ESTIMATING COMMUNITY EFFECTS OF HIGHWAYS

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Techniques to identify and estimate community effects of highways are needed to make good location decisions. If the effect of a highway on a community can be known before it is built, areas that may be harmed by highway proximity can be avoided in favor of areas that can be benefited. Efforts to identify neighborhoods that may be suitable or unsuitable for highway locations have included both objective social indicators (e.g., residential stability) and subjective indicators (e.g., attitudes of affected residents). In the middle and late 1960s efforts to develop and test objective indicators contributed to communication between citizens and highway agencies seeking to improve highway location procedures. Citizen participation has since overshadowed other techniques of identifying and estimating community effects. The social feasibility model described uses neighborhood characteristics such as household size and income, proportions of young and old people, automobile availability, length of time at current residence, and ethnic composition to determine the community effect of a highway. This procedure attempts to locate highway corridors where they are socially feasible by using mainly secondary data in a three-phase process.

•EFFORTS to foretell highway effects and, in this way, to optimize highway locations have typically relied on housing or population characteristics of the affected neighborhoods. These efforts have varied from easily managed methods with few characteristics that may be sensitive enough to indicate general effects to more complicated methods with several characteristics. Initially several neighborhood characteristics are used to determine the effects; later only selected indicators are recommended.

SELECTED SOCIAL INDICATORS

Mobility Index

One effort to estimate community effects has involved analyzing the residential stability of a neighborhood. The stability of a neighborhood can indicate its quality or ability to function as a neighborhood. This indicator was developed by the California Division of Highways to evaluate neighborhood effects of freeways in California and Washington. The indicator, in the form of a numerical index, was made up of the percentage of (a) owner-occupied houses, (b) single-family residences, and (c) people in the same houses over 5 years. The index can be calculated by using secondary data such as the U.S. census or city directories (1).

The California approach was extended and tested further by a Texas A&M study of 152 neighborhoods and 47 control neighborhoods in Austin, Dallas, and Houston. This study tested both a three-variable index and a simplified index that relies only on the percentage of residents in the same house for 5 years (2). This single-variable index, termed the mobility index (MI), yielded results similar to the three-variable index. It is simpler and less expensive to use. Index values are calculated by MI = 200 - 2R where R = the percentage of households in the same dwelling unit in the base year as there were 5 years earlier.

MI appears to be a good indicator of neighborhood solidarity or stability. Experience shows that MI is more likely to increase in freeway-segmented neighborhoods than in others, suggesting that these neighborhoods may become less stable.

The California and Texas A&M studies also developed and tested a neighborhood index which delineates neighborhoods. The components of this index are proportion of owner occupants, condition of dwelling units, proportion of crowded units, and number of rooms per dwelling unit.

The neighborhood index was useful for defining neighborhood boundaries for some purposes because it describes the character of a residential area. But the neighborhood cohesion or strength of interaction patterns is not defined by this index. Instead, similar housing areas are simply grouped together and considered a neighborhood. Using the neighborhood index as a predictive device for freeway effects was not feasible.

Neighborhood Social Interaction Index

Another effort to measure and predict neighborhood changes due to highways involves social interaction. This approach relies on neighborhood behavior (e.g., neighboring, use of local facilities, and participation) and neighborhood perception (e.g., identification, commitment, and evaluation). A neighborhood social interaction index has been developed that can be estimated by using residential mobility, percent of residential land, and housing units per acre. Mobility is so important that it alone can be used to provide rough estimates of social interaction changes that might be associated with highways (3). In this emphasis of the importance of residential mobility, the neighborhood social interaction index (by Burkhardt) agrees with the earlier studies of Hill and Frankland in California and in Washington and of Adkins and McLean in Texas.

SOCIAL FEASIBILITY MODEL

The method used for estimating neighborhood effects is based on neighborhood characteristics such as household size and income, proportions of young and old people, automobiles available, length of time at current residences, and racial and ethnic composition.

The tentative procedure is a social feasibility model (4), a method for locating highway corridors where they are socially feasible and acceptable to affected neighborhoods. By using mainly secondary data, a three-phase process examines in sequence physical constraints, activity patterns, and pedestrian dependence in a study area.

The social feasibility model is based partly on empirical data about the social effects in four distinctly different types of neighborhoods adjacent to two different freeways: I-290 in Worcester, Massachusetts, and the Grove-Shafter Freeway in Oakland, California. It suggests that low-density, suburban types of neighborhoods can tolerate freeways. These neighborhoods ordinarily depend on very little walking, have many automobiles, and have most of the activity locations for residents outside the neighborhoods. This approach to locating highway corridors relies mainly on existing information such as the U.S. census or city records. Some use has been made of the model recently to analyze alternative highway locations in California.

The first phase of the model examines topography, streets, buildings, and other structures. Sources for this include maps prepared by the U.S. Geological Survey, urban transportation planning groups, and local planning agencies. Figure 1 shows only the physical constraints (e.g., hills and big buildings) in the study area.

The second phase examines the extent to which various facilities (e.g., stores, schools) are used by neighborhood residents. An area surrounding a facility at which the pedestrian population is most highly concentrated is called a service area. Businessmen, school administrators, local agencies, and institutions are potential sources for information about these service areas. Figure 2 shows the study area with the neighborhood activities and physical constraints. Community facilities (e.g., colleges and hospitals) are marked C. Neighborhood facilities are designated 3 if they provide vital services, 1 for low vitality, and 2 for medium vitality.

The third indicator, the level of neighborhood pedestrian dependence, reflects low, medium, and high neighborhood dependency in walking to stores, schools, social institutions, and activity centers. The walking indicator is developed by analyzing census tracts that lie in the corridors under consideration. Characteristics examined include household size and income, proportions of young and old people, automobiles available,

Figure 1. Physical constraints in study area.

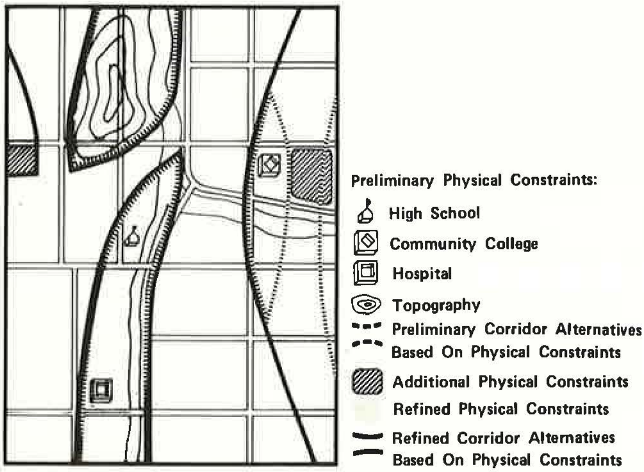


Figure 2. Physical constraints and neighborhood activities in study area.

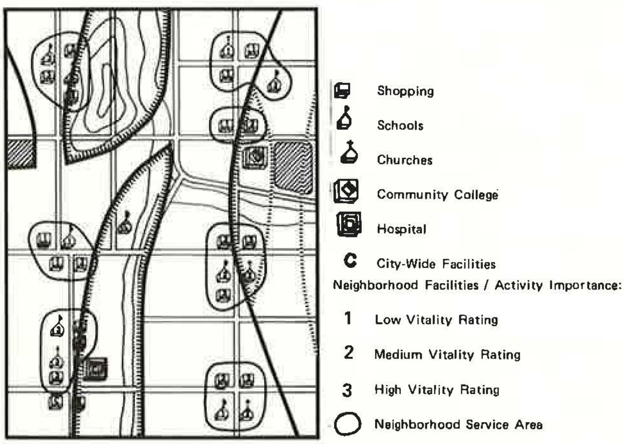


Figure 3. Physical constraints, neighborhood activities, and pedestrian dependency in study area.

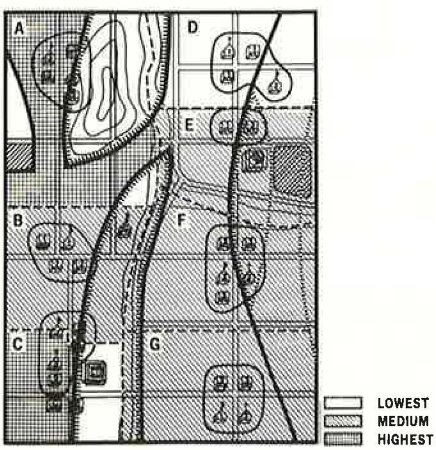
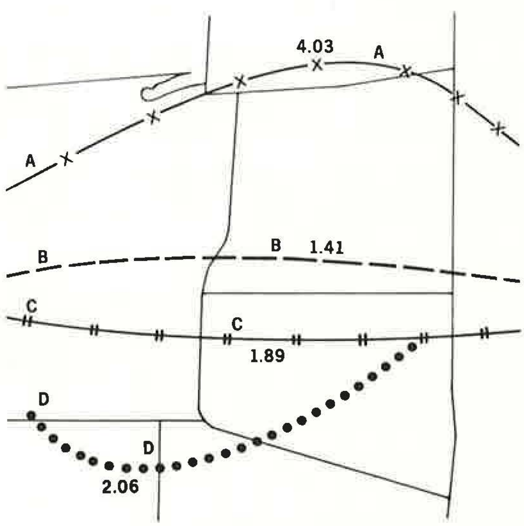


Figure 4. Pedestrian dependency scores for census tracts crossed by proposed routes for I-40 in Memphis.



residents in the same house 5 years, and ethnic composition. Published reports and computer tapes of the U.S. Bureau of the Census are the sources for data and maps required to develop this social indicator. Figure 3 shows the study area with pedestrian dependency, physical constraints, and neighborhood activities. One possibility for a highway corridor that would not disrupt the study area (based on the characteristics analyzed) appears to be generally along a path where census tract labels D, E, F, and G appear on the map.

MODEL APPLICATION

The potential use of the social feasibility model can be demonstrated by applying a simplified version of the model to a current location problem. This involves comparing the feasible route location identified by using the model with the route location recently selected for I-40 through an urban area in Tennessee. Figure 4 shows four alternate routes recently analyzed for I-40 and census tracts A, B, C, and D, which are directly affected by these routes.

In this partial testing, pedestrian dependency scores for four census tracts that would be crossed by the four suggested routes are calculated. Pedestrian dependency scores for the four tracts result from comparing scores for

1. General pedestrian dependency (GPD),
2. School pedestrian dependency (SPD),
3. Local shopping pedestrian dependency (LSPD), and
4. Social institution pedestrian dependency (SIPD).

These scores can be compared individually or combined in some way for overall comparison, e.g., by simply adding them. An unresolved problem in any combination is the weighting to be given to the individual scores for SPD, LSPD, SIPD, and GPD. (Efforts to combine scores to achieve proper weighting of ingredients are being continued primarily by Mingo.)

Additional information about the ingredients of pedestrian dependency follows.

General Pedestrian Dependency

GPD depends on neighborhood characteristics such as percentage of households without cars, number of people per household, and median household income in the neighborhood compared with income in the city. The higher the number produced by this formula is, the higher the dependence on walking is, and, supposedly, the more disruptive a freeway would be. GPD can be calculated by using

$$GPD = \frac{(h\% \times p \times I)}{i}$$

where

$h\%$ = decimal percentage of households without automobiles,
p = average number of persons per household,
I = median household income for the city, and
i = median household income for the census tract.

For the census tract touched by A route (Fig. 4): $h\% = 38$, $p = 3.8$, $I = \$7,000$, and $i = \$4,900$. Thus, $GPD = (38 \times 3.8 \times \$7,000)/(\$4,900) = 2.06$.

School Pedestrian Dependency

SPD shows the dependence of the study group or neighborhood on walking to school. It is simply the percentage of the local population made up by grade school children. The more children there are, the higher the dependency on walking will be, and the more vulnerable the neighborhood will be to disruption by a freeway. SPD can be calculated by the formula:

$$SPD = \frac{s}{N}$$

where

s = the number of elementary school children, and
N = number of people in the area or tract.

For tract A containing route A: s = 1,700 and N = 7,800. Thus, SPD = 1,700/7,800 = 0.22.

Local Shopping Pedestrian Dependency

LSPD indicates the importance to the study group of walking to local shopping and accounts for cars available and ages of the people involved. LSPD relates to the need and the ability of local residents to do their shopping while walking. It depends on the number of households without cars, the number of people per household, the number of people 65 years and older. Local shopping, especially grocery shopping, often involves packages that are serious problems for the carless or infirm. LSPD can be calculated by

$$LSPD = \frac{(h \times p + e)}{N}$$

where

h = number of households with no automobile,
p = average number of persons per household,
e = number of people over 65 years, and
N = number of people in the area.

For tract A crossed by route A: h = 770, p = 3.8, e = 600, and N = 7,800. Thus, LSPD = (770 × 3.8 + 600)/(7,800) = 0.45.

Social Institution Pedestrian Dependency

SIPD refers to the tendency of the group to walk to social institutions such as churches, clubs, libraries, community centers, and meetings. SIPD relies on the number of people in the same house for 5 years, the number of black people, and the number of foreign stock (people born abroad or with at least one parent born abroad). The presence of these groups or some of them may indicate a close-knit community where walking, visiting, and other interaction among residents may occur. SIPD is calculated by the formula:

$$SIPD = \frac{(t + f + b)}{N}$$

where

t = number of people in same house 5 years,
f = number of persons of foreign stock,
b = number of black people, and
N = number of people in the tract.

For tract A: t = 3,100, f = 150, b = 7,300, and N = 7,800. Thus, SIPD = (3,100 + 150 + 7,300)/(7,800) = 1.35.

CONCLUSIONS

Pedestrian dependency scores, as stated previously, consist of the sum of general, school, local shopping, and social institution pedestrian dependency scores. For tract A containing route A, GPD = 2.06, SPD = 0.22, LSPD = 0.45, and SIPD = 1.35; therefore PD = 4.08.

This pedestrian dependency score of 4.08 for tract A is relatively high, compared with the pedestrian dependency for the city and for the other study tracts. Pedestrian dependency scores are 1.41 for route and tract B, 1.89 for C, 2.08 for D, and 1.58 for the entire city (Fig. 4). The relatively high pedestrian dependency score, though only one of many considerations, suggests that tract A crossed by route A may not be suitable for a highway location. At least tract A seems less suitable (or socially feasible) than the other tracts analyzed. It is interesting that route A is not the current choice for I-40 in this area. (Route C and tract C in this exercise, the route that apparently has been selected based on all considerations, ranks second among the four tracts in this partial analysis of social characteristics.)

Locating highways where they will minimize disruption to residential neighborhoods is basic. Recent research has resulted in several methods for evaluating the relative sensitivity of neighborhoods to freeways. The methods attempt to predict the effects of highways on neighborhoods nearby by using primarily housing and population characteristics.

Limited use of these methods or indexes and other experience suggest that neighborhoods that may be particularly vulnerable to freeway disruption and therefore should be avoided are high-density, pedestrian-dependent neighborhoods with few automobiles available and strong racial or ethnic ties. Testing is needed to determine the extent to which these or other methods can predict what effects a highway will have on a neighborhood.

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