Parking Requirements for Transit-Oriented Developments

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Local transportation and land use planners are attempting increasingly to develop parking requirements (both minimum and maximum requirements) to encourage transit use and avoid excess parking supply. Planners are focusing particular attention on transit-oriented developments in proximity to transit where tight parking supply, good pedestrian access to transit, and dense development are aimed at increasing transit use. This paper presents a method for setting parking requirements for office, commercial, and industrial developments in proximity to transit stations and stops. The method presented relies on annual employee transportation surveys of the kind typically required under trip-reduction ordinances. These ordinances are now present, or soon will be, in many urban areas and are the result of air quality regulations, traffic management regulations, or both. The method of deriving parking requirements is demonstrated using employee survey data from the city of San Diego. The method derives a range of estimates for parking demand in proximity to transit stops on the basis of high and low use of transit and other alternatives to solo driving, as revealed in the employee survey data. The author draws implications for maximum and minimum parking requirements in San Diego and suggests general cautions in applying the method and areas for further research to improve results from the method.

Localities are increasingly interested in the issue of encouraging transit use through land use policies. Strategies being considered and implemented include locating office developments or housing near transit stations providing convenient pedestrian and bicycle access to transit, revising zoning codes to encourage more density and multiple uses in proximity to transit, and limiting parking supply and locating parking facilities to encourage transit use. For example, the county of Sacramento and city of San Diego, California, as well as the city of Portland, Oregon, are encouraging transit-oriented developments (TODs) in proximity to transit. According to guidelines adopted by Sacramento County (*1*), the purpose is to develop a link between transit and land use "to result in an efficient pattern of development that supports a regional transit system and makes significant progress in reducing traffic congestion and air pollutants."

Parking requirements in local codes are a key issue in planning TODs. To the extent that greater proportions of employees in developments near transit lines and stations use transit compared with employees at comparable developments further from transit, employee demand for parking ought to be less and parking requirements ought to be less. The area around transit stops and stations where lesser parking requirements might be considered is related to how far commuters will walk to transit stations. Generally, the distance is no more than a few blocks, although it all depends on the quality of transit service, typical weather, and perceived risks in walking. Figure 1 shows the cumulative percent of transit users walking to trolley and bus transit in San Diego. Here, weather, safety, and transit service combine to encourage transit use. The biggest bulk of transit users walk less than four blocks to access transit (*2*).

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PARKING REQUIREMENT ISSUES

One way to develop parking requirements for zoning codes, whether for TODs or other areas, is to base them on periodic surveys of actual parking demand across different land uses (commercial, industrial, residential). One source of such data is ITE. ITE periodically publishes results of local parking demand studies for various land uses. However, the ITE survey results suggest considerable variation in demand by community, even for the same land uses. It appears that parking demand depends on many variables unique to localities and development sites. Local parking surveys, if well executed, can be more accurate than national studies, but still cannot provide lasting predictions of parking demand. The number of cars traveling to and from any building is a function of many variables:

- Particular tenants,
- Price of parking and gasoline,
- State of the economy,
- Proximity to transit service,
- Attractiveness of on- versus off-street parking, and
- Regulations requiring employers to implement traffic-reduction programs.

Even if parking code requirements based on demand studies reflect true parking demand for a period of time, the match is sure to change as the determinants of parking demand vary.

Parking requirements eventually will err on the short side or the long side of actual parking demand, so which way is best to err? Given that the purpose of TODs is to encourage transit use, requirements should be set to encourage transit use. According to the results of at least one recent study, limited parking supplies encourage transit use (*3*). The result of erring on the short side of parking demand may be spillover. For example, if employees find insufficient long-term parking off street and are not attracted to transit or carpooling, they may park in neighborhoods or parking areas designated for shoppers. Thus, if parking requirements are set on the tight side of expected demand, guards against spillover need to be

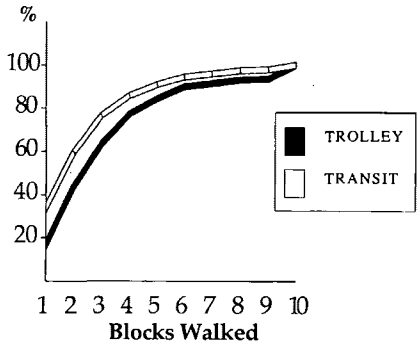

FIGURE 1 The walk to transit.

considered. Two guards are neighborhood resident preferential parking programs to discourage commuters parking on street and short-term parking zones (1 or 2 hr) or parking meters to discourage commuter parking in areas intended for shoppers.

SETTING PARKING REQUIREMENTS FOR TODS

Not only are parking demand surveys unlikely to reflect parking demand as conditions underlying demand change, such surveys are costly and time-consuming. A full-blown parking demand survey involves space and car counts, license plate turnover studies, and considerable data entry and analysis. Often, localities find surveys sufficiently demanding to contract the task to consulting companies. Here again, time is required to develop and issue a request for proposals, review proposals, select the winner, and negotiate a contract.

For some localities, employee mode-share surveys may offer a preferred alternative to parking demand surveys in setting parking requirements for TODs. Employee surveys assessing proportions of solo drivers, carpool users, transit patrons, and walkers may be used to deduce parking demand without the need for counting cars. Furthermore, annual employee surveys at employment sites are required by a growing number of local trip-reduction ordinances. Consequently, the survey data are never very dated, and no new survey instruments or data collection procedures are needed to develop parking demand estimates. The only requirement is a sample of employees drawn from employment sites in close proximity to transit. Preferably, the sample should include employers representing the usual breakdowns in parking codes: office, commercial, and industrial.

Table 1 shows how employee survey information may be used to arrive at parking demand estimates at employment sites near transit. The data in the table are based on a city of San Diego 1991 employee survey carried out under trip-reduction ordinance requirements. To arrive at a set of employers for the analysis, city staff drew a sample of employers from the data base of employees by employment site and assigned each employer to a matrix by proximity to transit (within and outside .25 mi of a transit trunk line) and land use (office, commercial, and industrial). Employers were drawn at random and assigned to the matrix cells. This procedure ensures that all the variables bearing on mode shares of employees are equally represented across the cells. Possible confounding variables include employer size, a particular transportation demand management (TDM) program encouraging transit and parking pricing. (In the particular illustrative sample, employers in the central business district (CBD) were excluded because parking demand and code requirements there were the subject of a separate study and different policies.)

Specific land uses were selected to reflect likely uses in TODs and to avoid uses with unusual levels of parking demand. For example, office use includes professional services, utility, and city and county, but not hospital and post office. Commercial includes retail, market, and discount, but excludes hotel, bank, and entertainment.

Table 1 involves three steps to arrive at parking demand:

1. Part 1 of the table arrays employee mode share ranges at the sample employment sites. For the sample of employers by each land use type (27 cases in all), the lowest and highest percent mode share was entered into Part 1 of the table, except for obvious outlyers. Solo shares then make up the balance after all alternative mode shares are subtracted from 100 percent. This high-low approach ensures the widest possible range of transit use, and other alternative mode use provides the basis for the parking demand analysis.
2. Part 2 of the table translates these mode shares into high and low parking demand cases. High use of transit, carpools, vanpools, walking, and drop offs translates into the least solo driving and parking demand. This part of the table also contains estimates of parking demand in addition to employee parking demand. Specifically estimated are visitor parking associated with office and industrial uses and shopper demand associated with commercial use.
3. Finally, Part 3 of the table arrays the total parking demand estimated in Part 2 by a range of employee densities found in the land uses for San Diego. The resulting demand expressed in parking spaces per 1,000 ft^2, is the typical ratio found in parking codes.

Certain important assumptions provide the basis for the table:

- Vehicle occupancies: carpool occupancy is assumed to be 2.5 per car, vanpool occupancy is 11 per van.
- Absenteeism, night shifts, and early arrivals and departures: 10 percent reduction for absenteeism and 5 percent for night shifts and early arrivals and departures (*4*).
- Visitor parking: for industrial uses, peak-period visitor rates range from .05 to .2 per employee, so .1 is used, with an 85 percent drive-alone rate (*5*). Visitor parking demand for commercial use is assumed to be the same rate as for industrial use. For office, daily visitors range from .14 to 1.0 per employee, so .5 per employee is assumed. Also assumed is daily turnover of 4 and 85 percent drive alone for visitors (*4*, *6*).
- Shopper parking: Studies of shoppers show large downtown retail stores draw a peak weekday demand of about 5.0 shoppers per 1,000 ft^2. Weekend peak shopper demand may exceed weekday demand by 20 to 30 percent; weekend holiday demand exceeds these levels (*4*, p. 103, 123). Commercial retail in the scope of the study (convenience, retail, discount) outside the CBD will attract less than this level, perhaps 3.0 on weekdays and 4.0 to 5.0 on weekends. At 4.0 to 5.0 maxi-

TABLE 1 Parking Space Demand by Land Use and Employee Densities

	Land Use					
	OFFICE		COMMERCIAL		INDUSTRIAL	
1. Hi-Lo Alternative Mode Use	LO	HI	LO	HI	LO	HI
Modes						
Transit	0	16.4	0	7.6	3.1	11.3
Carpool	2.5	20.2	0	10.3	9.8	16.1
Vanpool	0	1.3	0	2.7	0	.4
Walk, Drop, Cycle	0	13.9	1.5	27.7	4.4	9
Solo drive	97.5	48.2	98.5	51.7	82.7	63.2
Total	100	100	100	100	100	100
2. Parking Required						
Per 100 Employees						
Transit	.00	.00	.00	.00	.00	.00
Carpool	1.00	8.08	.00	4.12	3.92	6.44
Vanpool	.00	.12	.00	.25	.00	.04
Solo drive	82.88	40.97	83.73	43.95	70.30	53.72
Shoppers	.00	.00	148.75	119.00	.00	.00
Visitors	10.63	10.63	8.50	8.50	8.50	8.50
Total	94.50	59.79	240.98	175.81	82.72	68.70
3. Parking Demand						
By Employee Density						
	Parking Demand Per 1000 Sq. Ft.					
Employees/1000 Sq. Ft.						
4.0	3.78	2.39	9.64	7.03	3.31	2.75
3.5	3.31	2.09	8.43	6.15	2.90	2.40
3.0	2.84	1.79	7.23	5.27	2.48	2.06
2.5	2.36	1.49	6.02	4.40	2.07	1.72
2.0	1.89	1.20	4.82	3.52	1.65	1.37
1.5	1.42	.90	3.61	2.64	1.24	1.03

mum and 2.0 employees per 1,000 ft^2 (densities in San Diego for neighborhood and community shopping range from 1.0 to 3.0 employees per 1,000 ft^2) (*7*), shoppers per employee range from 2.0 to 2.5. The higher figure is used to create the most parking demand in the low alternative mode case in Table 1; the lower figure is used to create a lower range in the high alternative mode case. In downtowns, about 50 percent of shoppers walk in (*4*, p. 103). They are residents or commuters already parked elsewhere and generating no additional parking demand. Assume only 30 percent walk in for cases in the study sample. Of the remaining 70 percent coming in cars, assume 85 percent are drivers, the rest passengers.

Figure 2 graphically displays the range of parking demand results from Part 3 of Table 1.

CONCLUSIONS AND RECOMMENDATIONS

By creating their own Table 1 based on repeated annual employee surveys, localities can derive guidelines for parking

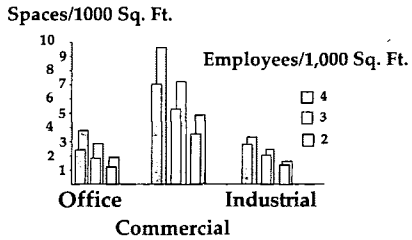

FIGURE 2 High and low parking demand by land use and employee density.

requirements in proximity to transit stops and stations. For localities looking to revise parking minimums or develop maximum parking requirements, the table will suggest possible limits on the minimums and maximums across ranges of employee densities for office, commercial, and industrial uses. The following conclusions and guidelines for San Diego (non-CBD) illustrate how the particular parking demand analysis applies to one locality.

Office

- Current policy: City engineering guidelines for local discretionary projects specify a minimum of 3.33 spaces per 1,000 ft², the same as required by the city code for commercial office classification.
- Results of the analysis: Parking demand ranges from 2.4 to 3.8 spaces per 1,000 ft² at a density of 4.0 employees per 1,000 ft². This density is typical of offices in the study area, except corporate offices in which densities are closer to 3.0 persons per 1,000 ft² (*7*).
- Recommendations: The analysis suggests a minimum of 2.0 spaces per 1,000 ft² and a maximum of 4.0 per 1,000 ft² would be a reasonable guideline for general office use. For corporate offices, a maximum of 3.0 per 1,000 ft² is recommended. If and where alternative mode use approaches 50 percent (some CBD employers with aggressive TDM programs may be applications), a maximum of 2.5 spaces per 1,000 ft² would be reasonable at usual employee densities. For comparison purposes, the ITE design standard for general office buildings outside downtowns is a minimum of 3.3 spaces per 1,000 ft² (*4*, Table 6-30).

Commercial

- Current policy: City engineering guidelines for local discretionary projects specify a minimum of 5.0 spaces per 1,000 ft². The city code for neighborhood commercial classification specified is the same amount, 5.0 per 1,000 ft². However, retail uses under the community commercial code applicable to "older established communities" (Section 101.0427) are required to provide only a minimum of 1.25 spaces per 1,000 ft².
- Results of the analysis: Peak weekend (nonholiday) parking demand ranges up to 7.0 spaces per 1,000 ft² at the highest employee density (3.0 employees per 1,000 ft²) and the lowest alternative mode use. Probably the most realistic assumption falls between the extremes, where employee densities are a little less than 3.0 and solo driving shares are less than 98 percent.
- Recommendations: A minimum of 3.0 per 1,000 ft² and a maximum of 6.0 per 1,000 ft² is suggested. For comparison purposes, a recent national survey of localities finds most localities specify a minimum of 5.0 per 1,000 ft² for retail, convenience, grocery, and hardware stores (*8*).

Industrial

- Current policy: City engineering guidelines for local discretionary projects specify 2.5 per 1,000 ft². The city code for M-L1 (assembly, fabrication, design, and development) specifies a minimum of 3.33 spaces per 1,000 ft². The city code for M-1P (assembly, distribution, fabrication, testing, and repair) for industrial parks specifies .67 space per employee on the shift with the most employees. At densities of 2.0 to 3.0 employees per 1,000 ft², this ratio translates to 1.3 to 2.0 spaces per 1,000 ft² of development. In short, code and policy appear to require between 1.0 and 3.3 spaces per 1,000 ft².
- Results of the analysis: Parking demand ranges from 1.0 to 2.9 spaces per 1,000 ft², up to a maximum light industry density of 3.5 employees per 1,000 ft². Typically, employee density at light industry, assembly, and distribution would be no more than 3.0 employees per 1,000 ft². At this employee density and assuming least use of alternative modes, the most parking demand expected would be 2.5 spaces per 1,000 ft².
- Recommendations: The analysis suggests a minimum of 1.0 space per 1,000 ft² and a maximum of 3.0 spaces per 1,000 ft² would be a reasonable guideline for industrial uses of the kind in the study and possible for TODs. If and where alternative mode use approaches 40 percent (60 percent solo) or employee densities are 3.0 persons per 1,000 ft² or less, a maximum of 2.5 spaces per 1,000 ft² would be reasonable. For comparison, most localities require minimums of 1.3 to 2.5 spaces per 1,000 ft² (*8*).

Summary

Office

- A minimum of 2.0 spaces per 1,000 ft², and a maximum of 4.0 per 1,000 ft²;
- For corporate offices, a maximum of 3.0 per 1,000 ft²; and
- If and where alternative mode use approaches 50 percent, a maximum of 2.5 spaces per 1,000 ft² (at usual employee densities).

Commercial

- A minimum of 3.0 per 1,000 ft², and a maximum of 6.0 per 1,000 ft².

Industrial

- A minimum of 1.0 space per 1,000 ft^2, and a maximum of 3.0 spaces per 1,000 ft^2; and
- If and where alternative mode use approaches 40 percent or employee densities are 3.0 persons per 1,000 ft^2 or less, a maximum of 2.5 spaces per 1,000 ft^2.

Application Considerations

The parking recommended requirement guidelines must be applied with reason and caution. Three important considerations are as follows:

- The importance of site variables. As found in some of the sample cases for San Diego, a building may be close to transit, but there may be barriers to transit access. Highways, waterways, or other developments may be such barriers. Thus, expected transit use may be lower than for other comparable developments close to transit without such barriers.
- Handling peak holiday demand. The guidelines for commercial parking demand are derived for peak weekend demand, but not for holiday demand. Therefore, an important consideration is the degree to which holiday demand is to be accommodated by on- versus off-street parking.
- Accounting for shift changes in industrial uses. The guidelines do not assume industrial work shifts will create overlapping demand. If such overlap is expected, higher-than-recommended maximum parking supply may be required. However, another alternative is to encourage staggered shifts such that first shift employees leave early enough to permit their parking spaces to be used by the second shift. Another option is to encourage development of areas to allow employees to be dropped off by family members, thereby reducing overall parking demand. An excellent, though dated, review of industrial parking demand and issues can be found in work published by ITE (*9*).

Another important consideration is employee density. As Table 1 indicates, parking demand is quite sensitive to employee density. Application of the guidelines can be fine-tuned by better data on densities for applicable land uses. Localities should monitor periodically employee densities for various land uses to derive the most appropriate parking guidelines. Additionally, other guidelines could be developed for specific uses not included here. For example, the guidelines for commercial use apply to general retail, grocery, discount, and the like, but not regional shopping centers, banks, entertainment, restaurants, or hotels.

Continued monitoring of other variables will improve application of the guidelines. Key variables include those used in deriving Table 1:

- Mode shares (often monitored by annual survey under TDM programs),
- Number of visitors and shoppers per employee, and
- Proportion of walk-in shoppers, shopper mode of travel, vehicle occupancy, and volume of shoppers in normal versus holiday periods.

Finally, planners attending to parking for TODs should guard against the possibility of spillover parking. Although the parking guidelines proposed here are not overly restrictive compared with expected parking demand in proximity to transit, there is always the possibility that maximum requirements will be too tight relative to demand for a particular site or project. Furthermore, parking demand may increase as a result of variables outside the control of any locality. Falling gasoline prices, changes in the economy, and a decline in transit service due to cuts in state or federal funding are only some of the possible variables. Therefore, planners are well advised to consider neighborhood preferential parking as one guard against spillover commuter parking and short-term parking controls (meters or timed zones) to reduce the chances of commuter parking in areas intended for shoppers.

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