San Francisco Travel Demand Forecasting Model Development

Visitor Model

Final Report

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Introduction

This report documents the estimation of models to predict the visitor trips by mode for San Francisco tourist destinations. These models were estimated using available visitor survey data collected in 1995 and 1998. The visitor models estimate the number of visitors to 29 destinations for each of three modes. Figure 1 shows where the visitor model is applied in the model system.

The model is developed as a series of multinomial logit (MNL) models that estimate the utility derived by a visitor in visiting a particular attraction/destination and in choosing a particular mode. Overall, 29 key visitor destination choices were modeled as a function of the LogSum variable and other destination specific information. Modal choices were determined based on utility functions specific to each mode. The maximum likelihood method of estimation was adopted to yield consistent and asymptotically efficient parameter estimates of the model.

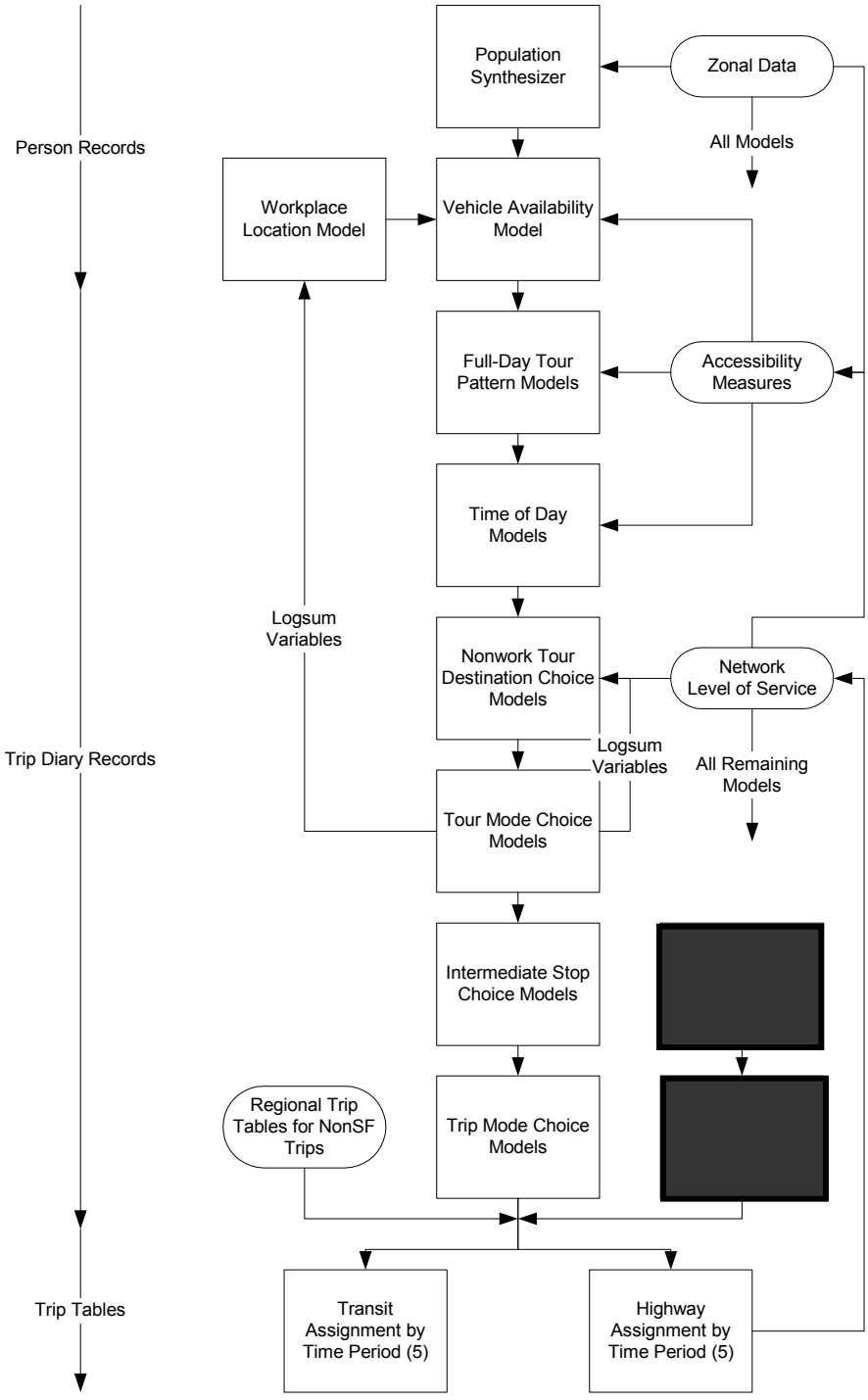
Overview

The visitor models were developed by estimating destination choice and trip generation from the visitor surveys that were available in the San Francisco region. These models compared favorably to similar models developed in Honolulu.

Mode choice models were borrowed from the Honolulu model development effort, since these tourist markets are somewhat similar and because the Honolulu model is one of the only visitor models estimated from visitor survey data. The visitor survey data in San Francisco did not have the available data needed to estimate mode choice models.

Time of day factors were estimated from available traffic count data at select tourist destinations in San Francisco. These were applied to generate trip tables for each of the five time periods: early AM, AM peak, midday, PM peak and evening.

Figure 1. San Francisco Model System



Estimation Data

The data for the estimation of the Visitor model was derived from two sources - the 1995 Visitor survey and the 1998 Hotel-based survey. Table 1 presents a summary of these survey data. The former was administered at various attractions and hotels, while the latter was a survey of guests at hotels around the city. The data from the two sets was reconfigured to contain the same information and merged together to create a single estimation file. Based on the number of visitations to each attraction, a set of 29 attractions was selected for modeling. The choice sets varied among the two surveys, that is, the two surveys did not present the respondent with the same set of attractions to choose from. This problem was overcome using non-availability criteria in ALOGIT, the software used for estimation.

Respondents identified all the attractions visited during their stay in the city. One of the shortcomings of the data is that the trip chain (the order in which the attractions are visited) is not available. It is worth noting that the main purpose of these surveys was to gather information on tourist/visitor characteristics rather than examine their travel behavior once within San Francisco. As a result of this structure of the data, the premise for the model estimation and application is that the visitor trips originate at a hotel and end at an attraction. All observations with missing origin locations were excluded from estimation.

The model uses the number of hotel rooms in each TAZ, and an estimate of visitor party size per room to predict visitor trip generations and origins. The data sets did not provide enough information to estimate a mode choice model for visitors. While the various modes used and the set of attractions visited during the stay were reported by each respondent, the information on the specific modes used for visiting each attraction was not available. Therefore, the LogSum variables for the various destinations were derived using the Visitor mode choice model developed for Honolulu by Parsons Brinckerhoff. During the model application process, calibration constants were applied to match the results with the relative mode shares observed in the surveys.

Table 1. Visitor Destinations from 1995 and 1998 surveys

		1995 visitor survey		1998 Hotel Survey			
Destination	**Location**	**ID**	**Visits**	**ID**	**Visits**	**Percent of Total**	**Included in Model**
Alcatraz		B	967	23	1,161	3.6%	x
Cable Car Ride	Hyde, Powell	F	1,485	2,30	2,814	7.3%	x
Cannery/Ghirardelli		Q	982	41,45	1,894	4.9%	x
Castro Street		U	296	12	456	1.3%	x
Chinatown		S	1,676	22	2,309	6.8%	x
Crocker Galleria				15	180	0.6%	
Dance Performance		J	119			0.4%	
Embarcadero		N	629	5	1,421	3.5%	x
Exploratorium				46	281	1.0%	x
Ferry Terminal				38	701	2.4%	x
Fishermans Wharf		D	1,870	13	3,018	8.3%	x
Golden Gate Bridge		A	1,634	21	2,348	6.8%	x
Golden Gate Park		C	1,222	24	1,370	4.4%	x
Haight Ashbury		W	463	7	610	1.8%	x
Highway 1				26	666	2.3%	x
Japan Center		T	385	9	561	1.6%	x
Live Theater		K	242			0.8%	x
Marina District - Chestnut				6	582	2.0%	x
Mission District		V	407	3	830	2.1%	x
Museums/Gallery	deYoung	G	149	25	217	0.6%	x
Museums/Gallery	Asian Art	G	89	29	128	0.4%	
Museums/Gallery	Acad Sci	G	142	32	206	0.6%	x
Museums/Gallery	MOMA	G	386	34	565	1.6%	x
North Beach		E	599	1,27	1,858	4.2%	x
Ocean Beach	Cliff House			26,35	1,200	4.1%	x
Opera	Davies	H	126			0.4%	
Palace of Legion of Honor				40	230	0.8%	x
Pier 39		R	1,480	42,43	2,108	6.1%	x
Presidio				31	777	2.6%	x
Richmond District - Clement				10	151	0.5%	
SOMA		Y	366			1.2%	x
Sports Event	3Com Park	M	149			0.5%	
Stonestown				16	88	0.3%	
Sunset District - Irving				4	155	0.5%	
Symphony/Concert	Davies	I	126			0.4%	
The Zoo		L	136			0.5%	
Union Square		O	1,534	11	2,878	7.5%	x
Union Street		P	623	8	1,450	3.5%	x
Yerba Buena/Moscone		X	532	28	447	1.7%	x
Total			18,814		33,660		

Sources: San Francisco Hotel Guest Survey, 1998 and San Francisco Visitor Demographics Survey, 1995

Model Estimation Results for Destination Choice

The initial model estimation exercise produced coefficient values that were statistically significant at the 95 percent confidence level. In addition, the coefficient associated with the LogSum variable was found to be positive. This indicates that as the accessibility to a destination increases, the utility of choosing to visit that particular destination also increases, which corroborates our basic hypothesis.

Testing Variables

Several other destination specific variables were also included in the model to test their explanatory power in determining the utility of choosing a destination. These variables included:

- region specific (dummy) variables,
- employment characteristics,
- safety issues,
- type of area, and
- acreage (in sq. ft.) of the various destinations.

The likelihood function, expressed as a function of model parameters, failed to converge indicating the irrelevance of such variables in the destination choice model. The reasons for this phenomenon are:

- Each of these destinations are unique in their own way in attracting visitors, and thus cannot be grouped into specific regions.
- A typical visitor opts to visit a certain destination based on its social/cultural/aesthetic value, rather than the employment type and number of employees in the destination.
- Information such as social/cultural/aesthetic value of each destination was not collected in either of the two surveys (1995 & 1998) which could have probably enhanced the predictability of the model.
- The safety and vitality issues were found to be significantly influencing the utilities, but however there is a possibility of the destination specific constants being biased. In other words, the constants capture most of these issues indicating the irrelevance of inclusion of safety and vitality variables in the model. As a matter of fact, almost all the destinations are found to be safe and vital in their own way based on the information gathered from the surveys.

Hence, the final destination choice model or visitor model for the San Francisco Bay area includes only the destination specific constants and the LogSum variable.

Overall Model Results for Destination Choice

Table 2 presents the overall model estimation results. The model incorporates a coefficient on the LOGSUM variable of 0.0822. The logsum variable is calculated as follows:

LOGSUM = LOG (EXP(auto utility)+EXP(transit utility)+EXP(walk utility)

The utility equations are determined by the mode choice model, which is described in the next section.

The visitor model was compared to the Honolulu visitor model, which was also developed from visitor survey data. The Honolulu model was used to define the logsum variable because the visitor survey data was designed specifically support model estimation and therefore contained full information on modal choices. This information is necessary to derive the logsum utility equations as part of mode choice model estimation.

Table 3 presents a comparison of the model estimation results between the Honolulu model and the San Francisco Model. These compare very favorably. The total of exponentiated coefficient was 5.1 in San Francisco compared to 5.0 in Honolulu. While these totals are quite similar, the maximum value in Honolulu was much larger than it was in San Francisco, implying that there is one destination that is a much bigger attraction in Honolulu, but in San Francisco the attractions are more evenly divided for visitors.

This model represents a combined generation and distribution model. In application, the number of visitor trips to each destination is determined by multiplying the number of hotel rooms by the utility equation for each destination.

Table 2. Visitor Destination Choice Model Results

Alt No	Alternative	Constant	Exp (Constant)	Prob (Alt)	Prob (IndAlt)
1	FISHWHAR	-0.8994	0.4068	7.97%	29%
2	UNIONSQ	-1.0855	0.3377	6.61%	25%
3	CABLECAR	-1.0498	0.3500	6.85%	26%
4	CHINATOW	-1.3322	0.2639	5.17%	21%
5	GGBRIDGE	-1.1896	0.3044	5.96%	23%
6	PIER39UW	-1.3023	0.2719	5.32%	21%
7	CANNGHIR	-1.3942	0.2480	4.86%	20%
8	GGPARK	-1.7401	0.1755	3.44%	15%
9	NBEACOIT	-1.5360	0.2152	4.21%	18%
10	ALCATRAZ	-1.9285	0.1454	2.85%	13%
11	UNIONST	-1.7081	0.1812	3.55%	15%
12	EMBARCAD	-1.6851	0.1854	3.63%	16%
13	MISSIOND	-2.3591	0.0945	1.85%	9%
14	HAIGHTAS	-2.6460	0.0709	1.39%	7%
15	YERBABUE	-2.9640	0.0516	1.01%	5%
16	SFMOMA	-2.7990	0.0609	1.19%	6%
17	JAPANTOW	-2.7912	0.0613	1.20%	6%
18	PRESIDIO	-2.4383	0.0873	1.71%	8%
19	CASTROST	-3.0105	0.0493	0.96%	5%
20	BAYCRUIS	-2.5480	0.0782	1.53%	7%
21	HIGHWAY1	-2.5562	0.0776	1.52%	7%
22	CHESTNUT	-2.8869	0.0558	1.09%	5%
23	CLIFFHOU	-2.8098	0.0602	1.18%	6%
24	SOMA	-2.2607	0.1043	2.04%	9%
25	EXPLORAT	-3.4635	0.0313	0.61%	3%
26	DEYOUNG	-3.7323	0.0239	0.47%	2%
27	CALACADE	-3.7840	0.0227	0.45%	2%
28	LIVETHTR	-2.7328	0.0650	1.27%	6%
29	LEGIONHO	-3.6316	0.0265	0.52%	3%
30	NoTrip	0.0000	1.0000	19.58%	
			5.1069		3.37

Table 3. Comparison with the Honolulu Visitor Model

	Constant		Exp (Constant)		Prob(Alt)		Prob(IndAlt)	
AltNo	**Honolulu**	**SF**	**Honolulu**	**SF**	**Honolulu**	**SF**	**Honolulu**	**SF**
1	-2.27	-0.90	0.10	0.41	0.02	0.08	0.09	0.29
2	-0.82	-1.09	0.44	0.34	0.09	0.07	0.31	0.25
3	-3.07	-1.05	0.05	0.35	0.01	0.07	0.04	0.26
4	-3.88	-1.33	0.02	0.26	0.00	0.05	0.02	0.21
5	-4.01	-1.19	0.02	0.30	0.00	0.06	0.02	0.23
6	-2.77	-1.30	0.06	0.27	0.01	0.05	0.06	0.21
7	-1.87	-1.39	0.15	0.25	0.03	0.05	0.13	0.20
8	-2.47	-1.74	0.08	0.18	0.02	0.03	0.08	0.15
9	-1.97	-1.54	0.14	0.22	0.03	0.04	0.12	0.18
10	-1.84	-1.93	0.16	0.15	0.03	0.03	0.14	0.13
11	-3.58	-1.71	0.03	0.18	0.01	0.04	0.03	0.15
12	-0.55	-1.69	0.58	0.19	0.11	0.04	0.37	0.16
13	-3.26	-2.36	0.04	0.09	0.01	0.02	0.04	0.09
14	-3.86	-2.65	0.02	0.07	0.00	0.01	0.02	0.07
15	-1.90	-2.96	0.15	0.05	0.03	0.01	0.13	0.05
16	-2.27	-2.80	0.10	0.06	0.02	0.01	0.09	0.06
17	-3.60	-2.79	0.03	0.06	0.01	0.01	0.03	0.06
18	-2.31	-2.44	0.10	0.09	0.02	0.02	0.09	0.08
19	-2.25	-3.01	0.11	0.05	0.02	0.01	0.10	0.05
20	-1.09	-2.55	0.34	0.08	0.07	0.02	0.25	0.07
21	-4.18	-2.56	0.02	0.08	0.00	0.02	0.02	0.07
22	-3.61	-2.89	0.03	0.06	0.01	0.01	0.03	0.05
23	-4.02	-2.81	0.02	0.06	0.00	0.01	0.02	0.06
24	0.16	-2.26	1.17	0.10	0.23	0.02	0.54	0.09
25	-2.45	-3.46	0.09	0.03	0.02	0.01	0.08	0.03
26		-3.73		0.02		0.00		0.02
27		-3.78		0.02		0.00		0.02
28		-2.73		0.07		0.01		0.06
29		-3.63		0.03		0.01		0.03
No trip	0.00	0.00	1.00	1.00	0.20	0.20		
Total			5.03	5.11	1.00	1.00	2.83	3.37

Mode Choice Model

Table 4 presents the mode choice model parameters that were borrowed from the Honolulu model, since the visitor survey data available in San Francisco did not contain model information for each trip. The model information that was collected was all modes used by a specific visitor for all trips, rather than individual modes for individual trips. This was not a priority when the data was collected, since it was not intended for use in model estimation. Party size was estimated from the visitor survey data as 1.69.

Table 4. Mode Choice Model Parameter

Utility Equations	Variable	Coeff
Auto Utility	Constant	-1.802
	Auto In Vehicle Travel Time	-0.02712
	Auto Out of Vehicle Travel Time	-0.05424
	38.2*Distance/Party Size	0.0003816
	Parking Cost * 2* 100/ Party Size	0.007776
Transit Utility if there is no transit path	Constant	-5.703
	Auto In Vehicle Travel Time	-0.02712
	(250+(Distance-0.5)*180)/Party Size	0.0003816
Transit Utility if there is a transit path	Constant	-2.876
	Transit In Vehicle Travel Time	-0.02712
	Transit Out of Vehicle Travel Time	-0.05424
	Transit Fare	0.0003816
Walk Utility	Walk Time if less than 20 Minutes	-0.05424
	Walk Time if greater than 20 minutes	-0.1322

Source: Honolulu Visitor Model, Parsons Brinckerhoff

Time of Day Factors

Time of day factors were developed using available traffic count data at select tourist destinations. There were two locations for auto modes, which reported data for all five time periods:

- LEGION OF HONOR
- US-101 RAMP @ GGBRIDGE

And three locations for transit modes, which reported data for AM, midday and PM time periods only:

- BEACH & HYDE
- POWELL & MARKET (or EDDY)
- TAYLOR & BAY

Early AM and evening time periods were developed from the auto data and applied to all modes. The walk mode was assumed to be the same as the auto mode, because it is not affected by service frequencies. Table 5 presents the time of day factors that were used in the visitor model, by mode.

Table 5. Time of Day Factors

Mode	Direction	Early AM	AM	Midday	PM	Evening
Auto/Walk	P-A*	0.4%	5.7%	25.4%	11.8%	6.6%
Auto/Walk	A-P	0.3%	4.4%	25.4%	13.7%	6.2%
Transit	P-A	0.4%	1.2%	20.8%	21.0%	6.6%
Transit	A-P	0.3%	10.6%	20.5%	12.4%	6.2%

P-A means from the trip production zone to the trip attraction zone, while A-P means from the trip attraction back to the trip attractions zone.

Model Application

All of the models in this chapter were incorporated into a TP+ program with the following structure:

- Calculate modal utility equations and logsum variable using values in Table 4.
- Compute generation and distribution for each destination using values in Table 2.
- Calculate modal shares using values in Table 4.
- Balance trip tables to origin and destination.
- Calculate time period trip tables using values in Table 5.

Files to Run the Visitor Model

The following input files are used in the application of this program:

- TRNWTWMD.MAT *; Midday transit skims for walk access and egress*
- HWYMD.MAT *; Midday highway skims*
- OPTERM.MAT *; Off-peak terminal times*
- TAZVISIT.DBF *; Zonal data file with hotel and parking cost data*

The following output files are generated in the application of this program:

- MATO=VISITOR.MAT with trip tables TOTAL,AUTO,TRANSIT,WALK
- MATO=DEST.MAT with balanced trip tables TOTAL,AUTO,TRANSIT,WALK
- EAVISIT.MAT with early AM tables AUTO,TRANSIT,WALK
- AMVISIT.MAT with AM tables AUTO,TRANSIT,WALK
- MDVISIT.MAT with midday tables AUTO,TRANSIT,WALK
- PMVISIT.MAT with PM tables AUTO,TRANSIT,WALK
- EVVISIT.MAT with evening tables AUTO,TRANSIT,WALK