==

GENERAL PLANNING CONSULTANT

TECHNICAL MEMORANDUM 87.1.1

YEAR 2020 FORECASTS

WORK PLAN

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1. INTRODUCTION

The objective of this task is to produce basic data for the year 2020
to be used in standard RTD travel forecast simulations. At present,
there exist trip tables for HBW, HBO, NHB (OTO and OTW) trip purpose
and other supporting zonal information for the years 1980, 1990, 2000,
and 2010. This information was provided to the District by SCAG.
Year 2020 trip tables and zonal information can be produced by one of
the following two methods:

1) Systematic generation of all the exogenous variables for every
   zone in the area. Those values are then input to trip generation
   models to produce zonal production and attraction tables. Those
   tables are the standard input to the trip distribution model which
   produces the basic trip tables to be used in the standard UTPS
   simulation process. In a similar way, zonal characteristics data
   must be generated to be used later in the mode choice model.

2) Application of growth factors for each zone in the area to produce
   new trip tables and zonal characteristics directly . The direct
   update of the trip tables can be done using the FRATAR method or
   some modified version of this model.

For the present, task the second method is recommended for the
following reasons:

1) In the first method, one needs to predict many exogenous
   variables, a task which would be very tedious and which would
   involve many judgmental decisions. These types of decisions have
   to do with future land use patterns and are outside RTD's range of
   responsibility.

2) The process might involve extensive data processing effort in two
   areas: first, the implementation of models necessary to predict
   the exogenous variables; second, the implementation of the trip
   generation and trip distribution models.

3) The growth factor method can be applied in a rather mechanical way
   involving no or very little judgment. The method is based on the
   assumption that past trends which occurred in the area in the
   previous periods can be extrapolated to the future. This
   assumption can be justified given that the new forecast is for a
   relatively not-too-distant future, extending the existing
   forecasts by only ten years. The FRATAR method is especially
   appropriate for relatively well-developed areas where no major
   shifts in development patterns are expected. Such conditions
   exist in much of the Los Angeles metropolitan area.

2. WORK PLAN

The actual work of creating the updated trip tables and supporting zonal information will consist of several steps. In addition to the updated trip tables for the year 2020, two major information sets used in the mode choice model need to be updated in order to perform the complete process of travel forecast for the Year 2020. Specifically, there is a need to update the following data sets:

1) Highway time and distance matrices for the Year 2020.

2) Zonal socioeconomic information used by the mode choice model to predict transit patronage. For each zone, the information consists of four market segments. Each market segment is defined by the following data:

   o Proportion of person trips in the segment
   o Autos owned per household
   o Licensed drivers per household
   o Annual income
   o Persons per household
   o Workers per household

The possible methods of updating these two data sets are described later. First, the trip table update procedure is described. The methods below are defined for three points in time -- the years 1990, 2000, and 2010. They can be extended easily to include the year 1980 information, should this be desired.

2.1   TRIP TABLES UPDATE

This task consists of three logical steps as outlined below.

2.1.1   Calculating Marginals

In this step, the row and column marginal sums for each of the trip table types for each existing year are calculated. Mathematically, it can be stated as follows:

$$P_i = \sum_j T_{ij} \quad \text{for every trip purpose}$$

$$P_j = \sum_i T_{ij} \quad \text{for every trip purpose}$$

This step can be accomplished by using the UMATRIX program.

2.1.2   Calculating Growth Factors

For each trip purpose, one will have three row and column sums as follows: $P_i(1990)$; $P_i(2000)$; $P_i(2010)$ and $A_j(1990)$; $A_j(2000)$; $A_j(2010)$. These values can be used to predict the year 2020 growth factors by one of the following three methods.

1) Moving Averages

In this method, the growth factor for the year 2020 is simply the average of the past growth factors. The average can be calculated as a simple arithmetic mean or as a geometric mean. The latter seems more appropriate, since the value which is averaged is a ratio. Furthermore, a geometric mean is never larger than an arithmetic mean, thus producing a more conservative growth factor. The method is defined as follows:

Let $FP_i(12) = P_i(2000)/P_i(1990)$ and

$FP_i(23) = P_i(2010)/P_i(2000)$

Then, $FP_i(34) = \text{sqrt}[FP_i(12)*FP_i(23)]$ or

$FP_i(34) = 1/2*[FP_i(12)*FP_i(23)]$

Special consideration should be given to the cases where the marginals are not all greater than zero. A recommended method to solve this problem will be described later.

2) Linear Regression

The value for $P_i(2020)$ can be directly predicted using the past three P_i values and fitting them into a linear regression equation. The value of $FP_i(34)$ necessary for the FRATAR method can then be calculated as $FP_i(34) = P_i(2020)/P_i(2010)$. If the values of $P_i(2020) \lessgtr 0$ or $P_i(2010) = 0$, then the value of FP(34) must be set to 0.

3) Parabolic Fit

The value for $P_i(2020)$ can be directly predicted based on a parabolic fit of the past three points. The parabolic equation can be calculated by fitting an equation of the form $P_i = Ax^2+Bx+C$ through three points. In this case, the curve is forced to pass through the three points to identify the three parameters of the equation - A,B,C. The general treatment of zeros is the same as with the linear regression method.

With respect to treatment of zeros, special problems may occur when some of the marginal values for the different years are equal to zero. Table 1 summarizes all the possible outcomes and the appropriate methods to calculate the predicted values.

The methods described above can be implemented using standard UTPS programs such as UMATRIX and UFIT. However. since one might want to calculate all four growth factors and then apply a decision rule to choose the most appropriate one, it is recommended that a special FORTRAN program be written.

TABLE 1

SUMMARY OF CALCULATION METHODS

METHOD/ OUTCOME	GROWTH FACTOR	LINEAR REGRESSION	PARABOLIC FIT
$P_1 = 0$ $P_2 = 0$ $P_3 = 0$	0	0	0
$P_1 = 0$ $P_2 \neq 0$ $P_3 = 0$	0	0	0
$P_1 \neq 0$ $P_2 = 0$ $P_3 = 0$	0	0	0
$P_1 \neq 0$ $P_2 \neq 0$ $P_3 = 0$	0	0	0
$P_1 = 0$ $P_2 = 0$ $P_3 \neq 0$	1	O.K.	O.K.
$P_1 = 0$ $P_2 \neq 0$ $P_3 \neq 0$	P_3/P_2	O.K.	O.K.
$P_1 \neq 0$ $P_2 = 0$ $P_3 \neq 0$	$0.5[1+P_3/P_2]$ OR $SQRT[P_3/P_2]$	O.K.	O.K.
$P_1 \neq 0$ $P_2 \neq 0$ $P_3 \neq 0$	O.K.	O.K.	O.K.

Note: The following equations assume three data points P_1, P_2, P_3

LINEAR REGRESSION

$Y = A+Bx$

$B = P_3-P_1$ $\qquad\qquad\qquad\qquad$ $A=1/3[P_1+P_2+P_3]-B$

PARABOLIC FIT

$Y=A+Bx+Cx^2$

$A = P_1$ $\qquad$ $B = -1.5P_1+2P_2+0.5P_3$ $\qquad$ $C = 1/2[P_1-2P_2+P_3]$

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2.1.3   <u>Trip Tables Update</u>

Several methods exist to update existing trip tables based on growth factors. The most well-known of all is the FRATAR method. This method has some variations, but the general structure of the procedure is common to all. The procedure consists of the following two steps:

Step 1 - Basic update of the matrix cells, which is defined as follows:

T_{ijh} horizon year number of trips between zones i&j

T_{ijb} base year number of trip between i&J

F_i & F_i growth factors for zones i&j

$F_i = P_{ih}/P_{ib}$ and $F_j = A_{jh}/A_{jb}$

A new entry in the trip table matrix will be:

$T_{ijh} = T_{ijb}*F_i*F_j$

This procedure updates all the matrix cells to their new values. However, this new value will not, in general, conserve the following marginal constraints.

$P_{ih} = \sum_j T_{ijh}$ and $P_{jh} = \sum_i T_{ijh}$

Thus, a second step which will insure the existence of the above constraints is necessary.

Step 2 - Consists of an iterative procedure which amounts basically to an iterative proportional fitting. The simplest method to achieve balance is to perform at each iteration the following operations:

$T_{ij(k)} = T_{ij(k-1)}*P_{ih}/\sum_j T_{ij(k-1)}$ for every row

$T_{ij(k+1/2)} = T_{ij(k)}*P_{ih}/\sum_i T_{ij(k)}$ for every column

This procedure will converge to a unique solution which preserves the marginal constraints, within some small approximation error.

There are two possible ways to perform this procedure. The first is to use the FHWA program which performs the FRATAR procedure. The second is to write a specific FORTRAN program. The first alternative is easier to implement.

2.2   UPDATE OF HIGHWAY SKIM MATRICES

The most trivial way to update this information is simply to use the existing 2010 highway skim values. Given the high level of congestion which exists in the metropolitan area, one should not expect major changes in travel times and distances if no major changes will occur in the network. Thus, such an approximation is quite acceptable.

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Another possibility is to perform a highway assignment using the updated trip tables. This assignment should be performed using the same methods, procedures, and assumptions that SCAG normally uses. The assignment can be performed in two variations. One is to use the 2010 highway network as is. The second is to update this network to include anticipated major changes (if they exist) in the 2020 network.

2.3   UPDATE OF SOCIOECONOMIC DATA

The socioeconomic information used by the mode choice model is presented at the beginning of 2. WORK PLAN. This information has to be updated for the year 2020 to be consistent with the updated trip tables. The following three methods can be applied to produce updated characteristics of the various zones.

1) Use of 2010 Socieconomic Values

    If it is expected that no major changes in the socieconomic characteristics will occur in the 10-year span from 2010, then the existing 2010 values can be used. Whether or not this assumption is reasonable can be decided only after the data is analyzed for its past trends. The validity of this approach should be checked with SCAG.

2) Simple Extrapolation of Past Trends

    The socieconomic values for the year 2020 can be extrapolated based on past trends. The linear regression method or the parabolic fit method described in section 2.1.2 can be applied to predict future socieconomic values. This approach is consistent with the general philosophy of the present work plan and is relatively easy to apply. A Fortran program can be written in such a way that will accommodate both the predictions of the trip table marginals as well as the socieconomic variables.

3) In-Depth Investigation of Past Trends

    The socieconomic characteristics for the year 2020 can be predicted based on an in-depth investigation of the driving exogenous variables for the target year. This approach would be very tedious and outside the scope of responsibilities of SCRTD. It is therefore not recommended.

    The decision whether to choose method 1) or 2) discussed above will be taken after an initial investigation of the existing socioeconomic data and consultations with SCAG.