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GENERAL PLANNING CONSULTANT:
TECHNICAL MEMORANDUM 3.1.1
REVIEW OF EXISTING EXOGENOUS VARIABLE FORECASTING TECHNIQUES

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1.0 INTRODUCTION

The regional travel forecasting models use various exogenous variables, particularly in the mode choice and mode of arrival models. These variables include:

- Highway Terminal Time
- Parking and Automobile Operating Costs
- Percent of zone (households) within walking distance of available transit service
- A multivariable market segmentation technique used in the modal choice models.

The following text is a historical summary of the analyses and/or techniques used to develop/project these exogenous variables for use in the travel forecasting process. In this regard, appropriate key staff members at SCAG and Caltrans were contacted to discuss the existing exogenous variable values and to document the derivation procedures.

2.0 HIGHWAY TERMINAL TIME

2.1 RELEVANT IMPORTANCE

Highway terminal time reflects the difficulty of moving between a traveler's ultimate origin or destination and the basic highway network, it includes parking and unparking, and walk time to destination. Terminal time is directly related to development density since parking space is more difficult to find in densely developed areas.

2.2 DOCUMENTATION OF EXISTING TECHNIQUES

The technique currently used to estimate highway terminal time is based on the relationship of walk distance data for several CBD zones observed in a parking study conducted in 1966.(1) This technique was first used and documented in the Los Angeles Metropolitan Area Mode Choice Model Development Study conducted by Alan M. Voorhees & Associates.(2)

The employment density to which these distances relate was prepared by the LARTS staff from 1967 land activity data. The results revealed an "erratic" relationship which was later generalized to obtain the terminal time values shown below.(3)

Employment Density*	Walk Time
Less than 200	2 minutes
200-250	3 minutes
250-300	4 minutes
Greater than 300	5 minutes

*Total employees per gross area.

Since few areas outside the CBD had employment densities in excess of 200 employees per gross acre, all areas outside the CBD were assigned a terminal time of one minute. In these instances, time required to find a parking place was ignored since work trips were assumed to be "regular" and drivers probably had chosen a readily available parking location ahead of time.(4)

3.0 PARKING AND AUTOMOBILE OPERATING COSTS

3.1 RELATIVE IMPORTANCE

Auto parking cost (work, non-work) and auto operating cost (on a per mile basis) are the two components of auto travel cost used in the new regional mode choice models.(5)

3.2 DOCUMENTATION OF EXISTING TECHNIQUES--PARKING COSTS

The estimation procedure employed by LARTS in developing these parking costs is based upon a "hierarchy of cost levels" (6) with the Los Angeles CBD portraying the highest price, and a descending order of costs allocated to the remaining study zones. The basis of classifying the remaining zones was as follows:

1.) Current parking costs
2.) Present and future density
3.) Rate of conversion of land to higher uses, and
4.) The Los Angeles County regional centers classification.

In addition, various economic factors (7) were considered, such as rising taxes (with higher land assessments), real wage increases for employees, higher and more intensive use of land, and maintenance of a set rate of return on invested capital by private investor.

The general approach was first to select zones where the forecasted employment densities implied paid-parking. These zones were then ranked based upon the above-mentioned criterion. All available documentation, including discussions with appropriate Caltrans staff imply that this ranking along with the actual assignment of cost was done qualitatively.

How were future values calculated?

3.3 DOCUMENTATION OF EXISTING TECHNIQUES--AUTOMOBILE OPERATING COSTS

The methodology for deriving auto operating cost was developed by a subcommittee of the Regional Modeling Task Force which consists of various staff members from SCAG, Caltrans, SCRTD, the City and County of Los Angeles, and all other surrounding counties. The subcommittee developed a three-step procedure (8) calculating an auto operating cost for 1980 as outlined below.

The basic methodology was as follows:

1. The non-gasoline costs (oil, tires, repairs, maintenance, accessories) for different size cars were derived from the FHWA publication Cost of Owning and Operating an Automobile. These costs were weighted by the percentage of various vehicle sizes in the automobile fleet to obtain the non-gasoline cost of a "composite vehicle" (see Table 1). This approach conforms to the method of calculating auto-operating costs for development of the original marginal disutility mode-choice model.

2. Estimate the gasoline cost in cents/mile by taking the actual cost in July, 1979 (i.e., 100 ¢/gal., and divide by the fuel economy (miles per gallon) of a composite vehicle.

100 ¢/gal. ÷ 15.0 mpg = 6.67 ¢/mile ('79$)

or

= 3.05 ¢/mile ('67$)

Wasn't the actual cost of gasoline somewhat higher (≈ $1.20) when considering both leaded and unleaded gasoline?

TABLE 1

COMPOSITE VEHICLE NON-GASOLINE COST

Size	Percent of Fleet (a)	Non-Gasoline Operating Cost ('79 $) (b)	CPI (c)	Non-Gasoline Operating Cost ('67 $)
Standard	59.6	5.66 ¢/mi	218.9	2.59 ¢/mi
Compact	23.4	4.96	"	2.27
Subcompact	17.0	4.21	"	1.92
Composite	100.0	5.23	"	2.40

(a) Percent of fleet taken from Table III-7, Estimated Distribution of Auto Registrations by Vehicle Size, Highway Travel Forecasts, FHWA, U.S. DOT, November, 1974.

(b) Source: U.S. DOT, FHWA, Cost of Owning and Operating Automobiles and Vans, 1979.

(c) Consumer Price Index for July, 1979. U.S. City Average.

Thus the July, 1979 auto-operating cost was:

		79$	'67$
non-gasoline operating cost	=	5.23 ¢/mi.	2.40 ¢/mi.
gasoline operating cost	=	6.67 ¢/mi.	3.05 ¢/mi.
total auto-operating cost	=	11.909 ¢/mi.	5.45 ¢/mi.

The choice of 15.0 miles per gallon is discussed further below, because it is related to the 15.6 mpg selected for the January, 1980 estimate.

3. Again, for January, 1980, the actual cost of gasoline was used to obtain the cost per mile of a composite vehicle:

   113 ¢/gal./15.6 mpg = 7.24 ¢/mile (January, 1980 $)

   and the total January, 1980 auto-operating cost is:

		'80 $		1980 CPI		'67 $ (d)
non-gasoline operating cost*	=	5.60 ¢/mi.	/	233.2	=	2.40 ¢/mi.
gasoline-operating cost	=	7.24 ¢/mi.	/	233.2	=	3.11 ¢/mi.
total auto-operating cost	=	12.84 ¢/mi.	/	233.2	=	5.51 ¢/mi.

   *Non-gasoline cost is assumed to be constant in real dollars.

The calculation of per mile gasoline cost hinges on the value assumed for the fuel economy of a composite vehicle in Southern California. The subcommittee reviewed a variety of fuel economy estimates from a number of sources. SCAG staff proposed using 14.21 mpg, the lowest value produced by the 1975 Federal Emission Test Procedures Report (ESCON model). Caltrans provided the alternate fuel consumption rates. The subcommittee agreed that the EMFAC-6 (California Emission Factor - Version 6) value of 16.6 mpg (at 25 mph) was too optimistic because it was based on dynamometer tests by EPA of new model year cars. In fact, all of the EPA projections of fuel economy are for new car fleet averages (i.e., federally regulated standards). It appears that the models for estimating the fuel economy of a composite automobile are based on the same set of historical data. Only one comprehensive set of data has been reported, a set derived from EPA studies of the emission levels of 1957 to 1974 vehicles. The

fuel economy values were measured during tests using the 1972 Federal Emissions Test Procedure. These values were corrected for differences between 1972 and 1975 test procedures and reported as the city fuel economy values as measured by 1975 Federal Emission Test Procedures (ESCON report). These annual fuel economy values apply to an average or U.S. automobile, not a Southern California vehicle. However, sales of small or compact cars in Southern California have been running at about twice the national average for the past four or five years. The subcommittee felt that the true value of composite fuel economy was higher than the 14.2 mpg espoused by SCAG, but lower than the EPA figures. After much discussion, a consensus was reached that the most reasonable value of fuel economy to be used for calculating an auto-operating cost was 15.6 mpg for 1980 based upon a Southern California Composite Vehicle.

This auto operating cost, expressed in 1967 dollars, was reviewed again in 1983; however, since the cost increase of auto operation (including a growth in real gasoline prices) was offset by an increase in fuel economy of the composite vehicle, the value was not changed.

4.0 PERCENT OF ZONE WITHIN WALKING DISTANCE OF AVAILABLE TRANSIT SERVICE

4.1 RELATIVE IMPORTANCE

The percent of a zone within walking distance of available transit service has a substantial impact on transit patronage since this percentage limits transit usage to only a portion of each zone. Therefore, patronage becomes very sensitive to these values and the forecasting techniques used to determine these values.

4.2 DOCUMENTATION OF EXISTING TECHNIQUES

Written documentation is not available which defines or outlines the procedure used to determine the percent of households in each zone which is within walking distance of available transit service. It is assumed therefore that this analysis was done qualitatively by LARTS staff. In general, however, the final zonal value was based upon a determination of the number or percent of households, or, for major employment zones, employees within no more than one-quarter mile of transit.

The value can be calculated as follows:

$$\% \text{ Walk} = \left[4(0.25)(\text{Zone Area})^{1/2} - 4(0.25)^2\right] / \left[\text{Zone Area}\right]$$

$$= \left[(\text{Zone Area})^{1/2} - 0.25\right] / \left[\text{Zone Area}\right]$$

If % Walk > 100 then % Walk = 100

This formula assumes the zone is square with transit service on each side and the walk distance measured as 0.25 mi. in from each side. Zones with different transit service should be reviewed and adjusted as needed

5.0 MULTIVARIABLE MARKET SEGMENTATION

5.1 RELATIVE IMPORTANCE

The market segmentation program, MSEG, developed in conjunction with the new regional modal choice models, processes specific data for each internal traffic zone and produces the market segmentation data used in the work and non-work mode choice models. This data includes socioeconomic, level of service, transit availability, and locational information for each of the zone's four market segments.(10) The specific data items for each market segment include the number of autos owned, number of licensed drivers, number of workers, and income.

A large number of input files are required in order to produce this zone-based data. Most of the input is defined directly from the trip generation model or from basic socioeconomic data. However, the number of workers and drivers is calculated using regression equations. The following section is a summary of the technique used to derive each of these values.

5.2 DOCUMENTATION OF EXISTING TECHNIQUES--WORKERS

The equation used to determine the number of workers is as follows:

$$W = 0.353\ ((HP*HU)^{**}1/2) + 0.198(I^{**}1/2)*HU;$$

where: W = Number of workers

HP = Household population

HU = Number of housing units

I = Median income (1967 dollars).

All input data items were extracted from 1970 census data. However, since the mode split model requires the data to be in terms of traffic analysis zones rather than census tracts, conversion equations were used to convert the data.

A regression analysis was then performed on the data which yielded the above-mentioned equation.

5.3 DOCUMENTATION OF EXISTING TECHNIQUES--LICENSED DRIVERS

The equation used to determine the number of licensed drivers is as follows:

$$LD = 0.5153*W + 0.3067*HP + 0.4294*HV;$$

where: LD = Number of licensed drivers

W = Number of workers

HP = Household population

HU = Number of housing units.

With the exception of the number of licensed drivers, all data were obtained from the 1970 census of population and converted to traffic analysis zones from the original census tract format.

The total number of licensed drivers for each county was obtained from the Department of Motor Vehicles for 1970. In order to convert these county totals into zonal projections, zonal characteristics determined by the 1967 origin-destination survey were used. In other words, the proportion of licensed drivers in each zone to that of the county, as found in the 1967 survey, was applied to the county total of licensed drivers supplied by the DMV. (It was assumed that these zonal characteristics remained constant from 1967 to 1970.) A regression analysis was then performed on the data which yielded the above-mentioned equation.