Estimating Downtown Parking Demands: A Land Use Approach

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ABSTRACT

A procedure for estimating and allocating downtown parking demand, based on land use and employment data, is presented. The procedure can be used to demonstrate how the peak parking accumulation can be prorated among analysis districts based on each district's share of employment (long-term parkers) and retail and service floor space (short-term parkers). The technique is similar to the gravity model approach to zonal interchanges. A case study of downtown New Haven, Connecticut, illustrates how the procedures are applied.

The traditional approach to estimating downtown parking demands involves detailed surveys of parker characteristics. Parkers along curbs and in lots and garages are queried as to their times of entry and exit, trip purpose, downtown destinations, and fee paid. The parking demands for each downtown block or analysis area are then obtained by aggregating parker destinations for each hour of the day. The peak demands for each analysis area are compared with the available spaces to identify parking space surpluses and deficiencies.

This procedure has been widely used for more than 25 years in parking planning and feasibility studies. Yet it is time consuming and costly because detailed surveys are required on a block-by-block basis. Sampling procedures have limited application because of the strong ties between where motorists park and where they are destined.

The need for a simple, yet reliable means of obtaining data on downtown parking demands is addressed. In this paper it is demonstrated how land use and employment data can be used to estimate demands on a subarea basis, and the concept is illustrated with a parking demand study for downtown New Haven, Connecticut.

CONCEPT

The concept is relatively straightforward. It is similar to that used by the gravity model to estimate zonal interchange.

1. The peak accumulation of parkers, as obtained for parking use studies, is assumed to approximate the aggregated hour-by-hour downtown parking demands.
2. This demand is allocated to the various subareas based on each area's relative share of downtown activity.

The data requirements include

1. Measures of the hour-by-hour accumulations of parkers within the downtown area,
2. Estimates of downtown floor space and employment by analysis district and type of use, and
3. Estimates of the approximate proportion of the total parking accumulation that represents long-term parkers.

Where information is available on the distribution of the peak parking accumulation between long-term (more than 3 hr) and short-term (less than 3 hr) parking, downtown employment can be used to allocate long-term parkers, and retail and service floor space can be used to allocate short-term parkers. Where this distribution is not available, either total employment or total nonresidential floor space can be used.

The following formula summarizes the procedure:

$$d_i = A_L \cdot (e_i/\Sigma^j e) + A_S \cdot (F_i/\Sigma^j F) \quad (1)$$

where

d_i = peak parking demand for zone i,
A_L = total peak long-term accumulation of parkers,
A_S = total peak short-term accumulation of parkers,
e_i = employment in zone i,
e = total employment in central business district (CBD),
F_i = retail and service floor space in zone i,
F = total retail and service floor space, and
j = number of zones.

A simplified three-zone example (Table 1) illustrates the procedure. The peak accumulation of 4,000 parkers includes 3,000 long-term parkers and 1,000 short-term parkers. The 3,000 long-term parkers are allocated to each zone based on its share of the total employment--60 percent in zone 1, 20 percent in zone 2, and 20 percent in zone 3. The 1,000 short-term parkers are allocated based on each zone's share of the retail and service floor space--33 percent in zone 1, 50 percent in zone 2, and 17 percent in zone 3. The long- and short-term demands for each zone are then added to obtain each zone's total demand--2,130 spaces in zone 1, 1,100 spaces in zone 2, and 770 spaces in zone 3.

CASE STUDY

The procedure was applied to downtown New Haven as a part of an overall traffic and parking study. The parking analysis region lies to the north of the Route-34 Expressway and contains major shops, offices, government buildings, and the main Yale University campus. The employment in the area exceeds 20,000, and about 80 percent of all peak-hour trips to this area are made by car. Parking facilities are provided outside of the area to accommodate demands in peripheral places. For example, a 2,400-space garage serves the Yale-New Haven Medical Center.

The parking analysis area (Figure 1) contains about 13,680 spaces. Field surveys found a peak accumulation of 9,770 parkers. Records of the New Haven Parking Authority garages found that more than 70 percent of the maximum accumulation remained for more than 3 hr. (The percentage for downtown Boston

TABLE 1 Illustrative Example

	CBD Activity				Parking Demand				
			Retail and Service Area						
	Employment		Floor Space (ft^2)		Long-Term Parkers		Short-Term Parkers		
Zone	No.	Percent		Percent	Percent	No.	Percent	No.	Total
1	3,000	60	200,000	33	60	1,800	33	330	2,130
2	1,000	20	300,000	50	20	600	50	500	1,100
3	1,000	20	100,000	17	20	600	17	170	770
Total	5,000		600,000			3,000		1,000	4,000

Note: Peak accumulation = 4,000; long term accumulation = 75 percent (or 3,000); and short term accumulation = 25 percent (or 1,000).

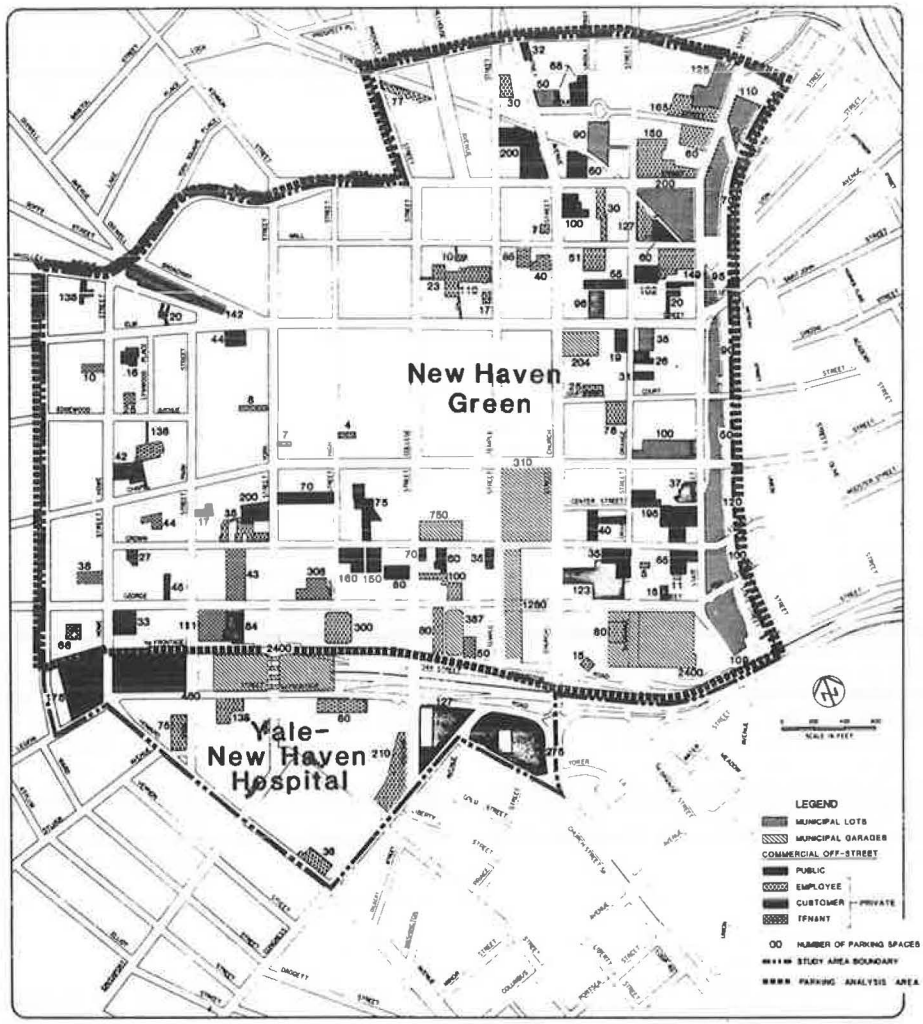

FIGURE 1 Off-street parking space, downtown New Haven, 1982.

was 79 percent.) Figure 2 shows the hour-by-hour accumulation for long- and short-term parkers.

The following steps were applied in estimating parking space demands and needs for each of the seven analysis districts located to the north of the Route-34 Expressway.

1. The parking supply within the analysis area was approximated to be 13,700 spaces. The effective supply, based on an efficiency factor of 0.9, was approximated to be 12,300 spaces. This reduction accounts for the fact that all facilities cannot be 100 percent occupied at the same time.

2. The maximum accumulation of parked vehicles was approximated to be 9,800 spaces. This number was increased slightly to 10,000 to allow for "walk-in" parkers. The long-term accumulation (more than 3 hr) was assumed to be 7,000, and the short-term accumulation 3,000. These figures were based on the 70-30 split between the long- and short-term accumulation in New Haven Parking Authority garages. (Earlier analysis revealed the numbers to be 6,900 and 2,870 based on the 9,770 spaces.) These numbers were assumed to represent the long- and short-term demand within the area.

3. Floor space employment estimates were ob-

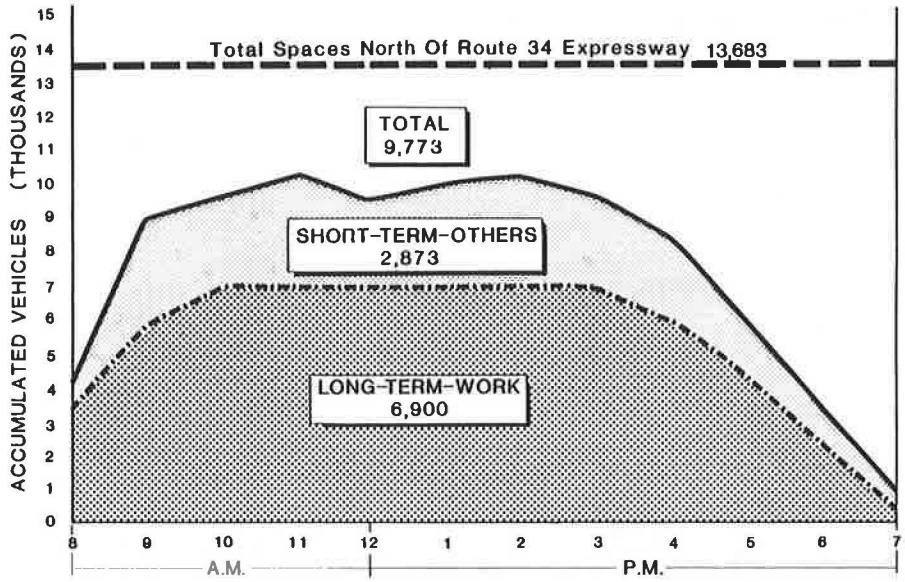

FIGURE 2 Parking accumulation north of Route-34 Expressway by trip purpose, typical weekday, 1982 (downtown New Haven).

tained from the city of New Haven. These estimates, although subject to variation, indicate the relative intensity of activity within each analysis district. It was reasoned that the parking demands in each district would reflect the relative amount of total activity in that district. (Reported employment figures tend to overstate the actual daytime work force because they do not account for absentees and vacations, people who do not work 5 full days, and workers who travel.)

4. Accordingly, 6,500 spaces of the long-term demand of 7,000 spaces were allocated to each analysis district based on its share of the existing downtown employment. The remaining 500 spaces represent Yale-New Haven Hospital parkers in the Coliseum Garage, who were allocated to district 3. (The hospital complex is located south of the Route-34 Expressway, and the parkers were bused to the garage in 1982 before the new 2,400-space Air Rights Garage opened.)

5. The 3,000 spaces of short-term demand were allocated to each analysis district based on its share of the existing total retail and service floor space.

6. The total demand for each district was obtained by adding the short- and long-term demand (steps 4 and 5).

7. The total parking demand was compared with the effective parking supply to obtain an estimate of existing space surpluses and deficiencies (i.e., needs).

The results of this analysis are given in Tables 2 and 3 and are shown in Figure 3. The data in Table 2 give the demand calculations; the data in Table 3 give parking space supply, demands, and needs by analysis district; and Figure 3 graphically summarizes parking space surpluses and deficiencies. Overall, there is a surplus of some 2,315 spaces in downtown New Haven. A large surplus--979 spaces--exists in district 1, located in the Arts Center area. Many parking spaces provided in this area serve the government and financial center. Substantial space surpluses are also found in districts 3, 4, and 6. Districts 7 and 8, largely occupied by Yale University, are currently in balance. The analysis indicates a deficiency of more than 300 spaces in the government and financial district (district 2).

It is interesting to note that the peak long-term demand of 6,500 spaces approximated 0.32 spaces per reported downtown employee. Similarly, the short-term demand approximated 1.46 spaces per 1,000 ft² of retail and service floor space.

TABLE 2 Estimated 1982 Peak Parking Space Demand by Analysis District (New Haven CBD)

	Long-Term Parking Demand			Short-Term Parking Demand			
District	Employees	Percent of Total	Spaces	Retail Plus Service Floor Space[a]	Percent of Total	Spaces	Total Parking Demand Spaces
1	2,155	10.7	696	97,538	4.7	141	837
2	3,926	19.4	1,261	223,734	10.9	327	1,588
3	6,340	31.3	2,535[b]	1,032,372	50.2	1,506	4,041
4	4,669	23.1	1,501	300,110	14.6	438	1,939
6	413	2.0	130	222,600	10.8	324	454
7	739	3.7	240	170,650	8.3	249	489
8	1,991	9.8	637	10,000[c]	0.5	15	652
Total	20,233		7,000	2,057,004		3,000	10,000[d]

Note: Table is based on data obtained from J. Farnham, city of New Haven.

[a] Excludes Malley's (in square feet).
[b] Includes 500 Yale-New Haven Hospital parkers.
[c] Assumed for allocation purposes.
[d] 9,773 peak accumulation rounded up to 10,000 to reflect walk-in traffic.

TABLE 3 Estimated Parking Space Surpluses and Deficiencies, Downtown New Haven, 1982

District	Supply			Effective Supply[a]	Demand			Surplus	Deficiency
	Curb	Off-Street	Total		Long Term (work)	Short Term (other)	Total		
1	214	1,804	2,018	1,816	696	141	837	979	
2	65	1,349	1,414	1,273	1,261	327	1,588		315
3	84	4,940	5,024	4,522	2,535	1,506	4,041	481	
4	97	2,605	2,702	2,432	1,501	438	1,939	493	
6	250	921	1,171	1,054	130	324	454	600	
7	205	403	608	547	240	249	489	58	
8	489	257	746	671	637	15	652	19	
Total	1,404	12,279	13,683	12,315	7,000	3,000	10,000	2,630[b]	315

[a] Space use efficiency factor of 0.90.
[b] Net surplus = 2,315.

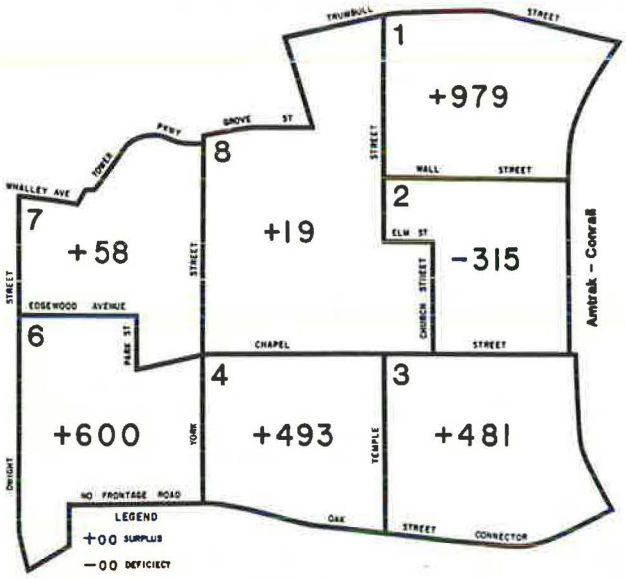

FIGURE 3 Estimated parking space needs, 1982.

PLANNING IMPLICATIONS

The use of employment and floor space data to allocate downtown parking demands provides a cost-effective approach to parking demand estimation. It also produces reasonable parking indices for use in estimating the impact of new downtown development. Its data needs, like the analysis steps, are simple.

The procedures need estimates of floor space and employment by type of use and the peak daytime downtown parking accumulation. The long- and short-term components of demand can be estimated from parking garage records or from the parameters identified in this paper (70 to 80 percent long term). Alternatively, the components can be estimated by using the 9:30 a.m. accumulation as the long-term estimate; the difference between that value and the maximum accumulation can be used at the short-term demand. Ideally, information should be obtained on the accumulations of people who park outside of the study area and have destinations within it to reflect unsatisfied or latent demand.

The demand analyses are based on the relative intensity of activity within each district. Thus they do not consider the unique characteristics of specific land uses that may raise or lower demands, especially in individual blocks. Some service and retail activities attract 5 to 10 times as many daily short-term parkers per 1,000 ft² as others (e.g., a doctor's office as compared with a piano store). Where such areas of high generation are significant in magnitude, it may be desirable to weight their floor areas occasionally. However, the differences in peak accumulation are usually less than those relating to daily parking demand. Moreover, nonwork demands represent the smallest component of total parking demand, and many visits to high-demand activities are made by downtown workers. Therefore, such adjustments are not essential for an overall CBD parking analysis.

The procedure works best in city centers where three-quarters or more of the downtown work force arrives by car and the differential impacts of public transport on CBD parking demand are not significant. In this case it is reasonable to assume that the proportions of the downtown daytime population arriving by transit are relatively uniform among analysis areas. Where there is heavy transit use, especially in city centers served by rail transit, allowance must be made for proximity to major rail stations. Consequently, the procedure is more applicable in New Haven rather than in New York, and in Providence rather than in Philadelphia.

Several adjustments may be necessary to compensate for CBD parkers who use outlying park-and-ride lots or people parking in the city center that have destinations outside of it.

1. Park-and-ride areas outside of the city center represent an additional component of downtown demand. However, they do not significantly affect the allocation of parking demands within the downtown corridor. They should, however, be included in the total CBD demand, and should be allocated on the same basis as work trips.
2. Where CBD parking facilities serve areas located outside of the city center, these outlying areas should be incorporated as additional analysis districts.

Accuracy of floor space and employment poses another constraint.

Despite these qualifications and constraints, the procedure can produce a realistic picture of current parking demands in the center of most cities in a cost-effective manner. It also provides a basis for estimating the effects of additional downtown development. Additional research is, of course, desirable to compare the results of this method with demands derived from interviews of parkers.

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