Regional Versus Local Accessibility: Implications for Nonwork Travel

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Susan Handy

The question of how alternative forms of development affect travel patterns has recently been the focus of a heated debate, much of which centers on the effects of suburbanization in particular. The concept of accessibility provides an important tool for resolving this question. By measuring both the accessibility to activity within the community, or "local" accessibility, and the accessibility to regional centers of activity from that community, or "regional" accessibility, the structure of a community is more fully characterized. The research summarized uses the concepts of local and regional accessibility to test the implications for shopping travel of alternative forms of development in a case study of the San Francisco Bay Area. The results show that higher levels of both local and regional accessibility are associated with lower average shopping distances but are not associated with differences in shopping frequency. As a result, higher levels of both local and regional accessibility are associated with less total shopping travel. However, the effect of high levels of local accessibility is greatest when regional accessibility is low and vice versa. These findings suggest that policies should be directed toward enhancing both types of accessibility, but that the effects may work against each other to some degree.

The question of how particular forms of metropolitan development affect travel patterns has long been of concern to planners but has recently been the focus of a heated debate. Much of this debate has centered on the effects of suburbanization in particular, with some arguing that the decentralization of housing and jobs reduces overall travel (*1; 2*) and most others arguing that the low density development that is associated with decentralization leads to more automobile travel and gasoline consumption (*3; 4*). At this level, it is a macroscale debate, centered on the overall structure of metropolitan regions and on total travel within those regions.

Within this discussion, the concept of neotraditional development has engendered more acceptance than true debate. Proponents of this concept suggest that the proper design of a suburban community can reduce the amount of automobile travel by its residents, particularly for nonwork travel, although little hard evidence has been presented to support the claim (*5*). At this level, it is a microscale debate, centered on the structure and travel patterns of a particular community. The broad question is to what degree—if at all—alternative types of suburban development create differences in travel patterns. The practical question is whether suburban form can be shaped to reduce automobile travel and mitigate the problems associated with it.

The concept of accessibility provides an important tool for resolving these questions, which demand a more comprehensive view—one that combines the micro- and macroscales. The amount that a person travels is influenced by both the character of the particular community in which he or she lives and the spatial structure of the region of which that community is a part. To test the implications for travel of alternative forms of suburban development it is necessary to characterize both the community and its region and to compare alternative forms in light of this dual-characterization. Further, the structure associated with various types of travel—particularly work versus nonwork travel—may be vastly different. The measures that have typically been used to characterize development—population density and the jobs/housing ratio—have proved inadequate for this task. By measuring both the accessibility to activity within the community, or "local" accessibility, and the accessibility to regional centers of activity from that community, or "regional" accessibility, the necessary dual characterization is achieved.

The first goal of this research was thus to develop and refine definitions of local and regional accessibility, as a way of describing the spatial structure of a metropolitan region and differentiating between specific communities within the region. The second goal of this research was to use these definitions to test the degree to which differences in nonwork travel patterns can be attributed to differences in the structure of communities. The basic hypothesis was that both local and regional accessibility would have significant correlations with nonwork travel patterns in a particular community and that the balance between the two would be important determinants of the amount of travel by residents of that community.

This paper presents the results of the first stage of research, an aggregate-level analysis of the San Francisco Bay Area for 1980 using existing data and simple measures of local and regional accessibility. First, basic definitions of regional and local accessibility are outlined. Second, the methodology used to calculate regional and local accessibility for the region is presented. The patterns of accessibility that these calculations generate are then compared to expectations based on qualitative knowledge of the character of the San Francisco Bay Area. Finally, the relationship between accessibility levels and travel patterns for the region are tested in a variety of ways. This analysis generated several interesting, although preliminary, conclusions.

DEFINITIONS

Accessibility, as generally defined, consists of two parts: a transportation element or resistance factor and an activity element or motivation factor (*6; 7*). The transportation element reflects the ease of travel between points in space as determined by the character and quality of service provided by the transportation system and as measured by travel distance, time, or cost. The spatial element reflects the distribution of activities, such as residences, employment, stores, offices, and so on. This distribution is characterized by both the amount and location of different types of activities. The spatial element is alternatively called the "attractiveness" of a particular location as a trip destination.

There is thus a substitutability between the transportation system and the distribution of activities in determining the level of accessibility (*8*). A given place may be very far from a few large activity centers or close to several small activity centers and have the same level of accessibility. Yet the implications for travel patterns may be very different. As a result, it is important to distinguish between types of accessibility, in particular, to differentiate between regional accessibility and local accessibility. Local accessibility depends on close proximity to locally oriented centers of activity, whereas regional accessibility depends on good transportation links to large, regionally oriented concentrations of activity. By evaluating both the local and the regional accessibility of a community, both the character of the community itself as well as the character of the region and the quality of the links between the community and the region have been accounted for.

Three interrelated variables are thus combined to distinguish between local and regional accessibility. The first approach is to differentiate based on the size and location of the commercial concentration. For example, activities located within a certain distance contribute to local accessibility, whereas activities beyond that distance contribute to regional accessibility. In the first case, activity concentrations are likely to be small, whereas in the latter only large concentrations of activity will be relevant. A second approach is to differentiate by type of activity. For example, a grocery store contributes to local accessibility, whereas a department store contributes to regional accessibility. The two approaches are linked in that the willingness of an individual to travel a certain distance depends on both the type of activity and the amount of activity at the destination, according to the shopping and travel behavior literature (*9; 10*).

Local accessibility is thus defined with respect to "convenience" establishments, such as supermarkets, drugstores, dry cleaners. Only such establishments that are nearby or that are nearest to the community are included, and usually these establishments will be found in small centers or in stand-alone locations. Local accessibility should be associated with short and relatively frequent "local" trips, whereas the choice of particular destinations will depend to a large degree on the distance to that destination. Regional accessibility is defined with respect to regional retail centers, such as suburban shopping malls or downtown commercial areas, which offer a wide range of "comparison" goods. These centers may be close to the community or relatively far, but they attract customers from a wide geographic area. Regional accessibility should be associated with longer and less frequent "regional" trips, where distance is less of a concern in destination choice.

However, these distinctions are not entirely clean. While serving primarily comparison shopping needs, regional centers may also include convenience establishments. Similarly, comparison establishments, such as a clothing or furniture store, may be located within a primarily residential community. Thus, there may be some substitutability between local and regional accessibility. A high level of local accessibility may reduce the frequency of regional trips, whereas a high level of regional accessibility may reduce the frequency of local trips. The possibility of this substitutability is particularly important in resolving how the design of a particular community within a metropolitan region influences the travel patterns of its residents.

METHODOLOGY

The method used to calculate local and regional accessibility levels for the San Francisco Bay Area and to test the relationship between these measures and travel patterns was driven by two goals. The first goal was to keep the analysis as simple and straightforward as possible. This way, the effectiveness of a simple approach was tested before more time and resources were expended—perhaps unnecessarily—for a more complicated approach. The second goal, which is related to the first, was to make use of existing data. Again, this approach either proves sufficient or suggests that additional data are needed. This phase of the research thus provided guidance for detailed case studies that were conducted in the second phase of research and are described elsewhere (*11*).

The primary data source for this phase of the analysis was the Metropolitan Transportation Commission's (MTC) travel forecasting data base, which includes land use data as well as travel data. The data are provided at the zone level for 550 zones that have been aggregated from census tracts or at the superdistrict level for 34 superdistricts that have been aggregated from zones, or both. The original source of the land use data is the Association of Bay Area Governments' forecasts based on the 1980 census. Travel data are from MTC's 1981 Travel Survey, which covered 7,235 Bay Area households and was aggregated to the zonal level using 1980 census data; this survey provides some disaggregate data that can also be used. Although now a decade old, these data are the most recent currently available. Beside the obvious disadvantage of using dated data, its age meant that it was difficult to even find all of the data needed in the appropriate form.

Given the stated goals of keeping the analysis simple and using existing data, an exponential form of the gravity model was used for calculating both regional and local accessibility. This is probably the most widely accepted form of accessibility measure, at least at the aggregate level, and has the strongest theoretical basis of such measures (*7; 12*). In addition, this form of accessibility measure was found to have the strongest correlation with travel patterns, and hence the strongest empirical basis, at least for this case study. The calculation of local accessibility will be described first, followed by a description of the calculation of regional accessibility.

Local Accessibility

For the purposes of this analysis, local accessibility was defined with respect to both the type of activity and the location of activity because only nonindustrial activity within a zone was included. The calculation of local accessibility using an exponential form of the gravity model required data on the attractiveness of local commercial activity and the impedance between residential areas and commercial areas. The measure of attractiveness was defined as retail, service, and other employment within the zone. Off-peak, automobile intrazonal travel times, computed by MTC as the average of the travel times to the three closest zones, was used for the impedance. The parameter is based on MTC's gravity model parameter for shopping trips, adjusted using data from the 1981 MTC survey on the trip length frequency distribution for convenience shopping trips.

The resulting formula for local accessibility was thus:

$$LA_i = \frac{(\text{retail + service + other employment})_i}{\exp\,(\text{time}_{ii} \times 0.1813)} \qquad (1)$$

where i is the origin zone.

After local accessibility was calculated for each of the 550 zones, normalized values were calculated by dividing each zone's value by the mean value (weighted by population) for the region as a whole, excluding San Francisco zones. These normalized values allow for a focus on relative differences between zones, rather than the absolute values, which are largely meaningless except in a relative sense. Because the focus here is on suburban development, the highly urbanized San Francisco zones do not provide an appropriate comparison and hence were excluded from the calculation of relative levels of accessibility. All results presented will be based on these relative accessibility levels.

For the purposes of the analysis of travel patterns presented below, averages of local accessibility for superdistricts were needed. When averaged to the superdistrict level, zonal local accessibilities were weighted by population. By weighting values by population, those zones with an abundance of employment but very little population had a proportionately smaller effect on the superdistrict average. The superdistrict average thus reflects the level of local accessibility that residents in the district experience on average. Nevertheless, such averaging may mask very great differences within a superdistrict (just as using zonal accessibilities may mask great differences within a zone).

Regional Accessibility

Regional accessibility was defined in terms of access to specific regional retail centers. Definitions of centers were taken from the 1982 U.S. Census of Retail Trade. These centers included central business districts (CBDs) of the three major cities plus the smaller downtowns of the older suburban communities, regional shopping malls, and some areas of strip development. The census provided data on the number of establishments by type and on employment, although not by type of establishment, for each center. Centers ranged in size from a low of 17 establishments and 78 employees (in downtown Richmond, in the East Bay) to a high of 2,527 and 15,705 (in downtown San Francisco).

Unfortunately, the set of centers included in the census does not appear to be particularly consistent, with retail centers in some areas better represented than in others. For this reason, only centers that were clearly either a CBD or an identified regional shopping center, termed a "planned center" by the retail census, were included. Thus, many of the areas of strip development were screened out. In general, these screened-out centers were much smaller than those that were included. This approach is consistent with the definition of regional accessibility, which focuses on concentrations of retail activity that have a potential drawing power from a large subarea of the region. In addition, the sizes of the San Francisco centers were dampened, to reflect the extra cost and difficulty of reaching these urban centers, relative to suburban centers.

Travel times were taken from MTC's 1980 estimates of off-peak zone-to-zone travel times by automobile, where off-peak times are based on assumed free-flow travel speeds. Regional accessibility was calculated at the zone level, using average travel times from each zone to the zone of each center. The following measure was used:

$$RA_i = \sum_j \left[\frac{(\text{retail employment}_j)}{\exp(\text{time}_{ij} \times 0.1302)} \right] \quad (2)$$

where i is the origin zone and j is the destination regional center.

The parameter is based on MTC's gravity model parameter for shopping trips, adjusted using data from the 1981 MTC survey on the trip length frequency distribution for comparison shopping trips. As for local accessibility, normalized values were calculated by dividing each zone's value by the mean value for the region as a whole. Results will be reported using these relative accessibility levels.

CHARACTERIZATION OF SUPERDISTRICTS

To test the appropriateness of the local and regional accessibility measures, the calculated values for the San Francisco Bay Area were evaluated with respect to how well they matched qualitative knowledge about differences between subareas of the region. In addition to demonstrating the strengths of the accessibility measures, this evaluation highlights several limitations.

The San Francisco Bay Area is a fast-growing metropolis of roughly 6 million people—over twice the population of only 3 decades ago. The area encompasses 9 counties and nearly 100 cities, including San Jose (now the largest), San Francisco, and Oakland. Whereas population and industry are concentrated on the flatlands around the bay itself, new development is increasingly found in surrounding valleys extending in strips to the north, south, and east because the area is geographically constrained by the bay and several mountain ranges. As a result, several relatively distinct subareas are often referred to: the Peninsula, stretching south from San Francisco (Figure 1; Superdistricts 5–7); the South Bay, better known as Silicon Valley (Superdistricts 8–14); the East Bay, including Oakland and Berkeley (Superdistricts 16–20); the North Bay, including Marin County and the wine country (Superdistricts 25–34); and the Inland East Bay, consisting of San Ramon and Livermore valleys, over the hills, and to the east of the East Bay (Superdistricts 15 and 21–24).

Calculated values of regional accessibility ranged from a low of 0.03 times the regional average for Superdistrict 28 (St. Helena) in the North Bay to a high of 2.22 times the regional average for Superdistrict 9 (Sunnyvale) in Silicon Valley (Table 1). Values of local accessibility ranged from 0.38 times the regional average in Superdistrict 28 to 2.13 times the regional average in Superdistrict 8 (Palo Alto). Regional accessibility was found to vary more between than within superdistricts, whereas local accessibility was found to vary more within than between superdistricts. This makes sense, given that regional accessibility should be relatively equal among zones in particular sections of the Bay Area, whereas local accessibility levels may vary greatly from one zone to the next, depending on the distribution of activities. Thus, the remainder of this section looks at each measure in turn and considers first how regional accessibility differs between subareas and, second, how local accessibility differs within subareas. In general, patterns of regional accessibility match with expectations to a greater degree than do patterns of local accessibility.

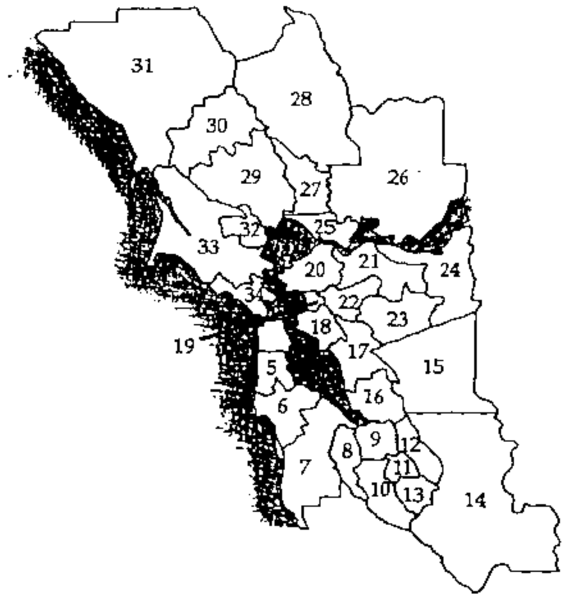

FIGURE 1 San Francisco Bay Area superdistricts.

Regional Accessibility Characterization

The pattern of regional accessibility levels matches well with the distribution of regional retail centers and transportation facilities. Superdistricts with high levels of regional accessibility are concentrated in the South Bay or Silicon Valley area. This area is less geographically constrained than other parts of the Bay Area. The area encompasses many regional shopping malls as well as several important CBD areas—20 of the 67 regional centers identified in the retail census. In addition, the area is served by both north/south and east/west freeways. The Peninsula includes superdistricts of both high and medium levels of regional accessibility. This area is more geographically constrained than Silicon Valley and is characterized by a linear concentration of development along the bayshore, served by two north/south freeways.

East Bay Superdistricts also have medium levels of regional accessibility, ranging from 0.57 (in Richmond) to 1.03 (in Hayward) times the regional average. This area is similar to the Peninsula, in that development is concentrated along the bay and is served by two north/south freeways. The superdistricts in the Inland East Bay have a similar range of levels of regional accessibility, from 0.42 to 1.11 times the regional average, but have lower levels on average than those in the East Bay. Finally, the North Bay superdistricts tend to have very low levels of regional accessibility, ranging from 0.03 to 0.55 times the regional average. This area is much more sparsely developed than the rest of the Bay Area and contains very few regional shopping centers.

TABLE 1 Regional and Local Accessibility Levels by Superdistrict

Number	Superdistrict	Accessibility* Local	Regional
5	Daly City/San Bruno	0.75	0.85
6	San Mateo	1.29	1.04
7	Redwood City	0.81	1.35
8	Palo Alto	2.13	2.08
9	Sunnyvale	1.23	2.22
10	Saratoga	1.24	1.95
11	Central San Jose	1.47	1.68
12	Milpitas	0.66	1.42
13	Southern San Jose	0.64	1.10
14	Gilroy	0.73	0.11
15	Livermore	0.71	0.52
16	Fremont	0.78	0.92
17	Hayward	1.37	1.03
18	Oakland	1.08	0.93
19	Berkeley	1.28	0.92
20	Richmond	0.85	0.57
21	Concord	0.92	1.06
22	Walnut Creek	0.97	1.11
23	Danville	0.53	0.77
24	Antioch	0.49	0.42
25	Vallejo	0.90	0.55
26	Fairfield	1.15	0.18
27	Napa	0.69	0.17
28	St. Helena	0.38	0.03
29	Petaluma	0.64	0.09
30	Santa Rosa	1.07	0.30
31	Healdsburg	0.51	0.06
32	Novato	0.57	0.11
33	San Rafael	0.83	0.19
34	Mill Valley	0.63	0.22

* normalized to regional average

Local Accessibility Characterization

Two basic types of suburban development, from different eras of the Bay Area's growth, can be identified. As the region expanded over the last century, many previously separated and outlying communities were absorbed into the regional fabric. Although now overwhelmed by what has become a continuous ring of development around the Bay, their structure can still be distinguished from that of newer development. In particular, these older communities were built on traditional rectilinear grids and had central commercial areas that provided shopping and services for residents. Although their importance declined because of competition from regional shopping malls beginning in the 1950s, many of these commercial areas have been revitalized in recent years. Quite often, residential areas continue to border the downtowns, so that the mixing of commercial and residential uses is better than that in newer suburban areas. In this way, these older communities resemble designs for neotraditional communities, although the reverse is more accurate. These older communities are concentrated on the San

Francisco Peninsula and along the East Bay, with some found in outlying areas in the Livermore Valley and the North Bay.

Areas of the region that developed after World War II have a distinctly different structure. These areas are characterized by the separation of residential and commercial activities typical of post-World War II residential and commercial development practices. Large residential subdivisions that have limited links to the major arterials that flank them, if they are not in fact closed in by solid walls, are the norm. Commercial activity lines the arterials or is concentrated in strip malls or large regional malls and is highly automobile oriented. In short, it is this sort of development that the neotraditionalists are reacting against. These communities have been built on the fringes of the developed region as it has pushed outward over time, beginning in the South Bay, and are now pervasive in the inland East Bay and in many parts of the North Bay. Although significant commercial and industrial activity has followed the residential development in these areas over time, the character of these communities remains distinctly different from that of the older communities.

The pattern of local accessibility at the superdistrict level is not entirely consistent with the distribution of each type of community (Figure 2). The South Bay superdistricts have the highest average levels of local accessibility, despite the fact that this area consists of a mix of newer and older suburbs. The Peninsula, which consists more exclusively of older suburbs, has lower average levels of local accessibility, perhaps because many of these suburbs were traditional bedroom communities for San Francisco. The Oakland and Berkeley superdistricts (18 and 19) in the East Bay have average levels of local accessibility only 1.37, 1.08, and 1.28 times the regional average, respectively. Yet these superdistricts also contain some of the highest local accessibility zones. Berkeley and Oakland's highest local accessibility zones are both higher than those of Palo Alto, although Palo Alto has a higher superdistrict average. Superdistrict averages are more consistent with expectations in the Inland East Bay and in the North Bay, where development is generally sparser and lower in density.

The characterization of local accessibility patterns is difficult, given the degree to which local accessibility can vary between neighboring zones. Two problems were evident when the pattern of local accessibility by zone for a particular community was analyzed. First, the local accessibility measure does not reflect the degree of mixing of land uses within the zone. Two zones may have the same distribution between residential and commercial land uses, yet in one zone, the uses are well mixed and in the other, they are completely segregated, with residential in one half and commercial in the other. Second, the measures are dependent on the definition of the zones. In some cases, zones may have been defined such that only residential development is included, whereas in others, both residential and commercial areas may be included. Or a zone may contain primarily residential uses, but be surrounded by zones with commercial uses. The fact that a different zone system may lead to very different results points to the importance of a disaggregate evaluation of local accessibility.

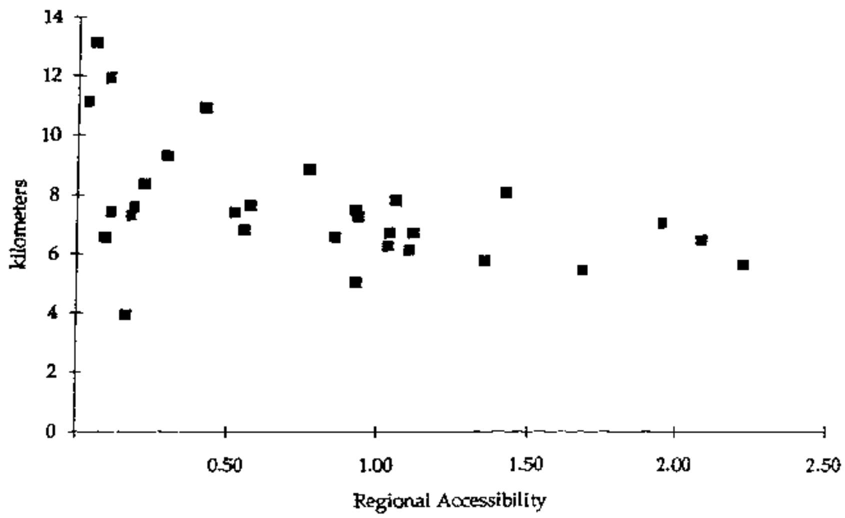

FIGURE 2 Average shopping distance versus regional accessibility.

RELATIONSHIPS TO TRAVEL PATTERNS

The relationships between regional accessibility, local accessibility, and travel patterns for shopping trips were tested in a variety of ways. The available data on travel patterns consisted of data aggregated from MTC's 1981 survey to the superdistrict level, rather than the zone level, and the raw survey data from which the superdistrict averages were aggregated. Thus, relationships at the aggregate, superdistrict level were first tested using both plots and simple correlations. For this analysis, data were available for all shopping trips, with no distinction between comparison and convenience shopping. This is a particularly important limitation, in that accessibility measures should match the type of travel being analyzed. Then, the relative importance of local versus regional accessibility and the balance between the two were evaluated.

Hypotheses

The first hypothesis to be tested is that accessibility levels will be negatively related to travel distances: high levels of accessibility imply that activities are closer to residences so that minimum distances to activities are shorter. The second hypothesis is that there will be a positive relationship between trip frequency and accessibility: residents will compensate for low levels of accessibility—regional or local—by taking fewer trips but accomplishing more on each trip (by visiting more establishments, for example) or will take advantage of high levels of accessibility by taking more trips because they are relatively easy to make. If these two hypotheses are put together, then the third hypothesis is that accessibility levels will have little impact on total travel, as the higher trip frequencies and shorter distances associated with high levels of accessibility will balance out.

Although these hypotheses apply to both regional and local accessibility, slight variations are expected to apply for both, and the relationships are expected to be much more complicated than the basic hypotheses would imply. For example, very high local accessibility may be associated with more walking and thus less travel by automobile. But part of the expected complication is driven by the fourth basic hypothesis: that the balance between regional and local accessibility of a community significantly influences the travel patterns of its residents. In particular, high levels of local accessibility will encourage fewer trips to regional centers, whereas high levels of regional accessibility will encourage more trips to bypass local commercial centers for regional centers. In other words, those areas with high local but low regional accessibility should induce the least amount of travel, whereas those with low local but high regional accessibility should induce the most.

Findings

Significant relationships were found when superdistrict averages of local accessibility and regional accessibility were compared to average superdistrict travel characteristics. Shopping distance is plotted versus regional and local accessibility in Figures 2 and 3, respectively. In both cases, shopping distance decreases with increasing accessibility. The correlations (excluding San Francisco superdistricts) are –0.48 and –0.47, respectively, significant at the 10 percent level. This finding is consistent with expectations, given the definition of accessibility; a high level of accessibility implies that more opportunities are located close by. If Superdistrict 8, which has much higher average local accessibility than any other superdistrict, is removed, the correlation increases to –0.71.

The relationship between regional accessibility and shopping trips per person was virtually nonexistent (r = –0.00), as was the relationship between local accessibility and shopping trips per person (r = –0.03). These findings do not support the initial hypothesis that higher levels of accessibility are associated with higher trip frequencies. In other words, residents in areas with poor accessibility do not com-

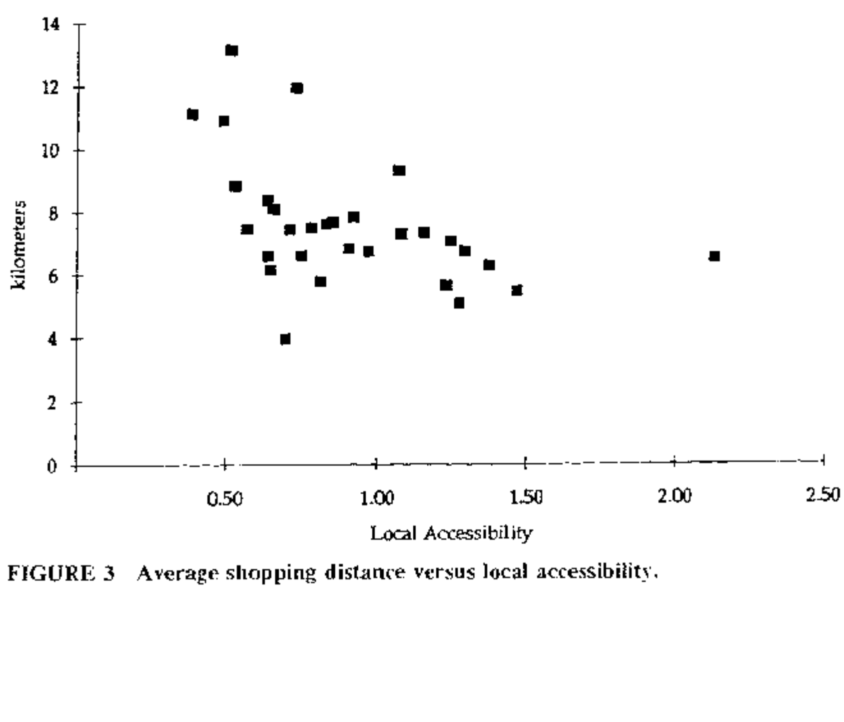

FIGURE 3 Average shopping distance versus local accessibility.

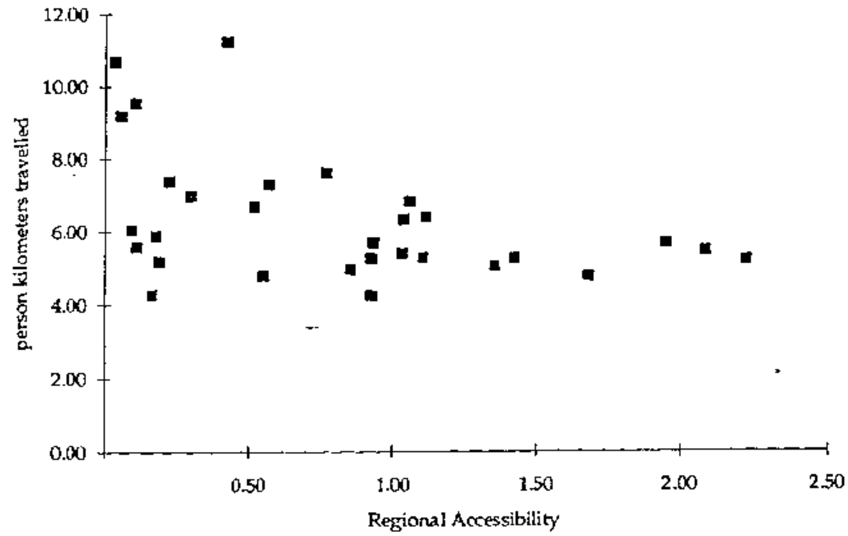

FIGURE 4 Average shopping travel versus regional accessibility.

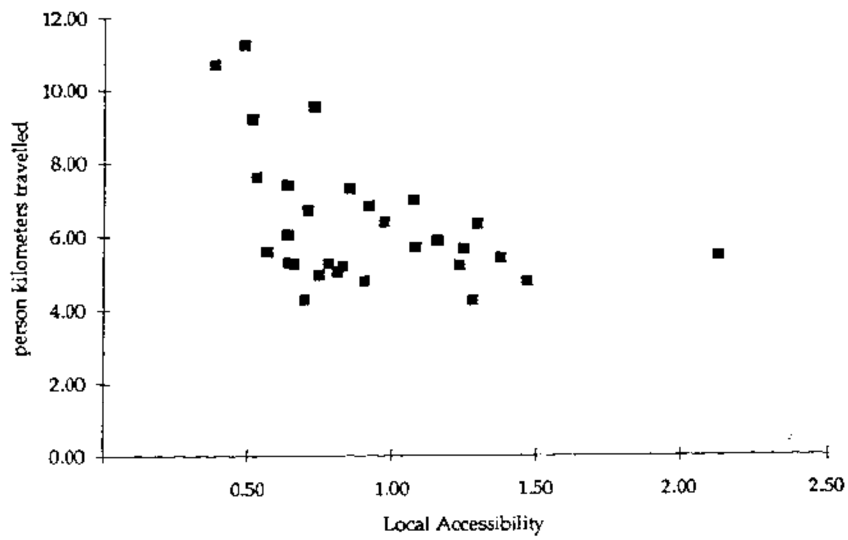

FIGURE 5 Average shopping travel versus local accessibility.

pensate by taking fewer trips, whereas residents in areas with good accessibility do not take advantage of this fact by taking more trips.

Combining trip frequency (trips per person per day) with trip length (kilometers) to estimate average person kilometers traveled (PKmT), significant correlations are again found for both regional and local accessibility, with values of –0.45 and –0.47, respectively, for shopping (Figures 4 and 5). Thus, the amount of nonwork travel is significantly lower in areas that have higher levels of accessibility, both regional and local. For example, the Hayward superdistrict, with high regional and local accessibility, has an average PKmT for shopping of 3.34, whereas the nearby Danville superdistrict, with low accessibility of both types, has an average PKmT for shopping of 4.73, or 42 percent more travel.

Regional versus Local Accessibility Balance

To test the importance of the balance between regional and local accessibility and their relative influence, superdistricts were grouped according to accessibility levels. Superdistricts were divided into types, as follows: high (>1) or low (<1) local accessibility; high (>1.5), medium (0.75 to 1.5), and low (<0.75) regional accessibility. Average values of local accessibility and regional accessibility as well as travel characteristics for each of five types (not six because there are no superdistricts with high regional accessibility and low local accessibility) are shown in Table 2. Note that the number of each type of superdistrict is quite small, so that the results are mostly suggestive, rather than conclusive.

Clearly, average shopping distances increase as levels of both types of accessibility decrease. Type 1 superdistricts, with high local and regional accessibility, have an average distance of 6.17 km (3.83 mi) versus 8.59 km (5.34 mi) for Type 6, with low local and regional accessibility, a difference of 40 percent. On the other hand, there does not seem to be a clear relationship for travel time or trips per person, consistent with results presented earlier. As a result, PKmT appears to increase as levels of accessibility decrease: Type 1 has an average PKmT of 5.27 versus an average of 7.33 for Type 6, also a difference of 40 percent.

A comparison of specific types of superdistricts helps to show the relative importance of regional versus local accessibility. First, local accessibility is held constant, whereas changes in regional accessibility are varied. In comparing Type 1 and Type 3, which both have high levels of local accessibility, but high or medium levels of regional accessibility, respectively, it seems that regional accessibility does not significantly affect the total amount of travel. But Types 1 and 3 have much lower PKmT than Type 5, which also has high (although not as high) local but low regional accessibility. In other words, a very large (seven times) decrease in regional accessibility (with a 37 percent decrease in local accessibility) has a substantial impact on PKmT—a 23 percent increase in this case. Note that the impact of regional accessibility was greater for communities with low local accessibility: for Types 3 and 5, which have high local accessibility but medium and low regional accessibility, respectively, the PKmT difference was 19 percent, whereas for Types 4 and 6, which have low local accessibility, the difference was 26 percent.

Second, regional accessibility is held constant whereas local accessibility is varied. A comparison of Types 5 and 6, both with low regional accessibility but with high and low local accessibility, respectively, shows that when regional accessibility is low, higher levels of local accessibility are associated with 13 percent less PKmT. Another interesting comparison is between Types 3 and 4, both with medium regional accessibility, but with high and low local accessibility, respectively. In this case, high local accessibility means only 8 percent less PKmT. The effect is in the same direction, but not of the same degree. This finding helps to confirm the hypothesized push-pull relationship between regional and local accessibility.

TABLE 2 Travel Characteristics by Superdistrict Type

Type	Accessibility Level		Average Accessibility		Average Travel Characteristics		
	Local*	Regional**	Local	Regional	Kilo-meters	Trips per Person	PKmT
1	High	High	1.52	1.99	6.17	0.86	5.27
2	Low	High	n.a.	n.a.	n.a.	n.a.	n.a.
3	High	Medium	1.26	0.98	6.34	0.85	5.41
4	Low	Medium	0.76	1.07	7.19	0.82	5.84
5	High	Low	1.11	0.24	8.32	0.78	6.46
6	Low	Low	0.66	0.25	8.59	0.86	7.33

* High is greater than 1.0; Low is less than 1.0.

** High is greater than 1.5; Medium is 0.75 to 1.5; Low is less than 0.75.

CONCLUSIONS

Despite the simplicity of the accessibility measures used and the limitations of the existing data, significant relationships between accessibility levels and patterns of shopping travel were found. High levels of either local or regional accessibility were associated with shorter average shopping distances, but not with trip frequency. Apparently, residents in areas with poor accessibility do not compensate by taking fewer trips, whereas residents in areas with good accessibility do not take advantage of this fact by taking more trips, suggesting that there is an average or standard number of trips that residents make, regardless of the distance they must travel. As a result, communities with high levels of both local and regional accessibility were shown to have as much as 40 percent less shopping travel than communities with low levels of both, a significant finding.

But the relationships with shopping travel are not entirely independent. The effect of each type of accessibility was most significant in those communities in which the other type of accessibility was low. On one hand, high levels of local accessibility were most important when levels of regional accessibility were low; the better the access to regional centers, the less the impact of local activity. On the other hand, high levels of regional accessibility were most important when levels of local accessibility were low; the greater the amount of local activity, the less the impact of good access to regional centers.

Thus, policies directed toward providing high levels of local accessibility in new developments or increasing levels of local accessibility in existing developments may result in less automobile travel than it would otherwise. But regional accessibility is also important. The fact that higher levels of regional accessibility decrease the distance but not the number of trips suggests that people will travel a certain amount no matter what the distance (at least within the range analyzed here), since certain needs simply cannot be provided for at the local level. In other words, proposals to enhance both local and regional accessibility may be right on the mark.

It is important to recognize that as levels of accessibility increase, the impact of accessibility-enhancing policies will tend to decrease and may cancel each other out to some degree. Neotraditional developments with high levels of local accessibility, for example, will have a greater effect on nonwork travel when located at the edges of the region than when they are located within the region surrounded by highly developed areas. Attention must directed toward the provision of commercial activity within a community, but the effect of surrounding development must also be considered.

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REFERENCES

1. P. Gordon, A. Kumar, and H.W. Richardson. The Influence of Metropolitan Spatial Structure on Commuting Times. *Journal of Urban Economics*, Vol. 26, 1989, pp. 138–149.
2. P. Gordon, H.W. Richardson, and M.J. Jun. The Commuting Paradox: Evidence from the Top Twenty. *Journal of the American Planning Association*, Vol. 47, No. 4, Fall 1991, pp. 416–420.
3. P.W.G. Newman and J.R. Kenworthy. *Cities and Automobile Dependence: A Sourcebook*. Gower Technical, Brookfield, 1989.
4. P.W.G. Newman and J.R. Kenworthy. Is There a Role for Physical Planners? *Journal of the American Planning Association*, Vol. 58, No. 3, Summer 1992, pp. 353–361.
5. S. Handy. Neo-Traditional Development: The Debate. *The Berkeley Planning Journal*, Vol. 6, 1991, pp. 135–144.
6. L. Burns. *Transportation, Temporal, and Spatial Components of Accessibility*. Lexington Books, Lexington, Mass., 1979.
7. J.G. Koenig. Indicators of Urban Accessibility: Theory and Application. *Transportation*, Vol. 9, 1980, pp. 145–172.
8. J.M. Morris, P.L. Dumble, and M.R. Wigan. Accessibility Indicators for Transport Planning. *Transportation Research A*, Vol. 13A, 1979, pp. 91–109.
9. R. Holton. The Distinction between Convenience Goods, Shopping Goods, and Specialty Goods. *The Journal of Marketing*, Vol. 23, July 1958, pp. 53–56.
10. D.L. Huff. *Determination of Intra-Urban Retail Trade Areas*. Real Estate Research Program, University of California, Los Angeles, 1963.
11. S. Handy. Regional Versus Local Accessibility: Neo-Traditional Development and the Implications for Non-Work Travel. Presented at the 1992 Annual Meeting of the American Collegiate Schools of Planning, Columbus, Ohio, Oct. 30, 1992.
12. A.G. Wilson. A Family of Spatial Interaction Models, and Associated Developments. *Environment and Planning A*, Vol. 3, 1971, pp. 1–32.

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