FREEWAY EFFECTS ON RESIDENTIAL MOBILITY IN METROPOLITAN NEIGHBORHOODS

Edward L. McLean, Clemson University; and
William G. Adkins, Texas A&M University

The objectives of the research reported were to delineate metropolitan neighborhoods, investigate the effect of the introduction of a freeway on residential mobility, analyze freeway-neighborhood relationship categories, and interpret these findings in a causal and predictive framework. Before-freeway and after-freeway and control group research designs were utilized. Residential mobility was the dependent variable and 4 freeway-neighborhood relationship categories were the independent variables: control neighborhoods, study neighborhoods not bordering the freeway, study neighborhoods bordering the freeway, and study neighborhoods segmented by the freeway. A total of 152 study neighborhoods and 47 control neighborhoods were examined in Austin, Dallas, and Houston. A "neighborhood" index was formulated to aid in neighborhood delineation and to measure residential socioeconomic level. A "mobility" index was formulated to measure residential mobility. Neighborhood indexes were calculated for 2 time periods, and mobility indexes for 3 time periods. Product-moment and rank-difference correlation analyses were conducted. It was concluded that the neighborhood index is an objective procedure for neighborhood delineation and that effects of introduction of a freeway in metropolitan neighborhoods on residential mobility can be accurately determined with the mobility index. Residential mobility can be expected to increase significantly if a neighborhood is segmented by the freeway right-of-way. Qualitative neighborhood characteristics are also more likely to decline if a neighborhood is segmented by the freeway.

•ALTHOUGH various benefits of freeways have been studied and demonstrated in depth, there are several types of freeway effects persistently argued as social costs or disbenefits. Foremost among these hypothesized negative effects is that freeways are detrimental to neighborhood social organization and, thus, to the social values on which the future of the community depends (1). To the extent that this proposition is correct, the location of freeways within urban and metropolitan residential areas must be more carefully considered. There is little known, however, of the nature and extent of freeway effects on social characteristics and behavior in urban and metropolitan neighborhoods. Such knowledge can be expanded through research and can, in turn, place neighborhood considerations in proper perspective for freeway planning.

Literature concerned with the social impact of freeways in residential areas is replete with lack of concrete evidence and contradictory findings. Delineation of spatial subareas such as communities or neighborhoods is seldom verified, and hard data to determine impact are infrequently analyzed objectively. One exception in the literature is represented by reports of research conducted by the California Division of Highways in California and Washington cities (3, 4, 5, 10). Residential areas were delineated and a

Sponsored by Committee on Social, Economic and Environmental Factors of Transportation and presented at the 50th Annual Meeting.

"mobility" index was suggested in these investigations; the mobility index comprised 3 variables: residential mobility, proportion of home ownership, and proportion of multiple-dwelling units. Few conclusions were drawn from these studies for several reasons, one being the heterogeneous nature of the mobility index. Residential mobility is, thus, a prime concern in studying freeway effects in metropolitan neighborhoods. Practical benefits accruing from research on this topic relate to planning for freeway location and, more specifically, to selecting the right-of-way route.

The research problem that guided this study, therefore, was to analyze residential mobility in metropolitan neighborhoods, including "before-and-after" and "control group" research design methodology, with introduction of a freeway being the independent variable. The research also investigated methods of delineating neighborhoods and attempted to determine additional characteristics of neighborhoods that may be subject to freeway effects.

The major objectives of this research are as follows:

1. Develop research methodology for delineation of metropolitan neighborhoods;
2. Investigate residential mobility of metropolitan neighborhoods in certain categories that include neighborhoods segmented by the freeway, neighborhoods bordering the freeway, neighborhoods not bordering the freeway, and control neighborhoods;
3. Analyze statistically the association between residential mobility data for neighborhoods (dependent variables) and neighborhood category and other characteristics (independent variables); and
4. Interpret causal and predictive findings for utilization of freeway planning efforts.

A freeway is a limited-access highway having 4 lanes or more and a permanent median divider. Residential mobility is the rate of movement of residents from their dwelling units during a given time period. Five-year time periods are utilized in the research reported here. The currently accepted definition of neighborhood in social science literature is based on homogeneity criteria. A neighborhood is, consequently, a residential area with like social and economic characteristics. In a spatial perspective, the authors of this paper have defined neighborhood as being larger than a city block and smaller than a census tract.

RESEARCH PROCEDURES

The research project began operationally in June 1968 and was completed in May 1970. The first task was to select study areas in Austin, Dallas, and Houston where a freeway had been introduced into established residential areas. Texas State Highway Department records were examined to determine the location of freeways and the dates when rights-of-way were authorized, construction began, and the freeway was completed.

Study area, as used in this report, refers to a given length of freeway and its surrounding environs. Four study areas were subsequently chosen in Dallas, 1 large area was chosen in Austin, and 5 areas were chosen in Houston. The 3 significant dates occurred between 1950 and 1960 in 6 study areas and between 1960 and 1965 in 4 study areas. The basic steps in conducting the research were identical in the study areas in all 3 cities and will be presented briefly.

Field observations of study areas were conducted to determine basic housing and the economic, transportation, and geographic characteristics of the study areas. While they observed the areas, the researchers used tape recorders to record their impressions of physical appearance of the neighborhood, evidence of land use change, and any evident social implications. Photographs were taken of representative dwelling units. Potential depths of the study areas were examined, that is, the distance or number of blocks from the freeway to the study area boundary. The recordings were transcribed and placed with the pictures for use in subsequent research steps.

Consultations were conducted with individuals and agencies who could provide knowledge regarding neighborhood and community variables, impact of freeways, land use, zoning, and previous research. City planning and transportation offices provided detailed information regarding land use patterns and trends and zoning designations. State highway department offices provided information regarding detailed transportation

studies. Individuals from other public and private agencies provided general information regarding neighborhood and community variables in each city.

Available information, such as that of the U. S. Bureau of the Census, was obtained and processed concerning social, economic, and housing characteristics of the residential areas in question. Census of Population data were obtained for tracts. These data, combined with information from previous steps, facilitated delineation of study and control area boundaries.

Neighborhood delineation was accomplished by calculating and mapping social and economic residential characteristics (Census of Housing data) for each block within each study area and then by calculating indexes for each block with the use of the index data originating from census data. Information from steps 1 and 2 supplemented the indexes in determining neighborhood boundaries. The socioeconomic or neighborhood indexes comprised combinations of the following variables:

1. Proportion of owner-occupied dwelling units,
2. Proportion of dwelling units in good condition,
3. Proportion of dwelling units not crowded,
4. Mean value of owner-occupied dwelling units,
5. Mean rental of renter-occupied dwelling units, and
6. Number of rooms per dwelling unit.

Variables 1 through 5 were available in the 1950 census reports, and variables 1 through 6 were available in the 1960 census reports.

The neighborhood index for 1950 comprised variables 1, 2, and 3. The formula for this index is simply the arithmetic summation of the 3 proportions with a numerical range of 0 to 300. The neighborhood index for 1960 comprised variables 1, 2, 3, and 6. Variable 6 was included in this formula by determining the numerical range of the empirical data and calculating weighted percentages. The 1960 index was arithmetically converted to a 0 to 300 numerical range.

Control neighborhoods were selected that matched as closely as possible the social and economic characteristics of study neighborhoods. The prime distinction between study and control neighborhoods was that the study neighborhoods were in close proximity to a freeway right-of-way.

City directory information was obtained and processed in preparation for the calculation of the mobility index. The mobility index is a 1-variable index, measuring residential mobility for a given neighborhood for 5-year intervals (1950 to 1955, 1955 to 1960, and 1960 to 1965). The formula for this index is 200 - 2X, where X is the proportion of residents in the same dwelling units, base year compared with 5 years past.

The 2 indexes, neighborhood and mobility, were calculated and coded in preparation for descriptive analysis and subsequent computer processing. Neighborhoods were grouped according to freeway relationship and index level categories. The freeway relationship categories were control neighborhood, study neighborhood not bordering the freeway, study neighborhood bordering the freeway, and study neighborhood segmented by the freeway. These formulations included neighborhood indexes for 1950 and 1960 and mobility indexes for the 3 time periods. In those study areas where the freeway was introduced between 1960 and 1965, only 1960 neighborhood indexes were calculated and mobility indexes were calculated for 2 time periods.

Product-moment and rank-difference correlation coefficients were calculated and intercorrelation matrices were formulated. Multiple regression analyses, based on intercorrelation matrices, were conducted to provide causal and predictive inferences.

Maps were prepared for the 3 cities and for each study area indicating study neighborhoods and control neighborhoods.

Numerous freeways have been built in the 3 cities since 1950, and considerable mileage had been completed by 1960. The final selection of study areas, and subsequent neighborhood delineation, resulted in 152 study neighborhoods and 47 control neighborhoods being included in the investigation.

FINDINGS

Discussion in this section summarizes the major findings from this research project. Neighborhood and mobility index levels and trends, product-moment correlation results, and multiple regression analyses are presented.

Index Levels and Trends

The neighborhood index, utilized for neighborhood delineation, is also a measure of residential socioeconomic level and has a potential range of 0 to 300. The 1950 empirical range in this investigation was 110 to 300, but few neighborhoods indicated high indexes. Previous research studies using similar indexes conclude that an index level of 200 is the approximate cut-off point for intermediate and low neighborhood residential socioeconomic level. A total of 152 study neighborhoods were included in this research, and 54 indicated an index of less than 200 for 1950.

Neighborhood and mobility index means, by neighborhood category, are given in Table 1. The neighborhood index mean for all study neighborhood indexes was 214 in 1950 and 235 in 1960; control neighborhood indexes, on the other hand, declined from 219 to 207 during this period. If all study neighborhoods are considered, introduction of freeways certainly did not result in overall socioeconomic decline in the study areas considered. Residential socioeconomic level actually increased in the freeway study neighborhoods and declined in the control neighborhoods.

The mobility index, used to measure residential mobility, has a potential range of 0 to 200, and the empirical range in this investigation was 0 to 200. Overall rates of residential mobility were quite high in the majority of the study and control neighborhoods; approximately 60 percent of all inhabitants changed their place of residence each 5-year period in the study and control neighborhoods. This mobility rate, high as it may seem, is normal for viable residential areas in metropolitan central cities.

The mean mobility index for all study neighborhoods was 124, 1950-55, and 117, 1960-65. The mean mobility index for all control neighborhoods was 123, 1950-55, and 113, 1960-65. Residential mobility declined slightly during the study period in both control and composite study neighborhoods. Some variation occurred in index levels and trends among the 3 cities, but the authors believe that these variations were not a result of freeway introduction. Of the 3 cities, Austin indicated the greatest proportional population growth, Dallas had more land use change in the study areas, and Houston indicated the greatest economic growth. These forces have an impact on the indexes but generally do not, in the authors' judgment, interfere with determining freeway effects in establishing neighborhoods.

Information concerning index trends by neighborhood category is also given in Table 1. If neighborhood index trends are considered for the 3 study neighborhood categories, neighborhood not bordering the freeway indicated the greatest increase in socioeconomic level, followed by neighborhood bordering the freeway. Neighborhoods segmented by the freeway indicated a slight increase in socioeconomic level, which probably results from some modern apartment complexes being built in these neighborhoods.

TABLE 1

NEIGHBORHOOD AND MOBILITY INDEX MEANS BY NEIGHBORHOOD CATEGORY

Neighborhood Category	Neighborhood Index		Mobility Index	
	1950	1960	1950-55	1960-65
Control neighborhoods	219	207	123	113
All study neighborhoods	214	235	124	117
Study neighborhoods not bordering freeway	205	241	116	111
Study neighborhoods bordering freeway	225	244	120	112
Study neighborhoods segmented by freeway	216	221	111	122

The mobility index trends for the 3 neighborhood categories show that residential mobility declined similarly in study neighborhoods bordering and not bordering the freeway and in control neighborhoods. Residential mobility increased in study neighborhoods segmented by the freeway, however.

Correlation Analyses

Product-moment and rank-difference correlation coefficients were calculated for each study area and for study and control neighborhoods. Product-moment correlation coefficients were calculated for all study areas combined by neighborhood category.

The correlation coefficients for individual study areas were generally well above the critical value for within-index analyses (neighborhood-by-neighborhood index and mobility-by-mobility index). This finding substantiates the neighborhood delineation methodology used in this research and also indicates that obliterative social and economic change did not take place in the study and control neighborhoods. Neighborhood by mobility index correlations were generally in the expected direction (negative), but only half of the coefficients were above the critical value. Product-moment coefficients were generally higher than rank-difference coefficients, indicating that change in neighborhood rankings within study areas was greater than change in index trends within neighborhoods.

	NI50	NI60	MI50	MI60
NI50	-	.93	-.47	-.31
NI60	.93	-	-.61	-.36
MI50	-.47	-.61	-	.58
MI60	-.31	-.36	.58	-

Control neighborhoods; critical value = ± 0.32.

	NI50	NI60	MI50	MI60
NI50	-	.25	-.33	-.20
NI60	.25	-	-.22	-.17
MI50	-.33	-.22	-	.43
MI60	-.20	-.17	.43	-

All study neighborhoods; critical value = ± 0.17.

	NI50	NI60	MI50	MI60
NI50	-	.16	-.25	-.11
NI60	.16	-	-.17	-.20
MI50	-.25	-.17	-	.52
MI60	-.11	-.20	.52	-

Study neighborhoods not bordering freeway; critical value = ± 0.24.

	NI50	NI60	MI50	MI60
NI50	-	.39	-.42	-.53
NI60	-.39	-	.12	-.32
MI50	-.42	.12	-	.72
MI60	-.53	-.32	.72	-

Study neighborhoods bordering freeway; critical value = ± 0.35.

	NI50	NI60	MI50	MI60
NI50	-	.35	-.54	-.16
NI60	.35	-	.10	.21
MI50	-.54	.10	-	.34
MI60	-.16	.21	.34	-

Study neighborhoods segmented by freeway; critical value = ± 0.37.

Figure 1. Matrices of product-moment correlation coefficients.

Product-moment correlation coefficients for the neighborhood categories are shown in Figure 1. In this figure, NI50 and NI60 refer to neighborhood indexes for 1950 and 1960 respectively; MI50 and MI60 refer to mobility indexes for 1950-55 and 1960-65 respectively. Critical value refers to level of significance; coefficients above the critical value are considered to be statistically significant at the 0.05 level.

The coefficients for all study areas and all study neighborhoods are considerably lower than the coefficients for individual study areas. This simply reveals that greater social, economic, and residential homogeneity prevails within study areas than between study areas. The coefficients for bordered and not bordered neighborhoods are similar to the coefficients for all study neighborhoods. The coefficients for segmented neighborhoods are considerably lower than for all study neighborhoods.

This finding (high correlation in control neighborhoods, low correlation in segmented neighborhoods) is true for neighborhood-by-neighborhood index correlations, mobility-by-mobility index correlations, and for neighborhood-by-mobility index correlations. This indicates that socioeconomic level and behavior resulting in residential mobility were least likely to change in control neighborhoods and most likely to change in neighborhoods segmented by the freeway right-of-way.

Multiple Regression Analyses

The product-moment correlation matrices just discussed were used to conduct multiple regression analyses to determine potential causal or predictive roles for each index and each neighborhood category.

The neighborhood categories—segmented, bordered, and not bordered—were coded by using the technique of dummy variables to be contrasted with the control area that would be reflected in the constant term of the regression formula. All 3 dummy variables were coded as zeros for a control neighborhood.

The basic regression equation proposed to predict mobility change with 4 independent variables is given in Table 2. The final regression with only the segmented neighborhood category and the initial mobility index as independent variables is given in Table 3. The basic regression equation yielded probabilities higher than 50 percent that bordered and not bordered neighborhood variables were not significant, and thus it is probably due to chance that they differed from the control neighborhoods with respect to residential mobility. These 2 variables were eliminated one at a time, and the final regression was calculated. The calculations indicate that the segmented neighborhood variable is significant with less than 1 percent probability of chance error accounting for the difference. Neighborhoods segmented by the freeway right-of-way indicate a significant increase in residential mobility when compared to the other 2 categories of study neighborhoods and to the control neighborhoods. If a neighborhood is segmented by a freeway, it is indicated that an estimated 13 index points in the mobility index will be added to the level of residential mobility. This relationship is shown in Figure 2. Other regressions were calculated by using each neighborhood category and index as input variables, but the findings were consistent with those just presented.

Correlation and other analyses discussed previously indicate that varying social and economic phenomena occur in neighborhoods that are divided by the freeway right-of-

TABLE 2

BASIC REGRESSION ANALYSIS FOR ALL STUDY NEIGHBORHOODS WITH MOBILITY INDEX AS BASE

Variable	t-Value	Probability
Mobility index 1950-55	-4.65	0.000007
Not bordered neighborhoods	-0.44	0.66
Bordered neighborhoods	-0.59	0.56
Segmented neighborhoods	2.07	0.04

Note: Mobility change = 41.6 - 0.384(MI50-55) + 11.5(segmented) - 3.14 (bordered) - 1.96(not bordered). Root mean square residual = 22.65. $F_{4,162} = 8.15$.

TABLE 3

FINAL REGRESSION ANALYSIS FOR SEGMENTED NEIGHBORHOODS WITH MOBILITY INDEX AS BASE

Variable	t-Value	Probability
Mobility index 1950-55	-4.73	0.000005
Segmented neighborhoods	2.75	0.0066

Note: Mobility change = 40.4 - 0.388(MI50-55) + 13.1(segmented). Root mean square residual = 22.54. $F_{2,164} = 16.3$.

way. The regression analysis presented here reveals the magnitude, direction, and nature of these variables. An increase in residential mobility can be expected in such neighborhoods.

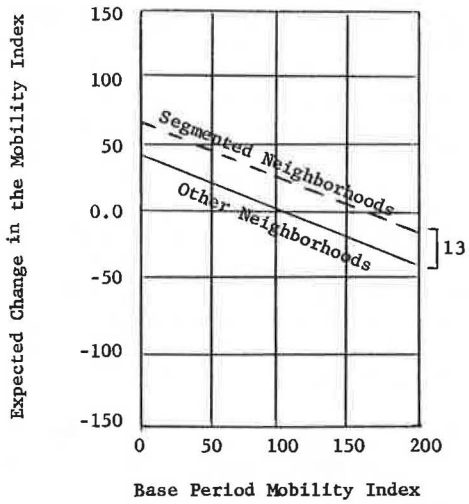

Figure 2. Expected change in residential mobility from 1950 to 1965. (Root mean square residual = 23; two-thirds of the estimates made should be within 23 of the actual change experienced. The regression is significant beyond the 0.001 level. $F_{2,164} = 16.3$.)

Segmented Neighborhoods by Type of Neighborhood

Because significant multiple regression findings are associated with segmented neighborhoods, an additional descriptive analysis of segmented neighborhoods was conducted. In this analysis, both segmented and control neighborhoods were classified according to residential characteristics and conditions. Only neighborhoods in which the freeway was introduced between 1950 and 1960 were considered in this analysis. This descriptive analysis of segmented and control neighborhoods may be briefly summarized as follows: Declines in socioeconomic level are more likely in segmented neighborhoods; net loss of total dwelling units (not including those displaced by the freeway) is much more prevalent in segmented neighborhoods; and conversion of single dwelling units to apartment houses (or addition of new multiple-dwelling units) is likely to take place in segmented neighborhoods.

With respect to neighborhood characteristics, it is concluded that diversion of a neighborhood by the freeway produces declining qualitative indexes in neighborhoods of varying social characteristics. The impact does tend more toward deterioration when some combination of old or intermediate single-family dwelling units and intermediate or new multiple-dwelling units prevails. It is worthwhile to note that all such neighborhoods are in a process of ecological transition; land use and functions of dwelling units are changing as a result of economic aging. Furthermore, in neighborhoods with initial low socioeconomic level, the impact cannot be defined as negative; i.e., neighborhood characteristics and socioeconomic level can decline very little.

SUMMARY AND CONCLUSIONS

Neighborhoods, in the research reported here, are operationally defined as metropolitan spatial areas that are homogeneous with respect to residential housing characteristics, based on combinations of city blocks. These neighborhoods were roughly delineated by field observations. Their boundaries were more finely fixed through use of block-by-block characteristics and finally by neighborhood index levels. Thus, neighborhoods were "derived" in terms of relative homogeneity of dwelling unit data (8). Previous research efforts reveal that dwelling unit data provide objective criteria for delineation of urban and metropolitan residential subareas (14).

The general objectives of this research project were to delineate metropolitan neighborhoods, investigate the effect of introduction of a freeway on residential mobility, analyze freeway-neighborhood relationship categories, and interpret these findings in a causal and predictive framework.

Neighborhood Index

The neighborhood indexes generated in the study were generally low, indicating low to intermediate socioeconomic levels of housing in most study and control neighborhoods. This is expected because the freeway right-of-way decision is, in part, economic; it

often costs less to go through a lower socioeconomic residential area than an upper socioeconomic residential area.

The most frequent pattern for the 1950-60 neighborhood index was one of increase; that is, the socioeconomic level was higher in 1960 than in 1950. However, the socioeconomic level of neighborhoods with low indexes in 1950 tended to increase from 1950 to 1960, and the socioeconomic level of neighborhoods with intermediate or high indexes in 1950 tended to decline from 1950 to 1960. The findings also suggest that residential socioeconomic levels were more likely to decline in segmented neighborhoods.

The neighborhood index typifies the social and economic residential character of an area, information that is needed by the transportation planner (12). Data for the neighborhood index in this investigation were obtained from the U. S. Bureau of the Census reports; the decennial nature of such data may not meet the critical dates involved in the anticipation of the freeway effects. It is worthwhile to note that similar data are available from other sources in many cities and metropolitan areas.

Mobility Index

The mobility index used in the research reported here is a 1-variable measure of household residential mobility, based on a 5-year period. Residential mobility, in an overall sense, was neither higher nor lower than was expected for the study areas considered in the study (as compared to residential mobility rates for the 3 cities studied). Considerable variation in residential mobility occurred between neighborhoods and over time periods.

With respect to mobility index trends, the general pattern was a decline in mobility. The direction of change in mobility was occasionally positive, however, regardless of initial mobility levels. It was determined that mobility is more likely to increase in freeway-segmented neighborhoods than in others.

Statistical Analysis

With respect to the correlation analyses for individual study areas, product-moment coefficients were higher than rank-difference coefficients, indicating that change in neighborhood rankings within study areas was greater than change in index trends within study areas. Coefficients for the within-index analyses were also generally well above the critical value, which substantiates the neighborhood delineation methodology.

With respect to the product-moment correlations for all study areas and all neighborhoods, these coefficients were lower than the coefficients for individual study areas, which reveals that greater residential homogeneity prevails within study areas than between study areas. The coefficients were higher than expected in control neighborhoods, indicating that the socioeconomic level and behavior resulting in residential mobility were least likely to change in control neighborhoods and most likely to change in neighborhoods segmented by the freeway right-of-way.

Multiple regression analyses were formulated by using product-moment correlation coefficients as raw data. The basic regression equation yielded probabilities greater than 50 percent that bordered and not bordered neighborhood categories were not significant independent variables. The final regression equation indicated that the segmented neighborhood category is a significant independent variable, and residential mobility can be expected to increase significantly in metropolitan neighborhoods segmented by a freeway right-of-way.

Residential Mobility and Freeways

Analyses conducted in this research project indicate that residential mobility is not likely to increase significantly and socioeconomic level and qualitative neighborhood indexes are not likely to decline in metropolitan neighborhoods in which a freeway is introduced, if the neighborhood is bordering or not bordering the freeway. If, however, the freeway right-of-way segments or divides the original neighborhood, residential mobility can be expected to increase significantly and socioeconomic level and qualitative indexes can be expected to decline. Conversion of single dwelling units to apartment houses or addition of new multiple-dwelling units is likely to take place in

segmented neighborhoods. These processes were indicated directly from neighborhood index trends and indirectly from mobility index trends. Descriptive, correlation, and multiple regression analyses substantiate these conclusions, which are based on a control group and "before-and-after" freeway research design.

Neighborhood delineation is consequently a critical phase in freeway right-of-way selection. It is concluded that neighborhood delineation can best be accomplished with U.S. Bureau of the Census city block data or with similar available data. The neighborhood index, used for neighborhood delineation in the research reported here, is a mathematically and statistically objective methodological procedure.

Findings in this paper indicate that research and decision-making prior to selection of the right-of-way route are most critical. It is recommended that sufficient resources and time be allocated for research during these phases of the freeway location process. Particular attention should be directed to right-of-way alternatives within the metropolitan area that do not intersect residential areas.

Further Research

A limitation of the research reported here is that detailed investigation was not conducted regarding the relationships between mobility and residential characteristics such as owner-occupied versus renter-occupied or multiple-dwelling unit versus single-dwelling unit. It is generally assumed that these factors have strong relationships and indeed they may. Over time, however, especially over a period of 10 or 15 years, the propensity for residents to move will change. Improvements become old and are likely to deteriorate at least in value; family stages are likely to change; age distributions and family stages of residents may shift; land use change may occur or become more imminent.

For these reasons, it is concluded that additional research may be warranted to investigate such relationships and also to explore additional neighborhood behavior and values that are associated with social and economic variables studied here.

ACKNOWLEDGMENTS

The material appearing in this paper is adapted from a final report (20) of research sponsored by the California Division of Highways, the Federal Highway Administration, and the Texas Transportation Institute. The findings, conclusions, and interpretations are those of the authors and not necessarily those of the sponsoring agencies.

REFERENCES

1. Adkins, W. G. Effects of the Dallas Central Expressway on Land Values and Land Use. Texas Transportation Institute, Texas A&M Univ., College Station, Bull. 6, Sept. 1957.
2. Adkins, W. G., and Tieken, A. W. Economic Impacts of Expressways in San Antonio. Texas Transportation Institute, Texas A&M Univ., College Station, Bull. 11, Aug. 1958.
3. Community Benefit Analysis of Alternate Route Locations. Right-of-Way Research and Development, California Division of Highways, Sacramento.
4. Eureka Impact Study: An Analysis of the Effect of Alternate Freeway Routes Within the City of Eureka. Right-of-Way Research and Development, California Division of Highways, Sacramento.
5. Santa Cruz Impact Study. Right-of-Way Research and Development, California Division of Highways, Sacramento.
6. Cline, M. G. Urban Freeways and Social Structure: Some Problems and Proposals. Highway Research Record 2, 1963, pp. 12-20.
7. Dansereau, H. K. Seminar on Sociological Effects of Highway Transportation: Five Years of Highway Research: A Sociological Perspective. Highway Research Record 75, 1965, pp. 76-82.
8. Gibbs, J. P. Urban Research Methods. D. Van Nostrand Co., Princeton, 1961.

9. Goldstein, S., and Mayer, K. B. The Impact of Migration on the Socio-Economic Structure of Cities and Suburbs. Sociology and Social Research, Vol. 50, Oct. 1965.
10. Hill, S. L. The Effects of Freeway on Neighborhood: An Analysis of the Relationship of Mobility to Community Values. Right-of-Way Research and Development, California Division of Highways, Sacramento.
11. Hoyt, H. The Structure and Growth of Residential Neighborhoods in American Cities. Federal Housing Authority, 1939.
12. Kemp, B. H. Seminar on Sociological Effects of Highway Transportation: Social Impact of a Highway on an Urban Community. Highway Research Record 75, 1965, pp. 92-102.
13. Mark, H., and Schwirian, K. Ecological Position, Central Place Function and Community Population Growth. American Jour. of Sociology, Vol. 73, No. 1, July 1967, pp. 30-41.
14. McLean, E. L. The Utilization of Factor Analysis in Community Research. Proc. 1968 Annual Meeting of Southwestern Social Science Assn., Dallas, April 1968.
15. Sabagh, G., Van Arsdol, M. D., Jr., and Butler, E. W. Some Determinants of Metropolitan Residential Mobility: Conceptual Considerations. Univ. of Southern California, Los Angeles, unpublished, Feb. 1968.
16. Sawhill, R. B. Freeways and Residential Neighborhoods. Univ. of Washington, Seattle, July 1965.
17. Thiel, F. I. Seminar of Sociological Effects of Highway Transportation: Introductory Remarks. Highway Research Record 75, 1965, pp. 75-76.
18. Thompson, R. H., Adkins, W. G., and Davis, D. R. Preliminary Study of the Economic Impact of a Section of San Antonio's Loop 13 Expressway. Texas Transportation Institute, Texas A&M Univ., College Station, Spec. Rept. E67-60, June 1960.
19. The Freeway in the City: Principals of Planning and Design. U. S. Govt. Printing Office, Washington, D. C., 1968.
20. McLean, E. L., Adkins, W. G., Ladewig, H. W., Guseman, P. B., and Rodriguez, W. Further Investigation of the Mobility Index for Use in Predicting Freeway Effects on Neighborhood Stability. Texas Transportation Institute, Texas A&M Univ., College Station, Bull. 41, June 1970, 259 pp.