blank-Cars owned reported by respondent 1-Cars owned estimated by interviewer
26	Income (Respondent's Estimate)	Col. 26 contains the following codes: 1-Without income 2-Under $3,000 3-$3,000- $4,999 4-$5,000- $6,999 5-$7,000- $9,999 6-$10,000- $14,999 7-$15,000- $24,999 8-$25,000 and over 9-Not given
27	Actual or Estimated	Col. 27 contains the following codes: Blank-Income reported by respondent 1-Income estimated by interviewer
28	Kind of Building Lived in by Respondent	Col. 28 contains the following codes: 1-Single family 2-Two family 3-Three and over family 4-Rooming house 5-Hotel/motel 6-Institution 7-Trailer 8-Row house 9-Residential and other 0-Other +-Not given
29-30	Total Persons in Household	Cols. 29-30 contain actual number of persons living in that housing unit.
<u>Person Data</u>		
31-32	Person Number	Cols. 31-32 contain a unique person number for each person living in that housing unit.
33-34	Age of Respondent	Cols. 33-34 contain actual age or 00 which indicates age was not given.
35	Sex	Col. 35 contains the following codes: 1-Male 2-Female 0-Not given

36	Race	Col. 36 contains the following codes: 1–White 2–Other 0–Not given
37–38	Occupation of Respondent	Cols. 37–38 contain the following codes: 00–Professional, technical and kindred workers 01–Farmers, and farm managers 02–Managers, officials and proprietors, except farm 03–Clerical and kindred workers 04–Sales workers 05–Craftsmen, foremen and kindred workers 06–Operatives and kindred workers 07–Private household workers 08–Other service workers 09–Farm laborers and foremen 10–Laborers, other than farm 90–Not in the labor force; unemployed, retired, housewife, student, not applicable 99–No answer
39–41	Educational Level Attained by Respondent	Col. 39 contains the following codes: 1–8–Elementary grade level attained 9–Not in this column Col. 40 contains the following codes: 1–4–High school level attained 9–Not in this column Col. 41 contains the following codes: 1–5–College level attained 9–Not in this column 000–Not given, does not apply 099–No schooling
42	Marital Status	Col. 42 contains the following codes: 1–Married 2–Widowed 3–Divorced 4–Separated 5–Never married 9–Not applicable, not household head 0–Not given
43	Relationship of Respondent to Head of Household	Col. 43 contains the following codes: 1–Head of household 2–Spouse 3–Son 4–Daughter

		5–Other male, related (father, son-in-law) 6–Other female, related 7–Other male, not related 8–Other female, not related 0–Relationship not given
44	Is the Respondent a Driver of a Car or Truck?	Col. 44 contains the following codes: 1–Yes 2–No 9–Not applicable (under 5 years of age) 0–Not given
45	Is the Respondent Employed?	Col. 45 contains the following codes: 1–Full-time employment 2–Part-time employment 3–Not employed 4–Student 9–Not applicable (under 18 years of age) 0–Not given
46–47	Land Use Code of Industry Where Respondent Works	Col. 46–47 contain the codes presented in the <u>Standard Land Use Coding Manual</u>, published by HUD and BPR in 1965, or 00 which indicates land use was not given or not applicable. (See table, abstracted from Manual, entitled "Standard Land Use Classifications.")
48–50	Traffic Zone in Which Industry is Located	Cols. 48–50 contain "001–411" if industry is located in the Region; if industry is outside the Region, cols. 49–50 contain the county code indicated on the accompanying list entitled "Complete County Code for Michigan" and Col. 48 contains the following codes: 7–Ten counties surrounding Region 8–Counties in remainder of State or the three counties in the Tri-County Region 9–States other than Michigan Cols. 48–50 contain blanks or "0" if no data were available.
<u>Trip Data</u>		
51–52	Trip Number	Cols. 51–52 contain a number for each trip made by each individual. Coded

		by a two digit consecutive number for purposes of identification (01=first trip, 02=second trip).
53-55	Zone of Trip Origin	Cols. 53-55 contain "001-411" if trip origin is in the Region; if trip origin is outside the Region, cols. 54-55 contain the county code indicated in the accompanying list entitled "County Code for Michigan" <u>if</u> col. 53 contains the following codes: 7-Ten counties surrounding Region 8-Counties in remainder of State or the three counties in the Tri-County Region If col. 53 contains a "9," which indicates a state other than Michigan, then cols. 54-55 contain the state code indicated in the accompanying list entitled "State Code for the United States," or the country code indicated in the accompanying list entitled "Country Code."
56-58	Zone of Trip Destination	Cols. 56-58 contain "001-411" if trip destination is in the Region; if trip destination is outside the Region, cols. 57-58 contain the county code indicated in the accompanying list entitled "County Code for Michigan" <u>if</u> col. 56 contains the following codes: 7-Ten counties surrounding Region 8-Counties in remainder of State or the three counties in the Tri-County Region If col. 56 contains a "9," which indicates a state other than Michigan, then cols. 57-58 contain the state code indicated in the accompanying list entitled "State Code for the United States," or the country code indicated in the accompanying list entitled "Country Code."
59-61	Start Time	Cols. 59-61 contain the time that the trip began from zone of origin; cols. 59-60 contain the hour (military time) and col. 61 contains tenths of hours. For example, 1:06 p.m. would be coded 131 in cols. 59-61.

62–64	Arrival Time	Cols. 62–64 contain the time that the trip ended at the zone of destination; cols. 62–63 contain the hour (military time) and col. 64 contains tenths of hours.
65–66	Land Use of Trip Origin	Cols. 65–66 contain the codes presented in the Standard Land Use Coding Manual, published by HUD and BPR in 1965. (See table, abstracted from Manual, entitled "Standard Land Use Classifications.")
67–68	Land Use of Trip Destination	Cols. 67–68 contain same codes as cols. 65–66.
69	Purpose Trip Origin	Col. 69 contains the following codes: 1–Work 2–Personal business 3–Medical–Dental 4–School 5–Social–Eat meal 6–Change travel mode 7–Shopping 8–Recreation and ride 9–Home 0–Business +–Serve passenger
70	Purpose of Trip Destination	Col. 70 contains same codes as col. 69.
71	Mode of Transportation	Col. 71 contains the following codes: 1–Auto driver 2–Auto passenger 3–Bus passenger 4–School bus passenger 5–Taxi passenger 6–Truck passenger 7–Walk to work 8–No answer
72	Car Available	Col. 72 contains the following codes: 1–Yes 2–No 3–Not given 0–Not applicable
73–74	Car Occupancy	Cols. 73–74 contain the actual number of people in the car including the driver or the following codes: –– –Not given ++ –Not applicable

75	Parking	Col. 75 contains the following codes concerning type of parking facility used: 1–Street free 2–Street meter 3–Lot free 4–Lot paid 5–Garaged free 6–Garage paid 7–Service or repairs 8–Residential property 9–Cruised 0–Not parked —–Not given ++–Not applicable
76	Day of Travel	Col. 76 contains the following codes: 1–Sunday 7–Saturday 8–Weekday
77	Month of Travel	Col. 77 contains the following codes: 4–April 5–May 6–June 7–July
<u>Factor</u> 78–80	Expansion Factor	Cols. 78–80 contain the number to nearest tenth, which expands the sample data to 100%.

Source: Tri–County Regional Planning Commission of Lansing, Michigan.

APPENDIX B

QUESTIONNAIRE AND CODESHEET — SOCIAL INTERACTION STUDY

Household Number ____________
Block Number ____________
Zone or Tract ____________

Do you think the transportation facilities — streets, expressways, bus service — adequately connect your neighborhood with downtown Lansing?

Concerning the three people — neighbors, friends, relatives — the wife(husband) visits for social purposes most frequently, either individually or as a family:

Person 1.

1. Location of person — street and block:____________________ (recode)

2. Estimated distance away:

1-Don't know	5-1 mile
2-Next door	6-2-3 miles
3-Same block	7-4-8 miles
4-Next block	8-More than 8 miles

3. Average number of visits to them per month:
   1-Less than 1
   2-1-2
   3-3-4
   4-5-6
   5-7 or more

4. Occupation of head of friend's household:

1-Professional, technical	6-Operative
2-Manager, official	7-Service worker
3-Sales worker	8-Laborer
4-Clerical worker	9-Housewife, student, unemployed
5-Craftsman, foreman	

5. How did you establish friendship tie:____________________ (recode)

6. Number of social phone calls to person per month:

1-1-2	4-7-8
2-3-4	5-9 or more
3-5-6	

Person 2.

1. Location of person — street and block: ____________________ (recode)

2. Estimated distance away:

1-Don't know	5-1 mile
2-Next door	6-2-3 miles
3-Same block	7-4-8 miles
4-Next block	8-More than 8 miles

3. Average number of visits to them per month: 1-Less than 1; 2-1-2; 3-3-4; 4-5-6; 5-7 or more

4. Occupation of head of friend's household:
   1-Professional, technical
   2-Manager, official
   3-Sales worker
   4-Clerical worker
   5-Craftsman, foreman
   6-Operative
   7-Service worker
   8-Laborer
   9-Housewife, student, unemployed

5. How did you establish friendship tie: ____________________ (recode)

6. Number of social phone calls to person per month: 1-1-2; 2-3-4; 3-5-6; 4-7-8; 5-9 or more

Person 3.

1. Location of person — street and block: ____________________ (recode)

2. Estimated distance away:
   1-Don't know
   2-Next door
   3-Same block
   4-Next block
   5-1 mile
   6-2-3 miles
   7-4-8 miles
   8-More than 8 miles

3. Average number of visits to them per month: 1-Less than 1; 2-1-2; 3-3-4; 4-5-6; 5-7 or more

4. Occupation of head of friend's household:
   1-Professional, technical
   2-Manager, official
   3-Sales worker
   4-Clerical worker
   5-Craftsman, foreman
   6-Operative
   7-Service worker
   8-Laborer
   9-Housewife, student, unemployed

5. How did you establish friendship tie: ____________________ (recode)

6. Number of social phone calls to person per month: 1-1-2; 2-3-4; 3-5-6; 4-7-8; 5-9 or more

Personal

1. Size of family at home ______________
2. Number of cars in household ______________
3. Length of residence in city: wife ______________
4. Length of residence in city: husband ______________
5. Length of time at present address for family ______________
6. Age of household head ______________
7. Occupation of head ______________
8. Total family income ______________

APPENDIX C

DESCRIPTION OF TRIP PURPOSES

The purpose "work" refers to the trip to the place of employment, but not a trip made as part of one's job. If a person drives to his place of employment he is making a work trip, but if he then drives to another destination in the course of his work, the purpose is "business." Return trips to the place of employment are counted as business trips. "Personal business" refers to any personal activity that does not entail a purchase, such as seeing a legal advisor, mailing a package, or going to the health club. "Medical-dental" refers to trips to obtain these services.

The purpose "school" applies to a child's bus trip to school, but if the parent drives the child to school the parent's purpose of the trip is "serve passenger." If the parent goes directly home from school, the purpose of his second trip is "home." But if the parent stops to visit at a friend's home on the way back to his own home, the purpose of this trip is "social-eat meal." Similarly, if he stops at a restaurant for a meal, this is also social-eat meal. If he goes from his friend's house back to his own home, the purpose of the last trip is "home." In the Home Interview Survey the social-eat meal trip purpose was rather loosely defined, including even stopping by a Dairy Queen for a snack, for example. The social trip component included not only inter-residential social trips, but also trips made for church, club or civic functions, as well as other activities in which two or more people come into contact socially.

"Change travel mode" refers to the case where the respondent goes by one mode of travel to a given destination in order to meet another mode of travel. This is considered as two trips, and the purpose of the first one is to "change travel mode," while the second trip may have a different purpose. "Shopping" refers to any shopping trip, even though a purchase may not have been made. Therefore, if the person merely goes window shopping or to price an item, the purpose remains a "shopping." Walking trips between stores, such as in a shopping center, are not counted as extra trips in this study. "Recreation and ride" applies to the instance where a person rides to a location in order to enjoy recreation there, or merely for the pleasure of a ride. If a wife accompanies the husband on a trip to the hardware store merely for the purpose of keeping him company, the husband's trip is "shopping," while the wife's trip is "recreation and ride." "Home" refers only to trips made to one's own home.