3.4 **Airport Passenger Ground Access Model**

3.4.1   Introduction

The airport passenger ground access model is actually a system of models of trip generation, trip distribution, and mode choice, which forecasts auto, transit, taxi, and shuttle van travel of air travel passengers using Sacramento International Airport, as well as return trips for picked-up and dropped-off passengers. The model also includes as an exogenous input estimates of passengers traveling to the airport from origins outside the SACOG region. The model does not include travel by employees of the airport, or airport-using or airport-serving businesses, which are represented by DAYSIM and commercial vehicle models.

This airport trip model application consists of five main components:

- Trip generation for SACOG (internal) passengers;
- Association of generated trips to representative survey trips, for use in computing survey expansion factors for internal passengers;
- Mode choice for internal passengers;
- Direct estimate of external (i.e. outside SACOG) passengers;
- Time-of-travel and vehicle trip factoring for auto mode trips; and
- Time-of-travel and person trip factoring for transit trips.

The airport passenger ground access model is calibrated to represent activity for a "planning day" at the airport, which is defined as an average day from the peak month of passenger activity at the airport[9]. Figure 3-8 illustrates the major model components and flow.

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[9] PB Aviation, "Sacramento International Airport Master Plan Study", March 8, 2001.

Figure 3-8 Airport Passenger Ground Access Model
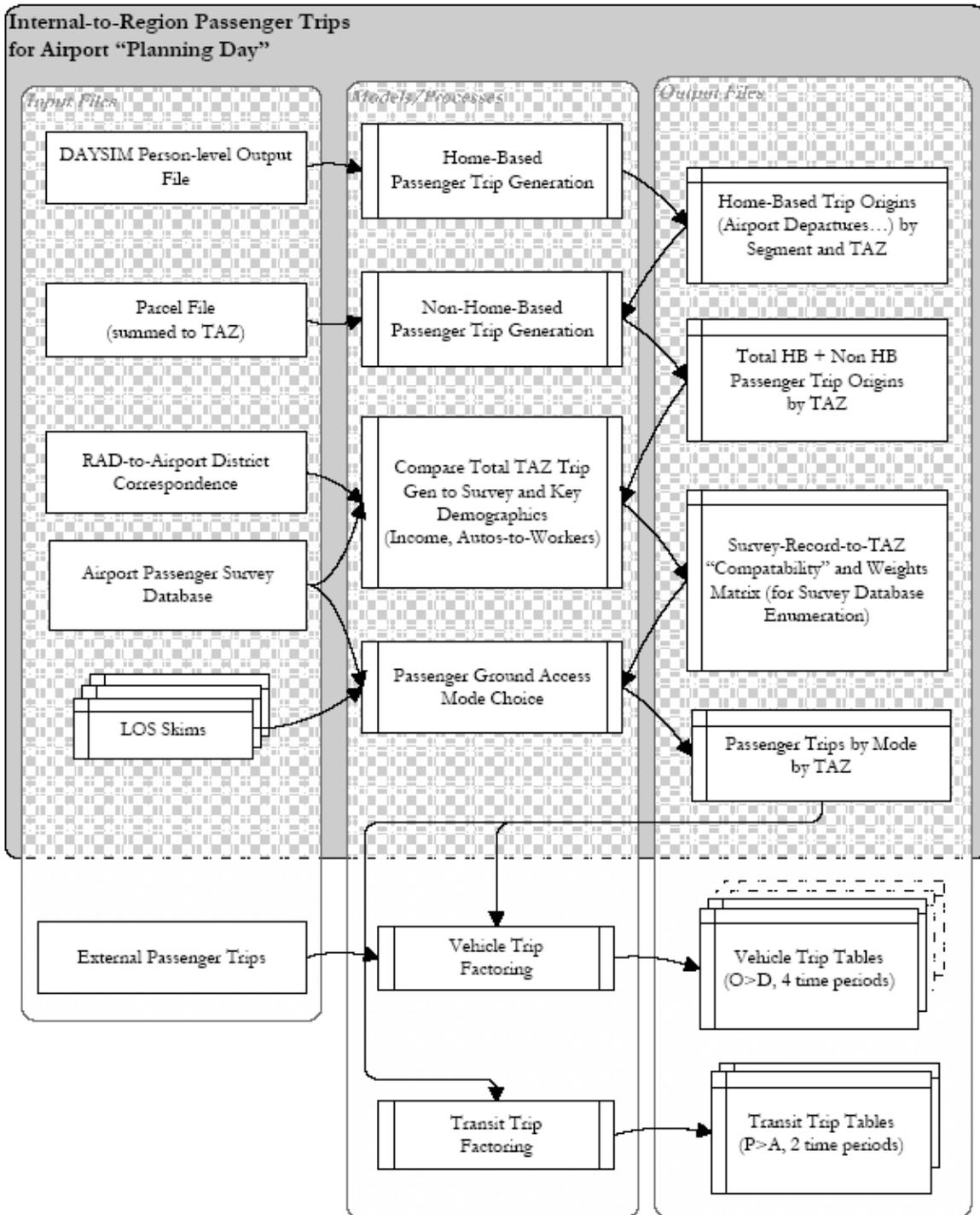
Source: SACOG 2020, based on work by DKS Associates (2008).

3.4.2 Trip Generation for Internal Passengers

SACSIM airport internal passenger trip generation was initially built from findings from the Downtown-Natomas Airport Study, 2003 (DNA). The DNA corridor analysis did not directly use trip generation by each model zone (TAZ). Instead, it used survey observation data, with each record's weight factor "grown" proportionally to the aggregate trip generation in its RAD (Regional Analysis District, of which there are approximately 58 in the Sacramento region).   This approach was modified for use in SACSIM, to allow for "on-the-fly" enumeration of the survey based on the population and employment in each TAZ.

This application uses the same trip generation factors for non-home-based trips: 0.006 per non-retail employee, except the Downtown Sacramento RAD, with 0.010 per non-retail employee.

But for home-based trips, trip generation factors are applied to household segmentations by income as shown in Table 3-13:

Table 3-13 Home-Based Airport Trip Generation based on Household Income (Enplaning Airport Passengers)

Household Income (c.2000 dollars)	Estimated Enplaning Passengers per Household
Under $15k	0.0060
$15k to 35k	0.0068
$35k to 50k	0.0133
$50k to 75k	0.0156
$75k or more	0.0269

Source: SACOG 2020.

Home-based trip generation rates apply to five household income strata as described above. These generated trips are then saved in four household categories used by the mode choice model, which can be considered a two-dimensional array of (1) whether the household income is over $50,000, and (2) whether there are as many autos available as persons in the household.

A concurrent process adjusts the survey records' expansion factors factored to match the respective grand totals of home-based and non-home-based trips. The Tripgen program is ideally suited to do this concurrently, treating each survey record's expansion factors as "attractions" flagged into either "purpose 1" or "purpose 2," respectively. Normally the "control totals" of these two purposes are determined by zonal trip generation, and naturally grow when forecasting with regional growth.

3.4.3 External Passenger Generation Rates from Population

To forecast SMF passenger demand outside the SACOG region within the SACSIM models, the full demographic detail used within the region is neither necessary nor appropriate. It would be appropriate and pragmatic to have simpler and more readily-forecast independent variables than income-stratified households and non-retail employment.

County populations were checked and found to be reasonably proportional to the preceding passenger demand estimates from detailed demographics. Non-retail employment is likewise reasonably proportional to county population. Proportionalities with respect to county population are significantly closer than to total households in county. Consequently, only one independent variable, population, is chosen for application of external airport passenger demand.

Table 3-14 shows airport passenger generation rates for external (non-SACOG) areas.   Table 3-14's rates count both arrivals and departures, unlike above tables that count departures only. Table 3-14 shows passenger generation rates split into the demographic strata needed by the airport access mode choice model, obtained by dividing the generation calculated for each particular stratum, by population.

Table 3-14 Two-Way SMF External Passenger Generation Rates

Trip Category	Income	Cars per Person	2-Way Rate per Population
Home-Based	Less than $50k	As many or more	0.00090
Home-Based	Less than $50k	Fewer	0.00039
Home-Based	More than $50k	As many or more	0.00179
Home-Based	More than $50k	Fewer	0.00022
Non Home-Based			0.00095

Source: SACOG 2020. For External Areas Only

3.4.4   Enumeration of Passenger Survey Database

This model application phase calculates appropriate weights for passenger survey observations to represent a given zone's generated trips for the sake of mode choice, so that the mode choice model can be applied as a modified sample enumeration procedure. Conversely, this phase can be considered to split or spread each survey record across several zones, instead of its one observed zone. (This phase is analogous to trip distribution, although, strictly speaking, the airport trip generation described above is also trip distribution, since the trips are attracted to one zone, the airport.) The general objective is that each zone's generated trips would be represented by "compatible" survey records, that is, compatible in demographics and geography, as well as matching in being home-based or non-home-based. (This phase was not needed in the DNA Corridor Study, in which survey records "stayed in their zones" and were growth-factored for forecasting.)

This association is represented as two matrices, one for home-based and the other for non-home-based trips; rows represent actual TAZs and columns represent survey records. The cells are zero if not "compatible," and have a spread weight value otherwise. The row-sums for home-based trips

must match the zonal home-based trip generation, and likewise the row-sums for non-home-based trips must match non-home-based trip generation. Column-sums are proportional to the base year expansion factor of the respective survey observation, but are scaled to the same grand total as the trip generation.

Ideally there would be several survey observations, of each demographic cross-classified category (persons by income by autos), that could be associated with each demographic category in each RAD. But there aren't enough survey cases to do this. Instead, we must combine RADs into yet larger districts just to provide home-based and non-home-based survey observations to all zones. Some cross-classified cells have few or no cases at all in the survey. Therefore, the more demographic variables of the modeled households we wish to match to representative survey records, the larger the districts must be for the computation to be possible.

For home-based trips, the present application chooses survey records for each trip in the same one of 8 regional districts, matching whether household income is less than $50,000 (a mode choice dummy variable), and whether there is a shortage of autos per person (as defined for another mode choice dummy variable). This could be conversely be thought of as spreading each survey record across all zones in the same of 8 districts, proportionally to the airport trip generation by households of the same of two income classes and two autos-per-person classes. This particular compatibility scheme is subject to change as validation and forecasting issues are considered.

For non-home-based trips, this application chooses all survey records in the same one of the 8 regional districts.

The actual mechanism to achieve these associations or spreads, subject to row and column constraints, is iterative proportional factoring, implemented in the TP+ Fratar program. The constraint vectors are the trip generation results (home-based and non-home-based zonal demand as productions, factored survey weights as attractions). The input matrix to the home-based process is the compatible-class trip generation of the zone; the input matrix for the non-home-based process is simply a 1 if in the same of 8 districts, and a 0 otherwise. The result matrices are the number of trips generated by the i zone, associated with survey record number j (or conversely, the number of trips of survey record j spread to zone i.)

3.4.5   Ground Access Mode Choice for Internal Passengers

The mode choice model used a two-by-two segmentation of air passengers: resident vs. non-resident, and business vs. other. The model was based on highway and transit network level-of-service measures obtained from a regional travel demand model. The model is applied by enumerating (i.e. expanding) the airport survey dataset according to residential growth (for home- or residence- based trips) or non-retail employment (for non-home-based trips).

The mode choice model is taken directly from an application spreadsheet used in the DNA Corridor Study. It is multinomial logit, with these seven alternatives:

- Auto Drop-Off
- Drive-and-park at airport (for residents)
- Return rental car at airport (for visitors)
- Taxi
- Van
- Transit Walk-Access
- Transit Drive-Access
- Transit Drop-Off Access

Table 3-15 shows the coefficients of this logit model. This paper does not report the numerous details in the definitions of the variables. Demographic variables only apply to home-based trips by residents.

This model is applied to the matrix of weighted trips computed in the preceding phase, in which the *i* zone is the zone of trip generation, and the *j* zone is the survey record number. It is thus a modified form of sample enumeration, with the survey records "spread" among numerous zones, instead of kept in their original zones. The actual output result of this application is the row sums of the seven modal matrices, that is, the aggregation of them by zone, collapsing all survey records. Reports aggregating modal trips by the segment (travelers, resident business, resident leisure, visitor business, and visitor leisure) are also provided; reports aggregating by any survey data variable can be generated.

Table 3-15 Airport Ground Access Mode Choice Logit Model Coefficients

Coeff No.	Variable	Passenger Market Segment			
		1 Resident/ Business	2 Resident/ Leisure	3 Visitor/ Business	4 Visitor Leisure
Mode Constants					
1	Auto Drop-Off	0	0	0	0
2	Auto-Park(Res)/Return Rental(Vis)	0.5303	0.5303	0.106	-1.1104
3	Taxi	-1.5858	-2.1639	-0.3116	-1.8789
4	Van	-1.0737	-0.5921	-0.4271	-1.2767
5	Transit-Walk Access	0.5281	0.5281	0.705	0.705
6	Transit-Drive Access	0.1097	0.1097	-0.5949	-0.5949
7	Transit-Drop-Off Access	-0.2191	-0.2191	0.3275	0.3275
Demographic Variables					
8	Autos<Persons	-0.2494	-0.2494	0	0
12	1 Persons	-0.3995	0	0	0
13	3+ Persons	0	0.6422	0	0
14	Income<$50K	0	0.7416	0	0
Cost Variables					
15	Parking Cost	-0.0155	-0.0155	0	0
16	Van/Taxi Cost	-0.0191	-0.0003	-0.0191	-0.0003
17	Transit Cost	-0.0422	-0.0422	-0.0422	-0.0422
Travel Time/Level-of-Service Variables					
18	Main Mode Time	-0.0095	-0.0095	-0.0095	-0.0095
19	Walk and Transfer Time	-0.0518	-0.0518	-0.0518	-0.0518
20	Drive Access Time	-0.0079	-0.0079	-0.0079	-0.0079
21	Chauffer Time	-0.0055	-0.0003	-0.0055	-0.0003
22	First Transfer	0	0	0	0
23	Second+ Transfer	-0.845	-0.845	-0.845	-0.845
Airport Egress Variables					
24	Walk Egress Time	-0.0183	-0.0183	-0.0183	-0.0183
25	Walk Egress Dummy	-0.0916	-0.0916	-0.0916	-0.0916
26	Shuttle Egeress Time	-0.0053	-0.0053	-0.0053	-0.0053
27	Shuttle Egress Dummy	-0.0526	-0.0526	-0.0526	-0.0526
Other Variables					
28	Scale Factor for Utility	1.865	1.865	3.0869	3.0869

Source: SACOG 2020. Using values from November 2008.
Based on technical memorandum by Bowman, John L., Bradley, Mark A., and Griesenbeck, Bruce "Sacramento RT
DNA Transit Access Mode Choice Model", July 3, 2002.

3.4.6   Updated Time-of-Day Distribution of Airport Access

No surveys or counts of trips entering or exiting the airport have been available that would yield time-of-day distributions of airport passenger arrivals or departures, either at the flight gate or on the road. An alternative basis is the time of day of aircraft arrivals and departures, assuming most flights are nearly full, and different-sized aircraft are scheduled consistently across the day.

Table 3-16 presents the approximate (shifted) distribution of passenger ground travel, in the nine time periods used in the updated SACSIM model system. (Arriving and departing percentages are both normalized to 50%.)

Table 3-16 Estimated Time-of-Day Distribution of Ground Access of SMF Airport Passengers

SACSIM Time Period	Percent Departing	Percent Arriving
AM Hour 7:00-7:59	3.0%	0.3%
AM Hour 8:00-8:59	2.7%	2.0%
AM Hour 9:00-9:59	4.7%	3.0%
Midday (10:00-14:59)	15.6%	16.1%
PM Hour (15:00-15:59)	2.7%	2.7%
PM Hour (16:00-16:59)	3.0%	2.7%
PM Hour (17:00-17:59)	2.4%	3.4%
Evening (18:00-19:59)	5.1%	6.0%
Night (20:00-6:59)	10.9%	14.0%

Source: SACOG 2020.