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GUIDELINES FOR ESTIMATING PARK-AND-RIDE DEMAND

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Guidelines for Estimating Park-and-Ride Demand

by

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During the past 5 to 7 years, development of park-and-ride lots has become a significant part of transit development plans in major Texas cities. At present, some 35 park-and-ride lots are in operation in 6 metropolitan areas in Texas, namely Houston, Dallas, Fort Worth, Austin, San Antonio, and El Paso. Several of these cities are actively pursuing the development of additional park-and-ride facilities. In essence, park-and-ride has proven to be a popular travel alternative.

As more lots are developed, with per parking space costs in the range of \$2500 to \$4500, it becomes increasingly necessary to develop techniques that can be used to estimate required lot size. It is also necessary to develop some relatively simple techniques for estimating demand — techniques that utilize readily available data and do not necessitate large-scale computer modelling to predict ridership at alternative park-and-ride lot sites. Development of such prediction techniques is the objective of this study.

This study provides a quantitative evaluation of 35 park-and-ride lots located in 6 different Texas cities. Many of these lots are already operating at or above capacity. Thus, using these data for estimating patronage may result in a conservative prediction of park-and-ride demand.

This study complements work documented in the following Texas Transportation Institute reports:

"Park-and-Ride Facilities: Preliminary Planning Guidelines," Research Report 205-2.

"Design Guidelines for Park-and-Ride Facilities," Research Report 205-3.

"Factors Influencing the Utilization of Park-and-Ride — Dallas/Garland Survey Results," Research Report 205-11.

"Houston Park-and-Ride Facilities, An Evaluation of Survey Data," Research Report 205-15.

Lot Location Guidelines

In developing alternative sites for park-and-ride facilities, attention should be given to the guidelines outlined below. If several of these guidelines are not adhered to, utilization of the lot will be less than expected and less than the values predicted using the demand estimation techniques developed in this report.

- Most successful lots in Texas are located at least 4 to 5 miles from the activity center served. Most park-and-ride patrons drive less than 5 miles to get to the lot. Since the typical work trip in Texas is about 8 miles in length, it appears that, if a lot is located closer than 4 miles to the activity center, the auto trip will constitute more than half of the total trip to downtown. This may cause the potential user to forego the mode change opportunity.

- Given appropriate development patterns, there appears to be no outer limit concerning how far a lot can be located from the activity center. Successful lots in Texas are located as far as 30 miles from the desired destination.

- The park-and-ride lot should be located in a congested travel corridor. The congestion index which was developed in Research Report 205-7 and provides relative measures of congestion on Texas freeways was found to be an important variable in predicting park-and-ride utilization. The more successful lots in Texas appear to be in corridors with congestion indices in excess of 1.0 to 1.5; as a general guide, this range of congestion index is experienced as average daily traffic per lane approaches about 20,000.

- The lot should be located to allow the facility to intercept traffic upstream of the point where that traffic would otherwise have to encounter intense congestion.

- As the total population in the park-and-ride lot market area or watershed increases and as the percentage of that population working in the activity center served by park-and-ride increases, so will park-and-ride utilization. As a result, the magnitude of development at the activity center can also be an important determinant of potential park-and-ride utilization, and variables such as activity center parking costs can be significant in estimating demand.

- Both the accessibility (a measure of the ease with which potential users can get to the general area of the park-and-ride lot) and the access (a measure of how easily users can get into and out of the specific lot site) associated with a park-and-ride lot can influence utilization.

- Although data are not sufficient to conclusively state that parking at the lot should be free, it appears that a parking charge may adversely affect ridership.

- If available park-and-ride spaces are serving "all" the demand from a given watershed, other lots in that same corridor should be located no closer together than 4 to 5 miles.
- "Competitive" local transit routes, especially when a fare differential exists between the local and the park-and-ride service, can siphon off potential park-and-ride utilization.

Demand Estimation Guidelines

Using information that is generally available for urban areas in Texas, 3 different procedures can be used to estimate potential park-and-ride utilization. In evaluating a potential lot site, it is suggested that all of these procedures be used to provide a range of estimates. That range can then be used as a basis for decision-making.

The 3 alternative approaches are defined below.

- *Market Area Population.* The percentage of the total population living in the park-and-ride watershed that is represented by ridership at the park-and-ride lot, i.e., (ridership ÷ market area population) x 100.
- *Modal Split.* The percentage of the person trips that originate in the park-and-ride "watershed," terminate in the activity center served by park-and-ride, and actually use the park-and-ride service.
- *Regression Equations.* The data base assembled as part of this project was evaluated in all possible manners to develop equations that can be used to estimate park-and-ride patronage.

Market Area Population

Analysis of data indicates that the population in the park-and-ride lot watershed or market area can be used to gain a "ballpark" estimate of potential park-and-ride utilization. While many factors may influence the shape of the market area, the market area is typically parabolic in shape, with a vertex 0.5 to 1.0 mile downstream of the lot, an axis of 5 to 7 miles in length following the major artery upstream of the lot, and with a chord of 6 to 8 miles in length.

The percentage of the market area population that is represented by ridership varies between Texas cities; however, within Texas cities, for those lots located in accordance with the lot location guidelines stated previously, a "ballpark" range appears to exist. Table 1 summarizes these data. Ridership appears to correlate with variables such as congestion and intensity of activity center development. The correlation with congestion is also shown in Figure 1.

Table 1. Ridership as Related to Market Area Compared to Other Indicators of Park-and-Ride Potential, by City

City	Ridership as a % of Market Area Population	"Representative" Congestion Index	Activity Center Size	
			Monthly Pkg. Cost	Employ-ment
Houston	0.7 to 2.0	2.0 to 3.0	$69	158,000
Dallas Area	0.4 to 1.3	1.0 to 2.0	$58	126,000
San Antonio	varies up to 1.2	0.5 to 1.5	$35	38,000
Austin	0.3 to 0.6	0.5 to 1.0	$35	17,000
Fort Worth	0.05 to 0.3	0.5 to 1.5	$32	45,000
El Paso	0.07 to 0.4	0.5 to 1.0	$40	19,000

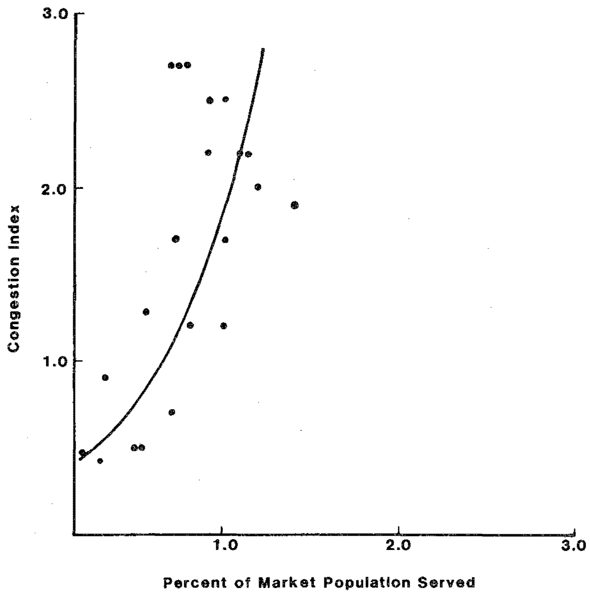

Figure 1. Relationship Between Congestion and Ridership at the Park-and-Ride Lot.

Modal Split

The market area analysis described previously assumes that all market areas have an equal affinity to the activity centers being served by park-and-ride. While that approach is simple to apply and uses the most available data, it does not account for the fact that different parts of a corridor or urban area can have different attraction rates to the activity centers being served.

To use the modal split procedure, it is necessary to identify the component of the market area population that works in the activity center served by park-and-ride. This information is not always readily available and, as a result, the attractiveness of this approach is diminished due to data availability concerns. In some instances it becomes necessary to use outdated census data.

Table 2 summarizes the available modal split data for Texas park-and-ride lots.

Table 2: Estimated Modal Split For Texas Park-and-Ride Lots

City and Lot	Modal Split[1]	Procedure to Estimate Modal Split[2]
Dallas/Garland Area		
Dallas North Central	7% to 8%	TTI Surveys (Research Report 205-11) and census analysis
Pleasant Grove	8%	Census Analysis
Oak Cliff	4%	Census Analysis
Garland, North & South	21%	TTI Surveys (Research Report 205-11)
Houston		
Clear Lake City	52%	Census Analysis
Gulf Edgebrook	24%	Census Analysis
Westwood	10%	TTI Surveys (Research Report 205-15)
Champions	23%	TTI Surveys (Research Report 205-15)
N. Shepherd	27%	TTI Surveys (Research Report 205-15)
Kuykendahl	22%	TTI Surveys (Research Report 205-15)
Kingwood	29%	Census Analysis
Beechnut (2 lots)	13%	Census Analysis
Alief	28%	Census Analysis
Sharpstown	4%	Census Analysis
Katy/Mason	50%	Census Analysis

[1] Modal split is defined as the percent of the market area population working in the activity center served by park-and-ride that uses the park-and-ride service.

[2] In using census data, the percent of the population working in the CBD was obtained from 1970. Due to the massive growth in many of the areas being considered, applying the 1970 percentage to the 1980 market area results in potential error.

The modal split data show a wide spread. Some agreement with the congestion correlation appears to exist; modal splits tend to be relatively high in the more congested corridors. Modal split at some lots is restricted by parking spaces available at the lot.

The following guidelines — recognizing constraints imposed by lot sizes or lots not located in accordance with the lot location guidelines — might be used for park-and-ride analysis.

- Dallas area lots. 10% to 20% modal split.
- Houston area lots. 15% to 30% modal split, with some modal splits in the range of 50%.

Regression Analysis

Average daily ridership was found to be the best measure of demand for the regression analysis. In order to determine the best set of independent variables to use for predicting park-and-ride patronage, a series of stepwise routines were run on all potential variables. With respect to independent variables, it was recognized that minimizing the number of variables improved the ease of using the demand prediction model. The highest correlation with the least number of variables was found in the following regression equation:

$$\text{Ridership} = -160 + 204\,(\text{CI}) + 0.0034\,(\text{MAPOP}) \qquad R^2 = 0.57$$

where: CI = Freeway Congestion Index

MAPOP = Total population in the lot's market area

The coefficient of multiple determination (R^2) for this equation is not as high as might be desired. For the larger lots, this equation generally does predict with an accuracy of $\pm$ 50%.

Part of the reason that the R^2 value is not higher is that the ridership at several of the lots included in the data base is not a true reflection of demand; that is, the actual ridership at those lots is either limited by the number of parking spaces provided or the number of buses available to serve the lot. It is hypothesized that, if more spaces or service were provided at these locations, a greater ridership would be served.

As a result, a new variable was developed to better "predict" the ridership at existing lots. Recognizing the constraining factors on ridership, the value of the new independent variable, referred to as MIN, was set equal to the minimum of the number of either the peak-hour buses multiplied by seats per bus, or the number of parking spaces at the lot multiplied by average auto occupancy for park-and-ride automobiles (1.5).

$$\text{MIN} = \min \begin{cases} \text{peak hour buses x seats per bus} \\ \text{or} \\ \text{parking spaces x 1.5 persons per auto} \end{cases}$$

MIN is, obviously, based on situations presently occurring at existing lots. If proposed new lots in a given urban area are to be significantly larger or have more bus service than existing lots, use of an equation with the MIN variable involves extrapolation. However, the same is true of any other equation developed using the available data base.

With the new variable MIN, another stepwise regression routine was run using ridership as the dependent variable. Again, the equation that contained the least number of variables without sacrificing correlation was selected from this regression run. The following equation was the result:

$$\text{Ridership} = -92 + 0.83(\text{MIN}) + 0.002\,(\text{MAPOP}) \qquad R^2 = 0.93$$

$$\text{where MIN} = \min \begin{cases} \text{peak hour buses x seats per bus} \\ \text{or} \\ \text{parking spaces x 1.5 persons per auto} \end{cases}$$

$$\text{MAPOP} = \text{market area population}$$

Although this equation was intended to predict ridership for all park-and-ride lots in Texas, its accuracy was not as high as might be desired for all lots. The percent error rates produced by this equation range from -63 percent to a $+290$ percent; most lots are predicted within $\pm$ 40%.

When the lots are stratified by congestion index, equations that better describe demand can be developed. The following equations appear applicable. The variables MIN and MAPOP have been defined previously.

$$\text{Ridership} = -86 + 0.8\,(\text{MIN}) + 0.002(\text{MAPOP}) \qquad R^2 = 0.93$$

Note: Applies to lots with $CI \geq 1.3$

$$\text{Ridership} = 61 + 0.1(\text{MIN}) + 0.001\,(\text{MAPOP})$$

Note: Applies to lots with CI between 0.9 and 1.2

$$\text{Ridership} = 7 + 0.43(\text{MIN}) \qquad R^2 = 0.81$$

Note: Use for lots with $CI < 0.9$

Guidelines for the Selection of MIN

While the equations using the variable MIN do a good job of "predicting" ridership at existing lots, their use in predicting demand at new lots requires estimating the value of MIN. Since MIN can vary considerably between lots in a given urban area, the "best" approach might be to locate an existing lot(s) that is similar to the proposed lot in terms of congestion index, distance to the activity center, and market area population. Using this approach, the value of MIN for the existing lot(s) can be used in the appropriate regression equation to estimate ridership at the new lot.

In the absence of a comparable existing lot that can be used to determine the MIN value, one of two approaches might be used. The values in Table 3 can be applied. These values were obtained for each urban area by averaging the MIN values for all existing lots in each urban area. Alternatively, graphical relationships shown in the main report might be used to estimate the value of MIN.

Table 3: "Typical" MIN Values For Urban Areas In Texas

Urban Area	"Typical" MIN Value
Houston	600
Dallas	425
San Antonio	250
Austin, El Paso, and Fort Worth	125 to 175

Conclusions

This report presents several alternative techniques for estimating the demand for park-and-ride service in Texas cities. Each technique has limitations, and all assume that the proposed lot is situated in accordance with the lot location guidelines presented in this report.

In planning for new park-and-ride facilities, it is suggested that several of the demand estimation techniques set forth in this report be applied. That analysis will provide a range of estimates. The analyst, using his knowledge of the local area, can use that range to estimate a lot size for a new park-and-ride facility.

The published version of this report may be obtained by addressing your request as follows:

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