Final Model Refresh Report

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Introduction

This document is a compilation of all the technical reports for the Oahu Metropolitan Planning Organization (OahuMPO) Model Refresh project. The model refresh project included:

1. Revising the Transportation Analysis Zone (TAZ) and districting system, and highway and transit line TransCAD layers.
2. Household and visitor travel survey coding and analysis.
3. Estimation of various residential tour-based model components.
4. Revised time of day choice component.
5. University student model
6. Updated visitor tour-based model.
7. Calibration and validation of model refresh components.

The models use population, household, and employment inputs from the Urbansim model for any forecast year. The models were estimated and calibrated based upon a set of household and visitor travel surveys collected by NuStats in 2012; a total of 4,000 households and 950 visitors were surveyed using state-of-the-art surveying methods including real-time geocoding. Other data sources included the 2010 Census data, and attendance at various attractions on the island from the *2011 State of Hawaii Data Book*. The model assignment results were validated based on traffic counts for 2010/2011, and the 2012 On-Board Survey.

This model will serve as the major travel forecasting tool for Oahu. The model system has been developed to ensure that the regional transportation planning process can rely on forecasting tools that will be adequate for new socioeconomic environments and emerging planning challenges. It is equally suitable for conventional highway projects, transit projects, and various policy studies such as highway pricing and HOV analysis. The OahuMPO model is a family of tour-based models that micro-simulate the travel patterns of Oahu residents and visitors. The tour-based framework retains many of the advantages of an activity-based model (ABM) while greatly simplifying the model system (see Estimation of the Residential Models section).

Network and Zone Development

Highway Network

The Oahu transportation infrastructure is rapidly changing especially in growing communities like Ewa and Kapolei. Thus, the TransCAD highway network was updated with major streets so trips would be loaded on to the network in reasonable places. There were also some recent restriping projects done to add lanes on Moanalua Freeway and H-1 to help relieve congestion. Figure 1 through

Figure 3 below documents the major additions for 2012 to the TransCAD highway network. Notice the dashed line in Figure 1 denoting the zone centroid connector. When new roads like Kamaaha and Kapolei Parkway were added, the zone centroid connectors were updated so trips will load onto those new links.

Diurnal distributions of traffic count in 2008/2009/2010 were also analyzed and showed that the time periods that were currently defined in the model (AM Peak Shoulder: 5-6AM, 8-9AM, AM 2 Hour Peak: 6-8AM, Midday: 9AM-2PM, PM 2 Hour Peak: 3-5PM, PM Peak Shoulder: 2-3PM, 5-6PM, Night: 6PM-5AM) did not do a good job of matching peak period conditions on the network. So, the time periods were redefined as follows:

a. Early AM: 3 AM to 6 AM
b. AM Peak: 6 AM to 9 AM
c. Midday: 9 AM to 3 PM
d. PM Peak: 3 PM to 7 PM
e. Evening: 7 PM to 3 AM

Note that the model will produce trip lists in half-hour periods; so ultimately trip tables and assignments for any time period can be created, from 30 minutes to 24 hours. But these time periods will be better than the older time period definitions for the purpose of creating skims that best represent average peak and off-peak conditions.

Figure 1: Kapolei Interchange and City of Kapolei Lane Additions for 2012

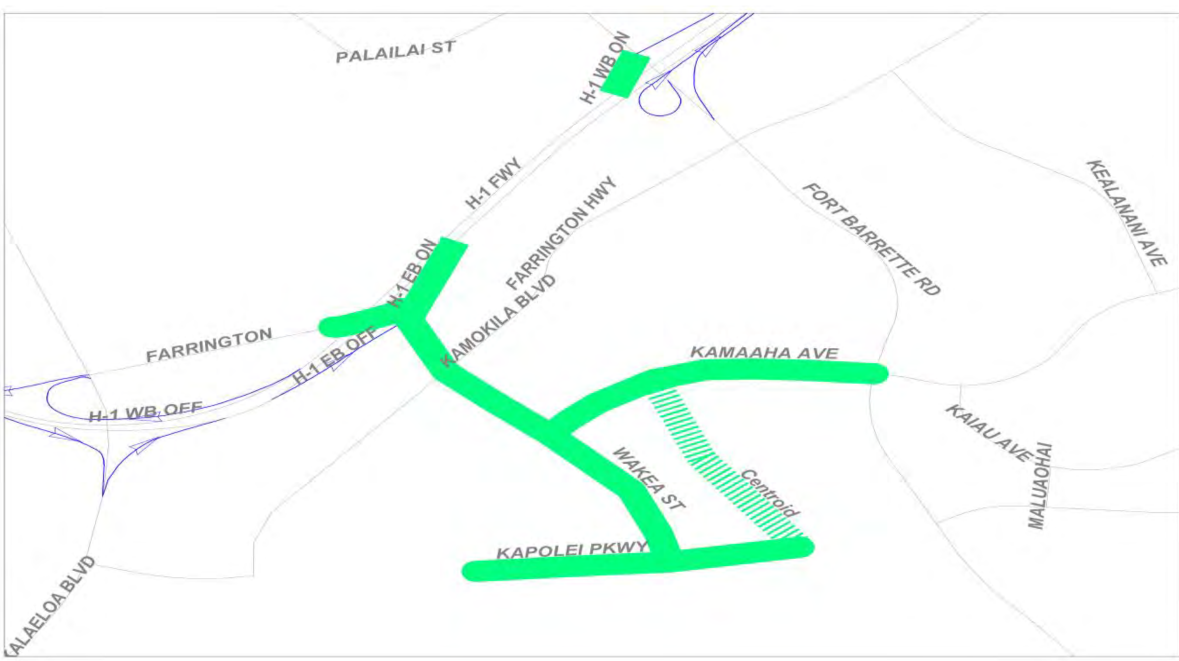
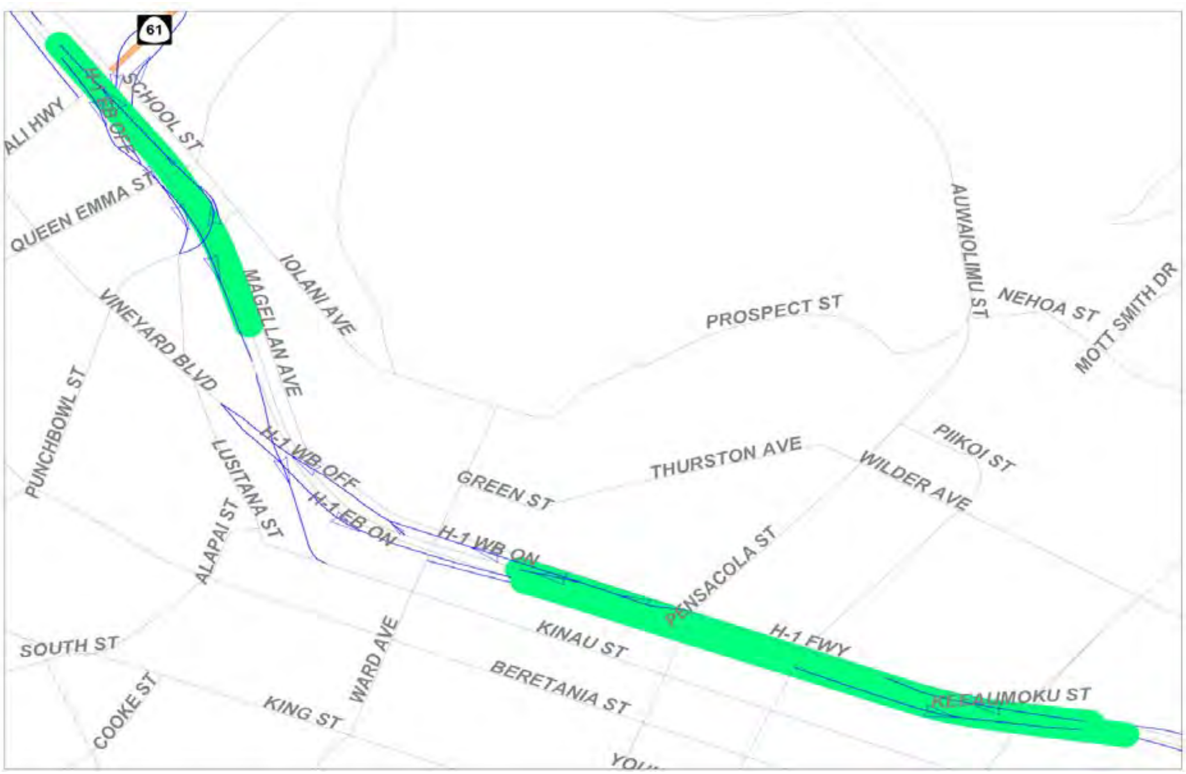


Figure 2: Moanalua Freeway in Halawa Lane Additions for 2012

Figure 3: H-1 Freeway near Pali Highway and Ward Avenue Lane Additions for 2012



Transit Network

Oahu's *The Bus* transit system is also changing slightly from year to year to accommodate heavily used or not heavily used routes to manage their budget. For the year 2012, spring (March) was used as the time of the year to represent the 2012 transit network since the 2012 Transit On-Board Survey was being conducted at this time. Table 1 shows the 2012 transit routes and headways used in the network.

The headways by the five time periods were calculated by using the observed distribution of trips by departing hour from the household travel survey to weight the frequency in each hour within each period, with the following caveats or exceptions:

- If, within a period, there are hours with no service frequency that precede one or more hours with service frequency, then the headway is calculated as the number of hours before frequency is available times 60 minutes per hour. In other words, if there is no service between 3 and 4 AM, but there is service between 5 and 6 AM, the headway between 3 and 4 AM is 2*60=120 minutes.
- If, within a period, there are hours with no service frequency that follows one or more hours with service frequency, then the headway is set to a maximum headway, which is currently defaulted to 90 minutes, for the purpose of averaging.
- If, within a period, the average headway is 0 or greater than a maximum headway (120 minutes).

Table 1: 2012 Oahu The Bus Transit Routes and Headways by Time Period

Route Name	Route Description	EARLY AM	AM PEAK PERIOD	MIDDAY	PM PEAK PERIOD	EVENING / NIGHT
1AE	Kalihi Transit Center - Lunalilo Home Rd	29	75	0	104	60
1AW	Lunalilo Home Rd - Kalihi Transit Center	37	0	0	63	49
1BE	Kalihi Transit Center - Kahala Mall	39	14	14	21	60
1BW	Kahala Mall - Kalihi Transit Center	31	13	14	20	83
2CE	Middle Street - Waikiki	23	10	15	17	23
2CW	Waikiki - Middle Street	35	15	15	14	22
3CE	Salt Lake - Koko Head/Waialae	21	13	20	21	36
3CW	Koko Head/Waialae - Salt Lake	21	14	16	16	39
3DE	Beretania/Aala - Koko Head/Waialae	78	82	85	82	0
3DW	Koko Head/Waialae - Beretania/Aala	83	57	0	0	0
4DE	Old Pali Road - Waikiki	27	21	19	22	51
4DW	Waikiki - Old Pali Road	60	24	20	30	54
4EE	Nuuanu/Vineyard - Waikiki	23	0	0	82	0

Route Name	Route Description	EARLY AM	AM PEAK PERIOD	MIDDAY	PM PEAK PERIOD	EVENING / NIGHT
4EW	Waikiki - Kuakini/Pali	0	66	0	60	0
4FE	Nuuanu/Kuakini - Waikiki	0	50	0	64	60
4GE	Wyllie/Kuakini-Waikiki	27	20	0	0	0
5AE	Ala Moana Center - Manoa	0	52	56	60	64
5AW	Manoa - Ala Moana Center	62	60	60	60	56
6AE	Pauoa - Woodlawn	39	20	21	30	53
6AW	Woodlawn - Pauoa	0	23	21	24	50
7AE	Kalihi Valley Homes - Kalihi Uka	62	43	44	45	62
7AW	Kalihi Uka - Kalihi Valley Homes	39	32	47	50	62
7BE	Mokauea/King - Kalihi Uka	0	82	143	47	0
7BW	Kalihi Uka - Mokauea/King	0	82	143	46	0
7CE	Kalihi Valley Homes - Kalihi Transit Center	0	69	0	0	0
7CW	Kalihi Uka - Kalihi Transit Center	0	50	0	104	79
8AE	Ala Moana Center - Waikiki	0	69	12	13	22
8AW	Waikiki - Ala Moana Center	0	34	11	14	26
9CW	Alapai/King - Pearl Harbor	30	58	0	0	0
9DE	Pearl Harbor - Alapai Transit Center	0	60	0	0	0
9FE	Pearl Harbor (Center/Nimitz) - Palolo Valley	60	75	43	49	64
9FW	Palolo Valley - Pearl Harbor (Center/Nimitz)	0	28	60	36	62
9GE	Pearl Harbor (Landing C) - Palolo Valley	0	25	0	41	0
9GW	Palolo Valley - Pearl Harbor (Landing C)	35	75	70	65	0
9HE	Kalihi Transit Center - Palolo Valley	0	90	0	0	0
9IW	Alapai TC - Pearl Harbor (Center/Nimitz)	58	0	0	0	0
9JW	Alapai TC - Pearl Harbor (Landing C)	35	60	0	0	0
10AE	Kalihi - Alewa Heights	39	52	52	53	62
10AW	Alewa Heights - Kalihi	62	46	60	45	64
11AE	Pearlridge - Alapai Transit Center	62	50	60	60	70

Route Name	Route Description	EARLY AM	AM PEAK PERIOD	MIDDAY	PM PEAK PERIOD	EVENING / NIGHT
11AW	Alapai Transit Center - Pearlridge	0	60	52	43	64
13BE	Liliha - Waikiki	15	14	15	15	28
13BW	Waikiki - Liliha	21	15	15	14	26
14BE	Maunalani Hts - Diamond Hd - Waikiki St. Louis Hts	0	30	52	36	62
14BW	St. Louis Hts - Waikiki - Diamond Hd - Maunalani Hts	60	30	52	36	62
15AE	Pacific Heights - Alapai/King	0	60	60	60	62
15AW	Alapai/King - Pacific Heights	62	60	60	60	64
15BE	Auwaiolimu/Puowaina - Alapai/King	0	50	143	32	0
15BW	Alapai/King - Papakolea	0	50	143	49	0
16AE	Moanalua Valley - Kalihi Transit Center	0	58	0	59	0
16AW	Kalihi Transit Center - Moanalua Valley	62	75	0	57	0
17AE	Makiki - Ala Moana Center	0	36	39	30	39
17AW	Ala Moana Center - Makiki	0	36	36	33	45
18BE	Ala Moana Center - UH	0	60	60	60	64
18BW	UH - Ala Moana Center	0	60	60	60	64
19BE	Hickam AFB - Waikiki	26	49	47	36	30
19BW	Waikiki - Hickam AFB	35	46	43	39	31
20CE	Pearlridge - Waikiki	35	38	43	51	0
20CW	Waikiki - Pearlridge	60	44	47	57	0
22BE	Waikiki - Sea Life Park (Beach Bus)	0	75	56	73	0
22BW	Sea Life Park - Waikiki (Beach Bus)	0	0	60	49	0
23AE	Ala Moana Center - Sea Life Park	0	60	60	43	79
23AW	Sea Life Park - Ala Moana Center	0	34	56	37	79
24BE	Ala Moana Center - Waikiki - Aina Haina	0	75	60	73	0
24BW	Aina Haina - Waikiki - Ala Moana Center	0	0	60	66	0
24CE	Kahala Mall - Aina Haina	0	54	0	60	79
24CW	Aina Haina - Kahala Mall	0	52	0	60	70

Route Name	Route Description	EARLY AM	AM PEAK PERIOD	MIDDAY	PM PEAK PERIOD	EVENING / NIGHT
31AE	Airport - Kalihi Transit Center - Tripler	60	44	60	60	64
31AW	Tripler - Kalihi Transit Center - Airport	39	44	60	52	64
32AE	Pearlridge - Salt Lake - Kalihi Transit Center	62	52	60	43	64
32AW	Kalihi Transit Center - Salt Lake - Pearlridge	39	36	52	36	64
40AE	Makaha Towers - Ala Moana Center	31	30	30	34	63
40AW	Ala Moana Center - Makaha Towers	37	30	27	37	48
40BE	Makaha Towers/Makaha Beach - Ala Moana Center	0	0	0	0	122
41AE	Kapolei Transit Center - Ewa Beach Transit Center	39	44	47	45	47
41AW	Ewa Beach Transit Center - Kapolei Transit Center	39	44	47	45	42
42AE	Ewa Beach - Waikiki	29	30	41	39	40
42AW	Waikiki - Ewa Beach	62	28	32	39	59
43AE	Waipahu - Alapai	0	38	30	58	0
43AW	Alapai - Waipahu	0	38	27	56	0
52AE	Haleiwa - Ala Moana Center	60	22	30	43	0
52AW	Ala Moana Center - Haleiwa	0	30	30	33	64
53AE	Pacific Palisades - Ala Moana Center	27	30	39	52	64
53AW	Ala Moana Center - Pacific Palisades	0	30	39	33	62
54AE	Upper Pearl City - Ala Moana Center	37	44	60	51	64
54AW	Ala Moana Center - Upper Pearl City	0	44	60	37	62
54BE	Lower Pearl City - Ala Moana Center	39	52	52	51	70
54BW	Ala Moana Center - Lower Pearl City	0	52	60	36	64
55AE	Haleiwa - Kaneohe - Ala Moana Center	39	60	60	54	53
55AW	Ala Moana Center - Kaneohe - Haleiwa	62	52	60	51	62
56AE	Kaneohe - Kailua - Ala Moana Center	37	34	51	45	64
56AW	Ala Moana Center - Kailua - Kaneohe	0	46	47	36	64

Route Name	Route Description	EARLY AM	AM PEAK PERIOD	MIDDAY	PM PEAK PERIOD	EVENING / NIGHT
57AE	Sea Life Park - Kailua - Ala Moana Center	27	34	38	42	59
57AW	Ala Moana Center - Kailua - Sea Life Park	0	60	40	25	62
62AE	Wahiawa Heights - Alapai Transit Center	25	21	34	43	52
62AW	Alapai Transit Center - Wahiawa Heights	37	38	30	33	62
65AE	Downtown - Kahaluu	0	60	60	36	59
65AW	Kahaluu - Downtown	39	34	60	44	62
70AE	Maunawili - Lanikai	0	60	60	60	79
70AW	Lanikai - Maunawili	0	60	60	60	79
71AE	Newtown - Pearlridge	62	60	0	59	0
71AW	Pearlridge - Newtown	0	50	0	60	0
72AE	Whitmore - Schofield	62	60	60	60	0
72AW	Schofield - Whitmore	62	60	60	66	0
73AE	Pearl City Peninsula - Pearl City Uplands - Lower Pearl City	0	22	37	57	0
73AW	Lower Pearl City - Pearl City Peninsula	0	22	32	48	0
74AE	Aiea Heights - Halawa Heights	62	66	0	60	0
74AW	Halawa Heights - Aiea Heights	0	66	0	66	0
76AE	Waialua - Haleiwa	0	52	47	45	79
76AW	Haleiwa - Waialua	0	46	43	45	0
77AE	Kaneohe - Waimanalo	62	60	60	66	0
77AW	Waimanalo - Kaneohe	0	60	60	73	0
80AE	Downtown - Hawaii Kai	0	0	0	47	0
80AW	Hawaii Kai - Downtown	39	56	0	0	0
81AE	Waipahu - Downtown	17	40	0	0	0
81AW	Downtown - Waipahu	0	0	0	28	0
82AE	Downtown - Kalama Valley	0	0	0	60	0
82AW	Kalama Valley - Downtown	39	66	0	0	0
83AE	Waialua - Downtown	60	0	0	0	0

Route Name	Route Description	EARLY AM	AM PEAK PERIOD	MIDDAY	PM PEAK PERIOD	EVENING / NIGHT
83AW	Downtown - Wahiawa Transit Center	0	0	0	66	0
83BE	Wahiawa Heights - UH	39	82	0	0	0
83BW	Downtown - Wahiawa Heights	0	0	0	61	0
83CE	Wahiawa Transit Center - Downtown	62	82	0	0	0
83CW	Downtown - Waialua	0	0	0	66	0
84AE	Wahiawa Armory - UH	62	0	0	0	0
84AW	Downtown - Wahiawa Armory	0	0	0	57	0
84BE	Wahiawa Armory - Downtown	60	82	0	0	0
85AE	Kailua/Kaneohe - UH (via Likelike)	62	0	0	0	0
85AW	UH - Kaneohe/Kailua/Keolu (via Likelike)	0	0	0	74	0
85BE	Kailua/Kaneohe - Downtown - UH (via Likelike)	62	82	0	0	0
85BW	Downtown - Kaneohe/Kailua/Keolu (via Likelike)	0	0	0	64	0
85CE	Keolu/Kailua - UH (via Pali)	62	0	0	0	0
85CW	UH - Downtown - Kaneohe/Kailua/Keolu (via Likelike)	0	0	0	82	0
85DE	Keolu/Kailua - Downtown - UH (via Pali)	0	75	0	0	0
85DW	UH - Keolu/Kailua/Kaneohe	0	0	134	0	0
85EW	Downtown - Keolu/Kailua/Kaneohe (via Pali)	0	0	0	64	0
88AE	Kahaluu - Downtown	0	75	0	0	0
88AW	Downtown - Kahaluu	0	0	0	57	0
89AE	Waimanalo - Downtown	62	82	0	0	0
89AW	Downtown - Waimanalo	0	0	0	64	0
90AE	Pearl City - UH	62	82	0	0	0
90AW	Downtown - Pearl City	0	0	0	64	0
91AE	Ewa Beach - Downtown	23	56	0	0	0
91AW	Downtown - Ewa Beach	0	0	0	33	0
92AE	Makakilo - Downtown	31	0	0	0	0
92AW	Downtown - Makakilo	0	0	0	57	0

Route Name	Route Description	EARLY AM	AM PEAK PERIOD	MIDDAY	PM PEAK PERIOD	EVENING / NIGHT
93AE	Makaha - Downtown	15	75	0	0	0
93AW	Downtown - Makaha	0	0	0	29	0
94AE	Villages of Kapolei - Downtown - UH	62	82	0	0	0
94AW	UH - Downtown - Villages of Kapolei	0	0	0	66	0
96AE	Waipio Gentry - Downtown	62	82	0	0	0
96AW	Downtown - Waipio Gentry	0	0	0	66	0
97AE	Village Park - Downtown	31	82	0	0	0
97AW	Downtown - Village Park	0	0	0	57	0
98AE	Waikalani - Wahiawa/Mililani P&R - Downtown	39	82	0	0	0
98AW	Downtown - Mililani/Wahiawa P&R - Waikalani	0	0	0	57	0
101AE	Ewa Gentry - Downtown	29	82	0	0	0
101AW	Downtown - Ewa Gentry	0	0	0	47	0
102AE	Kapolei - Downtown	39	82	0	0	0
102AW	Downtown - Kapolei	0	0	0	57	0
103AE	Waikele - Downtown	62	82	0	0	0
103AW	Downtown - Waikele	0	0	0	64	0
234AE	Kahala Mall - Waialae Nui	0	75	0	60	0
234AW	Waialae Nui - Kahala Mall	0	66	0	53	0
235AE	Kahala Mall - Waialae Iki	0	82	0	60	0
235AW	Waialae Iki - Kahala Mall	0	82	0	60	0
401AE	Waianae Transit Center - Waianae Valley	60	60	60	60	64
401AW	Waianae Valley - Waianae Transit Center	60	60	60	60	64
402AE	Waianae Transit Center - Lualualei Homestead	60	60	60	60	64
402AW	Lualualei Homestead - Waianae Transit Center	60	60	60	60	59
403AE	Waianae - Maili - Nanakuli	60	60	60	60	62
403AW	Nanakuli - Maili - Waianae	37	60	60	60	64
411AE	Makakilo Heights - Kapolei Transit	37	54	43	30	46

Route Name	Route Description	EARLY AM	AM PEAK PERIOD	MIDDAY	PM PEAK PERIOD	EVENING / NIGHT
	Center					
411AW	Kapolei Transit Center - Makakilo Heights	37	44	39	32	41
412AE	Panana Street - Kapolei Transit Center	60	44	51	45	0
412AW	Kapolei Transit Center - Panana Street	60	46	55	46	0
413AE	Campbell Industrial Park - Kapolei Transit Center	62	36	0	42	0
413AW	Kapolei Transit Center - Campbell Industrial Park	62	36	0	42	0
414AE	Makakilo - Kapolei Transit Center	62	60	60	60	0
414AW	Kapolei Transit Center - Makakilo	60	60	60	60	0
415AE	Kapolei Transit Center - Kalaeloa	39	82	0	69	0
415AW	Kalaeloa - Kapolei Transit Center	39	82	0	69	0
432AE	West Waipahu - East Waipahu	37	30	30	30	41
432AW	East Waipahu - West Waipahu	37	30	30	30	49
433AE	Waipahu Transit Center - Waikele - Waipio	37	46	30	30	49
433AW	Waipio - Waikele - Waipahu Transit Center	0	69	30	36	0
434AE	Village Park - Waipahu Transit Center	37	44	52	37	41
434AW	Waipahu Transit Center - Village Park	62	52	51	46	41
501AE	Mililani Transit Center - Mililani Mauka	62	60	60	60	64
501AW	Mililani Mauka - Mililani Transit Center	62	52	52	60	64
503AE	Launani Valley - Waikalani - Mililani Transit Center	62	60	60	60	0
503AW	Mililani Transit Center - Waikalani - Launani Valley	60	60	60	60	79
504AE	Mililani Transit Center - Mililani South	62	60	60	60	64
504AW	Mililani South - Mililani Transit Center	62	60	60	60	70

Route Name	Route Description	EARLY AM	AM PEAK PERIOD	MIDDAY	PM PEAK PERIOD	EVENING / NIGHT
1LAE	Aala Park - Lunalilo Home Road	62	38	35	43	0
1LAW	Lunalilo Home Rd - Aala Park	0	30	38	56	0
57BE	Enchanted Lake - Ala Moana Center	0	32	60	60	90
57BW	Ala Moana Center - Enchanted Lake	0	60	60	66	90
80BE	Dole/Lower Campus - Kalama Valley	0	0	0	66	0
80BW	Lunalilo Home Road - UH - Downtown	0	66	0	0	0
80CW	Kalama Valley - UH	0	75	0	0	0
80DW	Upper Aina Haina - Downtown	0	82	0	0	0
84BW	Downtown - Mililani	0	0	0	50	0
84CE	Mililani - University	0	75	0	0	0
84DE	Mililani - Downtown	39	0	0	0	0
85FW	Downtown - Kaneohe	0	0	0	57	0
85GE	Kaneohe - Downtown - UH	0	72	0	0	0
88BE	AMC - Kaneohe - North Shore - Wahiawa - Downtown	0	0	0	73	0
88BW	Wahiawa - North Shore - Kaneohe - Ala Moana Center	89	0	0	0	0
88CE	Ala Moana Center - Kaneohe - North Shore - Wahiawa - Aiea	0	0	0	82	0
88CW	Aiea - North Shore - Kaneohe - Ala Moana Center	83	0	0	0	0
98BE	Kunia - Waikalani - Wahiawa/Mililani P&R - Downtown	60	0	0	0	0
98BW	Downtown - Mililani/Wahiawa P&R - Waikalani - Kunia	0	0	0	64	0
AAE	Waipahu - UH	15	15	15	21	45
AAW	UH - Waipahu	31	14	14	17	51
CAE	Makaha Beach Park - Ala Moana Center	31	27	47	30	59
CAW	Ala Moana Center - Makaha Beach Park	39	28	47	36	51
EBE	Ewa Beach - Waikiki	29	36	35	34	53
EBW	Waikiki - Ewa Beach	29	27	34	36	45

Route Name	Route Description	EARLY AM	AM PEAK PERIOD	MIDDAY	PM PEAK PERIOD	EVENING / NIGHT
PH1AE	Makaha - Pearl Harbor	83	0	0	0	0
PH1AW	Pearl Harbor - Makaha	0	0	0	82	0
PH2AE	Mililani - Pearl Harbor	62	0	0	0	0
PH2AW	Pearl Harbor - Mililani	0	0	0	82	0
PH3AE	Wahiawa Heights - Pearl Harbor	62	0	0	0	0
PH3AW	Pearl Harbor - Wahiawa Heights	0	0	0	82	0
PH4AE	Pearl Harbor - Kaneohe	62	0	0	0	0
PH4AW	Kaneohe - Pearl Harbor	0	0	0	82	0
PH5AE	Pearl Harbor - Kaneohe - Kailua	62	0	0	0	0
PH5AW	Kailua - Kaneohe - Pearl Harbor	0	0	0	82	0
PH6AE	Pearl Harbor - Hawaii Kai	62	0	0	0	0
PH6AW	Hawaii Kai - Pearl Harbor	0	0	0	82	0
W1AE	Waipahu - Waikiki (via Farrington)	23	0	0	0	0
W1AW	Waikiki - Waipahu (via Farrington)	0	0	0	61	0
W2AE	Waipahu - Waikiki (via Paiwa)	31	82	0	0	0
W2AW	Waikiki - Waipahu (via Paiwa)	0	0	0	64	0
W3AE	Kalihi - Waikiki	62	82	0	0	0
W3AW	Waikiki - Kalihi	0	0	0	73	0

Survey Data Coding

This section describes the process and scripts used to generate tour and trip files for the OahuMPO Household Travel Survey. The overall procedure of coding tours and trips has been divided into five Microsoft SQL Server T-SQL scripts. Also, an additional script "OMPO_Tours_And_Trips_Stored_Procedures_Functions.sql" contains all the stored procedures and functions that are executed by these scripts. The following section describes the information needed to run the scripts and the input and output files generated by each script. It is assumed the scripts are run via Microsoft SQL Server Management Studio.

Inputs

For coding tours and trips, the following files are required as input:

- HH.csv – This file can be exported as a CSV file from the database, Oahu_HH_Final_081512.accdb provided by NuStats. The table name in the database is hh_deliv and it contains household level information including: household identifier, household TAZ, household size, household income, number of household workers and number of students in the household, etc.
- PER.csv – This file can be exported as a CSV file from the database, Oahu_HH_Final_081512.accdb. The table name in the database is per_deliv and it contains person level information including: household identifier, unique person identifier within each household, gender, age, work status, work TAZ, student status, student TAZ, number of jobs and occupation, etc.
- PLACE.csv –This file can be exported as a CSV file from the database, Oahu_HH_Final_081512.accdb. The table name in the database is place_deliv and it is the main input file for coding tours and trips. The file contains place level information including: household identifier, person identifier within each household, unique place identifier for each person, place TAZ, number of household members on trip on the day of survey, start and end time of each trip, mode and purpose of each trip, etc.
- Activities.csv – This file provides the necessary information for identifying the primary destination and purpose of each tour. It provides scores that are assigned to each activity on the tour based on "total time" that is equal to two times the travel time to reach activity place from the anchor point plus time spent during the activity. The activity with the lowest score is prioritized over all other activities on the tour. For example, in Table 2, several activities are shown along with their corresponding scores in different columns. For example, consider the case when the anchor point is home and the individual makes a trip from his/her home to perform a maintenance activity, then makes a second trip from the maintenance activity to a workplace, and then finally returns to home from work. Spending a "total time" of 180 minutes for the maintenance activity provides a score of 4.5 (see the fourth row and column d180 in Table 2), compared to a score of 1.5 (see the second row and column d180 in Table 2), if the same time is spent for work activity. Hence, the work activity is prioritized over the maintenance activity if time spent at both activities remains same. If "total time" does not fit in any of the column heading, then the score is interpolated between the nearest two columns. For example, if activity is work and "total time" is 200 minutes, then the value is interpolated between 1.5 and 1.4.

The following tour purposes are coded in this model :

1. Work tour: at least one of the trips on the tour is a work purpose.
2. University tour: at least one of the trips on the tour is a university purpose, and no trips on the tour are for work.
3. School tour: at least one of the trips on the tour is school purpose, and no trips on the tour are for work.
4. Escorting tour: one of the trips on the tour is an escorting trip, and no trips are work, university, or school.
5. Shopping tour: one of the trips on the tour is a shopping trip, and no trips are work, university, school or escorting.
6. Other Maintenance tour: one of the trips on the tour is a maintenance (not shopping) trip, and no trips are work, university, school, escorting, or shopping.
7. Eating Out tour: one of the trips on the tour is an eating out trip, and no trips are work, university, school, escorting, shopping, or maintenance trip.
8. Social/Visiting tour: one of the trips on the tour is a social/visiting trip, and no trips are work, university, school, escorting, shopping, or eating out.
9. Other Discretionary tour: one of the trips on the tour is an other discretionary trip, and no trips are work, university, school, escorting, shopping, eating out, or social/visiting.
10. At-Work Sub tour: this tour involves leaving the work place to go somewhere and returning back to the work place.

Table 2: Sample of activities and scores from activities.csv

tpurp	purp_label	d0	d60	d120	d180	d240	d300	d360	d420	d480
5	Escorting	8	7	5	4.5	4.4	4.3	4.2	4.1	4
8	Work	3	2.5	2	1.5	1.4	1.3	1.2	1.1	1
11	School/University	3	2.5	2	1.5	1.4	1.3	1.2	1.1	1
14	Maintenance	11	7	5	4.5	4.4	4.3	4.2	4.1	4
15	Shopping	10	6.5	4.5	4	3.9	3.8	3.7	3.6	3.5
24	Discretionary	13	8	6	5.5	5.4	5.3	5.2	5.1	5

Scripts

The scripts used in this process are:

1. Part-1_OMPO_Table_Definitions.sql
2. Part-2_OMPO_Fixing_Missing_Records.sql
3. Part-3_OMPO_Linking_Trips.sql
4. Part-4_OMPO_Coding_Tours_And_Trips.sql
5. OMPO_Tours_And_Trips_Stored_Procedures_Functions.sql

Part-1_OMPO_Table_Definitions.sql

Purpose: Create tables and insert initial data from the respective *.csv files.

Inputs: HH_deliv.csv, PER_deliv.csv, PLACE_deliv.csv and Activities.csv

This script generates the following tables in the database:

1. HH – It has all the required fields from HH_deliv.csv and 4,001 records in the database.
2. Person – It has all the required fields from PER_deliv.csv and 8,970 records in the database.
3. Place – It has all the required fields from PLACE_deliv.csv and 38,320 records in the database.
4. actpriority – It has all the required fields from Activities.csv and 26 records in the database.
5. TotalTourFile – It is an empty table with all the required fields in the database and table is populated with values when "Part-4_OMPO_Coding_Tours_And_Trips.sql" script is executed.
6. TotalTripFile – It is an empty table with all the required fields in the database and table is populated with values when "Part-4_OMPO_Coding_Tours_And_Trips.sql" script is executed.

Note: Before inserting data from *.csv files into SQL Server, preprocess the data to remove commas that exist within the text of some fields in the *.csv files. For example, Table 3: Sample records from PLACE_deliv.csv shows some records of field PNAME from PLACE_deliv.csv where text contains commas.

Table 3: Sample records from PLACE_deliv.csv

SAMPN	PERNO	PLANO	PNAME
1003332	1	2	SCHOFIELD BARRACKS HEALTH CLINIC, CAFAC
1004167	1	2	RESEARCHER AND DIRECTOR, NUTRITION SUPPORT SHARED RESOURCE
1004423	1	11	JACK IN THE BOX - PEARL CITY, HI
1005419	1	3	CITY MILL CO., LTD

Outputs: *HH*, *Person*, *Place*, *Vehicle*, *actpriority*, *TotalTourFile* and *TotalTripFile* tables in SQL Server.

Part-2_OMPO_Fixing_Missing_Records.sql

Purpose: Fix missing records, remove inconsistencies from *Person* and *Place* tables and code new fields in both tables.

During this step of the process, NULL values in several fields are recoded in the *Person* table. For example, NULL values for non-workers are recoded to 2. Two new fields to identify student status and person type are coded in the *Person* table. Also, several inconsistencies from the *Place* table are resolved including inconsistencies in the tpurp field and mode field. For example, mode is recoded to 3 ("Driver") for individuals reporting mode = 4 ("Passenger") and number of individuals in the vehicle on trip = 1. Two new fields are created (Aggact and Modename) in the *Place* table. Aggact refers to aggregate activity and is required while coding tour and trip purpose fields in final output files. Modename refers to mode name and is required for coding tour and trip mode fields in the final output files.

Inputs: *Person* and *Place* tables in SQL Server.

Outputs: *Person* and *Place* tables in SQL Server and ModifiedPerson.csv and ModifiedPlace.csv.

Part-3_OMPO_Linking_Trips.sql

Purpose: Link trips for change mode activity

In this script, a temporary table *templace* is created from *Place* table for further calculations. The main purpose of the script is to link change mode activity trips to the main activity trip. For example, Figure 4 shows a pattern of activities performed by Person 3 (PERNO) of Household number 1002862 (SAMPN). The person leaves home at 5:45 AM and drives to Moanalua Shopping Center and changes mode to school bus (mode =9) to reach HAJ Academy where the person goes to school. Hence, during a journey from home to school, one change mode activity was reported and the same is reported on his/her in-bound journey. This script removes change mode records (see Figure 5) but it also updates several fields including: opname, otaz, origin_long, origin_lat and origin_deptime. In addition, several fields for boarding, alighting and parking are generated. The script executes the ***LinkTripsFields*** function available in "OMPO_Tours_And_Trips_Stored_Procedures_Functions.sql" for the link trips processing and finally generates *LinkTripTable* with linked trips. At the end of the execution process of this script, *templace* table is removed from the database. Figure 4 and Figure 5 list the fields before and after processing.

Inputs : *Place* table in SQL Server.

Outputs: *LinkedTripTable* table in SQL Server and LinkedTripTable.csv.

Figure 4: Sample of household and person records before processing (table templace)

SAMPN	PERNO	PLANO	PNAME	TPURP	MODE	ARR_HR	ARR_MIN	DEP_HR	DEP_MIN	TRP DUR	TRIP DIST	opname	dpname	otaz	dtaz	ORIG_LONG	ORIG_LAT	DEST_LONG	DEST_LAT	ORIG_DEPTIME	DEST_ARRTIME
1002862	3	1	HOME	Home	**NULL**	3	0	5	45	**NULL**	**NULL**			**NULL**	**NULL**	**NULL**	**NULL**	**NULL**	**NULL**	**NULL**	300
1002862	3	3	HAJ ACADEMY	School	9	7	0	15	0	70	8.4258	HOME	HAJ ACADEMY	368	53	-157.9	21.4	-157.8	21.29	545	700
1002862	3	5	SALT LAKE ELEMENTARY SCHOOL (TUTORING)	Other	4	16	30	17	0	80	8.6419	HAJ ACADEMY	SALT LAKE ELEMENTARY SCHOOL (TUTORING)	53	365	-157.8	21.3	-157.9	21.35	1500	1630
1002862	3	6	HOME	Home	4	17	10	2	59	10	0.6	SALT LAKE ELEMENTARY SCHOOL (TUTORING)	HOME	365	368	-157.9	21.35	-157.9	21.36	1700	1710

Figure 5: Sample of household and person records after processing (table LinkedTripTable)

SAMPN	PERNO	PLANO	PNAME	TPURP	MODE	ARR_HR	ARR_MIN	DEP_HR	DEP_MIN	TRP DUR	TRIP DIST	opname	dpname	otaz	dtaz	ORIG_LONG	ORIG_LAT	DEST_LONG	DEST_LAT	ORIG_DEPTIME	DEST_ARRTIME
1002862	3	1	HOME	Home	NULL	3	0	5	45	NULL	NULL			NULL	NULL	NULL	NULL	NULL	NULL	NULL	300
1002862	3	2	MOANALUA SHOPPING CENTER (ROBERTS HAWAII BUS STOP)	Change Mode	4	5	55	6	0	10	0.8	HOME	MOANALUA SHOPPING CENTER (ROBERTS HAWAII BUS STOP)	368	387	-157.9	21.4	-157.9	21.35	545	555
1002862	3	3	HAJ ACADEMY	School	9	7	0	15	0	60	7.7	MOANALUA SHOPPING CENTER (ROBERTS HAWAII BUS STOP)	HAJ ACADEMY	387	53	-157.9	21.35	-157.8	21.29	600	700
1002862	3	4	MOANALUA SHOPPING CENTER (ROBERTS HAWAII BUS STOP)	Change Mode	9	16	10	16	20	70	7.7	HAJ ACADEMY	MOANALUA SHOPPING CENTER (ROBERTS HAWAII BUS STOP)	53	387	-157.8	21.29	-157.9	21.35	1500	1610
1002862	3	5	SALT LAKE ELEMENTARY SCHOOL (TUTORING)	Other	4	16	30	17	0	10	1.0	MOANALUA SHOPPING CENTER (ROBERTS HAWAII BUS STOP)	SALT LAKE ELEMENTARY SCHOOL (TUTORING)	387	365	-157.9	21.35	-157.9	21.35	1620	1630
1002862	3	6	HOME	Home	4	17	10	2	59	10	0.6	SALT LAKE ELEMENTARY SCHOOL (TUTORING)	HOME	365	368	-157.9	21.35	-157.9	21.36	1700	1710

Part-4_OMPO_Coding_Tours_And_Trips.sql

Purpose: Code tour and trip files from *LinkedTripTable* table.

> This is the main script where tours and trips are coded for each individual. Similar to the previous script, a temporary table *templace* is created from *LinkedTripTable* for further calculations. The script executes several stored procedures available in "OMPO_Tours_And_Trips_Stored_Procedures_ Functions.sql" starting with stored procedure ***AddColumns*** that adds required fields to the *templace* table for further calculations. Within each household, trips and tours for each person are coded by first identifying whether each individual made any tour on the survey day. A stored procedure, ***IdentifyTours,*** is executed which results in adding a sequence of tours to the *templace* table if the individual travelled on that day. An additional effort is made to identify an at-work sub-tour in the main tour using a stored procedure called ***IdentifyWorkSubTours*** and it adds a sequence of at-work sub-tours within the main tour. After tours have been identified, the records for each main tour are copied to the *Reqdtable* table for a particular person of a given household and further, new fields are added to capture several characteristics of the tour using the stored procedures ***AnchorPrimaryDestination***, ***StopActivityFields***, ***TotalTourFileCreation*** and ***TotalTripFileCreation*.** These stored procedures execute functions ***LinkTripsFields,*** ***OutboundStopFields*** and ***InboundStopFields*** available in "OMPO_Tours_And_Trips_Stored_Procedures_Functions.sql"**.** Finally, all the required fields are copied to the *TotalTourFile* and *TotalTripFile* tables from the *ReqdTable* table using the stored procedures ***WriteTotalTourFile*** and ***WriteTotalTripFile***. If an at-work sub-tour is identified within the main tour, then the *ReqdTable* table is emptied and records corresponding to at-work sub-tour are inserted into the *ReqdTable* table from the *templace* table using the same stored procedures as discussed above. At the end of this step, the *TotalTourFile* and *TotalTripFile* tables are appended with these tours using stored procedures ***WriteTotalTourFile*** and ***WriteTotalTripFile***. The process is repeated until all the at-work sub-tours within the main tour are exhausted and then, a new main tour is considered and steps discussed above are repeated.

Inputs: *LinkedTripTable* table in SQL Server.

Output: *TotalTripFile* and *TotalTourFile* tables in SQL Server and TotalTripFile.csv and TotalTourFile.csv

Outputs

The following files are output by the process:

1. ModifiedPerson.csv – Modified Person file (8970 records)
2. ModifiedPlace.csv – Modified Place file (38320 records)
3. LinkedTripTable.csv – Linked Trips (35979 records)
4. TotalTourFile.csv – Total Tours (9328 records)
5. TotalTripFile.csv – Total Trips (25764 records)

Run Batch File

A DOS batch file, "Run_OMPO_SQL_Scripts.bat", to run all the Microsoft SQL Server T-SQL scripts is included. The batch file also writes all the outputs into the required folders. To modify the batch file, open it in a text editor and modify the server name and database name. The server name can be obtained by executing "SELECT @@SERVERNAME" (without quotes) in Microsoft SQL Server Management Studio. Also, the user may need to change the OMPO path, which is the location of the input files. All scripts need to be saved in the folder "Scripts" within the OMPO path.

To run the batch file, double click on the file or right click on file and click open. A log file, "ResultLog.txt" is generated during execution.

Files Included with this Memo

The files included with this memo are:

1) Inputs – HH_deliv.csv, PER_deliv.csv, PLACE_deliv.csv and Activities.csv are in the Input folder.
2) Outputs – IndividualTourFile.csv, JointTourFile.csv, IndividualTripFile.csv and JointTripFile.csv are in the Output folder.
3) Intermediate_Inputs_Outputs – ModifiedPerson.csv, ModifiedPlace.csv, LinkedTripTable.csv, TotalTripFile.csv and TotalTourFile.csv are in Intermediate_Inputs_Outputs folder.
4) Scripts – Part-1_OMPO_Table_Definitions.sql, Part-2_OMPO_Fixing_Missing_Records.sql, Part-3_OMPO Linking_Trips.sql, Part-4_OMPO_Coding_Tours_And_Trips.sql, and OMPO_Tours_And_Trips_Stored _Procedures_Functions.sql are in the Scripts folder.
5) Batch File – Run_OMPO_SQL_Scripts.bat
6) Data Dictionary.xls – A data dictionary is included that describes each field in the individual and joint tour and trip tables. Also, person type, tour and trip activity and tour mode definitions are included.

Estimation of the Residential Models

This section describes the estimation of the OahuMPO Tour-Based Model (TBM) system. The models were estimated based upon a set of household and visitor travel surveys collected by NuStats in 2012; a total of 4,000 households and 950 visitors were surveyed using state-of-the-art surveying methods including real-time geocoding.

The OahuMPO travel models are designed as simple tour-based models, which are characterized by the following considerations:

1) A micro-simulation of travel using a fully-disaggregate population and a Monte Carlo discrete choice application paradigm wherein a database of residents are explicitly represented, and travel choices are modeled explicitly for each household and person.

2) Tours are used as fundamental unit of travel. A tour is a series of trips starting and ending at home. Tours have an anchor location (home), a primary destination (work, school, or some other dominant out-of-home activity) and zero or more intermediate stop locations. The use of a tour as the unit of travel allows the model system to predict activity locations, modes, and times of trips on tours consistently.

3) The tour-based modeling approach is simple, in that tours are modeled independently of each other. They are not scheduled into a daily activity pattern at a person level, nor are there interactions among household members. This is a key differentiating characteristics between a tour-based model and an activity-based model. In an activity-based model, tours or activities are scheduled such that no person can be in more than one place at the same time, and typically the number and schedule of higher-priority activities influence the number and schedule of lower-priority activities. Activity-based models also seek to coordinate travel across household members. Activity-based models offer many advantages over tour-based models, but require greater time and budget to develop.

The tour-based models micro-simulate the travel patterns of Oahu residents and visitors. The tour-based framework retains many of the advantages of an activity-based model (ABM) while greatly simplifying the model system (see Figure 6). In this model system, people generate tours and then tours are modeled independently without fitting them into an over-arching daily activity schedule. Many model components are statistically estimated based upon the data collected (green shaded boxes), while other model components utilize observed frequency distributions from the survey data in order to reduce development cost and time required (blue shaded boxes). Finally, some models are asserted and calibrated to match the travel patterns revealed in the Oahu travel survey (orange shaded boxes). This approach offers the following advantages as compared to a traditional trip-based model:

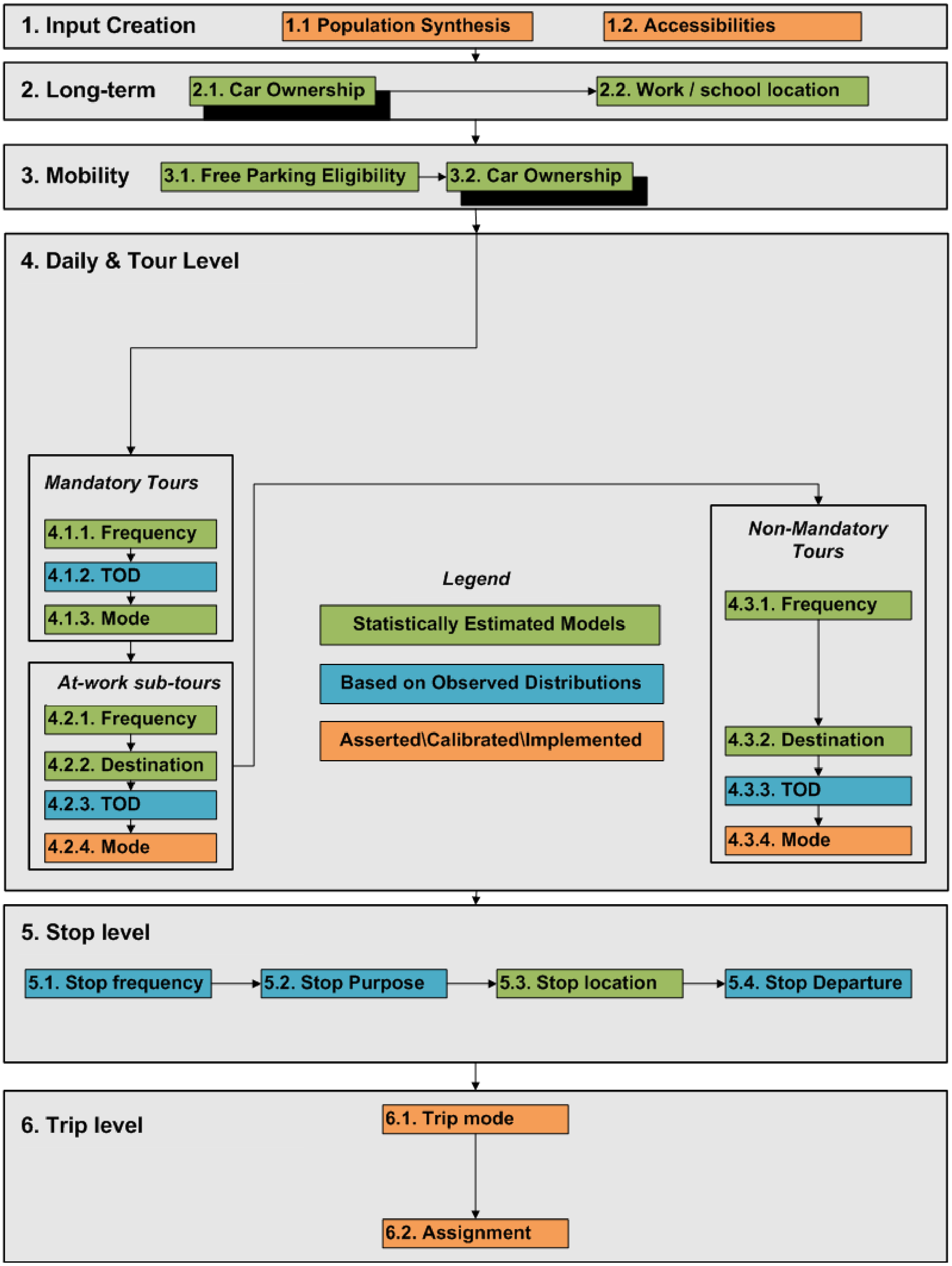
a. Sensitivity of tour generation to accessibility: The resident tour models take into account the travel time and cost to work and school for workers and students, as well as a general accessibility of each household to non-mandatory activities such as shopping and recreation.
b. Consistency of activity locations and modes used on tours: The models incorporate constraints such that the locations of intermediate stops on tours are consistent with the chosen tour mode.
c. Consistency between home and out-of-home locations on tours: The intermediate stop locations are selected based on out-of-direction cost based upon the home and primary activity location.

d. The tour-based model system contains a number of components (residential location choice, tour and stop destination choice, tour mode choice) that can be easily integrated with an activity-based model such as the Coordinated Travel – Regional Activity-Based Model Platform (CT-RAMP).

e. The model system incorporates and responds to many socio-economic and level-of-service variables due to the use of micro-simulation of tours as opposed to an aggregate four-step model framework

The model is implemented in Java using Parsons Brinckerhoff's Common Modeling Framework, a library of Java classes written specifically to implement travel demand models. The resident models are multi-threaded to take advantage of multiple processors, and micro-simulate a population of 1 million in approximately 30 minutes on a 12-core Intel Xeon workstation, while the visitors run in approximately 10 minutes. The survey data NuStats delivered was durable enough to support the rigorous demands of regional transportation models and detailed enough to support analysts seeking answers to local transportation problems.

Figure 6: OahuMPO Tour Based Model Structure



Model Components

The general description of each model component follows the flow chart in Figure 6

1. Input creation: A synthetic population is created for the region.
   1.1. Population synthesis: A synthetic population is generated by UrbanSim for the model scenario (some specific land-use\year combination).
   1.2. Accessibilities: A set of origin-based accessibilities are calculated for each TAZ and segment to be used in tour generation models. These accessibilities take the form of destination-choice logsums, but can be segmented by specific modes (walk or transit-only for example) as well as market segment (0 auto versus auto insufficient versus auto sufficient) and tour purpose (maintenance versus discretionary).
2. Long Term Models
   2.1. Auto ownership: The number of autos is determined for each household.
   2.2. Work\School location choice: The work TAZ for each worker and the school TAZ for each student is predicted.
3. Mobility Models
   3.1. Free parking eligibility: It is determined for each worker whether they have their parking paid for by their employer. This is determined by simulating from observed probabilities that were created from analysis of household survey data.
   3.2. Auto ownership: The number of autos model is re-run with exact accessibilities for each workplace and school location.
4. Daily and Tour Level Models: These models predict tour frequency, primary destination, outbound/return time period, and general or preferred tour mode. They are segmented into mandatory and non-mandatory models.
   4.1. Mandatory tour models: Mandatory purposes are tours made for work or school.
      4.1.1. Tour frequency: The exact number of work and school tours is predicted for each worker and student, based on the coefficients estimated through a multinomial logit model. Alternatives are 0 tours, 1 work\0 school, 2 work\0 school, 0 work\1 school, 0 work\2 school, 1 work\1 school.
      4.1.2. Tour Destination choice: Each tour is assigned a primary destination, based on the coefficients estimated through a multinomial logit model.
      4.1.3. Tour Time of Day: Each tour is assigned a departure and arrival half-hour period, based on probability distribution that varies by tour purpose.
      4.1.4. Tour Mode Choice: Each tour selects a preferred primary tour mode, based on the coefficients in an asserted nested logit model.
   4.2. At-work sub-tour models: At-work sub-tours are tours with an anchor location at work. These typically include lunch tours, personal business, and work-related tours.
      4.2.1. Tour frequency: The exact number of at-work sub-tours is predicted for each work tour, based on the coefficients estimated through a multinomial logit model. Exact alternatives are 0, 1, or 2 at-work sub-tours.
      4.2.2. Tour Destination choice: Each at-work sub-tour tour is assigned a primary destination TAZ, based on the coefficients estimated through a multinomial logit model.
      4.2.3. Tour Time of Day: Each at-work sub-tour is assigned a departure and arrival half-hour period, based on probability distribution.

4.2.4. Tour Mode Choice: Each tour selects a preferred primary tour mode, based on the coefficients in an asserted nested logit model.

4.3. Non-Mandatory tour models: Non-mandatory purposes are tours made for purposes other than work or school, such as escort, shopping, recreational, or eating-out.

4.3.1. Tour frequency: The exact number non-mandatory tours is predicted for each person, based on the coefficients estimated through a multinomial logit model. The alternatives are 0, 1, or two tours for each purpose, with a maximum of four non-mandatory tours in total which covers 99% of all observed daily patterns.

4.3.2. Tour Destination choice: Each tour is assigned a primary destination TAZ, based on the coefficients estimated through a multinomial logit model.

4.3.3. Tour Time of Day: Each tour is assigned a departure and arrival half-hour period, based on probability distribution that varies by tour purpose.

4.3.4. Tour Mode Choice: Each tour selects a preferred primary tour mode, based on the coefficients in an asserted nested logit model.

5. Stop Models

5.1. Stop Frequency Choice: Each tour is attributed with a number of stops in the outbound direction and in the inbound direction, based upon sampling from a distribution.

5.2. Stop Purpose: Each stop is attributed with a purpose, based upon sampling from a distribution.

5.3. Stop Location Choice: Each stop is assigned a location based upon an estimated multinomial logit model

5.4. Stop Departure Choice: Each stop is assigned a departure time-period (half-hourly) based upon sampling from a distribution.

6. Trip Level Models

6.1. Trip Mode Choice: Each trip within the tours selects a preferred trip mode, based on an asserted nested logit model.

6.2. Trip Assignment: Each trip is assigned to the appropriate time-of-day specific network.

Estimation of Long Term-Models

This section describes the estimation of each long term model component including the estimation dataset, the coefficients and t-statistics of the main explanatory variables used, the utility structure if applicable, and a summary of the findings of the estimation results.

Car Ownership Model

The household car ownership model predicts the number of autos (including motorcycles, vans, and trucks for personal use) available to a household. The model was estimated in a logit form using the ALOGIT software. In this model, household car ownership is a dependent variable derived from the activity needs of the household based on household characteristics, and the characteristics of persons within the household. The car-ownership model is applied twice. In the pre-location choice mode, origin-based accessibilities and household and person socio-economic variables are used, while in the post-location choice mode, actual mandatory accessibilities for each worker and student are also considered.

Estimation Dataset

The estimation dataset included 4,001 observed households from the Oahu Household Travel survey. Table 4 shows surveyed households by number of owned cars and by each of four districts used to sample households. The survey observations were joined with TAZ-based mandatory and non-mandatory accessibilities as well as other land-use data to create the estimation file. Mandatory and non-mandatory activity accessibilities are the logsum/utility measures calculated using asserted mode and destination choice models. Mandatory accessibilities reflect the actual workplace and/or school location for each worker and student in the household, while non-mandatory accessibilities reflect the general accessibility of the household to all potential non-mandatory destinations.

Table 4: Household Survey Observed Household Vehicles

District	N	Household Vehicles				Total	Mean
		0	1	2	3+		
PUC and East Honolulu (Pearl City to Hawaii Kai)	2,167	12.46%	41.16%	33.32%	13.06%	100 %	1.54
Koolauloa, Koolaupoko, Kaneohe, and Kailua	584	3.94%	27.40%	44.35%	24.32%	100 %	2.01
Central Oahu (includes Waipahu), Wahiawa, Haleiwa and Northshore	833	4.44%	28.57%	42.26%	24.73%	100 %	2.00
Ewa, Kapolei, and Waianae	417	7.91%	25.18%	44.60%	22.30%	100 %	1.92
Total	4,001	9.07%	34.87%	37.97%	18.10%	100 %	1.74

Main Explanatory Variables and Utility Structure

The following variables have been examined and proved to be significant in the utility functions:

Household composition:

- Ratio of workers (full time and part time) to driving age household members
- Ratio of pre-driving age school children to driving age household members
- Ratio of retirees to driving age household members

Household income group:

- Low income (less than $30,000)
- High income ($100,000 and more)

Household residence type:

- Detached or attached single family dwelling unit.

Zonal accessibility indices from residential zones to potential destinations:

- Non-motorized accessibility to maintenance activities in off peak period
- Difference between auto accessibility and transit accessibility to maintenance activities in off peak period.

Household mandatory activity auto dependency indices:

- Workers' mandatory activity auto dependency

The zonal accessibility indices for maintenance activities take the form of destination choice logsums and represent a result of summation of attractions across all destinations. They are calculated across destination zone attractions by mode (auto, transit, and walk) and time-of-day period. Off-peak skims are used for creation of maintenance accessibilities.

The worker's mandatory activity auto dependency variable is calculated using the difference between the single-occupant vehicle (SOV) and the walk to transit mode choice logsum. The logsums are computed based on the household TAZ and the work TAZ (for workers). The household auto dependency is obtained by aggregating individual mandatory auto dependencies (MandatoryAutoDependency) of workers in the household, according to the following formulas:

WorkAutoAdvantage = $Logsum_{SOV}$ – $Logsum_{WalkTransit}$ if $Logsum_{SOV}$ > $Logsum_{WalkTransit}$, else 0

WorkNonMotorizedFactor = 0.5 * (min(max(workDistance, 1.0), 3.0)) - 0.5

MandatoryAutoDependency = min(WorkAutoAdvantage /3.0, 1.0) * workNonMotorFactor

The WorkAutoAdvantage measures the relative attractiveness of SOV compared to walk transit. The measure is greater the more accessible the workplace is to home by auto compared to transit with walk access. If transit has a greater accessibility than auto, the difference is capped at 0 (auto has no advantage). The non-motorized factor measures how accessible the workplace is from home by walk. It ranges between 0 and 1, where 0 is very accessible and 1 is not accessible. The first part of the MandatoryAutoDependency equation scales the difference in utility between auto and transit to a measure between 0 and 1, where 0 is very auto dependent and 1 is not auto dependent. This is then multiplied by the non-motorized factor, to reflect that even if transit accessibility is poor relative to auto, the auto dependency is lower if the workplace is within walking distance of home.

Results

The car ownership estimation results are summarized in Table 5.

Table 5: OahuMPO Car Ownership Model Estimation Results

Observations:	4001
Final log likelihood:	-3489.5185
Rho-Squared (0):	0.3709
Rho-Squared (constant):	0.3090

Variable	Relevant types	Coefficient & T-Stat by Choice Alternative							
		0 car		1 car		2 cars		3 + cars	
		coeff	t-stat	coeff	t-stat	coeff	t-stat	coeff	t-stat
#of driving age members	1	ref	ref	(0.907)	(1.038)	(3.179)	(3.418)	(5.648)	(5.561)
	2	ref	ref	(0.601)	(0.692)	(0.761)	(0.827)	(3.644)	(3.650)
	3+	ref	ref	(1.226)	(1.375)	(1.085)	(1.156)	(2.069)	(2.049)
HH compositions									
#worker/#driver		ref	ref	0.461	2.288	0.759	3.115	1.063	3.529
# pre-driving age school children/#driver		ref	ref	0.471	1.193	0.726	1.764	0.827	1.915
# retiree/#driver		ref	ref	(0.454)	(2.438)	(0.611)	(2.630)	(0.826)	(2.651)
Single Family Dwelling HH		ref	ref	0.585	3.488	1.779	9.347	2.716	10.645
HH Income	Less than $30,0000	ref	ref	(1.386)	(9.974)	(2.028)	(11.030)	(2.411)	(8.035)
	More than $100,000	ref	ref	1.284	2.724	1.956	4.117	2.292	4.749
Zonal accessibility	Non-motorized maintenance	ref	ref	0.028	0.408	(0.062)	(0.850)	(0.079)	(0.965)
	auto-transit discretionary	ref	ref	1.267	4.705	1.327	4.800	1.379	4.863
Man auto dependency	worker	ref	ref	1.402	3.794	2.069	5.484	2.438	6.344

Red font: t-stat not significant

Findings

- The number of driving-age adults has a strong impact on household car ownership. Though the coefficients for owning more than one car are negative, they are much less negative for households with multiple driving-age adults. The workers to drivers ratio coefficient increases with increasing number of autos in the household. The higher the ratio, the higher the probability is of owning a car as workers in the household need enough cars to commute to work.
- The pre driving age school children to drivers ratio has similar coefficient patterns as those of the workers to adult household members ratio. This shows that households with school children need sufficient cars to transport both parent and children to work and school activities.
- The retirees to drivers ratio has negative coefficients for all car ownership choices. This shows that retirees tend to be less mobile and therefore tend to own less cars compared with younger households.
- Low income households are less likely to own cars as shown by the negative coefficients for all 1, 2, 3+ cars per household. The high income households have an opposite pattern compared with the low income households. The residence type variable has a strong impact on car ownership. Households that live in a single family dwelling unit have a large positive coefficient for 1, 2, 3+ car households. This is probably because single family dwelling units are more likely to be in suburban areas and have garage space for cars.
- The non-motorized variable represents the zonal accessibility of maintenance (e.g. shopping) activities by non-motorized travel modes, such as walking and biking, or in other words the ease of travel by walking and biking. The increasingly negative coefficient with increasing car ownership is consistent with the expectation that the more accessible a household is to maintenance activities by walking or biking, the more likely the household is to own less autos.
- The difference between auto and transit accessibility to discretionary (e.g. recreation) activities has an increasingly positive coefficient with increasing car ownership, and this is consistent with the expectation that households with relatively better auto access than transit access to discretionary destinations are more likely to own cars.
- The work tour auto dependency variable represents how much a household member's work tours are dependent on the auto mode. This variable has an increasingly positive coefficient with increasing car ownership. This shows that a household is more likely to own cars if workers in the household have a strong dependency on using the auto mode for commuting to work.

Mandatory Tour Location Choice Models

A destination choice model was estimated for each of the three mandatory tour purposes; Work, University, and School. The destination choice model predicts the location of where the traveler is going based on mode choice logsums, distance terms, zonal employment and household and person attributes as explanatory variables. These models were estimated in a multinomial logit form using the ALOGIT software. The utility structure of the model is described below.

Utility Structure

The utility (U_{ijn}) of choosing a destination (j) for an individual (n) in zone (i) is given by

$$U_{ijn} = S_j + \alpha \times L_{ij} + \sum \beta^k \times D_{ij}^k + \sum \beta^k \times D_{ij}^k N_n^k$$

Where, S_j is the size variable for destination zone *j*, L_{ij} is the mode choice logsum between zone pair *ij*, D_{ij}^k represents the various distance terms (linear, log, and squared), and N_n^k represent person or household characteristics for individual n and is used for creating interaction variable with distance terms.

Work Location Choice

The work destination choice model predicts the usual work location for full-time and part-time workers. This model is one of the first models applied in the model chain.

Estimation Dataset

In the 2012/2013 Oahu Household Travel Survey there are 4,863 observed worker records including both full-time and part-time workers. Table 6 below shows the working adults in surveyed households by worker status, gender and income group.

***Table 6**: Frequencies on Working Adults*

	Count	Percentage
Worker status		
Full-time	3,559	73.2%
Part-time	1,195	24.6%
Unknown	109	2.2%
Gender		
Male	1,565	51.0%
Female	1,483	48.3%
Unknown	23	0.7%
Income group		
Less than 30K	343	7.1%
30K to 60K	1093	22.5%
60K to 100K	1495	30.7%
100K to 150K	1113	22.9%
More than 150K	589	12.1%
Unknown	230	4.7%
Total	**4,863**	**100%**

Main Explanatory Variables

The following variables have been examined and proved to be significant in the utility functions:

- Mode choice logsum
- Impedance between the home and potential work destinations:
  - Linear distance
  - Distance squared
  - Natural Log of Distance
- Household income group interacted with distance terms:
  - Low Medium income ($30,000-$60,000)
- Household auto ownership interacted with distance terms:
  - Zero Auto Households
- Person Characteristics interacted with distance terms:
  - Age group interacted with distance terms"
    - Age 20 years and younger
    - Age 65+
  - Gender – Female vs. Male
  - Work Status – Full-time vs. Part-time.
- Size Terms: There are 7 work occupation segments and each segment has different sensitivities to employment that determine a person's work location choice
  - (1)Management, Business, Science, and Arts
    - Government Employment
    - Hotel Employment
    - Agriculture Employment
    - TCU Employment
    - Industry Employment
    - FIRE Employment
    - Service Employment
  - (2) White Collar Service
    - Government Employment
    - Service Employment
  - (3) Blue Collar Service
    - Government Employment
    - Hotel Employment
    - Agriculture Employment
    - TCU Employment
    - Industry Employment
    - FIRE Employment
    - Service Employment
    - Retail Employment
  - (4) Sales and Office Support
    - Government Employment
    - Hotel Employment
    - Agriculture Employment
    - TCU Employment
    - Industry Employment
    - FIRE Employment
    - Service Employment
    - Retail Employment
  - (5) Natural Resource, Construction

    - Government Employment
    - Hotel Employment
    - Agriculture Employment
    - TCU Employment
    - Industry Employment
    - FIRE Employment
    - Service Employment
    - Retail Employment
    - Construction Employment
  - (6) Products, Transportation, Material Moving
    - Hotel Employment
    - Agriculture Employment
    - TCU Employment
    - Industry Employment
    - FIRE Employment
    - Service Employment
    - Retail Employment
    - Construction Employment
  - (7) Military
    - Military Employment
    - Service Employment

A combination of distance terms were used in the utility such that the composite distance utility function is monotonically decreasing within the maximum chosen work distance (55 miles) range. Table 7 shows the frequency of distance to work location for 3,071 workers in the dataset.

***Table 7**: Frequency of Distance to Chosen Work Destinations*

Bin (miles)	Frequency
5	1,097
10	577
15	626
20	438
25	208
30	66
35	37
40	18
45	4
Total	3071

Results

The work destination choice results are summarized in Table 8.

***Table 8**: Oahu Out-of-Home Usual Work Location Choice Model Estimation Results*

Observations: 3061
Final log likelihood: -17454

Rho-Squared (0): 0.1411
Rho-Squared (constant): -0.0244

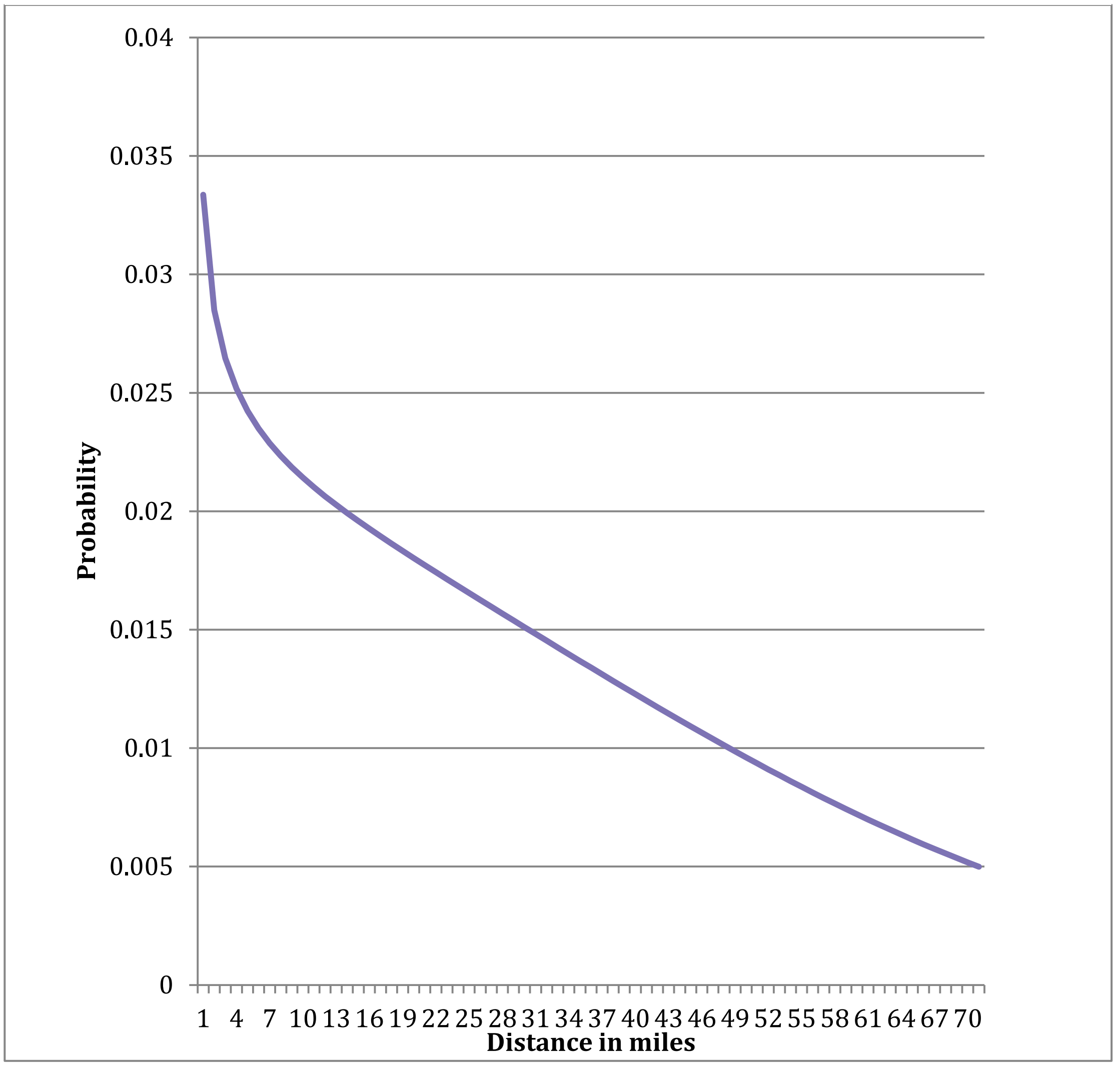
Utility Function Variables	**Coeff**	**T-Stat**
Mode Choice Logsums	0.343	4.95
Distance	0.000	
Distance Squared	0.000	-1.13
Distance Natural Log	-0.330	-6.40
Part-time worker		
Distance	-0.06101	-6.40
Female		
Distance	-0.03936	-6.32
Low Medium Income Group ($30K-60K)		
Distance	-0.01846	-2.42
Age 20 Years and Younger		
Distance	-0.04432	-1.53
Age 65 and Up		
Distance	-0.01624	-1.25
0 Auto Households		
Distance	-0.08710	-2.77
Size Function		
Service Employment (Total Emp)	1.000	
Management, Business, Science, and Arts		
Government	1.833	4.20
Hotel	0.000	-0.02
Financial, Real Estate, Insurance	0.909	-0.31
Retail	0.000	-0.04
Industry, TCU	1.128	0.64
White Collar Service		
Government	1.336	2.23
Hotel	0.000	-0.01
Financial, Real Estate, Insurance	0.000	-0.07
Retail	0.000	-0.06
Industry, TCU	0.000	-0.07
Blue Collar Service		
Government	0.530	-1.05
Hotel	2.843	2.24
Financial, Real Estate, Insurance	0.000	-0.01
Retail	1.672	1.20
Industry, TCU	0.089	-0.95
Sales and Office Support		
Government	2.208	4.06

Hotel	0.387	-0.99
Financial, Real Estate, Insurance	2.615	4.01
Retail	1.271	0.82
Industry, TCU	1.179	0.60
Nat Resource, Constr, Maintenance		
Government	2.280	1.14
Hotel	2.812	0.96
Financial, Real Estate, Insurance	0.000	-0.01
Retail	0.000	-0.02
Agriculture, Construction	13.376	3.81
Industry, TCU	12.490	4.56
Prod, Trans, Material Moving		
Government	0.000	-0.02
Hotel	17.193	2.27
Financial, Real Estate, Insurance	0.000	-0.02
Retail	4.640	1.06
Agriculture, Construction	23.040	2.33
Industry, TCU	32.990	3.04
Military		
Military	6.643	9.76
Unknown		
Tot Non-Service Employment	4.229	2.36

Findings:

- The coefficient on mode choice logsum is positive and between 0 and 1 as expected.
- *Composite distance function* (or distance decay factor) has been defined as a combination of linear, squared and natural logged distance terms with different coefficients. This term should be analyzed as a composite term and the coefficient (positive or negative) of individual terms should not be looked at. For example, the coefficient on linear distance is positive but it does not mean that workers choose distant locations as work places. But, combined effect of all terms should be looked at. Figure 7 shows the distance decay factor. This function is monotonously decreasing in within the maximum chosen work distance range.
- The effects of work status (full-time vs. part-time), gender (females vs. males) and household income was found siginificant on distance to work location. The findings are below:

Figure 7: Work Distance Decay Factor



- *Part-time workers* are most sensitive to longer commute than full-time workers. The sensitivity increases with longer distances. In other words, part-time workers are more likely to choose a workplace closer to home than full-time workers.
- *Females* are more likely to choose a workplace close to home compared to males. This could be due to household responsibility and children at home.
- *Income group:* Low income workers are more sensitive to commuting longer distances. Longer distances would increase the cost of commuting and it could be the reason low income workers prefer to work close to their homes.

- Size term effects:
  - There are 7 work segments and each have different employment categories that determine a person's work location choice.
    - For workers in the *Management, Business, Science, and Arts* occupation segment, government employment is twice as attractive as service, financial/insurance/real estate TCU, industry and retail employment.
    - For workers in the *White Collar Service* occupation segment, government employment is nearly one third more attractive than service employment.
    - For workers in the *Blue Collar Service* occupation segment, hotel employment is nearly 3 times more attractive than service employment,

retail employment is 1.7 times more attractive than service employment, government employment is half as attractive as service employment, and TCU, industry employment was not as attractive as service employment.

- For workers in *Sales and Office Support* occupation segment, government and financial/insurance/real estate and retail employment was 2 times more attractive than service employment, retail, TCU, industry employees are 1.2 times more attractive than service employment, and hotel employment was one-third less attractive as service employment.
- For workers in *Natural resources, construction and maintenance* occupation segment, government and hotel employment are over 2 times more attractive service employment, and agriculture, construction, TCU, industry employment are over 12 times more attractive than service employment.
- For workers in the *Production, Transportation, and Material Moving* occupation segment, hotel, agriculture, construction, TCU, industry employment are over 17 times more attractive than service employment, retail employment are 5 times more attractive than service employment.
- For workers in the *Military* occuption segment, military employment was nearly 7 times more attractive than service employment.

Oahu University Location Choice

The university destination choice model predicts the usual school location for all college students. This model is applied very early in the model chain with the work destination choice model.

Estimation Dataset

In the 2012/2013 Oahu Household Travel Survey there are 517 university students. However, it should be noted that the survey did not capture university students living on campus, and it is likely that the survey under-represents students living in off-campus non-family households. Table **9** below shows the student in the surveyed households by income group, person type and age categories.

Table 9: Frequencies on Students

	University	
	Count	%
Age		
Under 25 years	190	37%
Income Group		
Less than 30K	62	12%
30K to 60K	155	30%
60K to 100K	138	27%

100K to 150K	102	20%
More than 150K	40	8%
Unknown	20	4%
Total	517	100%

Main Explanatory Variables

The following variables have been examined and were significant in the utility functions:

- Mode choice logsum
- Household income group interacted with distance terms:
  - Low income <$20,000)
- Household size interacted with distance terms:
  - Single Person household
- Person Characteristics interacted with distance terms:
  - Age group interacted with distance terms"
    - Age 20 years and younger
    - Age 65+
  - Gender – Female vs. Male
  - Work Status – Full-time vs. Part-time.
- Size Terms: Total Enrollment, and service employment

Table 10 shows the frequency of distance to 174 university or college locations in the dataset.

Table 10: Frequency of observed distance to usual university/college location

Bin(miles)	University(4)
5	59
10	41
15	18
20	24
25	15
30	12
35	3
40	2
Total	174

Results

The university destination choice results are summarized in Table 11.

Table 11: Oahu Usual University Location Choice Model Estimation Results

Observations: 172
Final log likelihood: -553.7504
Rho-Squared (0): 0.5150

Rho-Squared (constant): -0.3483

Utility Function Variables	Coeff	T-Stat
Mode Choice Logsums	0.684	5.84
Low Income Group (<$20K)		
Distance	-0.048	-1.75
Household Size 1		
Distance	-0.163	-1.07
Size Function		
Total University Enrollment	1.000	
Service Employees	0.073	-14.53

Findings:

- The coefficient on mode choice logsum is positive and between 0 and 1 as expected.
- The effects ofhousehold size and household income was found significant on distance to university location. The findings are below:
  - Students in *low income households* are less likely to to travel longer commutes than students inhigher income households.
  - *Single person households* are less likely to travel longer distances as compared to larger households. This is likely due to the flexibility of single-person households to locate close to their university, or perhaps due to a greater number of apartments near universities..
- Size term effects:
  - University enrollment is the dominant size term effect. However, service employment also attracts some university tours; probably because some portion of service employment is continuing education or trade-oriented education services.

Oahu School K-12 Location Choice

The school destination choice model predicts the usual school location for all students. This model is applied very early in the model chain with work destination choice model.

Estimation Dataset

In the 2012/2013 Oahu Household Travel Survey there are 1,157 observed student records including 123 preschoolers, 694 kindergarten to 8th graders, and 340 9th -12th graders. Table 12 below shows the student in the surveyed households by income group, and age categories.

Table 12: Frequencies on Students

	Preschool		K to 8th		9th to 12th	
	Count	%	Count	%	Count	%
Age						
0 to 3 years	61	49.6%	2	0.3%	0	0.0%
4 to 5 years	59	48.0%	55	7.9%	0	0.0%
6 to 13 years	0	0.0%	594	85.6%	12	3.5%
14+ years	0	0.0%	17	2.4%	317	93.2%
Unknown	3	2.4%	26	3.7%	11	3.2%
Income Group						
Less than 30K	8	6.5%	42	6.1%	20	5.9%
30K to 60K	19	15.4%	145	20.9%	64	18.8%
60K to 100K	37	30.1%	259	37.3%	131	38.5%
100K to 150K	30	24%	130	19%	76	22%
More than 150K	27	22%	102	15%	40	12%
Unknown	2	2%	16	2%	9	3%
Total	123	100%	694	100%	340	100%

Main Explanatory Variables

The following variables have been examined and significant in the utility function:

- Mode choice logsum
- Impedance between the home and potential school destinations:
    - Natural Log of Distance
- Household auto ownership interacted with distance terms:
    - Zero Auto Households
- Person Characteristics interacted with distance terms:
    - Age group interacted with distance terms
        - Age 5 years and younger
        - Age 6 through 13
- Size Terms: Total Enrollment

Table 13 shows the frequency of distance to 930 school locations in the dataset.

Table 13: Frequency of Distance to Chosen School Destinations

Bin (miles)	Frequency
5	648
10	136
15	82
20	25
25	34
30	3
35	2
Total	930

Results

The school destination choice results are summarized in Table 14.

Table 14: Oahu Usual School Location Choice Model Estimation Results

Observations: 723
Final log likelihood: -2564.7274
Rho-Squared (0): 0.4656
Rho-Squared (constant): 0.2400

Utility Function Variables	**Coeff**	**T-Stat**
Mode Choice Logsum	0.515	3.70
Distance	0.000	
Distance Squared	0.000	
Distance Natural Log	-1.122	-12.45
Age 5 Years and Younger		
Distance	-0.087	-3.53
Age 6 through 13		
Distance	-0.077	-6.13
0 Auto Households		
Distance	-0.13512	-1.42
Size Function		
Total Enrollment	1.00	

Findings:

- The coefficient on mode choice logsum is positive and between 0 and 1 as expected.
- The effects of age and household auto ownership was found siginificant on distance to school location. The findings are below:
    - *Children age 5 and under* are most sensitive to longer distances than older children. This reflects the relatively shorter trips for daycare and pre-school as opposed to grade school or high school.
    - *Children ages 6 to 13 are also* less likely to travel longer distances compared to older children, but more likely to travel further for school than children under 5. The

distance coefficients reflect a relatively longer trip length for high school students (children age over 13).
    - *Zero auto households:* Students in households with no cars are more sensitive to longer distances. These students are likely to go to schools closer to home, perhaps because they are less likely to go to private schools.
- Size term effects:
    - Public and private school enrollment is the only size term in the school location choice model. Zones with more enrollment have higher probability of being chosen.

Oahu Parking Costs

This section documents how parking costs and free parking eligibility shares were developed for model estimation. An existing data search was conducted to identify possible sources of parking cost data including number of available on-street and off-street parking spaces, parking rates, and utilization. The search revealed little useful, comprehensive parking cost data, so the household travel survey was used to analyze expected parking costs and percent parking for free.

Using the household survey, an averaging methodology was developed to calculate an average weighted parking cost for each zone. This averaging method was implemented because the survey did not capture parking in every zone that could have a parking cost, as it was a sample of parkers. Also, the average parking cost for a destination zone must take into account the parking cost paid by persons who park in other zones and walk to their destination. The algorithm calculates a weighted average of the parking costs for all zones that fall within a maximum walk distance of 0.5 miles from each zone. The following formula was used to calculate the weighted average parking cost:

$$AvgCost_j = \sum e^{\beta * distance_{kj}} * Cost_k * Obs_k \,/ \sum e^{\beta * distance_{kj}} * Obs_k$$

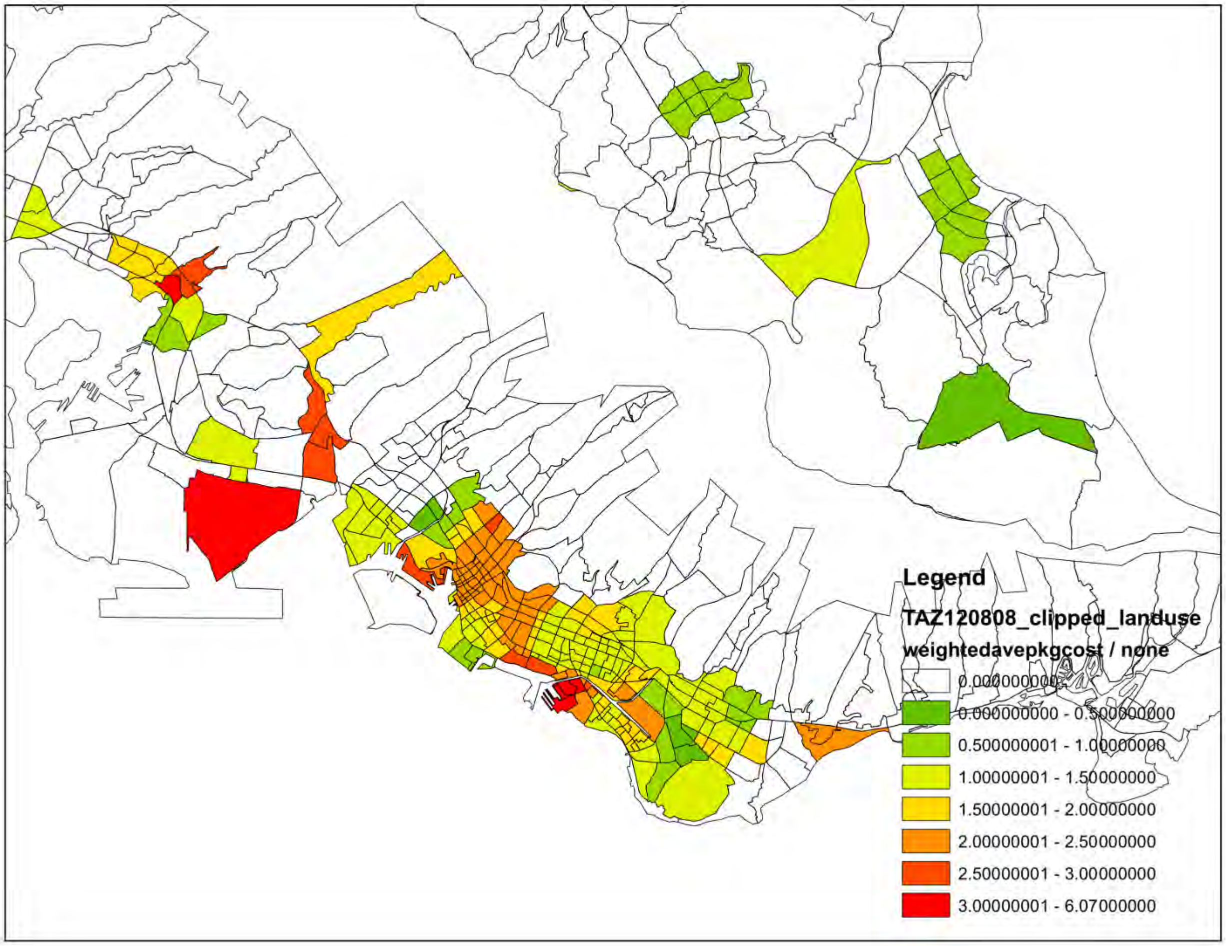
Where β is a coefficient on distance which was based on previous estimation performed in San Diego (-5), $distance_{kj}$ is the distance in miles between parking zone k and destination zone j, $Cost_k$ is the cost of parking in zone k, and Obs_j is the number of people parking in zone k. The formula results in a weighted average parking cost where parking further from the destination zone j is discounted by the distance from the parking zone k to the destination zone j, across all potential parking zones k within the maximum half-mile buffer.

Two different parking costs were developed. One set was for non-work tours and one for work tours. Separate parking costs were developed for each because most non-work tours pay the full hourly or daily parking rate, while many workers pay monthly or annually parking rates, in order to obtain a lower parking cost than the daily rate.

Non-work related Hourly Parking Costs

The household survey data was tabulated for all persons that made a non-work tour and paid for parking. An hourly rate for each tour was calculated based on the tour duration if the person paid at a rate other than an hourly rate. Then an average hourly parking cost was calculated at each destination zone according to the formula above. Figure 8 shows the resulting average parking costs, which are higher in downtown and Waikiki than other parts of Oahu. Parking costs are free in most areas outside downtown and Waikiki.

Figure 8: Weighted Average Non-Work Hourly Parking Costs by TAZ



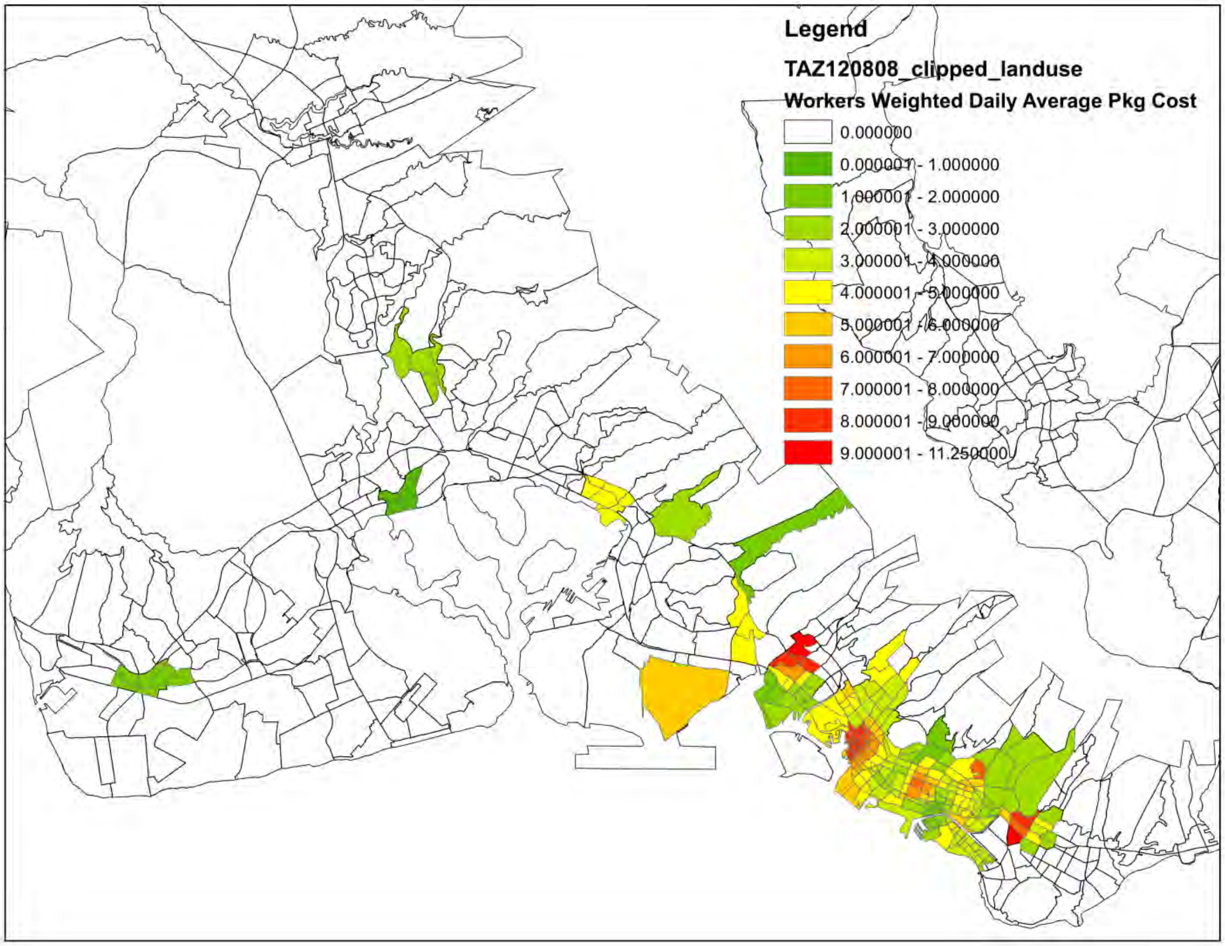
Work Daily Parking Costs

The household survey data was tabulated for all workers that made a work tour and paid for parking. A daily rate for each trip was calculated based on the following assumptions if the person paid at a rate other than a daily rate:

- Daily cost = weekly cost/5
- Daily cost = monthly cost/20
- Daily cost = yearly cost/210 (assumes 12 holidays, 12 vacation days, 12 sick days, and 12 travel\telecommute days per worker on average)

Then an average daily parking cost was calculated at each destination zone according to the formula above. Figure 9 shows the weighted average work parking cost by TAZ. Note the higher parking costs in downtown, and other small pockets where there are parking costs. Waikiki seems to have a relatively low parking cost, which could be because some workers pay a lower rate to park there.

Figure 9: Weighted Average Work Daily Parking Costs by TAZ



Estimation of Daily and Tour Level-Models

This section describes the estimation of the daily and tour level model components including the estimation dataset, the coefficients and t-statistics of the main explanatory variables used, the utility structure if applicable, and a summary of the findings of the estimation results.

Mandatory Tour Frequency

The mandatory tour frequency choice model predicts the number of mandatory (work and school) tours for each person. The model has six alternatives: 0 mandatory tours, one work tour, one school tour, two or more work tours, two or more school tours, one work tour plus one school tour. It was estimated in a multinomial logit form using the ALOGIT software.

Estimation Dataset

The estimation dataset included 6244 observations of workers and students. In order to evaluate the potential impact of workplace and school location on the number of mandatory tours, the survey observations were appended with distance, and mode choice logsums of work and school locations. Accessibilities at the work location (TAZ) and accessibilities for the escort purpose from the residence location (TAZ) were also tested in the estimation.

Observed Frequency of Mandatory Tours

Table 15 shows the frequency of mandatory tour patterns by person type and gender. For workers or students making mandatory tours, most have either 1 work tour or 1 school tour. Only around 4% have two or more tours of same type or different types.

Table 15: Frequency of Mandatory Tour Patterns by Person type and Gender

	0 Work, 0 School	1 Work, 0 School	2+ Work, 0 School	0 Work, 1 School	0 Work, 2+ School	Work & School	Total
Person Type							
Full-time Worker	856	2,472	82	0	0	0	3,410
Part-time Worker	604	347	24	0	0	0	975
University Student	186	180	9	177	3	15	570
Driving Age School Child	36	3	1	138	2	3	183
Pre-driving Age School Child	134	1	0	609	13	0	757
Pre-school Child	225	1	0	123	0	0	349
Gender							
Male	928	1,546	60	530	10	9	3,083
Female	1,095	1,437	56	498	8	9	3,103
Missing	18	21	0	19	0	0	58
Total	**2,041**	**3,004**	**116**	**1,047**	**18**	**18**	**6244**

Main Explanatory Variables

The following variables have been examined in the estimation process:

- **Personal characteristics stratified by person type**
  - Female
  - Age 18 through 35 for full time and part time worker
  - Age greater than 35 for university student
- **Household composition stratified by person type**
  - Zero cars
  - Cars not sufficient for drivers for worker, university student, and school age children
  - Cars sufficient for drivers for worker, university student, and school age children
  - Number of preschool children for full and part time workers, and university student
  - Number of children 6 through 18 for full and part time workers
  - Household income for full and part time workers, and university student
- **Mandatory tour destination location**
  - Workplace location within walking distance bins (0-1 and 1-3 miles)
  - School location within walking distance bin (0-1, 1-2, 0.5-3 miles)
  - Work and school mode choice logsums
  - Accessibility at workplace
- **Population accessibility to household**
  - Escorting accessibility by car ownership
  - A measure of the mixture of employment and households, as follows:

    Mix = (-1)*(Household Proportion * log(Household Proportion) + Employment Proportion * log(Employment Proportion)) /log(2),

    Where household proportion = total households/(total households + total employment), and employment proportion = 1-household proportion

Results

The final estimation results are presented in Table 16 below for all workers and students.

Table 16: Mandatory Tour Frequency Model Estimation Result

Observations:	6244
Likelihood – Constants only	-7022.6981
Final log likelihood:	-6781.1867
Rho-Squared (0):	0.3939
Rho-Squared (constant):	0.0344

Variable	Relevant person types	Coefficient and T-Stat by Choice Alternative (T-Stat)									
		1 Work		2+ Work		1 School		2+ School		Work & School	
		Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Constant	1=Full-time worker	1.697	13.685	-1.213	-2.535	N/A	N/A	N/A	N/A	N/A	N/A
	2=Part time worker	0.501	5.522	-2.231	-4.646						
	3=University student	0.410	1.257	-2.586	-5.616	-0.377	-2.449	-0.377	-2.449	-0.887	-2.729
	6=School child 16-17	-2.485	-4.135	-3.584	-3.535	1.096	4.539	-3.138	-4.227	-2.159	-3.583
	7=School child 6-15	N/A	N/A	N/A	N/A	2.810	29.497	-1.037	-3.571	N/A	N/A
	8=Preschooler <=5	N/A	N/A	N/A	N/A	0.967	8.628	0.000	0.000	N/A	N/A
Person is female (dummy)	1=Full-time worker			-0.287	-1.245						
	2=Part time worker			0.725	1.422						
	3=University student	-0.837	-3.581	-0.837	-3.581	-0.358	-1.704	-0.358	-1.704		
	6=School child 16-17					0.536	1.511	0.536	1.511		
	7=School child 6-15										
	8=Preschooler <=5										
Young adult (age <=35)	1=Part-time worker	0.845	3.809	1.338	2.483						
Age older than 35	3=University student	0.438	1.893	0.438	1.893						
Distance to Work 0 to 1 miles & Distance to School 0 to 1 miles (dummy)	1=Full-time worker									-2.267	-5.019
	2=Part time worker									-2.267	-5.019
	3=University student									-2.267	-5.019
	6=School child 16-17									-2.267	-5.019
Distance to Work 1 to 3 miles & Distance to	1=Full-time worker									-2.842	-6.911
	2=Part time worker									-2.842	-6.911
	3=University student									-2.842	-6.911

Variable	Relevant person types	Coefficient and T-Stat by Choice Alternative (T-Stat)									
		1 Work		2+ Work		1 School		2+ School		Work & School	
		Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
School 1 to 2 miles (indicator)	6=School child 16-17									-2.842	-6.911
No cars in household (dummy)	1=Full-time worker			-1.528	-2.062						
	2=Part time worker			-1.528	-2.062						
# of pre-school children in household	2=Part-time worker	-0.428	-1.952	-0.428	-1.952						
	3=University student	-0.281	-1.161	-0.281	-1.161	-0.351	-1.254	-0.351	-1.254		
# of children age 6-18 in household	1=Full-time worker			0.317	2.754						
Household income medium ($30-$100K) (dummy)	1=Full time worker	0.267	2.020	0.794	1.633						
	3=University student	0.571	1.790	0.571	1.790						
Household income high ($100K+) (dummy)	1=Full time worker	0.354	2.557	0.757	1.496						
	3=University student	0.996	2.826	0.996	2.826						
Work Logsum	1=Full time worker	-0.278	-8.548	0.507	4.142						
	2=Part-time worker	-0.181	-3.370	0.425	1.789						
	3=University student	0.004	7.153	0.004	7.153					0.003	3.224
School Logsum	3=University student					0.003	3.077	0.003	3.077	0.407	2.242

Findings

The following section summarizes the most important findings and impacts on mandatory tour frequency:

- Person-type constants are very significant showing that person type itself and the characteristics of the person explains the frequency and purpose of the tours. For example, a full time worker is more likely to make one work tour than no tours at all as noted by the positive significant coefficient. Also the constant for full time workers making 2+ work tours is negative and significant as this shows a full time worker spends most of the day at work and thus not likely to make 2+ work tours in a day.
- Gender has a certain impact on frequency and purpose of mandatory tours. Female full-time workers are less likely to make two or more work tours. However, a female part time worker is more likely to make two or more work tours compared to a male, which may be because female workers tend to work near their residence and need to take care of children related issues. Female university students are less likely to make one work tour or one or more school tours. And female drive age students are more likely to make one or more school tours.
- Part time workers of younger age (under 35) are more likely to make one or more work tours. This may be because they have more than one job. Older (greater than 35) university students are more likely to have one or more work tours.
- The number of preschool children in household has a negative impact on part time workers and university students making one or more work tours or one or more school tours. The pre-schoolers are keeping part-time workers and university students from going to work and school. The number of older children (6-18) in the household has a positive impact on full time workers making two or more work tours. Full time workers with older children are more likely to go to work.
- Zero car households reduce the probability of workers making two more work tours.
- The work location logsum coefficient is positive for full-time workers, part time workers, and university students to make more than one work or school tour.
- The school location logsum coefficient is positive for university students making one or more school tours, or a combination of work and school tours. So the more accessible the school location is, the more work and school tours university students make.

Non-Mandatory-Tour Frequency Estimation

The non-mandatory tour frequency model predicts the number of tours for each person who has at least one non-mandatory tour. The model is applied after the mandatory tour frequency model. The model has twenty three alternatives which include all combinations of 0,1, or 2 escort, maintenance and discretionary tours, with no more than four total tours allowed. A separate model was estimated for each person type: full time worker, part time worker, university student, retiree, driving age student, non-driving age student, and preschool student. All were estimated in a multinomial logit form using the ALOGIT software.

Estimation Dataset

The estimation dataset included 8,970 observations of non-mandatory tours. The observed frequency by choices are in Table 17 below. In order to evaluate the potential impact of varying accessibilities as well as zone-specific characteristics at the home locations (by TAZ), data containing accessibilities, logsums, and demographic information by zone was appended.

Table 17: Non-Mandatory Tour Frequency Available Alternatives

alt	escort	maintenance	discretionary	total	frequency
1	0	0	0	0	5882
2	0	0	1	1	855
3	0	0	2	2	127
4	0	1	0	1	1086
5	0	1	1	2	176
6	0	1	2	3	26
7	0	2	0	2	149
8	0	2	1	3	38
9	0	2	2	4	3
10	1	0	0	1	206
11	1	0	1	2	56
12	1	0	2	3	14
13	1	1	0	2	81
14	1	1	1	3	24
15	1	1	2	4	2
16	1	2	0	3	18
17	1	2	1	4	5
18	2	0	0	2	138
19	2	0	1	3	27
20	2	0	2	4	4
21	2	1	0	3	41
22	2	1	1	4	7
23	2	2	0	4	3

Main Explanatory Variables

The following variables have been examined in the estimation process. All variables were stratified by the number of tours by purpose (i.e., 1 or 2 escort tours).

- **Income of household:**
  - Low, medium, high, and very high income
- **Household characteristics stratified by tour purpose:**
  - Number of workers
  - Worker status (for university students)
  - Household size
  - Female
  - Age
- **Home location accessibility**
- **Mix of households and employment at home location**
- **Distance to work or school, depending on person type**

Due to the small number of observations for some of the alternatives, some of the variables did not have a significant effect. These were dropped from the estimation, except in a couple of cases where they were close to significance and the sign was in the correct direction.

Results

The final estimation results are presented in Table 18.

Table 18: Phase 1 Estimation Results for Non-Mandatory Tour Frequency Model

	Full Time Worker	Part Time Worker	University Student	Retiree	Non-Working Adult	Other Students
ASC						
one escort tour	-3.143 (-19.39)	-2.708 (-14.89)	-3.099 (-14.81)	-16.966 (-2.70)	-3.112 (-16.35)	-3.756 (-29.66)
two escort tours	-4.201 (-15.13)	-3.823 (-11.24)	-4.441 (-10.80)	-19.952 (-2.42)	-3.377 (-11.91)	-5.212 (-27.47)
one maintenance tour	01.346 (-12.13)	-0.505 (-4.27)	-0.977 (-2.32)	-3.818 (-2.46)	-4.567 (-2.57)	-0.672 (-9.14)
two maintenance tours	03.369 (-13.24)	-2.317 (-8.59)	-1.731 (-1.91)	-13.226 (-2.98)	-6.346 (-3.54)	-2.595 (-14.36)
one discretionary tour	-1.435 (-8.49)	-1.180 (-8.67)	-2.250 (-14.84)	-11.254 (-4.86)	-0.727 (-3.31)	-1.298 (-15.68)
two discretionary tours	-3.343 (-7.54)	-3.015 (-9.90)	-5.040 (-10.81)	-30.514 (-3.99)	-2.117 (-4.75)	-3.347 (-16.49)
two total tours	0.444 (2.90)	0.216 (1.24)	0.840 (2.74)	-0.378 (-2.58)	-0.068 (-0.40)	0.235 (3.12)
three total tours	0.908 (3.31)	0.424 (1.42)	1.699 (3.33)	-0.455 (-1.74)	-0.059 (-0.21)	0.732 (5.64)
four total tours	1.187 (2.13)	-0.589 (-0.85)	2.495 (2.65)	-1.173 (-1.96)	-0.173 (-0.34)	0.809 (3.02)
Low income						
discretionary, 1+ tours					-0.888 (-3.91)	
Medium Income						
discretionary, 1+ tours					-0.335 (-1.89)	
Accessibility						
escort, 1 tour				1.028 (2.11)		
escort, 2 tours				1.249 (1.96)		
maintenance, 1 tour				0.318 (2.27)		
maintenance, 2 tours				1.003 (2.55)		
discretionary, 1 tour				0.822 (4.31)		
discretionary, 2 tours				2.276 (3.66)		
maintenance, 1+ tours					0.329 (2.08)	
Logsum						
escort, 1+ tours						0.0003 (3.31)

	Full Time Worker	Part Time Worker	University Student	Retiree	Non-Working Adult	Other Students
maintenance, 1+ tours	0.199 (4.25)	0.185 (2.97)				0.001 (16.57)
discretionary, 1+ tours	0.187 (4.00)	0.088 (1.37)				0.001 (8.77)
HH size						
escort, 1 tour						0.291 (9.00)
escort, 2 tours						0.450 (11.68)
maintenance, 1 tour			-0.214 (-2.03)			-0.170 (-6.94)
maintenance, 2 tours			-0.823 (-2.70)			-0.263 (-4.25)
discretionary, 1 tour	-0.161 (-3.42)				-0.196 (-2.91)	-0.136 (-5.11)
discretionary, 2 tours	-0.265 (-1.88)				-0.261 (-1.79)	-0.185 (-2.75)
escort, 1+ tours				0.215 (2.86)		
maintenance, 1+ tours				-0.274 (-5.12)		
Workers in Household						
discretionary, 1 tour				-0.235 (-2.71)		
discretionary, 2 tours				-0.477 (-2.02)		
Distance to Work						
escort, 1+ tours						
Worker Status - Work						
maintenance, 1 tour			-0.870 (-2.94)			
maintenance, 2 tours			-1.264 (-1.99)			
Presence of Preschool children						
escort, 1 tour	0.300 (1.79)	0.789 (3.13)			0.410 (1.60)	
escort, 2 tours	0.688 (3.31)	0.993 (3.12)			0.979 (4.88)	
Presence of Non-driving age children						
escort, 1 tour	0.666 (7.16)	1.116 (7.81)			0.932 (5.56)	

	Full Time Worker	Part Time Worker	University Student	Retiree	Non-Working Adult	Other Students
escort, 2 tours	0.902 (6.62)	1.386 (7.22)			1.061 (6.48)	
Presence of Driving age children						
escort, 1 tour	0.536 (2.12)				1.180 (3.00)	
escort, 2 tours	0.873 (2.49)				0.963 (2.13)	
escort, 1+ tours		0.686 (1.89)				
Single Adult households						
escort, 1+ tours					-1.00 (-2.11)	
discretionary, 1 tour					0.521 (2.91)	
discretionary, 2 tours					0.749 (2.20)	
Number of Work Tours						
escort, 1 tour	-0.772 (-4.34)	-0.609 (-2.50)				
escort, 2 tours	-2.413 (-7.14)	-1.317 (-3.02)				
maintenance, 1 tour	-1.193 (-9.67)	-1.498 (-7.81)				
maintenance, 2 tours	-1.938 (-5.97)	-1.858 (-3.89)				
discretionary, 1 tour	-0.360 (-2.89)	-0.643 (-3.64)				
discretionary, 2 tours	-1.029 (-3.10)	-1.238 (-2.54)				
Number of School Tours						
maintenance, 1+ tours						-2.189 (-2.15)
Number of University Tours						
maintenance, 1+ tours			-1.011 (-2.86)			

Findings

The following section summarized the most important findings and impacts on non-mandatory tour frequency.

- **Full Time Worker**
  - Being in a low-income bracket means that a person is more likely than a higher income person to take one or two maintenance tours. The coefficient on two maintenance tours is higher than the coefficient on one, which could be because low income workers are not working a typical 8-5 shift, meaning they have more time during the work day to do maintenance activities.
  - The logsum term was significant and positive for maintenance and discretionary tours, as is expected.
  - Household size had a negative and significant coefficient on discretionary tours, which means that in a larger household a person is less likely to make discretionary tours during the day. This could be reflecting that other household members are participating in these tours, or that there is less time during the day for discretionary tours due to the time used for the escort tours.
  - The presence of children had a positive and significant effect on the number of tours of all three purposes. Children were grouped into three categories (preschool, non-driving age, and driving age) and all three groups had significant coefficients. The magnitude was larger for 2 tours than for one.
  - The number of work tours had a negative and significant effect on all three purposes. This is expected, because it reflects that the more mandatory tours the person is making, the less time they have for non-mandatory tours.
  - A mix variable was tested, which measures the density of households and employment at the household location. This variable was not significant.

- **Part Time Worker**
  - Part Time Worker estimation was based on the Full Time worker estimation.
  - The logsum coefficients were positive and significant.
  - The presence of children was significant and positive again. For the driving age children group, the number of escort tours was combined into a category for 1+ escort tours.
  - The number of work tours was negative and significant.

- **University Student**
  - Somewhat surprisingly, neither accessibility nor the mix variable were significant.
  - Household size was negative and significant for one and two maintenance tours, which means that as there are more household members, the university student is less likely to make maintenance tours during the day.
  - University students who are also workers have a negative and significant coefficient on maintenance tours. This means that if they work, they are unlikely to make one or two maintenance tours. This most likely reflects a lack of time in the day for additional tours.

- The number of university tours had a negative and significant coefficient for 1+ maintenance tours. This is a reasonable result, as it reflects that the more mandatory tours the person is making, the less time they have for non-mandatory tours.

- **Retiree**
  - Accessibility was positive and significant for all tour types for retirees. This may reflect a difference in mobility and auto ownership among retirees. The coefficients on two tours are higher than the coefficients on one tour, reflecting that higher accessibility means more tours are taken.
  - The mix coefficient was not significant.
  - Household size had a significant and positive term on two escort tours. It had a negative and significant coefficient for two maintenance tours. As discussed in the full time worker summary, this is an expected result.
  - The number of workers in the household had a negative and significant coefficient on the discretionary tour purpose. This could be reflecting that the retiree is not choosing to make those kinds of tours, as the working adult is doing them during the day.

- **Non-working Adults**
  - Low and medium income had a negative and significant coefficient on discretionary tours. This is a reasonable result because these persons have less income to spend on entertainment activities.
  - Household size had a positive and significant coefficient on one and two escort terms, as seen for other person types. There is a negative and significant coefficient on one and two discretionary tours and on one maintenance tour. The coefficient for two maintenance tours was not significant.
  - Accessibility had a positive and significant coefficient on maintenance tours, which means that in more accessible locations, more maintenance tours are chosen.
  - Household size had a positive and negative coefficient on discretionary tours. As discussed for other purposes, this could be reflecting that the non-working adult in the household is not making these tours because the working adult did them during the day.
  - Single adult households had a negative and significant term on escort tours, which means that these respondents are not driving other householders around and dropping them off. This could reflect smaller household sizes, lack of children in home (presence of children is explained by another coefficient), or that the single adult is doing the other mandatory tours and therefore unable to do escort tours. The coefficient was positive and significant for one and two discretionary tours, which is reasonable because the householder is solely responsible for the tours.

- **Students**
  - Estimation was attempted for students within three sub-groups: driving age students, non-driving students, and preschool students. Not all alternatives were represented in those subgroups. Additionally, it was not possible to estimate reasonable coefficients due to lack

of observations in many categories. Therefore, all student records were combined into one estimation.

- The logsum was significant and positive for all purposes.
- Age was estimated in order to determine differences in the driving age student's tours, but was not significant for any purpose.
- Household size was positive and significant for one and two escort tours, and negative and significant for one and two discretionary and maintenance tours. This is the same pattern as seen for other person types.
- The number of school tours had a negative and significant coefficient on the number of maintenance tours. This reflects that the more mandatory tours the person is making, the less time they have for non-mandatory tours.

At-Work Sub-Tour Frequency Estimation

The at-work sub-tour frequency model predicts the number of tours for each person who has at least one work tour. The model is applied after the mandatory tour frequency model. The model has three alternatives: No at-work sub tours, 1 at-work sub tour, 2+ at-work sub tours. It was estimated in a multinomial logit form using the ALOGIT software.

Estimation Dataset

The estimation dataset included 3,399 observations of work tours. Of these, only 405 had one or more at-work sub tours.

Table 19: Observed Frequency of At-Work Sub-Tours

Alternative	Frequency
No tours	2994
1 at-work subtour	360
2+ at-work subtours	45
Total	**3399**

Main Explanatory Variables

The following variables have been examined in the estimation process:

Income stratified by alternative:

- Low, medium, high income

Person type stratified by alternative:

- full time
- part time
- university student

Household characteristics stratified by alternative:

- Number of adults (drivers 16 and up)
- Number of non-workers
- Number of workers
- Number of children (non-driving)
- Female, with pre-school children

Accessibility at work location stratified by alternative:

- At work walk accessibility
- At work walk to transit accessibility

Results

The final estimation results are presented in Table 20.

Table 20: Estimation Results for At-Work Sub-Tour Frequency Model

Initial likelihood (zero coefficients)	-3734.1832
Likelihood with constants only	-1382.7053
Final likelihood	-1337.8821
Rho-squared w.r.t. Zero	0.6417
Rho-squared w.r.t. Constants	0.0324

Variable	Alternative	Coefficient	T-Stat
Constant	No at-work subtours	0	reference
	1 at-work subtour	-2.842	-8.53
	2+ at-work tours	-5.541	-4.84
Part time worker	1 at-work subtour	-0.703	-3.00
Low income	1 at-work subtour	-0.694	-2.17
	2+ at-work tours	-1.298	-1.25
Medium income	1 at-work subtour	-0.322	-2.72
	2+ at-work tours	-0.658	-2.06
Number of Workers	1 at-work subtour	-0.228	-2.91
	2+ at-work tours	-0.296	-1.36
Number of non-workers	1 at-work subtour	-0.201	-1.47
	2+ at-work tours	-0.606	-1.32
Female	2+ at-work tours	-0.846	-2.54
At-work accessibility, non-motorized	1 at-work subtour	0.155	5.04
	2+ at-work tours	0.283	2.63

Findings

The following section summarized the most important findings and impacts on at-work tour frequency.

- Part time workers are not likely to make at-work sub-tours as noted by the significant negative coefficient. This makes sense as a full time worker with a longer day would result in more likelihood of these types of tours.
- A low or medium income household has a significant and negative effect on the number of at-work sub-tours. This is intuitively correct, since workers with money will make more tours to purchase food and other goods and services.
- A low income household for 2+ at-work sub tours was not statistically significant but does have a negative sign. This variable was left in the model even though it is not significant, because it is likely that lower income workers do not attend as many business meetings as their higher income counterparts.
- The number of workers and number of non-workers in the household has a negative and significant effect on the frequency of at-work sub tours. This is presumably because another

adult could take the necessary other tours (for example, shopping). Another adult could also perhaps prepare a lunch for a working adult.

- Females are less likely to make 2+ at-work sub tours than males.
- The at-work walk accessibility is statistically significant and positive as expected. Workers in more accessible locations are more likely to take tours.

Non-Mandatory Tour Location Choice Models

A destination choice model was estimated for each of the non-mandatory tour purposes; Maintenance, Discretionary, and Escorting. The destination choice model predicts the location of where the traveler is going based on mode choice logsums, distance terms, zonal employment and household and person attributes as explanatory variables. These models were estimated in a multinomial logit form using the ALOGIT software. The utility structure is the same as the structure used for the mandatory tour location choice models described earlier.

Maintenance Location Choice

The maintenance purpose destination choice model predicts primary destination for maintenance tours, which include shopping and other maintenance purposes such as banking, medical appointments, and other personal business.

Estimation Dataset

In the 2012/2013 Oahu Household Travel Survey there were 1,874 tour records that were used to estimate the maintenance tour destination choice model.

Main Explanatory Variables

The following variables have been examined and proved to be significant in the utility functions:

- Mode choice logsum
- Impedance between the home and potential maintenance destinations:
    - Linear distance
    - Distance squared
    - Natural Log of Distance
- Person Characteristics interacted with distance terms
    - Age group
        - Age 20 years and younger
        - Age 65+
    - Gender – Female vs. Male
    - Work Status – Full-time vs. Part-time.
- Size Terms: Retail, Service, and Government employment

Table 21 shows the frequency of distance to maintenance locations for all persons in the dataset.

Table 21: Frequency of Distance to Chosen Maintenance Destinations

Bin (miles)	Frequency
5	1,377
10	305
15	187
20	74
25	53
30	19
35	6
40	2
45	0
50	0

55	2
Total	2,025

Results

The maintenance destination choice results are summarized in Table 22.

Table 22: Maintenance Location Choice Model Estimation Results

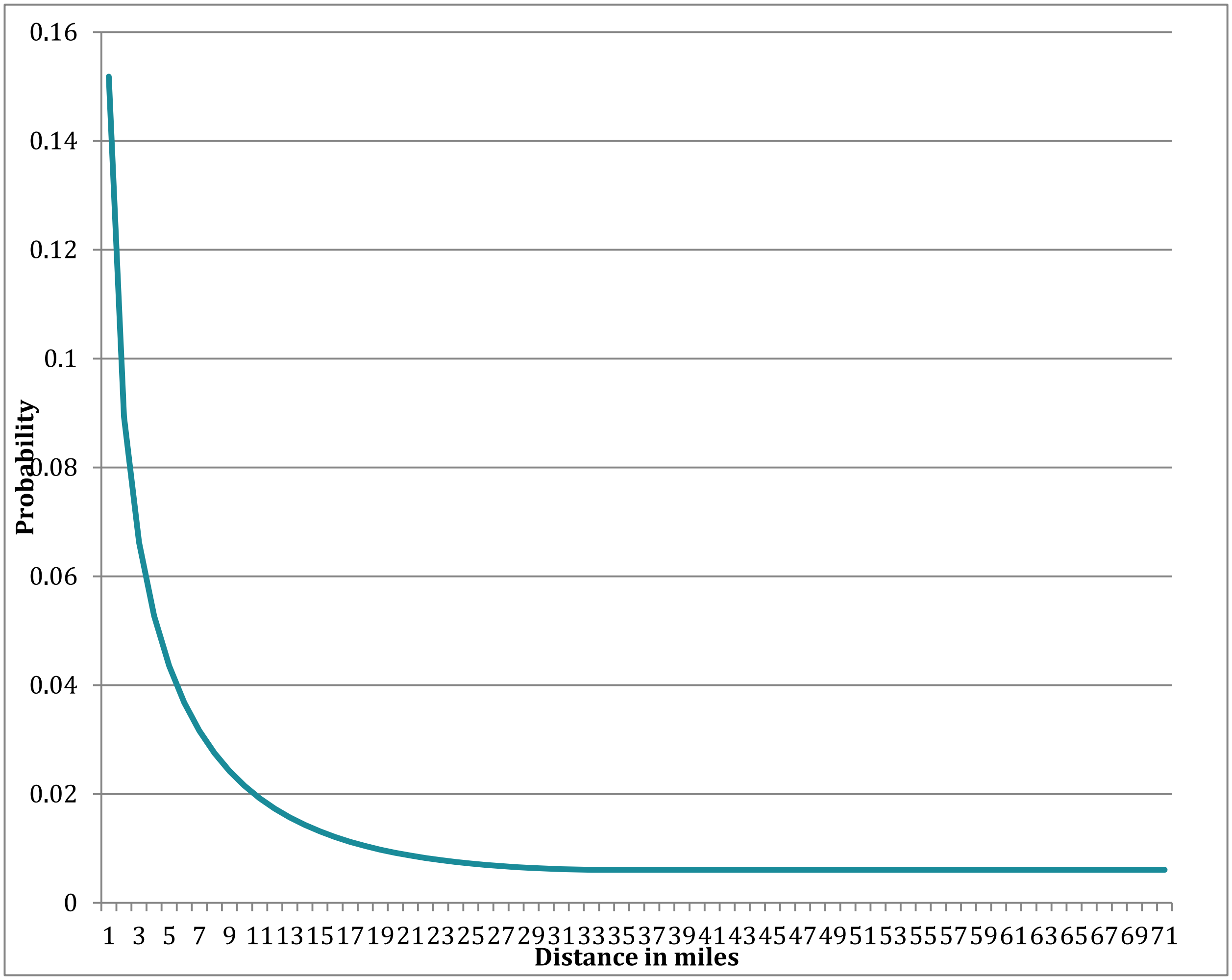
Observations: 1874
Final log likelihood: -9211.6361
Rho-Squared (0): 0.2596
Rho-Squared (constant): 0.0104

Utility Function Variables	Coeff	T-Stat
Mode Choice Logsum	0.444	2.89
Distance	-0.108	-3.86
Distance Squared	0.002	2.62
Distance Natural Log	-0.893	-12.12
Full-time worker		
Distance	-0.033	-2.68
Female		
Distance	-0.015	-1.67
Age 20 Years and Younger		
Distance	-0.031	-1.59
Age 65 and Up		
Distance	-0.034	-3.26
0 Auto Households		
Distance	-0.08710	-2.77
Size Function		
Retail Employment	1.000	
Service Employment	0.124	-24.17
Government Employment	0.017	-6.98

Findings:

- The coefficient on mode choice logsum is positive and between 0 and 1, as expected.
- A *Composite distance function* (or distance decay factor) has been defined as a combination of linear, squared and natural logged distance terms with different coefficients. This term should be analyzed as a composite term. For example, the coefficient on linear distance is positive but it does not mean that people choose distant maintenance locations. But, the combined effect of all terms should be looked at. Figure 10 shows the distance decay factor. This function is monotonously decreasing within the maximum chosen maintenance distance range.

Figure 10: Maintenance Distance Decay Factor



- The effects of work status (full-time vs. part-time vs. non-work), gender (females vs. males) and age was found siginificant on distance to maintenance location. The findings are below:
    - *Full-time workers* are most sensitive to longer distances to maintenance locations than those that are part timers or non-workers. This may be because full-time workers have less time to spend travelling for maintenance tours after allocating time to work tours.
    - *Females* are less likely to travel longer distances as compared to males.
    - *Age (young and old):* People less than 20 years old, and those older than 65 years old tend to travel shorter distances for maintenance activities than those age 21 to 64.
- Size term effects:
    - Retail employment has the highest size term coefficient, relative to service or government employment, and therefore will attract a relatively higher share of maintenance tours.

Discretionary Location Choice

The discretionary purpose destination choice model predicts the primary destination of discretionary tours. Discretionary tours include tours for recreation, visiting, eating out, and other discretionary activities.

Estimation Dataset

In the 2012/2013 Oahu Household Travel Survey there were 1,560 tour records that were used to estimate the discretionary tour destination choice model.

Main Explanatory Variables

The following variables have been examined and proved to be significant in the utility functions:

- Mode choice logsum
    - Distance
- Person Characteristics interacted with distance terms:
    - Age 20 years and younger
    - Work Status – Full-time vs. Part-time.
- Size Terms: Retail, Service, Hotel employment, and households

Results

The discretionary destination choice results are summarized in Table 23.

Table 23: Discretionary Location Choice Model Estimation Results

Observations: 1560
Final log likelihood: -8701.6417
Rho-Squared (0): 0.1598
Rho-Squared (constant): 0.0167

Utility Function Variables	Coeff	T-Stat
Mode Choice Logsum	1.000	
Natural Log of Distance	-0.835	-25.70
Full-time worker		
Distance	-0.041	-3.68
Age 20 Years and Younger		
Distance	-0.050	-3.77
Size Function		
Retail Employment	1.000	
Service Employment	0.264	-9.48
Hotel Employment	0.226	-3.74
Households	0.306	-11.77

Findings:

- The coefficient on mode choice logsum was set to 1 because the ALOGIT estimated the coefficient as slightly over one.

- The effects of work status (full-time vs. part-time vs. non-work), and age was found significant on distance to discretionary location. The findings are below:
    - *Full-time workers* are most sensitive to longer distances to discretionary locations than those that are part timers or non-workers. This is likely due to full-time workers having less time to travel to discretionary activities after allocating time to work tours.*Age (20 and younger):* People less than 20 years old tend to engage in discretionary activities that are closer to home compared to those older than 20.
- Size term effects:
    - Retail employment is the dominant size term, with service employment and hotel employment attracting about 25% as many discretionary tours. Households also attract discretionary tours.

Escorting Location Choice

The escorting purpose destination choice model predicts the primary destination for escorting tours, which involve picking up or dropping off household members, often at school locations.

Estimation Dataset

In the 2012/2013 Oahu Household Travel Survey there were 887 tour records that were used to estimate the escorting tour destination choice model.

Main Explanatory Variables

The following variables have been examined and proved to be significant in the utility functions:

- Impedance between the home and potential escorting destinations:
    - Linear distance
    - Distance squared
    - Natural Log of Distance
- Size Terms: total employment, service employment and households

Table 24 shows the frequency of distance to escorting locations for all persons in the dataset.

Table 24: Frequency of observed distance to escorting location

BIN (MILES)	FREQUENCY
5	627
10	164
15	75
20	30
25	12
30	4
Total	912

Results

The escorting destination choice results are summarized in Table 25.

Table 25: Escorting Location Choice Model Estimation Results

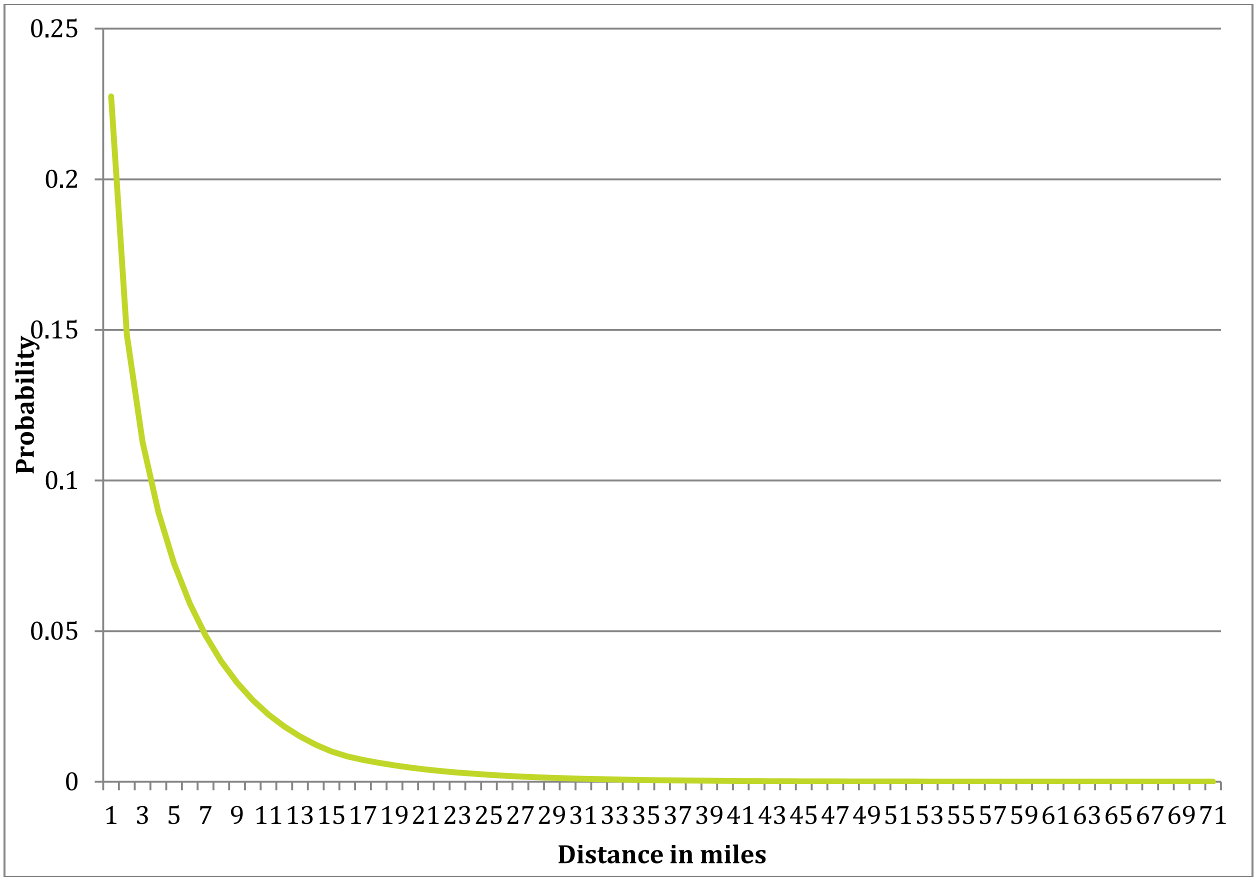
Observations: 887
Final log likelihood: -4364.1952
Rho-Squared (0): 0.2588
Rho-Squared (constant): 0.0534

Utility Function Variables	Coeff	T-Stat
Distance	-0.171	-4.81
Distance Squared	-0.0019	-0.85
Distance Natural Log	-0.6598	-8.22
Size Function		
Total Enrollment	1.000	
Households	0.353	-7.84
Service Employment	0.750	-2.71

Findings:

- The coefficient on mode choice logsum could not be estimated as it had a coefficient over 1.
- A *Composite distance function* (or distance decay factor) has been defined as a combination of linear, squared and natural logged distance terms with different coefficients. Figure 11 shows the distance decay factor. This function is monotonously decreasing within the maximum chosen escorting distance range.
- Size term effects:
    - School enrollment has a much greater tour attraction rate than households or service employment.

Figure 11: *Escorting* ***Distance Decay Factor***



At-Work Location Choice Model

The at-work sub tour purpose destination choice model predicts primary destination location for at-work subtours. At-work sub-tours are tours made for eating out (e.g. lunch), business, and other personal reasons, where the workplace is the tour origin.

Estimation Dataset

In the 2012/2013 Oahu Household Travel Survey there were 455 tour records that were used to estimate the at-work sub-tour destination choice model.

Main Explanatory Variables

The following variables have been examined were significant in the utility functions:

- Mode choice logsum
- Impedance between the workplace and potential at-work destinations:
    - Natural Log of Distance
- Size Terms: retail, service, military, government employment, and households

Table 26 shows the frequency of distance to escorting locations for all persons in the dataset.

Table 26: Frequency of observed distance to an at-work location

Bin(miles)	At-work(4)
5	359
10	50
15	23
20	13
25	7
30	6
Total	458

Results

The at-work sub tour destination choice results are summarized in Table 27.

Table 27: At-Work Sub Tour Location Choice Model Estimation Results

Observations: 455
Final log likelihood: -2319.2954
Rho-Squared (0): 0.2322
Rho-Squared (constant): -0.0117

Utility Function Variables	Coeff	T-Stat
Mode Choice Logsum	0.343	4.95
Natural Log of Distance	-0.6144	-7.56
Size Function		
Retail Employment	1.000	
Service Employment	0.745	-1.01
Military Employment	0.794	-0.61
Government Employment	0.963	-0.13
Households	0.418	-3.11

Findings:

- The coefficient on mode choice logsum is positive and between 0 and 1 as expected.
- Only the natural log of distance turned out significant for this purpose.
- Size term effects:
    - Retail employment has the highest tour attraction rate, but service and government employment is also a strong attractor of at-work sub-tours. Interestingly, military employment is a strong attractor of at-work sub-tours, perhaps due to at-work sub-tours being made for business reasons, or perhaps due to at-work sub-tours being

generated bt military base employment. Households also attract at-work sub-tours, as some workers go home for their lunch hour.

Stop Level Models

Only the intermediate stop location choice model was estimated using the household survey data and is described below.

Intermediate Stop Location Choice Model

The intermediate stop location choice model predicts the location (TAZ) of each intermediate stop (each location other than the origin and primary destination) on the tour. In this model, a maximum of 3 stops in outbound and 3 stops in inbound direction are modeled for each tour. A number of variables were tested in the stop location choice models, including mode choice logsum, travel distance deviation for stop from the half-tour path, tour specific variables (purpose, mode, origin location, destination location), person and household attributes (gender, age, household income) and land use variables (employment, household, school enrollment and university enrollment). The models were estimated in ALOGIT software as a multinomial logit model.

Estimation Dataset

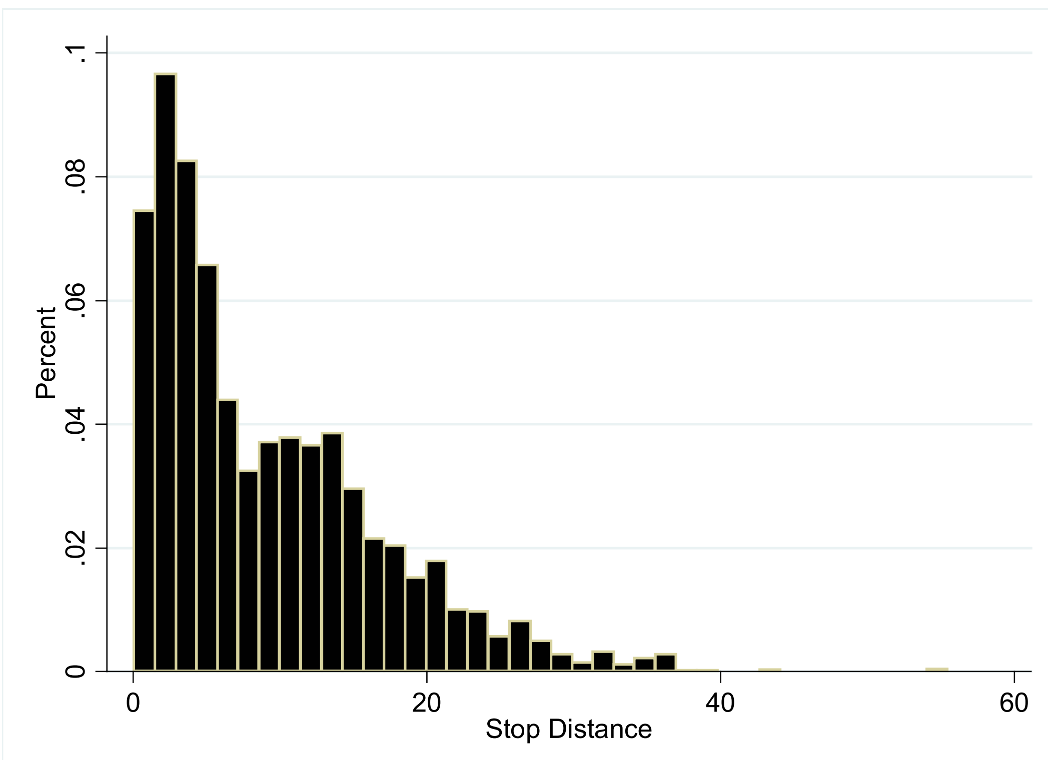
The estimation dataset included 6,659 observed stop records including up to 3 stops in each direction. Table 28 below shows the number and percentage of stop records by primary tour purpose and stop purpose. Most of the stops are made for escorting, maintenance and shopping activities comprising for more than 70% of all stops. Nearly 35% of the stops are made on work tours.

Figure 12 shows the proximity of a stop from the previous stop and the end location of the half-tour. A half-tour is the trip beginning from a tour/trip origin and ending at the primary destination of that tour. An outbound half-tour is from the tour origin to the primary destination of that **tour**. An inbound half-tour begins at the primary destination of a tour and ends at the **half-**tour destination (which was also the tour origin). In case of the first stop on the outbound half-tour, the previous location is home (or work for at-work subtours) and end location is the tour primary destination (or subtour destination for at-work subtours). In case of second or later **stops** on the same tour, the previous location is the previous stop on the half-tour and end location is the half-tour destination. Please refer to the section on "Processing of Stops" for more detail.

Table 28: Number of Stop Records by Stop Purpose and Tour Purpose

Purpose	# Stops on Tours by Tour Activity Purpose		# Stops by Stop Activity Purpose	
Work	2,313	35%	50	1%
University	112	2%	0	0%
School	481	7%	0	0%
Escorting	456	7%	1,760	26%
Shopping	1,249	19%	1,468	22%
Maintenance	642	10%	1,522	23%
Eating Out	137	2%	675	10%
Visiting	189	3%	382	6%
Discretionary	488	7%	422	6%
At Work	592	9%	380	6%
Total	6,659	100%	6,659	100%

Figure 12: Distribution of Stop Distance



Model Utility

The utility ($U^{tm}_{isjnkod}$) of choosing a stop MGRA (*s*) for an individual (*n*) for stop purpose (k) between the previous location MGRA (*i*) and half-tour destination MGRA (j) is given by Equation 1.

Equation 1

$$U^{tm}_{isjnkod} = S_{sk} + \alpha \times L^{tm}_{isj} + \sum_{g} \delta \times Fn[d_{os}, d_{sd}]T^{g} + \sum_{p} \beta^{p} \times d^{p}_{isj} + \sum_{q} \phi^{q} \times d_{isj} N^{q}_{n} + \sum_{g} \delta^{g} \times d_{isj} T^{g} + C_{s}$$

Where:

S_{sk} = the size function for stop mgra (s) and stop purpose (k)

L^{tm}_{isj} = the mode choice logsum for half-tour between zone pair ij via stop s, conditional upon tour purpose (t) and tour mode (m).

$Fn[d_{os}, d_{sd}]$ = function of distance from tour origin to stop (d_{os}) and distance from tour destination to stop (d_{sd}). The final function used is $d_{os}/(d_{os}+d_{sd})$.This ratio shows if the stop location is closer to tour origin than tour destination.

d^{p}_{isj} = the various distance deviation terms (*p = linear, log, square root, squared, and cubed*) for stop *(s).*

N^{q}_{n} =the q^th stop/tour/person /household characteristics (such as stop purpose, tour purpose, stop number, income, age group, person type) for individual n and are used for creating interaction variable with linear distance deviation term(d_{isj}),

T^{g} =the g^th stop/tour characteristics (such as stop purpose, tour purpose, stop number, half-tour direction etc.) and are used for creating interaction variable with linear distance deviation term (d_{isj}),

C_{s} = a correction term to compensate for the sampling error in the model estimation (i.e. represent the difference between the sampling probability and final estimated probability for each alternative). The appendix explains how this correction factor is calculated.

The size function (S_{sk}) for stop location s, purpose k is a combination of different (*r*) size variables (S_{skr}) such as enrollment, employment by class, households, and their interaction with person/household characteristics. It is included in the utility function as a log term. The coefficients (γ_{rk}) on the size terms are constrained as positive in the estimation process. Note that the implied value of the coefficient on the first size term variable (r=1) is 1 for each stop purpose. This is to ensure that the size term is not over-specified; all other parameter values are interpreted as ratios of the impact of their corresponding independent variable to the first size term variable. Size term parameters are estimated simultaneously with other stop location choice parameters in ALOGIT. The final estimation results for size variables are shown in Table 3.

Equation 2

$$S_{sk} = \log(S_{sk1} + \sum_{d>1} \gamma_{dk} \times S_{skd})$$

A combination of distance deviation terms is used in the utility such that the composite distance deviation utility function is monotonically decreasing within the maximum chosen distance deviation range.

Main Explanatory Variables

It is not straightforward to segment the model by purpose because size (or attraction) variables are related to purpose of the stop activity while impedance variables are strongly related to the tour characteristics – primary tour purpose, primary mode used for the tour, etc. Therefore, a single model is estimated with size variables based on stop purpose and utility variables based on both stop and tour characteristics.

The following variables have been examined and proved to be significant in the utility functions:

- Mode choice logsum

2. Distance deviation or "out-of-the-way" distance for stop location when compared to the half-tour distance without detour for any stop

    Linear distance

    - Distance squared
    - Distance logged

5. Distance of stop location from tour origin and destination is used to define closeness to tour origin or destination. This term is interacted with tour purpose, direction of half-tour and stop number.
6. Tour- and stop-specific variables interacted with distance deviation:

    Stop purpose

    - Tour purpose
    - Tour mode
    - Dummy for 2nd or 3rd stop
    - Direction of the half-tour

11. Household income group interacted with distance deviation:

    Low income (less than $30,000)

    - Medium income ($30,000-60,000)
    - High income ($60,000 and more)

14. Person characteristics interacted with distance deviation:

    Gender – female vs. male

    - Age group

16. Size variables

    Employment by categories

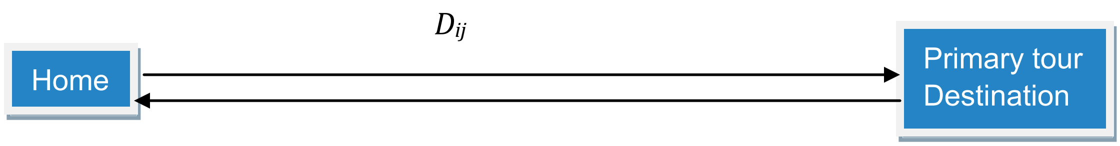
    - Number of households

- School enrollments – pre-school, K to 6 grade and 7th to 12th grade, based on type of school child in the household
- University and other college enrollments

The model operates at a half-tour level using distance and level-of-service to get from half-tour origin to half-tour destination via stop location. In case of multiple stops on a half-tour, the stop locations are processed in a chronological order. The first stop is considered as the origin zone for the second stop, and second is considered the origin zone for the third stop. Detailed processing of stops is explained below.

Processing of Stops

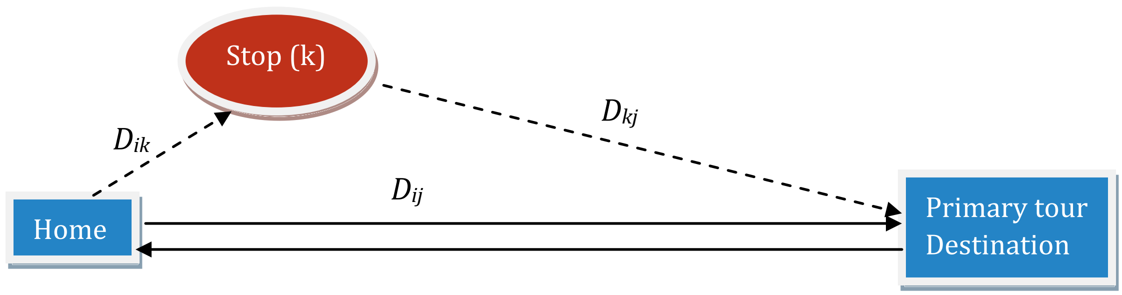
The example below explain show the stops are processed and how the distance deviation is calculated. Consider a tour from home (i) to primary tour destination (j) with distance D_{ij} between the two locations. Assume that this tour has two stops on the outbound half-tour and one stop on the inbound half-tour. The process described below applies to additional stops in any direction.



First, process the first outbound stop (k) for the half-tour. The absolute distance deviation (d_k) for stop k is given by $d_k = D_{ik} + D_{kj} - D_{ij}$ and relative distance deviation (R_k) is given by

$R_k = \frac{[D_{ik}+D_{kj}-D_{ij}]}{D_{ij}}$,

where D_{ik} is the distance from home (i) to stop k and D_{kj} is the distance from stop k to primary destination (j).



Let's consider the second stop (m) on the half-tour. Since the location of stop (k) is already decided, the deviation for next stop is calculated based on stop (k) as the origin.

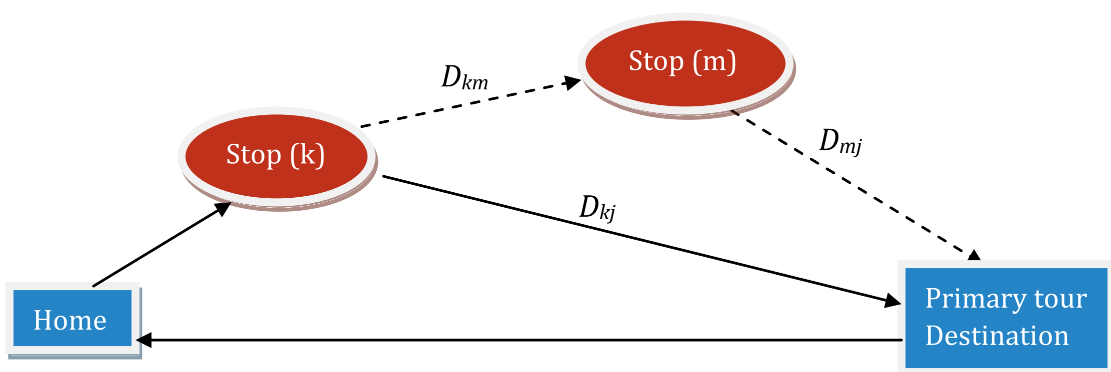
The absolute distance deviation (d_m) for stop m is given by:

$$d_m = D_{km} + D_{mj} - D_{kj}$$

The relative distance deviation (R_m) is given by:

$$R_m = \frac{[D_{km} + D_{mj} - D_{kj}]}{D_{kj}}$$

where D_{km} is the distance from stop k to stop m, and D_{mj} is the distance from stop m to primary destination (j).



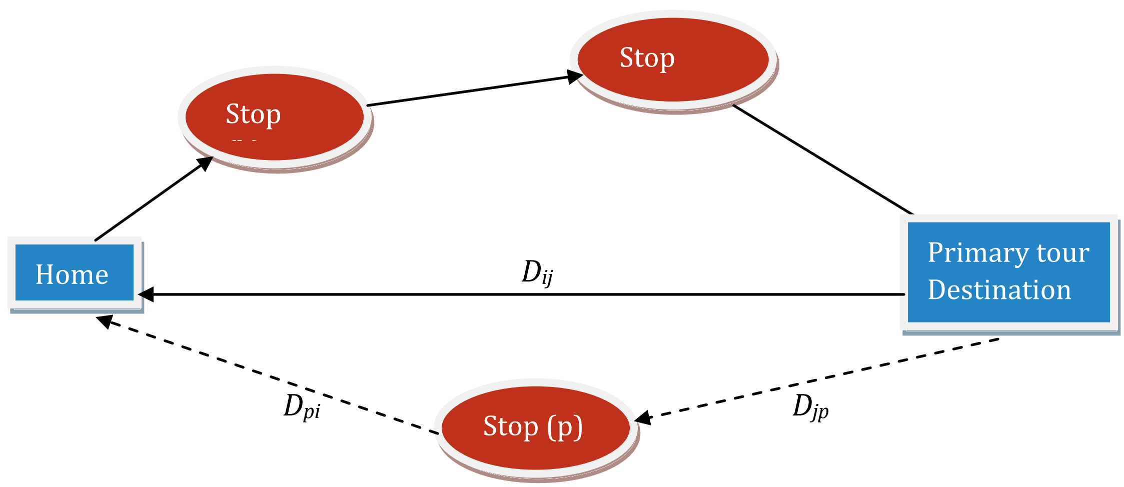
Multiple stops are processed along the half-tour using the same process. For inbound half-tour, the processing is carried out in the same way except that the primary tour destination (or previous stop on inbound half-tour) becomes origin location and home becomes destination location. The absolute distance deviation (d_p) for stop p on the inbound half-tour is given by:

$$d_p = D_{jp} + D_{pi} - D_{ij}$$

And the relative distance deviation (R_p) for stop p on the inbound half-tour is given by:

$$R_p = \frac{[D_{jp} + D_{pi} - D_{ij}]}{D_{ij}}$$

where D_{jp} is the distance from primary destination (j) to stop p and D_{pi} is the distance from stop p to home (i).



Results

Tables 29 and 30 show the estimation results for the intermediate stop destination choice model. The total number of observations is 6554. Some records were dropped due to unacceptable choices and errors in size variables during the estimation process.

Table 29: Intermediate Stop Destination Choice Model (Impedance Variables)

Number of Observations	6,554
Likelihood with Constants only	-38143.1120
Final likelihood	-31646.6037
ρ^2 w.r.t. zero	0.2625
ρ^2 w.r.t. constants	0.1703

Utility Function Variables	Coeff	T-stat
Mode Choice Logsum	1.3442	26.52
Closeness to Tour Origin		
Linear	-6.1616	-23.28
Square	5.1668	20.59
First outbound	0.1214	0.73
First Inbound Stop	0.9995	6.92
Mandatory Tour Purpose - Outbound	-0.3353	-1.90
Mandatory Tour Purpose - Inbound	0.6931	4.84
Absolute Distance Deviation		
Linear	-0.0948	-2.61
Square	0.0014	1.17
Log	-0.4941	-5.47
Absolute Distance Deviation - Stop Sequence		
Number of Stops on the half-Tour	0.0159	6.77
2nd Stop	-0.0402	-4.08
3rd Stop	-0.0501	-3.29
Absolute Distance Deviation - Stop Purpose		
Escort	0.0532	5.94
Discretionary	0.0502	5.44
Absolute Distance Deviation - Tour Purpose		
University	-0.1055	-2.52
School	-0.1859	-12.06
Escorting	-0.1678	-10.71
Maintenance	-0.1011	-9.96
Discretionary	-0.1007	-7.81
At-Work	-0.0525	-3.82
Household Variables		
Absolute Distance Deviation - Income - $29,999 or Less	0.0438	2.53

Utility Function Variables	Coeff	T-stat
Person Variables		
Absolute Distance Deviation - Female	-0.0153	-2.11
Relative Distance Deviation - Age 35 to 54 yrs	-0.0318	-3.17
Relative Distance Deviation - Age >=55	-0.0397	-3.95

*Table 30: Intermediate Stop Destination Choice Model (Size Variables)***

Stop Purpose	Escorting	Maintenance	Discretionary
	Coeff	Coeff	Coeff
Retail Employment		1.0000	1.0000
University Enrollments	1.0000		
Number of Households	0.3530		0.3064
Service Employment	0.7500	0.1240	0.2645
Government Employment		0.0174	
Hotel Employment			0.2256

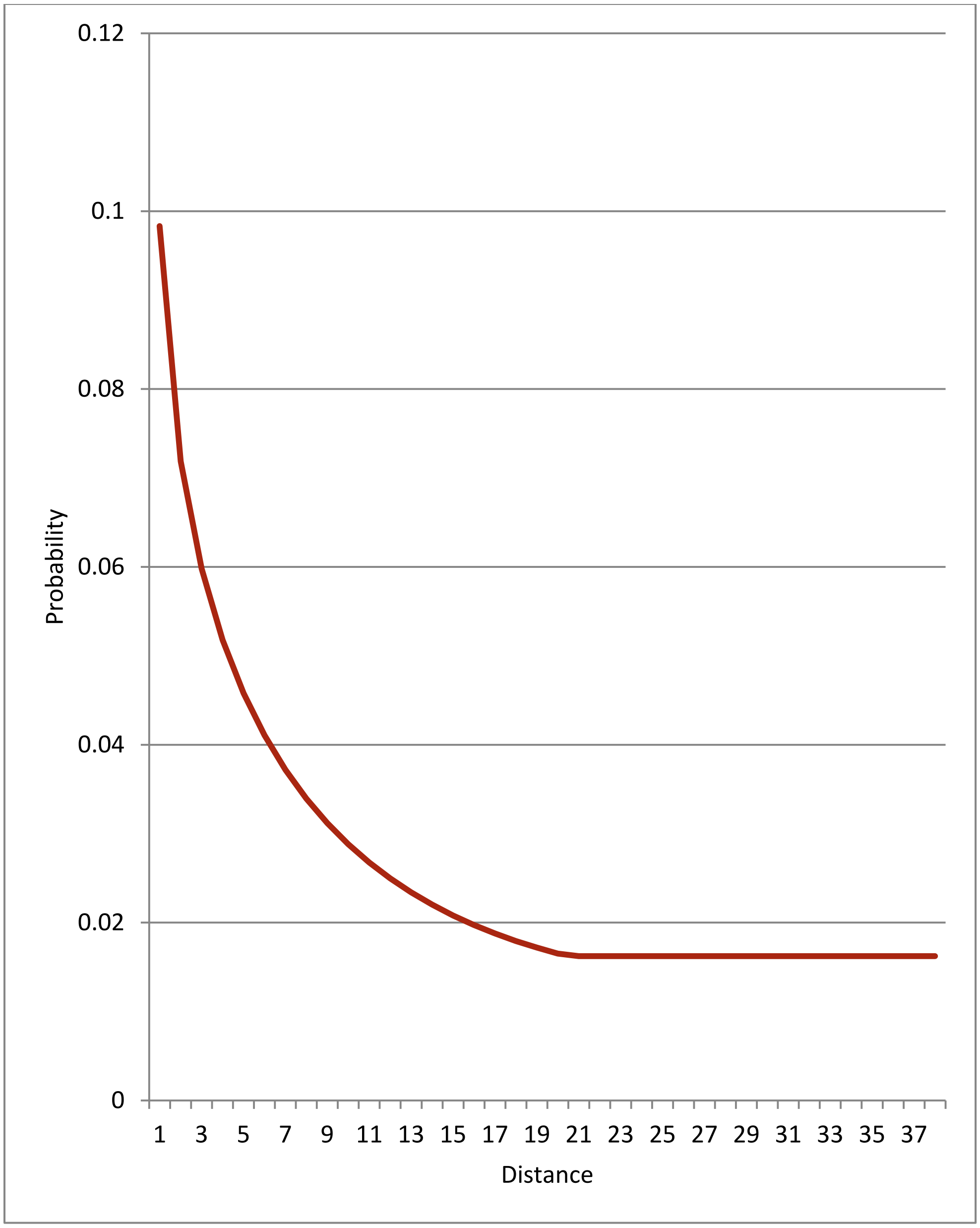
These coefficients were borrowed from the non-mandatory tour location choice models.

Findings

The estimated mode choice logsum parameter is **1.34** and is very significant.

The distance deviation function measures how far "out-of-way" a stop location is compared to the half-tour path distance. There are two terms used in the utility expression: relative deviation and absolute deviation. Relative distance is more relevant for short distance tours where absolute deviation is small but its proportion to half-tour distance is significant. The composite function (with linear, log and square terms) defined for both terms are strongly negative, as shown in Figures 13.

Figure 13: Absolute Distance Deviation and Relative Distance Function in the Utility Function



Below are interesting findings for the interaction of distance deviation with stop, tour, household and person characteristics:

- *Tour Purpose:* Stops on at-work tours tend to be more out-of-the-way than on any other type of tours as noted by the negative terms on the other tour purposes while work tours is the base.
- Stop Purpose: Stops made for purposes other than escorting and discretionary tend to be larger deviation from the straight line half tour path with stops for mandatory purposes on the inbound direction having the largest deviation.
- Half-Tour Direction: Stops on the inbound half-tour tend to be more “out-of-the-way” than stops on the outbound half-tour for mandatory tours.
- Number of Stops and Stop Sequence: The deviation tends to be larger for multi-stop half-tours. However, second and the third stop tend to be less “out-of-the-way” compared to first stop.
- Person and Household characteristics: There are strong effects of gender, income and age group on distance deviation. Females and individuals 35 years or older tend to be more sensitive to longer deviations for the stop. Low income household members ($29,999 or less) tend to go more out-of-the-way for stops compared to high income household members.
- Closeness to Tour Origin or Tour Destination: The ratio of distance from tour origin to sum of distance from tour origin and tour destination is used as a measure of closeness of stop to tour origin. Overall, stops tend to be closer to tour origin (usually home).On a multiple stop half-tour, the first stop is closer to origin in the outbound direction and close to destination in the inbound direction. Also, the stops are closer to origin, more on the outbound direction than in the inbound direction, on mandatory tours as compared to non-mandatory tours.

The size variables in Table 3 were borrowed from the primary non-mandatory tour destinations of the same purpose.

Time of Day Choice Component

Tour time-of-day choice is the composite choice made up of the tour start and end times. In the OahuMPO model, the tour-start and end times are represented by several temporally contiguous discrete time periods with a resolution of 30 minutes (resulting in 48 time-bins per day). In order to control for reasonability of travel schedule, all the alternatives where the tour-start time period is before the tour-end time period is discarded from the choice set.

The temporal profiles of tours modeled are based on the observed distributions from the 2012/2013 household travel survey. Separate distributions are developed for each of the seven travel purposes. A Monte-Carlo simulation procedure is then applied to select the time-of-day for each tour. The simulation involves:

1. Computing the probabilities for each time-of-day alternative – in the current framework this is assumed to be the sample share from the survey. This defines a lower bound of probability for the choice alternatives.
2. Computing the cumulative probabilities for each time-of-day alternative – this defines an upper bound of probability for the choice alternatives.
3. Random number generation from a uniform distribution between 0 and 1 – the probability interval in which this number falls in is the chosen time-of-day.

Figure 14 through Figure 20 compares the observed and the predicted temporal profiles of tours by purpose. As expected, the predicted outcomes match observed distributions perfectly – since the simulation is based on observed sample share this model does not require any calibration.

Figure 14: Work Tours TOD Results

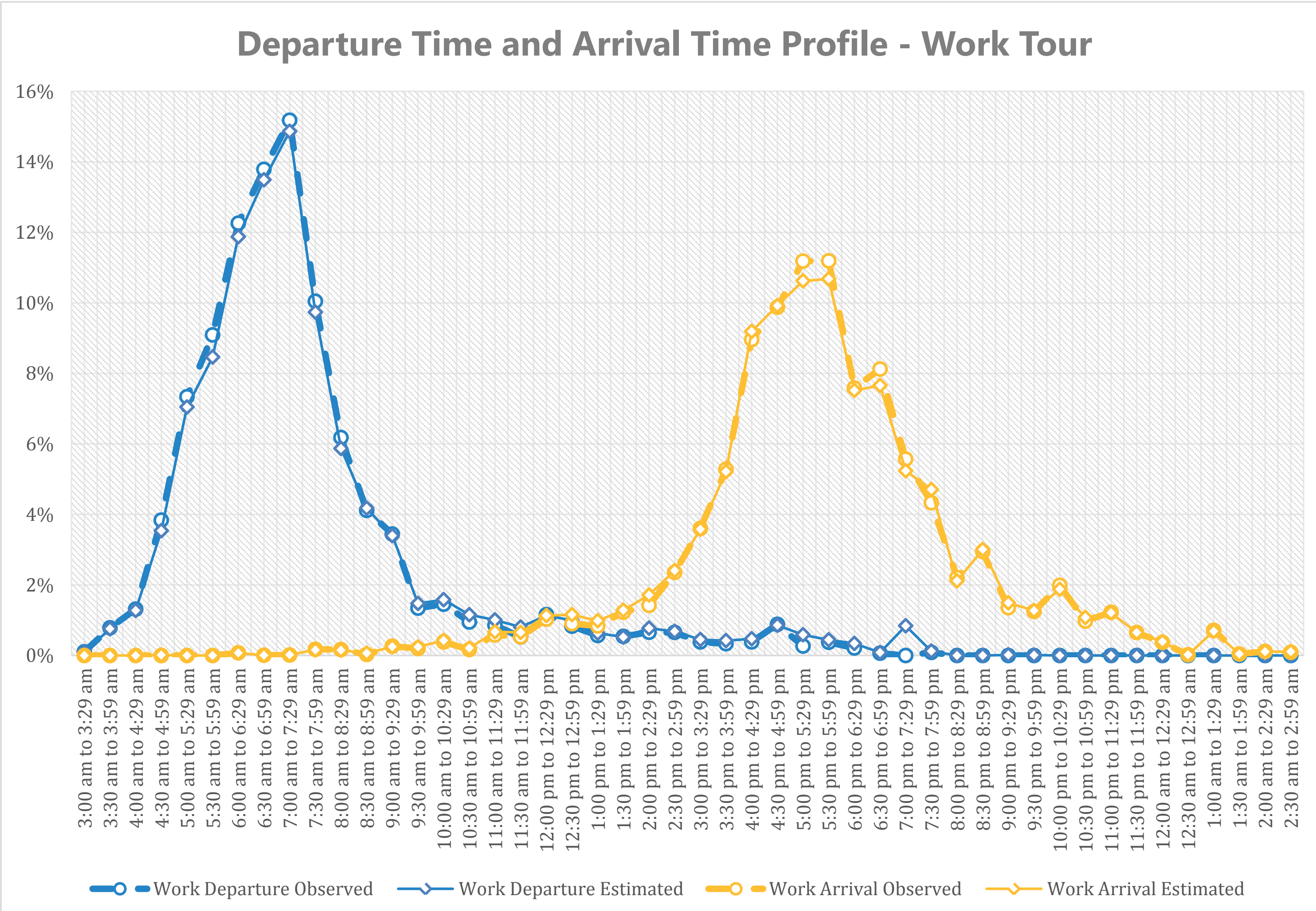


Figure 15: University Tours TOD Results

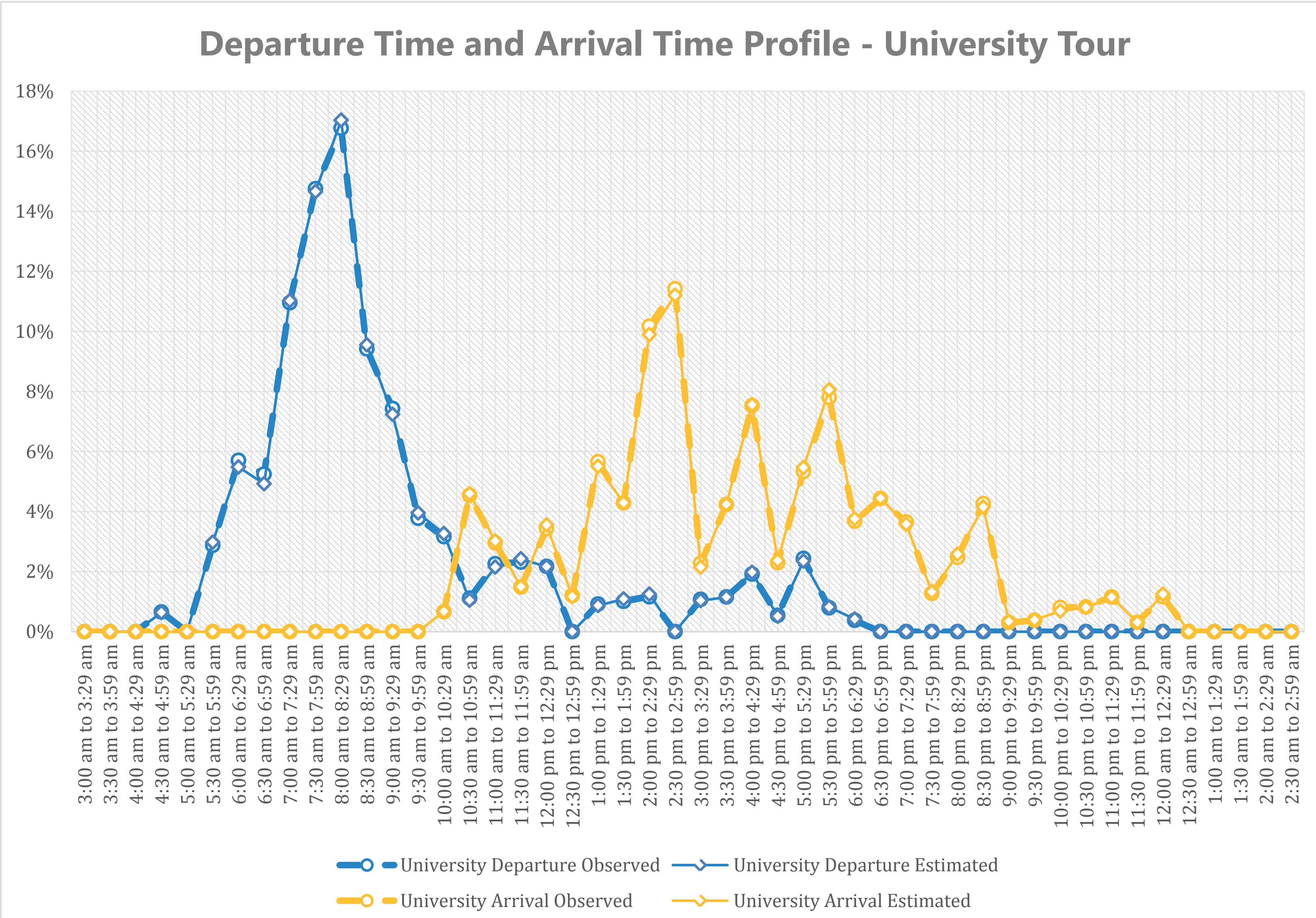


Figure 16: School Tours TOD Results

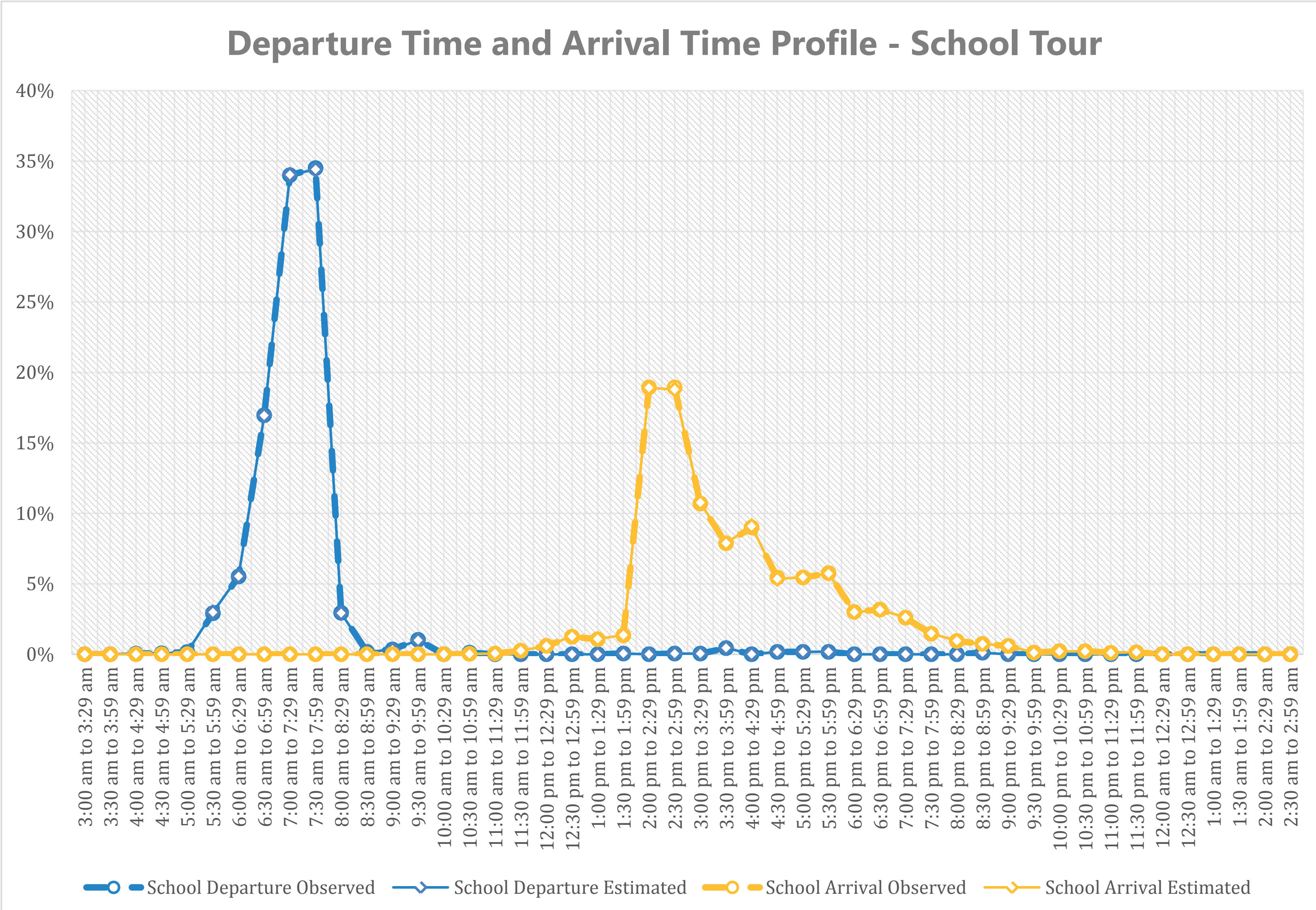


Figure 17: Escorting Tours TOD Results

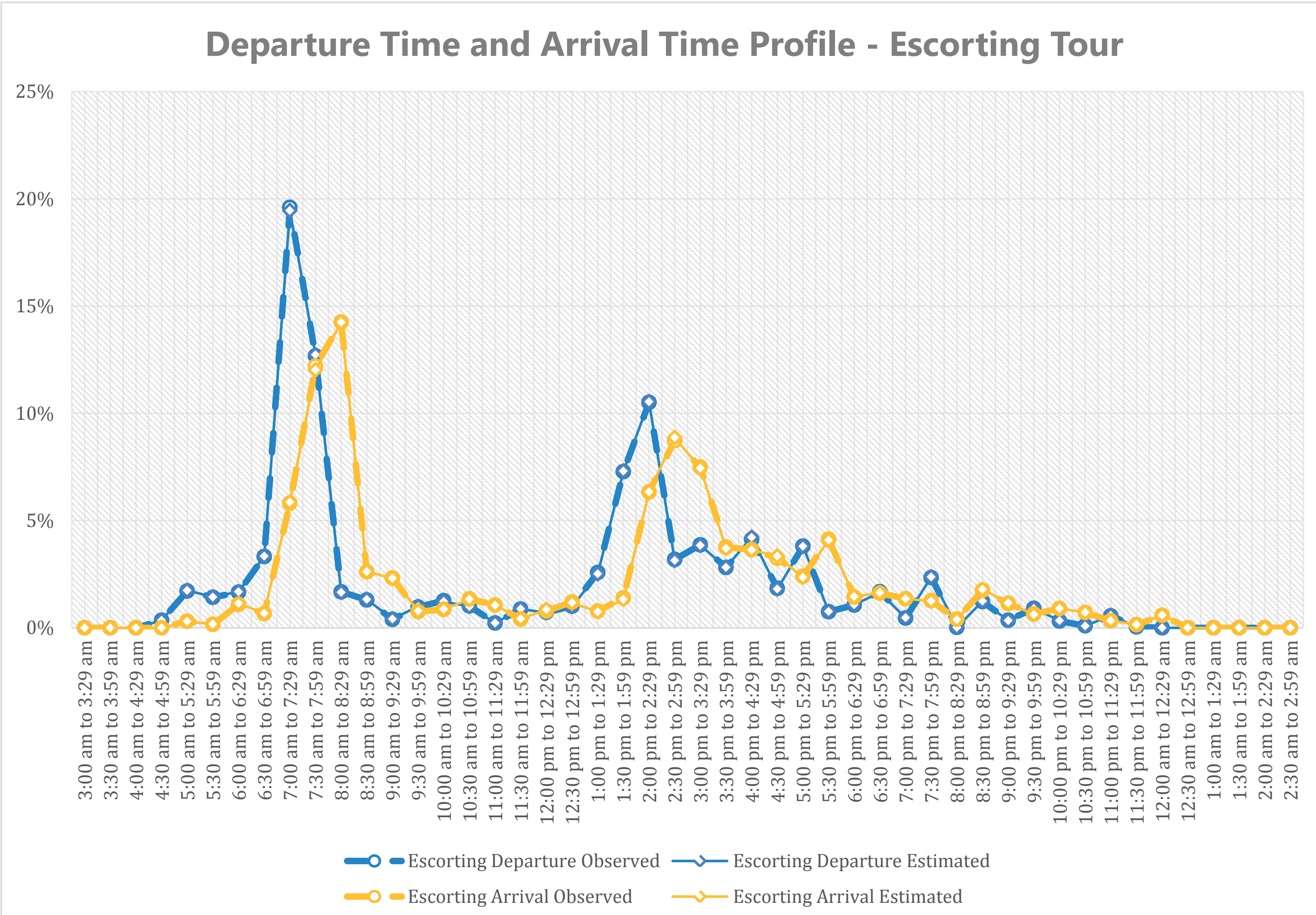


Figure 18: Maintenance Tours TOD Results

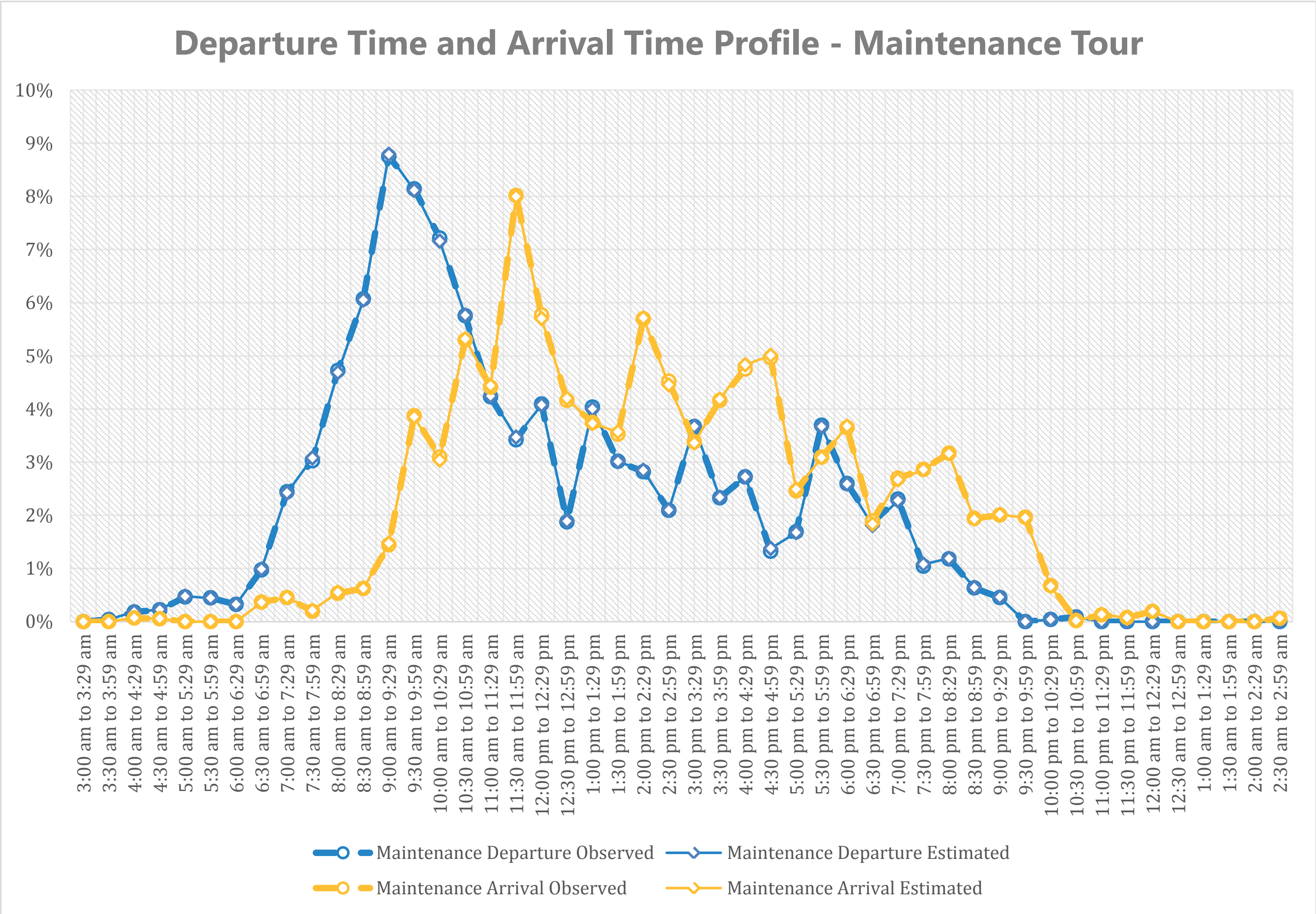


Figure 19: Discretionary Tours TOD Results

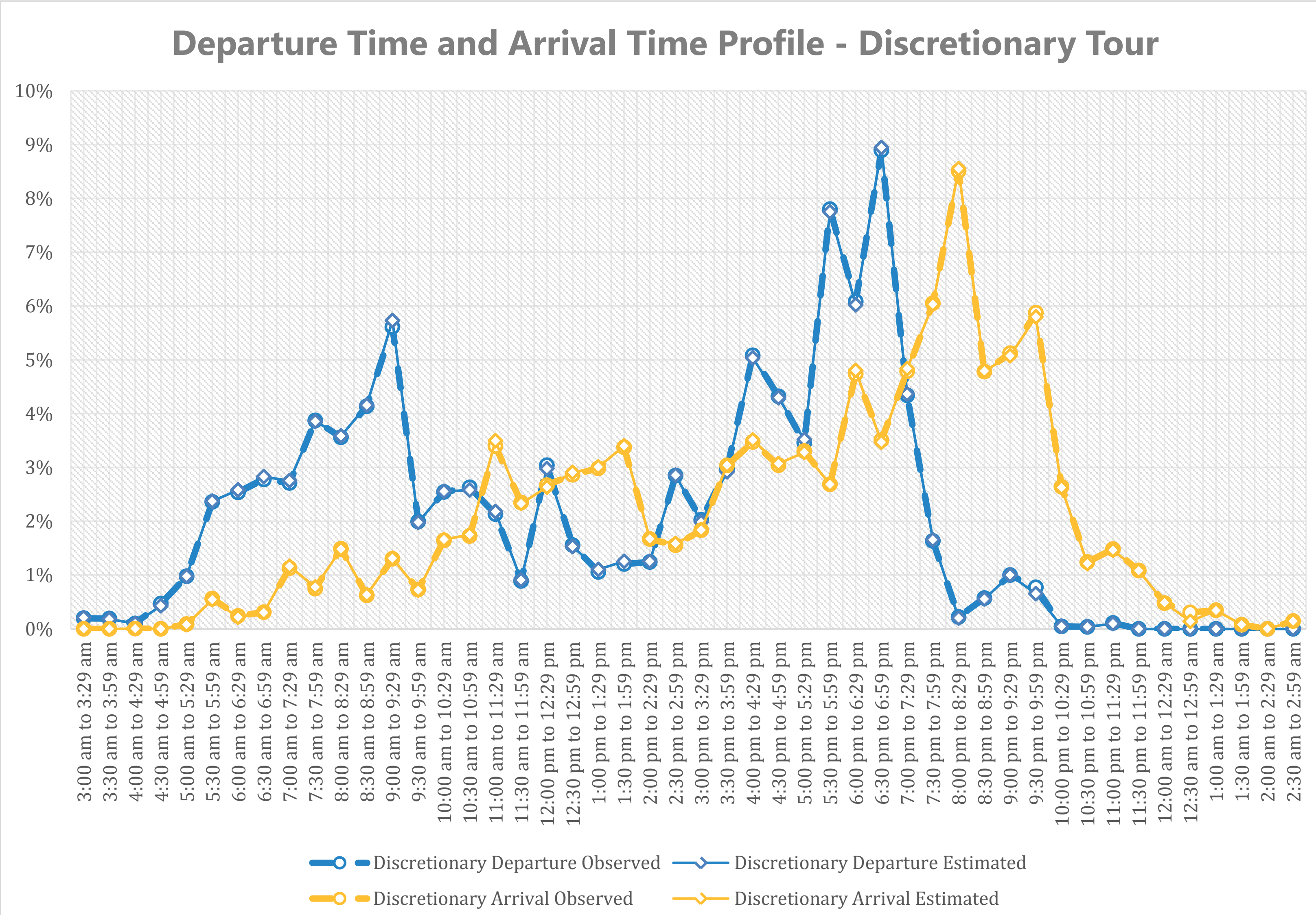
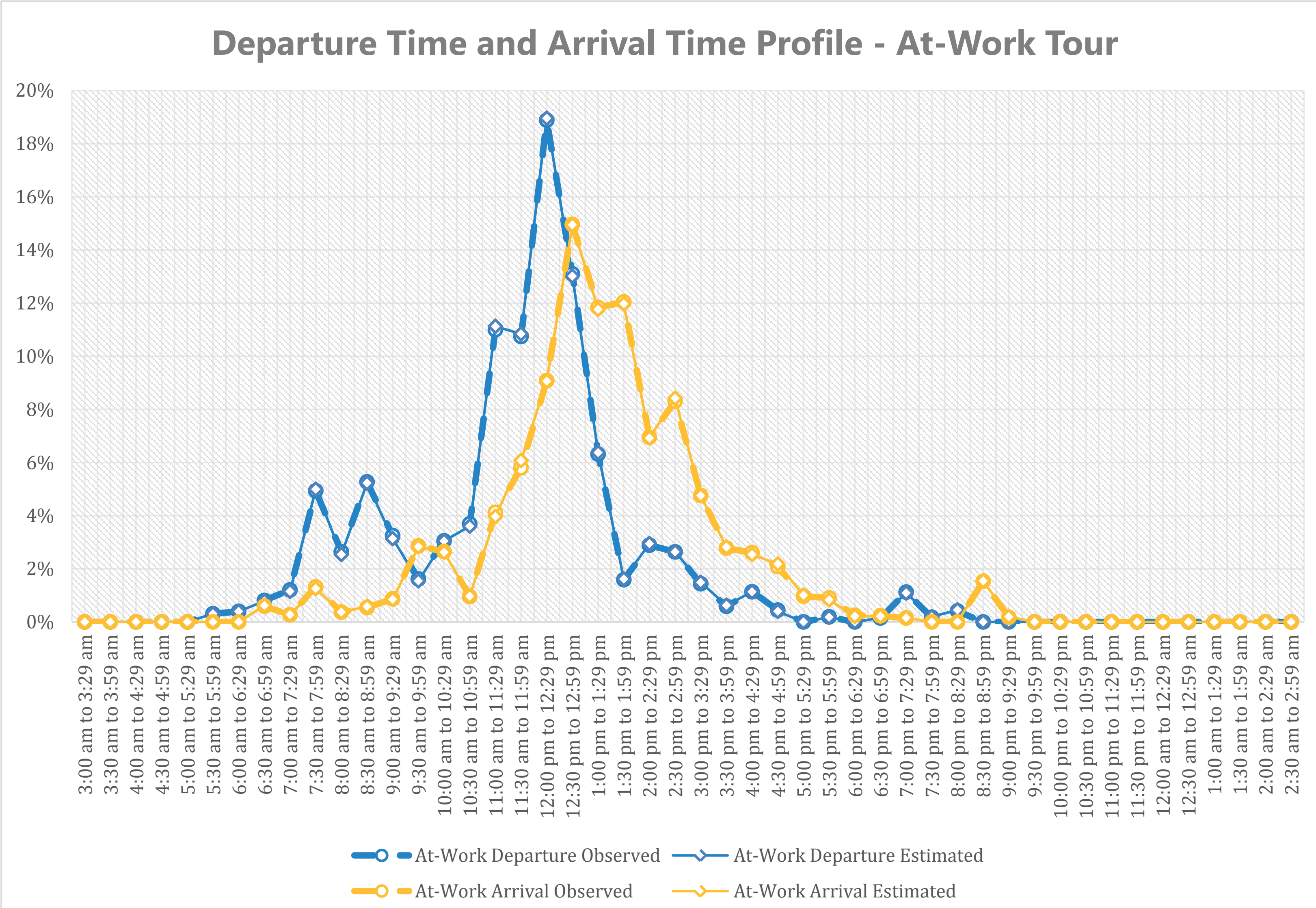


Figure 20: At-Work Tours TOD Results



University Model

This section documents the university model component of the OahuMPO Tour-Based Model. Recognizing the unique mobility needs and travel patterns of university students as well as the considerable traffic from trips made by university students on Oahu, explicit modeling of this market segment has been implemented. It was difficult to obtain surveys for university group quarters because of privacy issues and the willingness of students to participate in the survey, but surveys obtained from students living in households were used to calibrate the university models. These models will help better predict travel behavior on Oahu. The university model is comprised of a series of discrete choice models and is used to predict the university location choice, tour frequency, intermediate stop locations, tour and trip mode choice and time-of-day choice for university students.

University Location Choice Results

The university destination choice is modeled as a segment of the student school location choice. The university location models did not need to be calibrated as the observed results matched closely to survey. **Table** 31 through **Table** 78 displays the district to district flows for university trips for the observed, estimated, and percent difference, respectively.

Figure 21 shows this graphically and reveals that the model is predicting university locations accurately. This result is further reinforced by a correlation coefficient of 93.9%. The trip length frequency distributions in Figure 22 also show that the estimated distribution matches the observed quite well.

Table 31: Scaled Observed Survey University Flows of Home District to University District

HOME DISTRICT	UNIVERSITY DISTRICT									
	1	2	3	4	5	6	7	8	9	Total
1	2,692	8,928	-	134	-	-	764	-	168	**12,686**
2	6,010	11,682	-	258	-	75	54	130	-	**18,208**
3	144	2,936	316	-	-	-	111	-	-	**3,507**
4	944	6,025	-	4,153	-	-	-	100	98	**11,320**
5	325	751	-	-	707	-	2,128	752	-	**4,664**
6	579	1,434	62	48	-	1,301	1,182	240	-	**4,846**
7	1,931	3,475	-	832	-	-	4,023	255	102	**10,619**
8	1,299	2,118	-	1,225	124	108	5,236	1,285	178	**11,573**
9	738	2,730	-	111	-	-	77	-	1,041	**4,696**
Total	**14,662**	**40,079**	**379**	**6,760**	**831**	**1,483**	**13,575**	**2,762**	**1,587**	**82,119**

Table 32: Estimated University Flows of Home District to School District

HOME DISTRICT	UNIVERSITY DISTRICT									
	1	2	3	4	5	6	7	8	9	Total
1	3,967	7,993	69	194	11	14	209	93	136	**12,686**
2	4,851	12,217	121	310	16	13	316	142	222	**18,208**
3	726	2,544	62	63	6	3	48	24	31	**3,507**
4	3,165	4,221	94	3,079	47	12	395	163	144	**11,320**
5	1,177	1,270	31	334	101	22	1,428	220	81	**4,664**
6	1,431	1,532	34	149	16	80	1,371	133	100	**4,846**
7	2,893	3,399	66	317	56	67	3,257	335	229	**10,619**
8	3,313	4,225	80	337	75	51	2,855	380	257	**11,573**
9	1,783	2,147	34	124	14	5	360	91	138	**4,696**

Total	23,306	39,548	591	4,907	342	267	10,239	1,581	1,338	82,119

Table 33: Percentage Difference between Observed and Estimated University Flows

HOME DISTRICT	UNIVERSITY DISTRICT									
	1	2	3	4	5	6	7	8	9	Total
1	47%	-10%	0%	45%	0%	0%	-73%	0%	-19%	**0%**
2	-19%	5%	0%	20%	0%	-83%	485%	9%	0%	**0%**
3	403%	-13%	-80%	0%	0%	0%	-57%	0%	0%	**0%**
4	235%	-30%	0%	-26%	0%	0%	0%	62%	47%	**0%**
5	262%	69%	0%	0%	-86%	0%	-33%	-71%	0%	**0%**
6	147%	7%	-45%	211%	0%	-94%	16%	-45%	0%	**0%**
7	50%	-2%	0%	-62%	0%	0%	-19%	31%	124%	**0%**
8	155%	99%	0%	-72%	-40%	-53%	-45%	-70%	45%	**0%**
9	142%	-21%	0%	12%	0%	0%	368%	0%	-87%	**0%**
Total	**59%**	**-1%**	**56%**	**-27%**	**-59%**	**-82%**	**-25%**	**-43%**	**-16%**	**0%**

Figure 21: Scatter Plot of District to District University Flows (0.939 Correlation Coefficient)

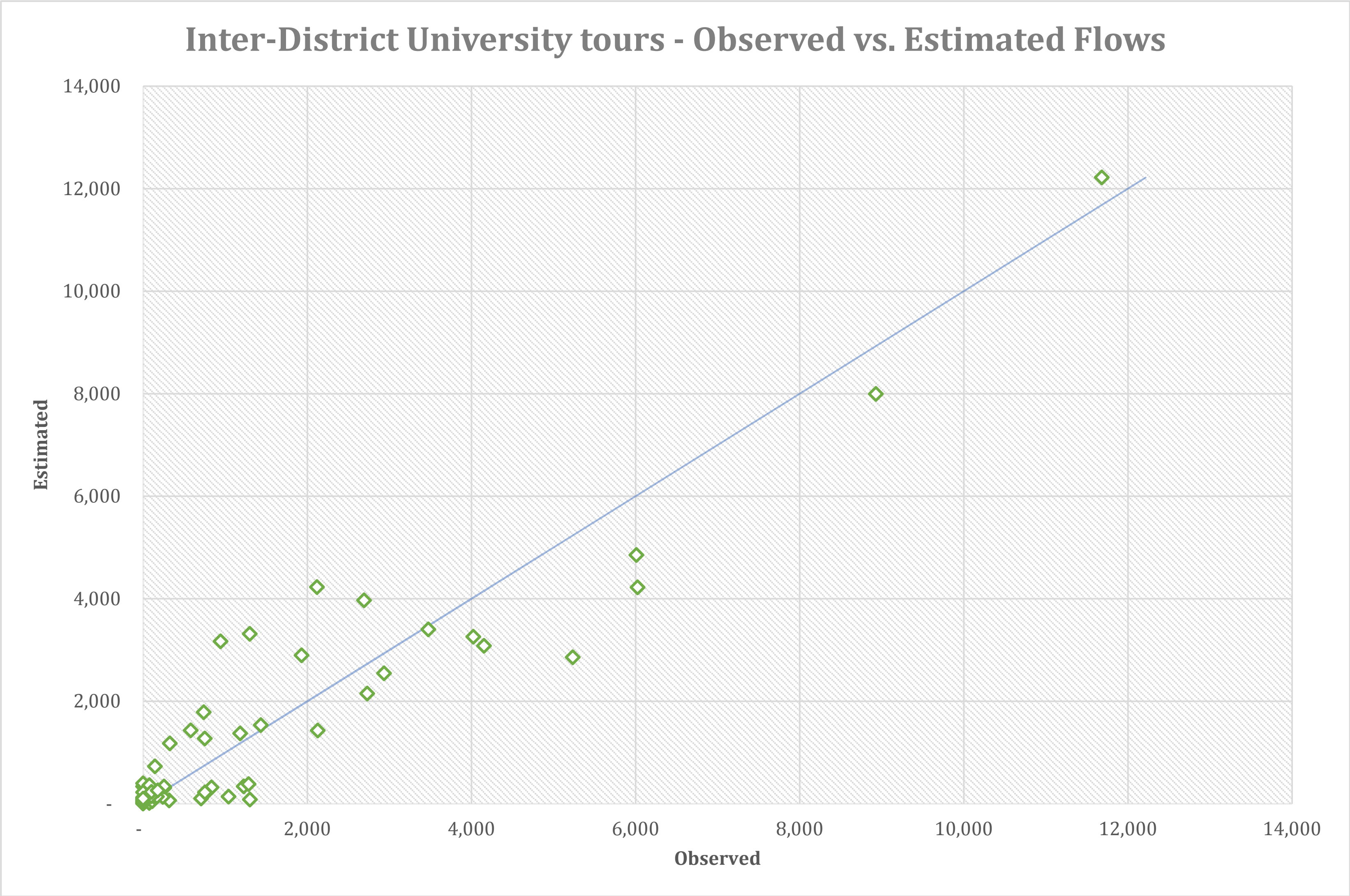
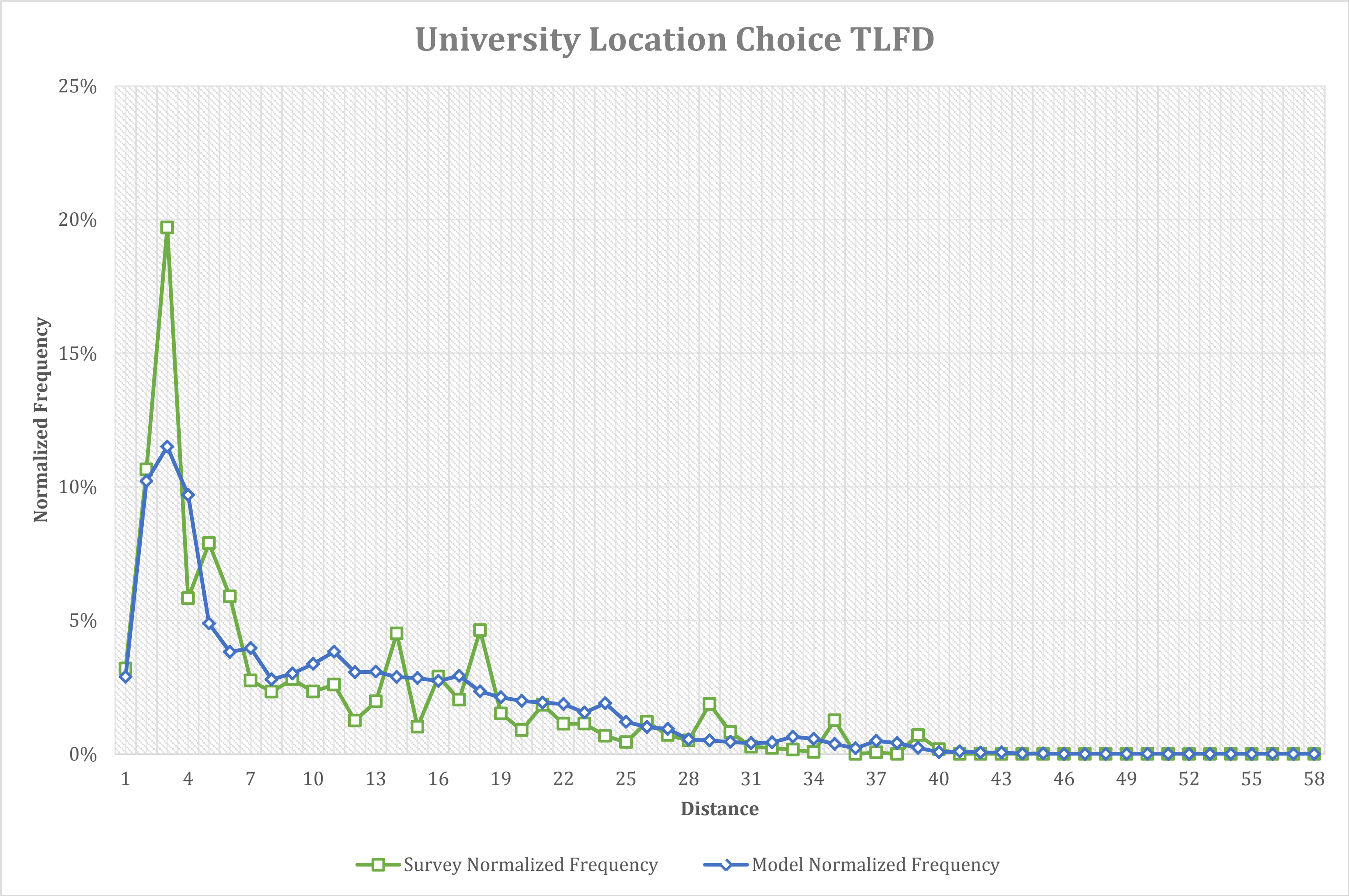


Figure 22: Trip Length Frequency Distribution University Flows



Mandatory Tour Frequency – University Student

The university tour frequency is predicted as a part of the mandatory tour frequency choice model for the university student. The model predicts the number of mandatory school tours for each university student. The model has six alternatives: no mandatory tours, one work tour, one school tour, two or more work tours, two or more school tours, one work tour plus one school tour. The base alternative for calibrating the Mandatory Tour Frequency model is the zero mandatory tour alternative. Several runs through the model were done to achieve satisfactory levels of calibration.

Table 79 summarizes the tour frequency model for the person type – university student. The survey shares and the modeled probabilities for all tour patterns match perfectly. The final adjustment factors applied to the model are also shown.

Table 34: Summary of Mandatory Tour Frequency model for University Student

University Student	*Pattern*						
	0 Work, 0 School Tours	1 Work Tour	2+ Work Tours	1 School Tour	2+ School Tours	Work & School Tours	Total
Survey shares	34.7%	27.8%	1.3%	32.2%	0.7%	3.3%	**100.0%**
Model probabilities	34.7%	27.8%	1.3%	32.2%	0.7%	3.3%	**100.0%**
Difference	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	**0.0%**
Final adjustment factors	Base	(0.4998)	2.4804	0.5664	(3.2910)	(0.5723)	--

Non-Mandatory Tour Frequency – University Student

The non-mandatory tour frequency model component of the university model predicts the number of non-mandatory (escorting, maintenance and discretionary) tours by purpose for each university student member. The base alternative for calibrating the non-mandatory tour frequency model is the 0 frequency alternative for each tour purpose. Several runs through the model were done to achieve satisfactory levels of calibration.

The results are tabulated in **Table 83** below. The observed and the predicted shares match very closely. The final adjustment factors used are also shown.

Table 35: Summary of Non-Mandatory Tour Frequency model for University Student

University student	**Tour Purpose Frequency**								
	Escorting			**Maintenance**			**Discretionary**		
	0	**1**	**2+**	**0**	**1**	**2+**	**0**	**1**	**2+**
Survey shares	91.7%	5.4%	3.0%	89.9%	9.1%	0.9%	87.2%	11.6%	1.2%
Model probabilities	91.7%	5.4%	3.0%	88.9%	8.9%	2.3%	87.2%	11.7%	1.1%
Difference	0%	0%	0%	-1%	0%	1%	0%	0%	0%
Final adjustment factors	base	0.04	(0.09)	base	(0.45)	(0.38)	base	0.07	(0.37)

At-Work Sub-Tour Frequency – University Student

The at-work sub-tour frequency model predicts the number of tours for each person who has at least one work tour. The model is applied after the mandatory tour frequency model. The model has three alternatives: no at-work sub tours, 1 at-work sub tour, and 2+ at-work sub tours. The base alternative for calibrating the At-Work Sub Tour frequency model is the zero tours alternative.

Table 36: Summary of At-work sub-tour Frequency model for University Student

University student	Number of tours			
	No Tours	1 at-work sub tour	2+ at-work sub tours	Total
Survey shares	92.9%	6.7%	0.4%	**100.0%**
Model probabilities	92.9%	6.8%	0.4%	**100.0%**
Difference	0.0%	0.0%	0.0%	**0.0%**
Final adjustment factors	Base	(0.4305)	(1.1840)	**--**

University Tour Mode Choice Model

The tour mode choice model predicts the tour mode for each tour. Tour mode choice model calibration was performed by comparing estimated versus observed tours by tour purpose, auto sufficiency, and tour mode.

The base alternative for calibrating the tour mode choice model was the drive alone mode, except for zero auto households, where the base alternative was the shared ride two-person mode since drive-alone is not available for households without cars. In some cases, the shared ride two-person mode was not available for some purposes in the zero auto household market, so another mode was chosen as the base. If this was the case, they are denoted in the tables below. Several runs through the model were done to achieve satisfactory levels of calibration. For details on how the calibration targets were arrived at, the reader is referred to the overall model calibration documentation.[1]

University Tour Mode Choice Results

A comparison of the model results with the observed data is presented in tables below. **Table 37** compares the observed and modeled mode shares by auto ownership levels for the university tour purposes. The percentage shares are tabulated in **Table 38**. **Table 39** summarizes the percentage differences. The modeled mode-shares match very closely with the observed mode-shares as can be seen from the tables. The final adjustment factors applied to the mode choice model for the university tour purpose is presented in **Table 40**.

[1] Tour-Based Travel Model Calibration/Validation: for Oahu Metropolitan Planning Organization, June 2013

Table 37: University Purpose Tour Mode Choice by Auto Ownership

Tour Mode	Observed				Estimated			
	Auto Sufficiency			Total	Auto Sufficiency			Total
	No Vehicles	Vehicles< Adults	Vehicles>= Adults		No Vehicles	Vehicles< Adults	Vehicles>= Adults	
Drive-Alone	0	3,869	5,141	**9,010**	0	3,866	5,140	**9,006**
Shared 2	0	3,643	1,940	**5,582**	0	3,637	1,940	**5,577**
Shared 3+	1,398	1,117	605	**3,120**	1,316	1,121	604	**3,041**
Walk	242	566	89	**897**	231	564	90	**885**
Bike	158	196	140	**495**	149	198	141	**488**
Walk-Transit	3,014	5,546	2,819	**11,379**	2,969	5,549	2,816	**11,334**
PNR-Transit	0	45	85	**129**	0	45	84	**129**
KNR-Transit	37	219	289	**545**	37	215	292	**544**
School Bus	0	0	0	**-**	0	0	0	**0**
Total	**4,850**	**15,200**	**11,108**	**31,158**	**4,702**	**15,195**	**11,107**	**31,004**

Table 38: University Purpose Tour Mode Choice Shares by Auto Ownership

Tour Mode	Observed				Estimated			
	Auto Sufficiency			Total	Auto Sufficiency			Total
	No Vehicles	Vehicles< Adults	Vehicles>= Adults		No Vehicles	Vehicles< Adults	Vehicles>= Adults	
Drive-Alone	0%	25%	46%	**29%**	0%	25%	46%	**29%**
Shared 2	0%	24%	17%	**18%**	0%	24%	17%	**18%**
Shared 3+	29%	7%	5%	**10%**	28%	7%	5%	**10%**
Walk	5%	4%	1%	**3%**	5%	4%	1%	**3%**
Bike	3%	1%	1%	**2%**	3%	1%	1%	**2%**
Walk-Transit	62%	36%	25%	**37%**	63%	37%	25%	**37%**
PNR-Transit	0%	0%	1%	**0%**	0%	0%	1%	**0%**
KNR-Transit	1%	1%	3%	**2%**	1%	1%	3%	**2%**
School Bus	0%	0%	0%	**0%**	0%	0%	0%	**0%**
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Table 39: Difference (Estimated minus Observed) in University Purpose Tour Mode Choice Shares by Auto Ownership

Tour Mode	Auto Sufficiency			Total
	No Vehicles	Vehicles< Adults	Vehicles>= Adults	
Drive-Alone	0%	0%	0%	0%
Shared 2	0%	0%	0%	0%
Shared 3+	-1%	0%	0%	0%
Walk	0%	0%	0%	0%
Bike	0%	0%	0%	0%
Walk-Transit	1%	0%	0%	0%
PNR-Transit	0%	0%	0%	0%
KNR-Transit	0%	0%	0%	0%
School Bus	0%	0%	0%	0%
Total	**0%**	**0%**	**0%**	**0%**

Table 40: Final Adjustment Factors for University Purpose Tour Mode Choice by Auto Ownership

Tour Mode	Final Adjustment Factors		
	Auto Sufficiency		
	No Vehicles	Vehicles< Adults	Vehicles>= Adults
Drive-Alone		base	base
Shared 2	N/A	1.34	0.62
Shared 3+	3.74	1.80	1.11
Walk	0.50	1.87	-1.18
Bike	-0.05	0.11	-1.39
Walk-Transit	base	2.14	1.16
PNR-Transit	N/A	0.44	0.46
KNR-Transit	0.51	1.54	1.30
School Bus	N/A	N/A	N/A

Intermediate Stop Location Choice Model

This model predicts the location of each intermediate stop (each location other than the primary destination) on the tour. In this model, a maximum of 4 stops on the outbound and 4 stops on the inbound direction are modeled for each tour. The OahuMPO stop location model was calibrated to match distributions from the home-interview survey. Three estimated versus observed frequency distributions were created to analyze model goodness-of-fit, out of direction stop distance, stop distance from the tour primary destination, and stop distance from the tour anchor location. The results are described below.

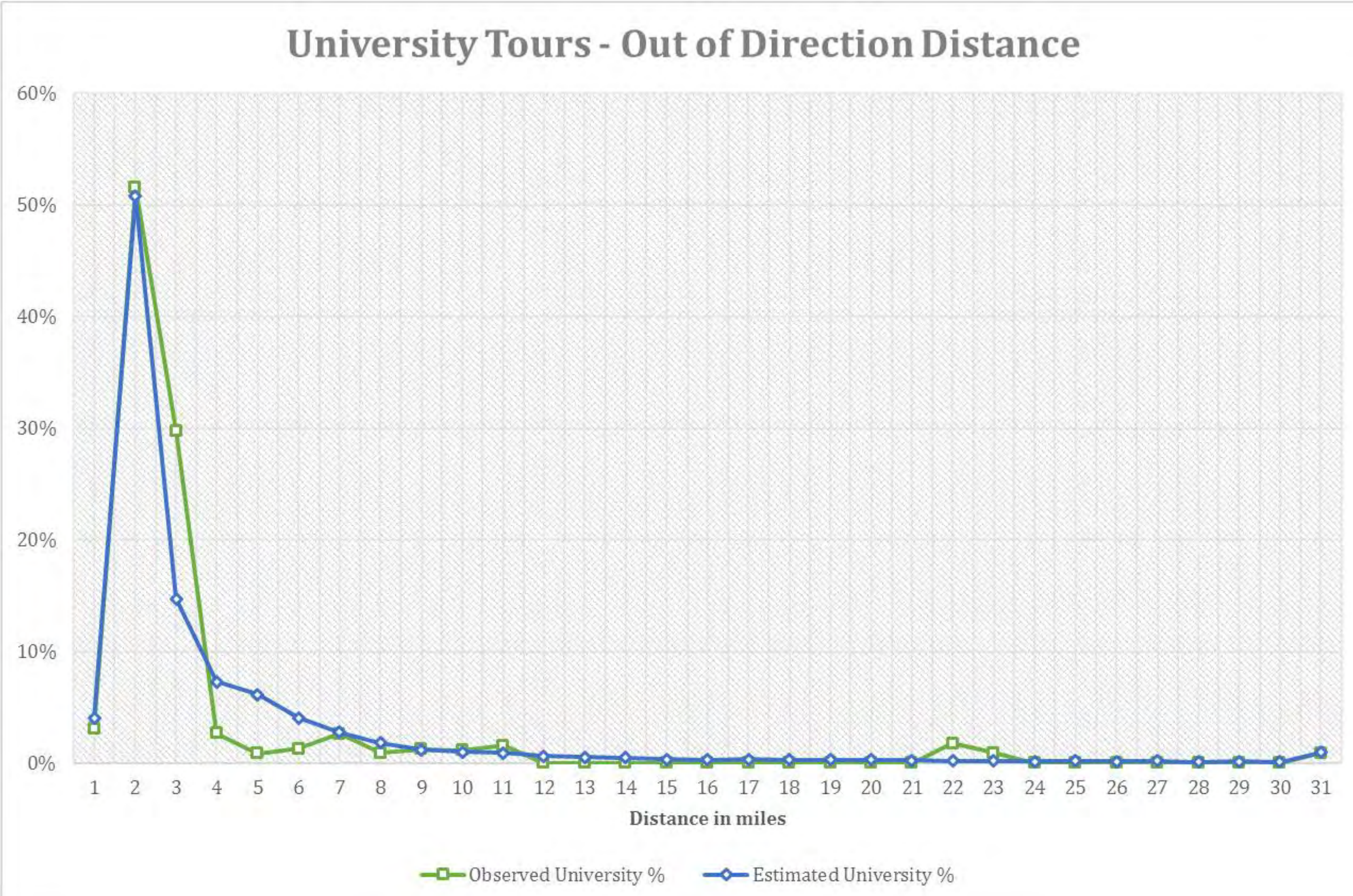
Out of Direction Stops

Table 136 shows the observed and estimated average out of direction distances by tour purpose. The normalized coincidence ratio is also shown to determine how well the estimated matched the observed out of direction distance in one mile increments. For the university tour purpose the model's average out of direction distance matches well. This result is reinforced visually - **Figure 23** displays the stop location choice model out of direction stop deviation distribution for the university tour purpose compared to the home interview survey.

Table 41: Observed versus Estimated Average Out of Direction Distance by Tour Purpose

Purpose	Observed Average out of direction Distance	Estimated Average out of direction Distance	Normalized Coincidence Ratio
University	2.27	2.72	0.68

Figure 23: University Tours Out of Direction Stop Location Distribution



Distance from Anchor Location (Origin Location on Tour) Stops

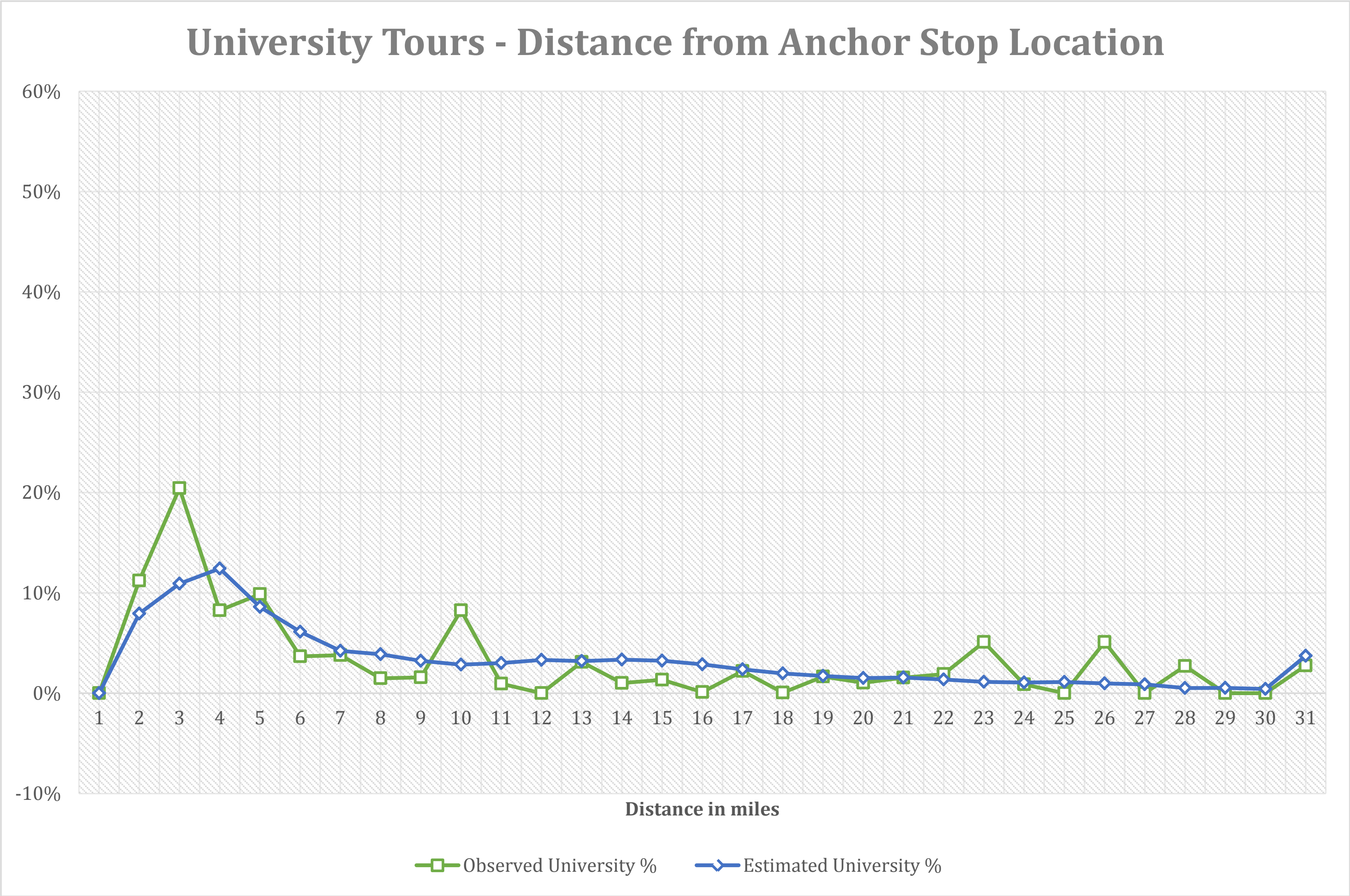
Table 42 shows the observed and estimated distance from anchor location for the university tour purpose. The normalized coincidence ratio is also shown to determine how well the estimated matched the observed distance from anchor location in one mile increments. This table shows that the model's average distance from anchor location is close to the observed value.

Table 42: Observed versus Estimated Average Distance from Anchor Location by Tour Purpose

Purpose	Observed Average Distance from Anchor Location	Estimated Average Distance from Anchor Location	Normalized Coincidence Ratio
University	8.57	8.90	0.53

Figure 24 displays the model's distance from anchor stop location frequency distribution for university tour purpose compared to the home interview survey. The model seems to perform well – the modeled distribution reasonably mimics the observed distribution.

Figure 24: University Tours Distance from Anchor Stop Location Distribution



Distance to Primary Destination Location Stops

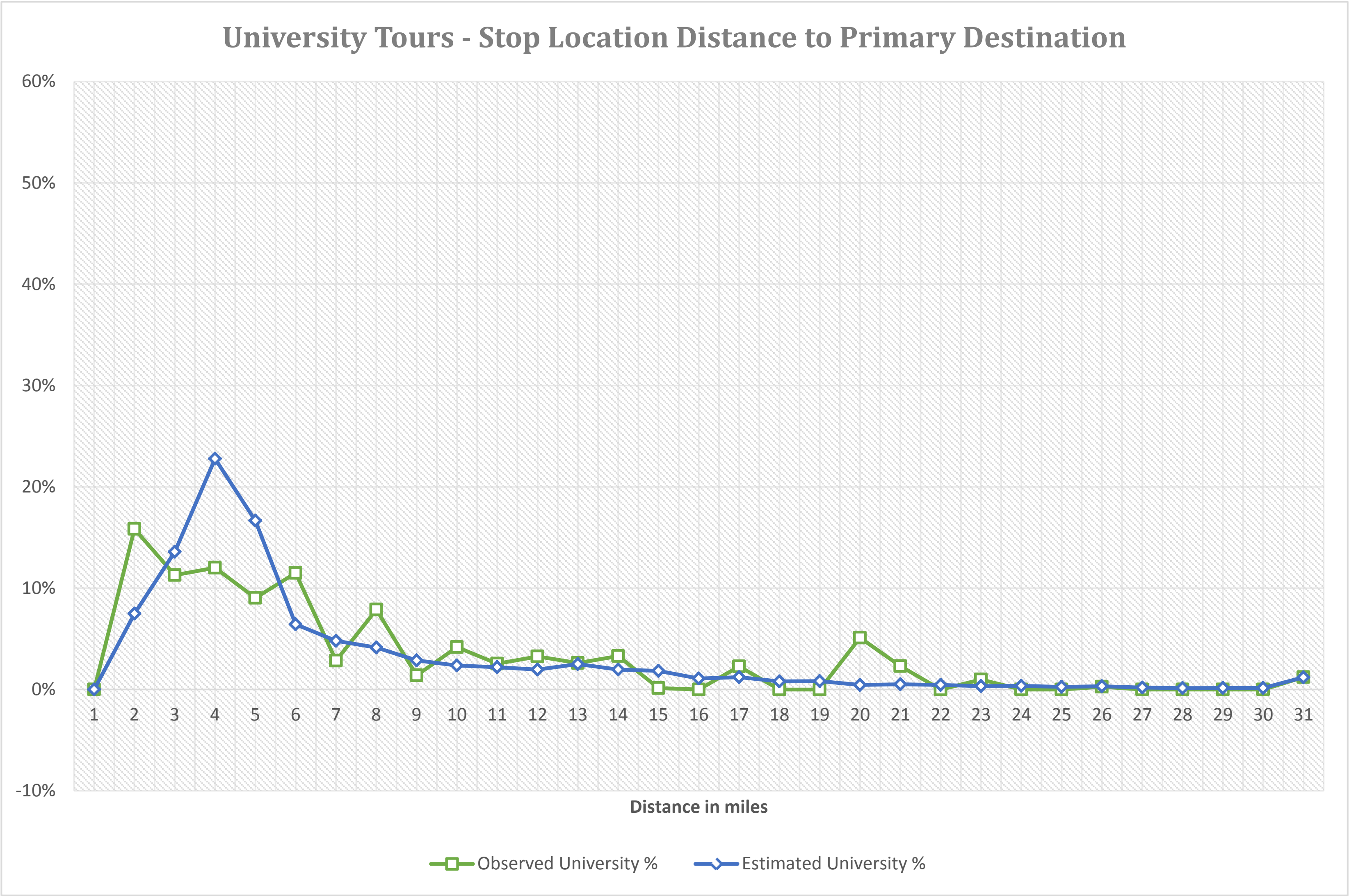
Table 138 shows the observed and estimated stop location distance to primary destination for the university tour purpose. The normalized coincidence ratio is also shown to determine how well the estimated matched the observed stop location distance to primary destination in one mile increments. This table shows that the model's average stop location distance to primary destination is short compared to the observed for the university tour purpose.

Table 43: Observed versus Estimated Average Distance to Primary Destination Location by Tour Purpose

Purpose	Observed Average Distance to Primary Destination Location	Estimated Avg. Distance to Primary Destination Location	Normalized Coincidence Ratio
University	6.21	5.54	0.54

Figure 25 displays the model's stop location distance to primary destination frequency distribution for the university tour purpose compared to the home interview survey. The estimated frequency distribution match the observed frequency distribution quite reasonably.

Figure 25: University Tours Stop Location Distance to Primary Destination Distribution



University Trip Mode Choice Model

The main tour mode is chosen at the tour level but this model predicts the mode for each individual trip on the tour. It is referred to as a trip mode "switching" model because it predicts the likelihood of each trip mode constrained by the chosen tour mode. The trip mode choice model was calibrated by tour purpose and tour mode, with constants applied to each trip mode. For details on how the calibration targets were arrived at, the reader is referred to the overall model calibration documentation.[2]

University Trip Mode Choice Results

Table 44 is a comparison of the observed and estimated trips by tour mode for the university tour purpose. **Table 45** shows the comparison of observed trip mode shares and estimated trip mode shares by tour mode. The next table, **Table 46,** shows the difference between the observed and estimated trip mode shares by tour mode. The final adjustment factors by trip mode and tour mode that were needed to calibrate each purpose is presented in Table 47. **Table 48** shows the estimated constants that the final adjustment factors will be added to in order to obtain the equivalent in-vehicle minutes of time (**Table 49**). Overall, the comparison shows that the model is performing well in predicting the trip mode for the university tour purpose.

[2] Tour-Based Travel Model Calibration/Validation: for Oahu Metropolitan Planning Organization, June 2013

Table 44: Observed vs. Estimated University Trips by Tour Mode

OBSERVED Trip Mode	Tour Mode: Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	24,355	3,343	1,063	0	0	0	0	48	0
Shared Ride 2	0	11,567	1,558	0	0	3,244	0	0	0
Shared ride 3+	0	0	4,671	0	0	591	0	0	0
Walk	0	114	248	2,275	0	3,721	0	0	0
Bike	0	0	0	0	1,360	0	0	0	0
Walk to Local	0	0	0	0	0	23,607	0	17	0
Walk to Express	0	0	0	0	0	290	547	0	0
Kiss and Ride	0	0	0	0	0	0	818	0	0
Park Ride Informal	0	0	0	0	0	0	0	226	0
Park Ride Formal	0	0	0	0	0	0	0	32	0
School Bus	0	0	0	0	0	0	0	0	0
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
		23,624		**837**			**32**		**226**

ESTIMATED Trip Mode	Tour Mode: Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	24,344	3,352	1,120	0	0	0	0	36	
Shared Ride 2	0	11,550	1,699	0	0	3,154	**170**	**42**	
Shared ride 3+	0	0	5,108	0	0	555	**183**	**35**	
Walk	0	115	284	2,412	0	3,514	**0**	**0**	
Bike	0	0	0	0	1,291	0	0	0	
Walk to Local	0	0	0	0	0	22,929	37	15	
Walk to Express	0	0	0	0	0	602	226	0	
Kiss and Ride	0	0	0	0	0	0	734	0	
Park Ride Informal	0	0	0	0	0	0	0	169	
Park Ride Formal	0	0	0	0	0	0	0	25	
School Bus									
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
		22,981		**828**			**25**		**169**

Table 45: Observed vs. Estimated University Trip Shares

OBSERVED Trip Mode	Tour Mode								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	100.0%	22.3%	14.1%	0.0%	0.0%	0.0%	0.0%	14.8%	0.0%
Shared Ride 2	0.0%	77.0%	20.7%	0.0%	0.0%	10.3%	0.0%	0.0%	0.0%
Shared ride 3+	0.0%	0.0%	61.9%	0.0%	0.0%	1.9%	0.0%	0.0%	0.0%
Walk	0.0%	0.8%	3.3%	100.0%	0.0%	11.8%	0.0%	0.0%	0.0%
Bike	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%
Walk to Local	0.0%	0.0%	0.0%	0.0%	0.0%	75.1%	0.0%	5.3%	0.0%
Walk to Express	0.0%	0.0%	0.0%	0.0%	0.0%	0.9%	40.1%	0.0%	0.0%
Kiss and Ride	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	59.9%	0.0%	0.0%
Park Ride Informal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	70.0%	0.0%
Park Ride Formal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	9.9%	0.0%
School Bus	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
		96.6%		**3.4%**			**12.4%**		**87.6%**
ESTIMATED Trip Mode	**Tour Mode**								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	100.0%	22.3%	13.6%	0.0%	0.0%	0.0%	0.0%	11.2%	0.0%
Shared Ride 2	0.0%	76.9%	20.7%	0.0%	0.0%	10.3%	12.6%	13.0%	0.0%
Shared ride 3+	0.0%	0.0%	62.2%	0.0%	0.0%	1.8%	13.6%	10.9%	0.0%
Walk	0.0%	0.8%	3.5%	100.0%	0.0%	11.4%	0.0%	0.0%	0.0%
Bike	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%
Walk to Local	0.0%	0.0%	0.0%	0.0%	0.0%	74.6%	2.7%	4.7%	0.0%
Walk to Express	0.0%	0.0%	0.0%	0.0%	0.0%	2.0%	16.7%	0.0%	0.0%
Kiss and Ride	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	54.4%	0.0%	0.0%
Park Ride Informal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	52.5%	0.0%
Park Ride Formal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	7.8%	0.0%
School Bus	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
		96.5%		**3.5%**			**12.9%**		**87.1%**

Table 46: Difference Estimated minus Observed University Trip Mode Share

Trip Mode	Tour Mode								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	0.0%	0.1%	-0.5%	0.0%	0.0%	0.0%	0.0%	-3.6%	0.0%
Shared Ride 2	0.0%	-0.1%	0.0%	0.0%	0.0%	-0.1%	12.6%	13.0%	0.0%
Shared ride 3+	0.0%	0.0%	0.3%	0.0%	0.0%	-0.1%	13.6%	10.9%	0.0%
Walk	0.0%	0.0%	0.2%	0.0%	0.0%	-0.4%	0.0%	0.0%	0.0%
Bike	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Walk to Local	0.0%	0.0%	0.0%	0.0%	0.0%	-0.5%	2.7%	-0.7%	0.0%
Walk to Express	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%	-23.3%	0.0%	0.0%
Kiss and Ride	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-5.6%	0.0%	0.0%
Park Ride Informal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-17.5%	0.0%
Park Ride Formal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-2.1%	0.0%
School Bus	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
		-0.1%		**0.1%**			**0.5%**		**-0.5%**

Table 47: Final Adjustment Factors for University Trip Mode Choice

Trip Mode	**Tour Mode**								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	BASE	0.4220	0.8611					-0.5507	
Shared Ride 2		BASE	0.7364			-0.4946	N/A	N/A	
Shared ride 3+			BASE			-1.1040	N/A	N/A	
Walk		1.2492	1.0230	BASE		1.6924	-0.7680	-1.9764	
Bike					BASE				
Walk to Local						BASE	N/A	0.7387	
Walk to Express						BASE	7.1963	N/A	
Kiss and Ride							BASE		
Park Ride Informal								BASE	
Park Ride Formal								BASE	
School Bus									BASE
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
		BASE		**-0.5386**			**0.3383**		**BASE**

Table 48: Estimated Constants for University Trip Mode Choice

Trip Mode	Tour Mode								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	BASE	-1.2413	-1.4807					-1.3823	
Shared Ride 2		BASE	-1.0979			-2.6892	-2.0000	-2.0000	
Shared ride 3+			BASE			-2.6892	-2.0000	-2.0000	
Walk		-4.6158	-2.9345	BASE		-2.5518	N/A	N/A	
Bike					BASE				
Walk to Local						BASE	-2.1140	-2.4039	
Walk to Express						BASE	-2.1140	-2.4039	
Kiss and Ride							BASE		
Park Ride Informal								BASE	
Park Ride Formal								BASE	
School Bus									BASE

Table 49: Equivalent In-vehicle minutes for University Trip Mode Choice

Trip Mode	Tour Mode								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	BASE	33	25					77	
Shared Ride 2		BASE	14			127	N/A	N/A	
Shared ride 3+			BASE			152	N/A	N/A	
Walk		135	76	BASE		34	N/A	N/A	
Bike					BASE				
Walk to Local						BASE	N/A	67	
Walk to Express						BASE	-203	N/A	
Kiss and Ride							BASE		
Park Ride Informal								BASE	
Park Ride Formal								BASE	
School Bus									BASE
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
		BASE		**22**			**-14**		**BASE**

Visitor Model

In 2011, a survey of airport departing passengers was conducted in which data was collected on their travel using standard Intercept survey methods and a web-based retrieval software (Tripbuilder) designed to map all locations visited and capture details about each location for the 24-hour period prior to departing the island. The survey relied on the willingness of visitors to (1) provide demographic information about the visitor, and (2) record all travel-related details including information for all locations visited, trip purpose, mode, and travel times. In total, 846 visitors were recruited to participate in the visitor study; which produced a total of 5,231 places visited. This survey was used to develop and calibrate the Oahu visitor model.

The visitor model has the following features:

- A disaggregate micro-simulation treatment of visitors by person type, with explicit representation of party attributes.
- Special consideration of unique visitor travel patterns, including rental car usage and visits to Oahu area attractions like Polynesian Cultural Center, and Waikiki Aquarium.
- The full set of modes like the residential model, including auto trips by occupancy, transit trips, non-motorized trips. The Oahu visitor model also includes trolley, tour bus, and taxi as competing modes.

The visitor model represents all travel made by visitors to Oahu on an average weekday. It is a more comprehensive treatment than the trip-based visitor model that it replaces. The model flow and inputs are shown in Figure 26, and described in detail in the following sections.

Model Inputs

The model system requires the following exogenously-specified inputs:

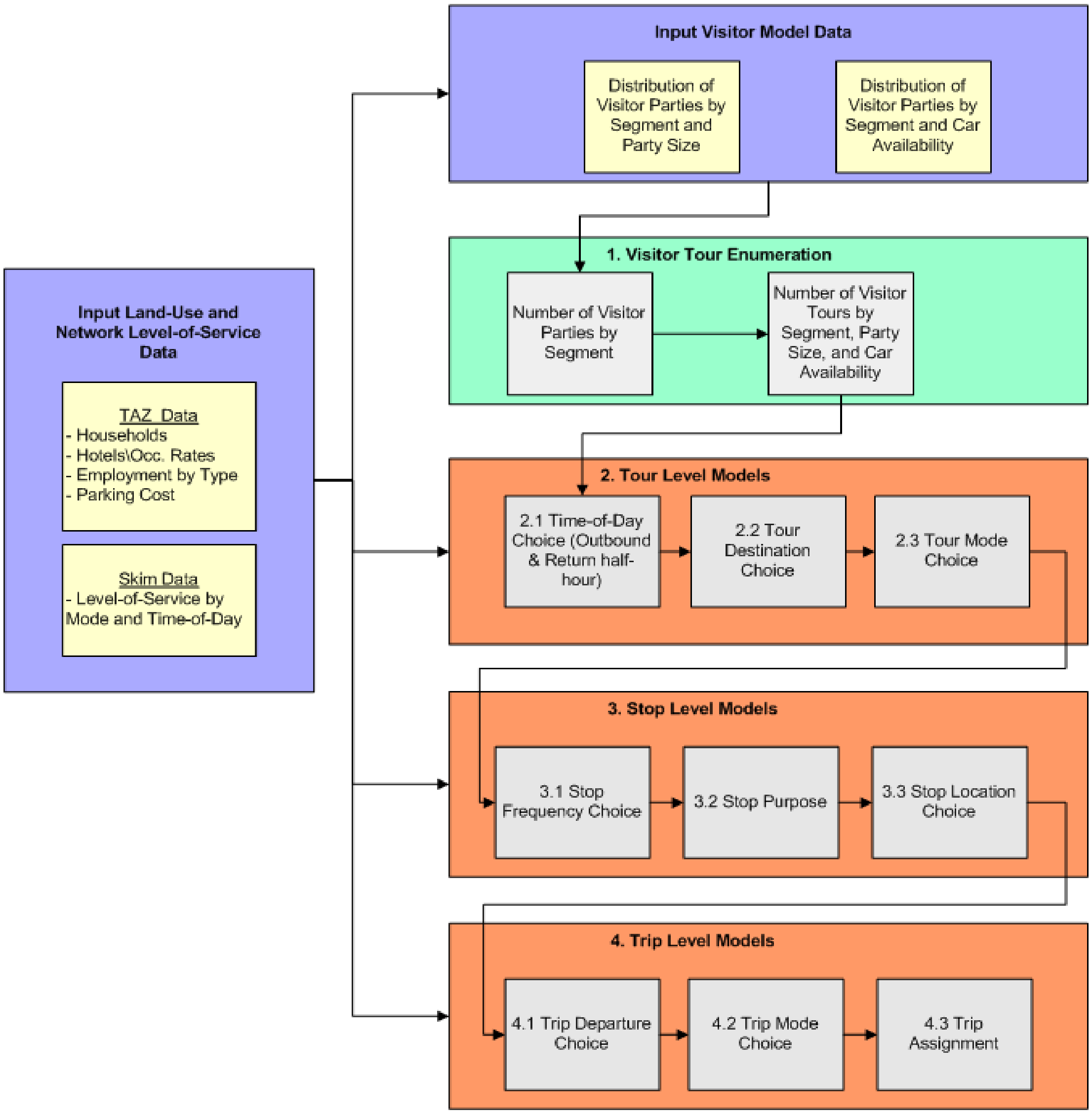
- **Traveler characteristics distributions**. There are a number of distributions of traveler characteristics that are assumed to be fixed but can be changed by the analyst to determine their effect on the results. These include the following:
  - Rates of visitor occupancy for hotels and separately for households
  - Shares of visitor parties by visitor segment for hotels and separately for households
  - The distribution of visitor parties by household income.
  - The distribution of business segment travel parties by number of tours by purpose
  - The distribution of personal segment travel parties by number of tours by purpose
  - The distribution of visitor tours by tour purpose and party size
  - The distribution of visitor tours by tour purpose and auto availability
  - The distribution of visitor tours by outbound and return time-of-day and tour purpose
  - The distribution of visitor tours by frequency of stops per tour by tour purpose, duration, and direction
  - The distribution of stops by stop purpose and tour purpose
  - The distribution of stops on outbound tour legs by half-hour offset period from tour departure period and time remaining on tour

    - The distribution of stops on inbound tour legs by half-hour offset period from tour arrival period and time remaining on tour
- **TAZ data.** The population, employment (by type), and number of hotel rooms in each TAZ. This is the same data set used in the resident tour-based model.
- **TAZ skim data.** Auto and transit network level-of-services between each transportation analysis zone. This provides sensitivity to auto and transit network supply and cost. These are the same data sets as are used in the resident tour-based model.

Model Description

This section describes the model system briefly, followed by a more in-depth discussion of each model component.

Figure 26: Oahu Visitor Model Design



- **Visitor Tour Enumeration:** Visitor travel parties are created by visitor segment based upon input hotels and households. Travel parties are attributed with household income. Tours by purpose are generated for each party. Each tour is attributed with auto availability and party size. The tour origin TAZ is set to the TAZ where the tour was generated.
- **Tour Level Models**

.1. Tour Time of Day: Each tour is assigned a time of day, based on probability distribution.

.2. Tour Destination choice: Each tour is assigned a primary destination, based on the coefficients estimated through a multinomial logit model.

.3. Tour Mode Choice: Each tour selects a preferred primary tour mode, based on an asserted nested logit model (the resident tour mode choice model).

- **Stop Models**

.1. Stop Frequency Choice: Each tour is attributed with a number of stops in the outbound direction and in the inbound direction, based upon sampling from a distribution.

.2. Stop Purpose: Each stop is attributed with a purpose, based upon sampling from a distribution.

.3. Stop Location Choice: Each stop is assigned a location based upon a multinomial logit model (asserted based upon resident stop location choice models)

- **Trip Level Models**

.1. Trip Departure Choice: Each trip is assigned a departure time period based upon sampling from distributions.

.2. Trip Mode Choice: Each trip within the tours selects a preferred trip mode, based on an asserted nested logit model.

.3. Trip Assignment: Each trip is assigned to the network.

Visitor Travel Parties and Tour Generation

This section describes the generation of visitor travel parties, the generation of tours, and the attribution of each.

Visitor Travel Party Generation

The number of visitors to Oahu according to the Hawaii Tourism Authority 2010 Annual Visitor Research Report, are summarized by visitor segment in Table 50.

Table 50: Number of Visitors

Trip Purpose	Count	%
Business Only	494,242	11%
Pleasure Only	3,679,941	85%
Both (Imputed)*	154,666	4%
Total	4,328,849	100%

Visitors are generated for two visitor segment types:

- **Business:** Self-identified as business traveler, or self-identified as 'Both Business and Personal' but took at least one 'business' purpose trip on travel day
- **Personal:** Self-identified as personal traveler, or self-identified as 'Both Business and Personal' but took no business purpose trips on travel day. A few self-identified Personal travelers have reported Work tours.

The model generates visitor parties by segment by applying separate occupancy rates to hotels and households, which were obtained from the Hawaii Tourism Authority and the Visitor Travel Survey, respectively. The occupancy rate for hotels is 85%, while the occupancy rate for households is 2.2% (a bit more than 2 out of every 100 households on Oahu have visitors, on average).

Visitor parties are attributed with household income based upon the distribution of parties by visitor segment and income, as shown in Table 51. Note that party size and auto availability are attributed on a tour-by-tour basis, since these attributes can change depending on which tour is undertaken and which day it is taken on.

Table 51: Visitor Parties by Visitor Segment and Household Income

Income	Business	Personal
Less than $10,000	0.64%	0.73%
$10,000 to $14,999	0.00%	1.05%
$15,000 to $24,999	0.00%	2.58%
$25,000 to $34,999	1.92%	3.55%
$35,000 to $49,999	7.05%	13.24%
$50,000 to $74,999	15.38%	20.58%
$75,000 to $99,999	14.74%	10.17%
$100,000 to $149,999	16.67%	15.09%
$150,000 to $199,000	8.97%	3.55%
$200,000 or more	12.82%	4.68%
Refuse to answer	21.79%	24.78%
Total	100.00%	100.00%

Tour Generation

Next, tours are generated by visitor parties and attributed with party size, auto availability, and income attributes. There are four tour purposes, which were coded based on the reported trip purpose in the survey, as follows:

- **Work:** Business travel made by Business travelers
- **Recreational:** All other recreational purposes besides shopping and dining
- **Shopping:** Shopping at malls or other shopping places
- **Dining:** Travel to eating establishments

Tour purpose was coded according to a hierarchy of trip purposes, with work at the top and dining last. Tours by visitor segment are shown in Table 52.

Table 52: Tour Purpose by Visitor Segment

Person Type	Business	% of Total	Personal	% of Total
Work	4,736	45%	742	1%
Recreational	2,301	22%	75,767	60%
Shopping	1,174	11%	23,087	18%
Dining	2,355	22%	27,598	22%
Total	10,565	100%	127,194	100%

Each travel party can generate one or more tours of each purpose on any given day. The tour generation rates are shown in Table 53 (for the business segment) and Table 54 (for the personal segment).

Table 53: Tour Distribution, Business Parties

Work	Recreational	Shopping	Dining	Frequency
0	0	0	1	3.19%
0	0	1	0	2.13%
0	0	2	0	1.06%
0	1	0	0	9.57%
0	1	0	1	5.32%
0	1	1	0	4.26%
0	2	0	0	2.13%
0	2	0	1	1.06%
1	0	0	0	29.79%
1	0	0	1	21.28%
1	0	0	2	2.13%
1	0	1	0	4.26%
1	0	1	1	3.19%
1	1	0	0	6.38%
1	1	0	1	1.06%
1	1	1	0	1.06%
2	0	0	0	1.06%
2	2	0	0	1.06%

Table 54: Tour Distribution, Personal Parties

Work	Recreational	Shopping	Dining	Frequency
0	0	0	1	2.40%
0	0	0	2	0.14%
0	0	1	0	7.07%
0	0	1	1	3.68%
0	0	1	2	0.28%
0	0	2	0	1.98%
0	0	2	1	0.14%
0	0	3	0	0.14%
0	1	0	0	29.99%
0	1	0	1	18.39%
0	1	0	2	1.13%
0	1	1	0	10.04%
0	1	1	1	1.84%
0	1	2	0	1.13%
0	1	2	1	0.14%
0	2	0	0	11.88%
0	2	0	1	4.53%
0	2	0	2	0.14%
0	2	1	0	2.55%
0	2	1	1	0.28%
0	2	1	2	0.14%
0	3	0	0	0.71%
0	3	0	1	0.28%
0	3	1	0	0.28%
1	0	0	0	0.42%
1	0	0	1	0.14%
1	0	1	0	0.14%

The average party size observed in the survey is used in the model. The distribution of visitor tours by party size and tour purpose is shown in Table 55.

Table 55: Tours by Party Size and Tour Purpose

Party Size	Work	Recreate	Shopping	Dining
1	48.6%	9.6%	11.9%	9.4%
2	23.0%	54.0%	51.4%	55.2%
3	12.2%	13.1%	17.4%	12.2%
4	6.8%	13.5%	8.7%	13.2%
5	0.0%	3.6%	4.7%	5.2%
6	0.0%	2.3%	1.6%	1.7%
7	2.7%	0.5%	0.4%	1.7%
8	0.0%	1.0%	1.2%	0.3%
9	0.0%	0.6%	0.4%	0.3%
10	6.8%	1.8%	2.4%	0.7%
Total	100%	100%	100%	100%

Most visitors in the visitor survey did not have access to an automobile. The model uses the distribution of tours by auto availability to attribute each tour with whether an auto is available, as shown in Table 56.

Table 56: Auto Availability by Tour Purpose

	Work	Recreate	Shopping	Dining
Auto Available	41.9%	36.4%	27.3%	32.6%
No Auto Available	58.1%	63.6%	72.7%	67.4%
Total	100%	100%	100%	100%

Visitor Time of Day

Number of Models: 4 (Work, Recreational, Shopping Dining)
Decision-Making Unit: Tour
Model Form: Look up table
Alternatives: 40 half-hour time-of-day periods by purpose

This model selects an outbound and return half-hour period, based on a probability distribution created using the visitor survey observed tour arrival and departure data, by tour purpose. Model input is the observed percent of tours by purpose with each combination of departure and arrival time period.

Visitor Destination Choice

Number of Models: 4 (Work, Recreational, Shopping, Dining)
Decision-Making Unit: Tour
Model Form: Multinomial logit

Alternatives: MGRAs

The visitor tour destination choice model predicts the 'preferred' destination for the tour at the TAZ level for each the 4 purposes; work, shop, recreation, and dining. The model predicts the location of where the traveler is going based on mode choice logsums, distance terms, zonal employment as explanatory variables. These models were estimated in a multinomial logit form using the ALOGIT software.

Visitor Work Model Estimation

The first model estimated was the visitor work purpose. This purpose had 74 observations in the survey set.

Main Explanatory Variables

The following variables have been examined and proved to be significant in the utility functions:

- Mode Choice Logsum (the coefficient was held constant at 1 since the estimated value was slightly over 1). A mode choice logsum larger than 1 is not considered reasonable, because it means that the choice of mode has the most influence on the choice of destination.
- Size Terms:
    - Military Employment
    - All Other Employment (not military)
- Indicator for Convention Center as work location

Results

The visitor work destination choice results are summarized in Table 22.

Table 57: Oahu Visitor Work Destination Choice Model Estimation Results

Observations: 74
Final log likelihood: -382.0538
Rho-Squared (0): .2223
Rho-Squared (constant): -0.5477

Utility Function Variables	Coeff	T-Stat
Mode Choice Logsum	1.0	--
Size Function		
Military Employment	1.000	
All Other Employment	0.32712	-2.52
Convention Center Indicator	19440.3	19.92

Findings:

- The coefficient on mode choice logsum was slightly over 1, so it was held constant at 1.
- Size term effects:
    - Military employment, and 'other' employment attracts visitor work tours.

- The convention center indicator's relatively large and signfiicant value showed that the convention center is a highly attractive destination for visitors on business or work tours.

Visitor Recreation Model Estimation

The visitor recreation purpose had 779 observations in the dataset. This purpose includes all tours that have a primary stop other than work or dining.

Main Explanatory Variables

The following variables have been examined and proved to be significant in the utility functions:

- Mode Choice Logsum
- Natural log of distance
- Rental car indicator by distance
- Visitor party size by distance
- Size Terms:
    - Retail Employment
    - Hotel Employment
- Indicators for:
    - Ala Moana Park
    - Aloha Tower
    - Bishop Museum
    - Diamond Head
    - Hanauma Bay
    - Honolulu Zoo
    - Iolani Palace
    - Pearl Harbor/Arizona Memorial
    - Polynesian Cultural Center
    - Punchbowl National Cemetery
    - Fort Derussy Museum
    - University of Hawaii Museum
    - Waikiki Aquarium
    - Waimea Falls Park

Results

The visitor recreation destination choice results are summarized in Table 58.

Table 58: Oahu Visitor Recreation Destination Choice Model Estimation Results

Observations: 74
Final log likelihood: -382.0538
Rho-Squared (0): .2223
Rho-Squared (constant): -0.5477

Utility Function Variables	Coeff	T-Stat
Mode Choice Logsum	0.199	1.62
Log Distance	-0.221	-3.06
Rental Car Indicator by Distance	0.034	4.37
Visitor Party Size by Distance	-0.016	-3.47
Size Function		
Retail Employment	1.000	
Hotel Employment	1.88394	4.71
Ala Moana Park	1714.15	24.96
Aloha Tower	960.926	20.80
Bishop Museum	624.822	11.00
Diamond Head	4618.95	41.48
Hanauma Bay	5663.74	38.31
Honolulu Zoo	230.005	11.63
Iolani Palace	1998.31	24.28
Pearl Harbor/Arizona Memorial	5782.33	52.20
Polynesian Cultural Center	5812.99	31.70
Punchbowl National Cemetary	741.268	13.04
Fort Derussy Museum	2137.72	27.04
University of Hawaii Manoa	219.881	7.21
Waikiki Aquarium	1079.97	18.38
Waimea Falls Park	2071.96	28.81

Final Model:

- The coefficient on mode choice logsum was between 0 and 1 as expected.
- The log of distance as well as rental car availability and visitor party interacted with distance had a significant effect on visitors making recreational tours.
- Size term effects:
    - Retail and hotel employment attracts visitor recreational tours.

- A number of popular visitor attractions were also included in the model that indicated their relative attractiveness as a recreational destination for visitors. Special size terms were used for these locations since the number of visitors they attract is much larger than the employment for these locations would otherwise indicate. The size terms were further adjusted in model calibration to better match observed data for a subset of these locations where such data was available.

Visitor Shopping Model Estimation

The visitor dining purpose had 253 observations in the data set.

Main Explanatory Variables

The following variables have been examined and proved to be significant in the utility functions:

- Mode Choice Logsum
- Log distance
- Size Terms:
  - Retail Employment
  - Other Employment (not retail)
- Indicators for:
  - Ala Moana Shopping Center
  - International Marketplace
  - Royal Hawaiian Shopping Center
  - Waikele Premium Outlets

Results

The visitor shopping destination choice results are summarized in Table 59.

Table 59: Oahu Visitor Shopping Destination Choice Model Estimation Results

Observations: 253
Final log likelihood: -901.7107
Rho-Squared (0): 0.4631
Rho-Squared (constant): -0.1708

Utility Function Variables	Coeff	T-Stat
Mode Choice Logsum	0.726	4.32
Log Distance	-0.929	-8.17
Size Function		
Retail Employment	1.000	
Other Employment	0.45267	-2.03
Ala Moana Shopping Center	22.3012	10.14
International Marketplace	2.76998	4.27
Royal Hawaiian Shopping Center	1.73016	2.60
Waikele Premium Outlets	36.0509	7.19

Final Model:

- The coefficient on mode choice logsum was between 0 and 1 as expected.
- The log distance term had a significant effect on visitors making shopping tours.

- Size term effects:
    - o Retail, and other employment attracts visitor shopping tours.

- Four popular visitor shopping centers were also included in the model that indicated their relative attractiveness as a shopping destination for visitors.

Visitor Dining Model Estimation

The visitor dining purpose had 288 observations in the data set.

Main Explanatory Variables

The following variables have been examined and proved to be significant in the utility functions:

- Mode Choice Logsum
- Distance terms (linear, squared, log)
- Rental car indicator by distance
- Size Terms:
    - o Retail Employment
    - o Service Employment
    - o Hotel Employment
    - o Households

Results

The visitor dining destination choice results are summarized in Table 60.

Table 60: Oahu Visitor Dining Destination Choice Model Estimation Results

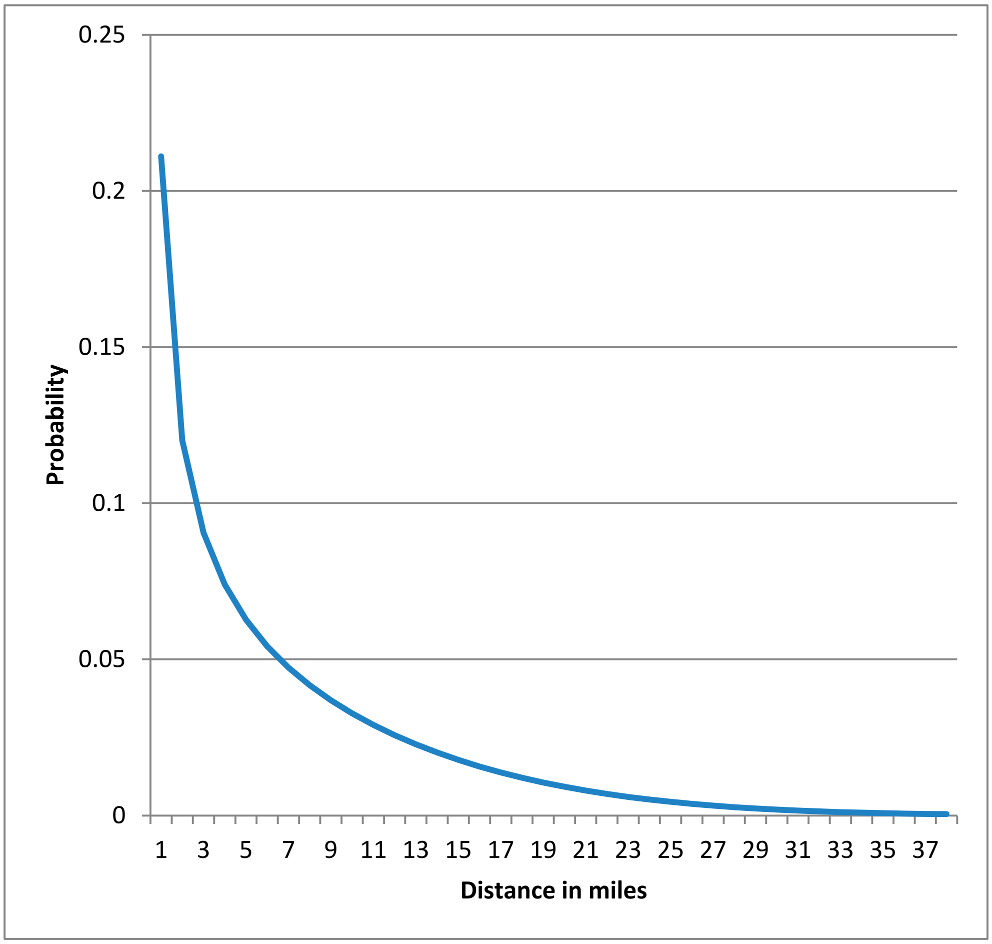
Observations: 288
Final log likelihood: -913.8345
Rho-Squared (0): 0.5220
Rho-Squared (constant): -0.0067

Utility Function Variables	Coeff	T-Stat
Mode Choice Logsum	0.310	2.04
Linear Distance	-0.026	-0.30
Squared Distance	-0.002	-1.24
Log Distance	-1.118	-9.36
Rental Car Indicator by Distance	0.071	1.36
Size Function		
Retail Employment	1.000	
Service Employment	0.07901	-3.81
Hotel Employment	2.74431	4.69
Households	0.02174	-3.50

Final Model:

- The coefficient on mode choice logsum was between 0 and 1 as expected.
- The linear, square, and log distance terms as well as rental car availability interacted with distance had a significant effect on visitors making dining tours.
- *Composite distance function* (or distance decay factor) has been defined as a combination of linear, squared and natural logged distance terms with different coefficients. This term should be analyzed as a composite term and the coefficient (positive or negative) of individual terms should not be looked at. For example, the coefficient on linear distance is positive but it does not mean that workers choose distant locations as work places. But, the combined effect of all terms should be looked at. Figure 27 shows the distance decay factor. This function is monotonously decreasing in within the maximum chosen distance range.

Figure 27: Visitor Dining Purpose Distance Decay Factor



- Size term effects:
    - Retail, service, and hotel employment attracts visitor dining tours.
    - Households also attract visitor dining tours.

Visitor Tour Mode Choice

Number of Models:	1
Decision-Making Unit:	Tour
Model Form:	Nested Logit
Alternatives:	15 Tour Modes (all the residential tour modes plus trolley, tour bus, and taxi except, park and ride, kiss and ride, and school bus)

In 2011, OahuMPO conducted a survey of airport passengers departing Honolulu International Airport to their country of residence in which data was collected on their travel while visiting Oahu. Based upon this data, a model of visitor travel was developed. The visitor tour mode choice model determines the "main tour mode" used to get from the origin to the primary destination and back.

Mode Specification

The visitor tour mode choice model predicts the 'preferred' mode for the tour. The model considers the following alternatives:

- Auto (Drive alone, s hared ride 2 persons, shared ride 3+ persons)
- Non-motorized (Walk or Bike)
- The Bus (local transit)
- Waikiki Trolley
- Tour Bus or Shuttle Bus
- Taxi

The mode of each tour is identified based on the combination of modes used for all trips on the tour, according to the following rules:

- ✓ If any trip on the tour is The Bus, then the tour mode is The Bus (local transit).
- ✓ If any trip on the tour is trolley, then the tour mode is trolley.
- ✓ If any trip on the tour is tour or shuttle bus, then the tour mode is tour or shuttle bus
- ✓ If any trip on the tour is taxi or limo, then the tour mode is taxi or limo..
- ✓ If any trip on the tour is Shared-Ride 3+, then the tour mode is Shared-Ride 3+
- ✓ If any trip on the tour is Shared-Ride 2, then the tour mode is Shared-Ride 2.
- ✓ If any trip on the tour is Drive-Alone, then the tour mode is Drive-Alone.
- ✓ If any trip on the tour is bike, then the tour mode is bike.
- ✓ All remaining tours are Walk.

These tour modes create a hierarchy of importance that ensures that transit is available for trips on tours with transit as the preferred mode, and that high-occupancy vehicle lanes are available for trips on tours where shared-ride is the preferred mode.

Model Utility and Structure:

Because of the small visitor survey data set size, the visitor tour mode choice is a simple logit model with time and cost coefficients. The utility expression for each mode (i) is specified as a linear function of alternate specific constants, level of service variables (such as time and cost), location specific measures and socio-economic (SE) characteristics as shown below:

$$U_i = \beta_1 * Time_i + \beta_2 * Cost_i$$

The travel time variables are typically disaggregated into in-vehicle and out-of-vehicle time at a minimum, with out-of-vehicle time stratified by walk time, initial wait, and transfer wait time (the latter two categories applicable to the transit mode(s)). Similarly, travel cost is often disaggregated into the more general out-of-pocket costs (i.e., automobile operating costs and transit fare) and destination parking cost

And the following is the equation for the probability of choosing auto:

$$P_{Auto} = \frac{e^{U_{Auto}}}{e^{U_{Auto}} + e^{U_{Non-motorized}} + e^{U_{TheBus}} + e^{U_{Trolley}} + e^{U_{TourBus}} + e^{U_{Taxi}}}$$

Estimation Datasets

The visitor survey used for tour mode choice estimation consisted of 846 completed surveys. These 846 surveys generated 1,339 visitor tours. See Table 62 for distribution of tours by mode and purpose.

Main Explanatory Variables

The following variables have been examined and proved to be significant in the utility functions:

- Total time on tour
- Travel cost on the tour
- Mixed use variable for each TAZ as defined by:

$$hhprop = \frac{totalHH(taz)}{totalHH(taz) + totalemp(taz)}$$

$$empprop = 1 - hhprop$$

$$if\ hhprop{>}0\ then\ hhterm = hhprop \times \ln hhprop\ end$$

$$if\ empprop{>}0\ then\ empterm = empprop \times \ln empprop\ end$$

$$mix = \frac{-(1) \times (hhterm + empterm)}{\log(2)}$$

- The following are some constraints within this model:
    - Tour bus/shuttle only available for recreation tours

- Since tour bus isn't really a mode choice (people choose to go on a tour, they don't choose to go on a tour bus instead of walking, for example), only the constant was estimated for tour bus/shuttle mode.
- The wait time and walk time variables were constrained to be the same as in-vehicle time, on the premise that visitors don't really know about bus alternatives.
- The wait and walk times for non-bus modes was set to 0, since they are just constants for non-bus modes (they don't vary)

Results

The visitor tour mode choice estimation results are summarized in Table 61.

Table 61: Oahu Visitor Tour Mode Choice Model Estimation Results

Observations: 1339
Final log likelihood: -1128.7256
Rho-Squared (0): 0.4485
Rho-Squared (constant): 0.2290

Utility Function Variables	Coeff	T-Stat
Total time on tour	-.008193	-6.7
Travel cost on tour	-.02147	-4.7
Mixed Use for walk	0.2074	1.1
Constants		
Walk	1.846753	11.10
Trolley	-0.283261	-1.07
Local Bus	0.353831	1.63
Tour Bus/Shuttle	-0.607946	-3.59
Taxi	-0.797271	-3.08
Rental Car available Walk mode	-1.980893	-10.67
Rental Car available Local Bus mode	-3.622526	-6.80
Rental Car available Trolley mode	-2.870359	-5.66
Rental Car available Tour Bus/Shuttle mode	-2.546276	-8.59
Rental Car available Taxi mode	-2.231856	-5.64
Shopping Purpose Walk Mode	0.623080	2.47
Shopping Purpose Local Bus mode	1.017787	3.05
Shopping Purpose Trolley mode	1.720115	4.58
Shopping Purpose Taxi mode	0.369927	0.77

Dining Purpose Walk mode	1.306206	5.20
Dining Purpose Local Bus mode	-0.835750	-1.30
Dining Purpose Trolley mode	-0.815274	-1.04
Dining Purpose Taxi mode	1.018327	2.43
Work Purpose Walk mode	-0.018586	-0.05
Work Purpose Taxi mode	0.901955	1.64

Findings:

- The coefficient on total time and travel cost on tour is negative as expected.
- The mixed use variable for the walk mode is positive which is good because it gets walk tours in the right places.
- Finally, alternative specific constants (ASCs) were tested for each mode and tour purpose.

Table 62: Survey Respondents by Purpose and Tour Mode (Tours and Distribution)

Mode	Auto Available				Auto Unavailable			
	Work	Recreation	Shopping	Dining	Work	Recreation	Shopping	Dining
DA/motorcycle	1,172	973	128	78	20	509	1,536	108
SR2	1,017	7,340	822	1,332	152	3,867	222	286
SR3	246	9,149	2,082	1,403	1,279	4,466	597	440
The Bus	-	192	372	-	-	5,204	2,824	118
Trolley	-	208	171	-	-	3,289	2,993	193
Tour Bus	-	782	-	182	533	7,952	222	590
Shuttle	-	561	60	-	103	531	675	-
Taxi/limo	33	792	-	-	167	1,513	550	886
bike/moped					-	1,013	723	49
walk	130	6,728	2,358	7,014	1,384	25,924	9,776	18,012
Total	2,599	26,726	5,993	10,008	3,637	54,267	20,118	20,682
Mode	Auto Available				Auto Unavailable			
	Work	**Recreation**	**Shopping**	**Dining**	**Work**	**Recreation**	**Shopping**	**Dining**
DA/motorcycle	45%	4%	2%	1%	1%	1%	8%	1%
SR2	39%	27%	14%	13%	4%	7%	1%	1%
SR3	9%	34%	35%	14%	35%	8%	3%	2%
The Bus	0%	1%	6%	0%	0%	10%	14%	1%
Trolley	0%	1%	3%	0%	0%	6%	15%	1%
Tour Bus	0%	3%	0%	2%	15%	15%	1%	3%
Shuttle	0%	2%	1%	0%	3%	1%	3%	0%
Taxi/limo	1%	3%	0%	0%	5%	3%	3%	4%
bike/moped	0%	0%	0%	0%	0%	2%	4%	0%
walk	5%	25%	39%	70%	38%	48%	49%	87%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Visitor Stop Frequency

Number of Models: 1
Decision-Making Unit: Tour
Model Form: Probability Distribution Lookup table
Alternatives: 0-1 outbound stops by 0-3 inbound stops

Number of stops per tour is determined by sampling from the observed distribution of number of stops per tour. The model input is the percentage of observed number of stops (both inbound and outbound) by purpose and tour duration. The input frequency table is too large for documentation, but the frequency of stops by tour purpose and segment is shown in Table 63.

Table 63: Frequency of Stops on Tour

Number of Stops	Tour Purpose				
	Work	Recreation	Shopping	Dining	Total
0	44.1%	33.5%	40.3%	90.0%	47.2%
1	34.6%	27.2%	34.0%	8.2%	24.7%
2	9.7%	16.4%	15.1%	1.8%	12.7%
3+	11.7%	22.9%	10.5%	0.0%	15.3%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Visitor Stop Purpose

Number of Models: 1
Decision-Making Unit: Stop
Model Form: Probability Distribution Lookup Table
Alternatives: Work, Other Recreational, Dining

Purpose of stops is determined by the observed purpose of stops in the visitor survey. The model input is the percentage of observed stops by purpose, stop number, number of stops on tour, and stop direction (inbound or outbound). The actual table used is too large to include in documentation, but the frequency of stops by tour purpose and stop purpose is shown in Table 64.

Table 64: Stops by Purpose

Stop Purpose	Tour Purpose				
	Recreation	Shopping	Dining	Total	Recreation
Work	19.1%	0.0%	0.0%	0.0%	0.7%
Rec/Sight/Other	14.2%	33.7%	0.0%	0.0%	26.5%
Shop	23.5%	24.7%	45.8%	0.0%	27.7%
Eat/Drink	38.9%	36.3%	45.9%	97.1%	39.4%
Change Mode	4.4%	5.3%	8.3%	2.9%	5.7%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Visitor Stop Location

Number of Models: 1
Decision-Making Unit: Stop
Model Form: Multinomial Logit
Alternatives: MGRAs

The stop location model was asserted, based on the discretionary purpose of the resident stop location choice model. See the section, Intermediate Stop Location Choice Model.

Visitor Trip Time of Day

Number of Models: 1
Decision-Making Unit: Travel party
Model Form: Lookup table
Alternatives: Half-hour offsets

The stop time of day is chosen based on a distribution of observed stop durations from the survey. Distributions were prepared for stop duration for outbound and inbound stops, by purpose, and overall tour duration.

Visitor Trip Mode Choice

Number of Models: 1
Model Form: Nested Logit
Alternatives: 15 Tour Modes (all the residential tour modes plus taxi except park and ride, kiss and ride, and school bus)

The trip mode choice is based on the visitor tour mode choice model coefficients where the coefficients are twice the value of the corresponding tour mode coefficients since most tours have at least two trips per tour.

The visitor trip mode selection is based on the following explanatory variables:

- Auto availability indicator
- In-vehicle time (auto and transit)
- Walk time
- Auto operating cost
- Auto parking cost
- Auto terminal time
- Auto toll value
- Transit first wait time
- Transit transfer time
- Number of transit transfers
- Transit walk access time
- Transit walk egress time
- Transit walk auxiliary time
- Transit fare

Each of the visitor model components were then calibrated. See Visitor Model in the calibration section.

Calibration of the Models

This section describes the calibration of each model component that was either statistically estimated or asserted. The models that were based on observed distributions are not shown here. The 2010 Census Data was used to calibrate the auto ownership results. The other models were calibrated to match summaries from the home-interview travel survey (HIS) conducted for OahuMPO in 2012/2013 and the on-board survey conducted in 2012.

Generally speaking, each model was calibrated as follows. First, comparisons between observed data and estimated model results were created and analyzed. For example, tours by mode, auto sufficiency, and tour purpose were calculated from a base-year application of the model, and compared to observed data. Next, models were calibrated by estimating and applying alternative-specific constants to each alternative except one (the base alternative). Observed distributions of the alternatives for each model were obtained from OahuMPO home interview survey data and on-board survey data. A set of alternative-specific constants are calculated in each iteration of calibration by dividing the observed percentage by the estimated percentage for each alternative and taking the natural log of the result. An adjustment factor (typically set to 0.5) is applied to the constants to help eliminate oscillating patterns between iterations of the calibration routine. To ensure that the model is not over-specified[3], a base alternative for each model is selected. The constant for the base alternative is added to the constant for each alternative, and the base alternative constant is set to 0. The constants values for the current iteration are then added to the alternative specific constants for the previous iteration, and entered into the Utility Expression Calculator spreadsheet on a separate line so that the calibrated constants can be tracked separately from the estimated constants.

Car Ownership Model

The auto ownership model was calibrated to match households by auto ownership from the 2010 Census data. The base alternative for calibrating the auto ownership models is the 0 auto household group. Several iterations of adjustments to the alternative-specific constants were necessary for the auto ownership model due to small changes in the accessibility terms that are used in the model.

Calibration Results

Table 65 shows the resulting auto ownership results compared to census. The table shows that the models match census data closely given the final adjustment factors[4] shown in Table 66.

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[3] Logit models estimate probabilities of a certain alternative compared to the base alternative of occurring, so a base case is chosen to compare to. An over-specified model is one in which all alternatives have an alternative-specific constant.

[4] The final adjustment factors are additional constants added to the estimated constants. The estimated constants for each model are documented in the model estimation memos.

Table 65: Auto-Ownership Calibration Results

Total Vehicles Available	Census	Estimated Auto Ownership
0	10.48%	11.31%
1	33.98%	34.15%
2	35.51%	35.03%
3+	20.04%	19.51%

Table 66: Auto-Ownership Final Adjustment Factors

Total Vehicles Available	Auto Ownership
0	Base
1	0.447549
2	0.297592
3	0.257085

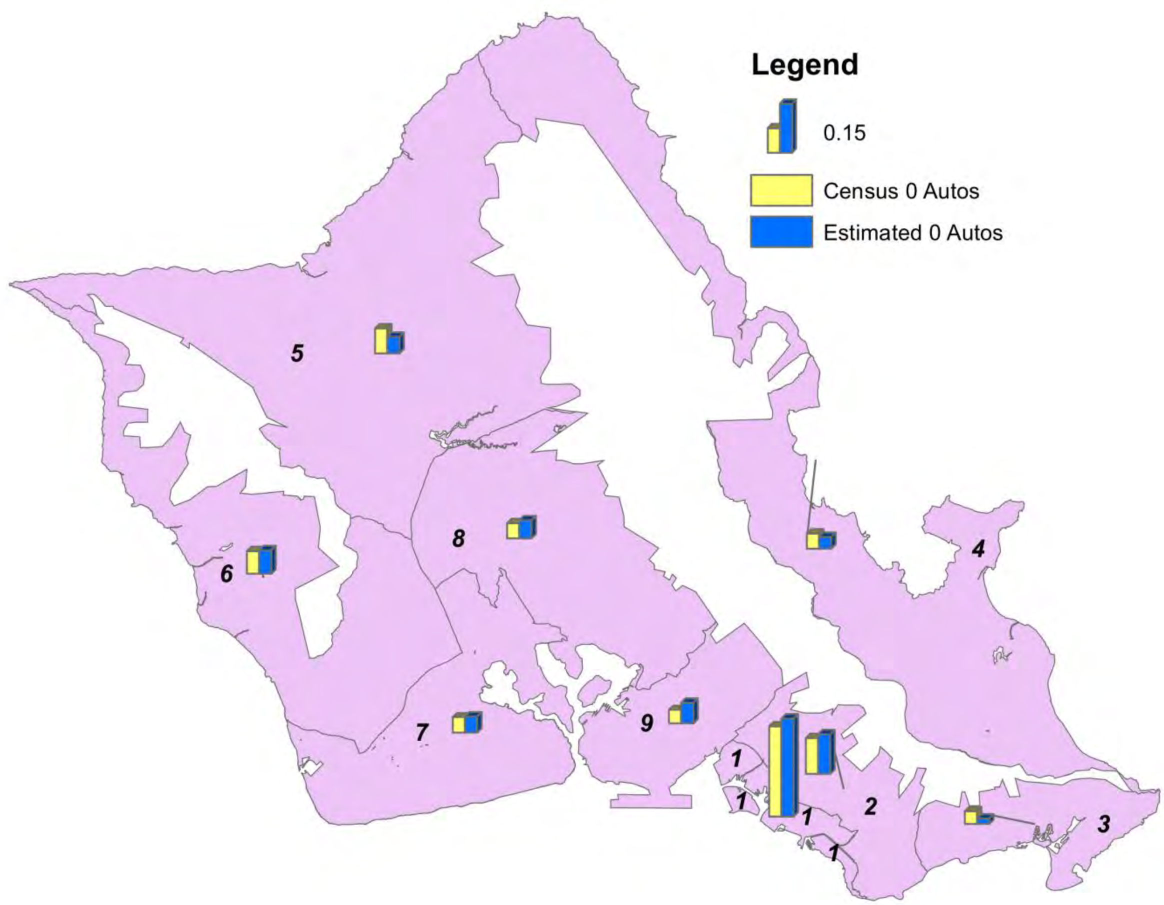
The auto ownership results were aggregated to the 9 districts, the same district system that was used to expand the household interview survey. Table 67 displays the zero auto household shares by district, while Figure 28 shows these results visually.

The table and figure shows that estimated auto ownership 0 auto share matches census well by the 9 districts. This is especially important to match since 0 auto households are usually transit captive riders and the tour mode choice model was calibrated by the auto-sufficiency market segment (0 autos, autos less than adults, and autos greater than or equal to adults).

Table 67: Auto-Ownership Results by District

District	2000 Census	Estimated Auto Ownership	
	Share 0 Auto Households	Share 0 Auto Households	Difference
1	28%	30%	2%
2	11%	12%	1%
3	4%	2%	-2%
4	5%	4%	-1%
5	8%	5%	-3%
6	7%	7%	0%
7	5%	5%	0%
8	5%	6%	1%
9	4%	6%	2%
Total	10%	11%	1%

Figure 28: Comparison of 0 Auto Household Shares between Census and Model Estimated



Mandatory (workplace/university/school) Activity Location Choice

Work Location Results

The work destination choice model predicts the usual work location for all workers. This model was compared to the 2012/2013 OahuMPO home interview survey. The survey flows were scaled to match the estimated work trips from the home district. Some calibration was needed as the model was not estimating enough intra district trips and trips to the Downtown/Chinatown/Ala Moana District so district constants were added as shown in Table 68

Table 68: Work Location District Constants

Intra-Kalihi (District 2)	0.5814
Intra-Windward Oahu (District 4)	0.6282
Intra-Central Oahu/Pearl City/Aiea (District 8)	0.2293
Intra-Airport/Pearl Harbor/Salt Lake (District 9)	0.8417
To-Chinatown/Downtown/Ala Moana (District 1)	-0.1529

After calibration the comparisons indicated that the estimated model replicated observed worker flows well in the base year.

Table 69 through Table 71 display the district to district flows of work trips for the scaled survey, estimated model and percent difference. Figure 29 shows this graphically and reveals that the model is predicting work locations accurately as it has a correlation coefficient of 99.1% compared to survey. The trip length frequency distribution in Figure 30 also shows that the estimated distribution matches the observed quite well.

Table 69: Scaled Observed Survey Worker Flows of Home District to Work District

HOME DISTRICT	WORK DISTRICT 1	2	3	4	5	6	7	8	9	Total
1	40,207	9,578	387	966	784	115	654	1,762	5,825	60,277
2	44,522	21,580	1,329	2,344	402	692	3,541	2,415	9,389	86,214
3	14,812	4,830	2,023	535	50	-	619	367	2,005	25,241
4	18,099	4,985	457	26,189	417	30	3,265	4,230	6,013	63,686
5	3,503	1,209	-	1,985	9,192	337	3,010	5,959	1,922	27,116
6	4,096	1,337	-	265	683	5,653	7,487	3,793	3,682	26,997
7	22,497	5,244	841	734	2,963	766	16,215	7,232	13,923	70,416
8	23,164	5,772	689	1,657	3,058	1,209	7,171	17,128	16,614	76,464
9	6,941	3,042	116	352	666	-	869	1,400	14,114	27,500
Total	**177,841**	**57,579**	**5,843**	**35,027**	**18,215**	**8,802**	**42,830**	**44,286**	**73,488**	**463,911**

Table 70: Estimated Worker Flows of Home District to Work District [5]

HOME DISTRICT	WORK DISTRICT 1	2	3	4	5	6	7	8	9	Total
1	43,699	7,880	791	1,255	133	55	543	1,089	4,832	60,277
2	49,239	22,666	1,505	2,301	259	84	920	1,827	7,413	86,214
3	13,979	4,421	2,565	1,282	74	26	303	581	2,010	25,241
4	21,582	5,402	945	26,233	547	96	948	1,877	6,056	63,686
5	4,839	1,200	100	1,245	8,657	191	2,243	5,834	2,807	27,116
6	5,682	1,280	113	518	595	3,929	9,607	2,440	2,833	26,997
7	20,439	4,928	530	1,872	2,212	1,643	19,096	8,869	10,827	70,416
8	24,943	5,973	689	2,152	3,644	509	6,226	16,789	15,539	76,464
9	8,749	1,996	183	551	171	60	548	1,372	13,870	27,500
Total	**193,151**	**55,746**	**7,421**	**37,409**	**16,292**	**6,593**	**40,434**	**40,678**	**66,187**	**463,911**

[5] Only persons in non-group quarter households and persons with a valid work location were used (I.e. person is a worker and did **not** work at home).

Table 71: Percentage Difference between Observed Survey and Estimated Worker Flows

HOME DISTRICT	WORK DISTRICT									
	1	2	3	4	5	6	7	8	9	Total
1	9%	-18%	105%	30%	-83%	-52%	-17%	-38%	-17%	0%
2	11%	5%	13%	-2%	-36%	-88%	-74%	-24%	-21%	0%
3	-6%	-8%	27%	140%	47%	0%	-51%	58%	0%	0%
4	19%	8%	107%	0%	31%	218%	-71%	-56%	1%	0%
5	38%	-1%	0%	-37%	-6%	-43%	-25%	-2%	46%	0%
6	39%	-4%	0%	96%	-13%	-30%	28%	-36%	-23%	0%
7	-9%	-6%	-37%	155%	-25%	114%	18%	23%	-22%	0%
8	8%	3%	0%	30%	19%	-58%	-13%	-2%	-6%	0%
9	26%	-34%	58%	57%	-74%	0%	-37%	-2%	-2%	0%
Total	9%	-3%	27%	7%	-11%	-25%	-6%	-8%	-10%	0%

Figure 29: Scatter Plot of Worker flows for Home District to Worker District between Oahu Household Travel Survey and Estimated (0.99147 Correlation Coefficient)

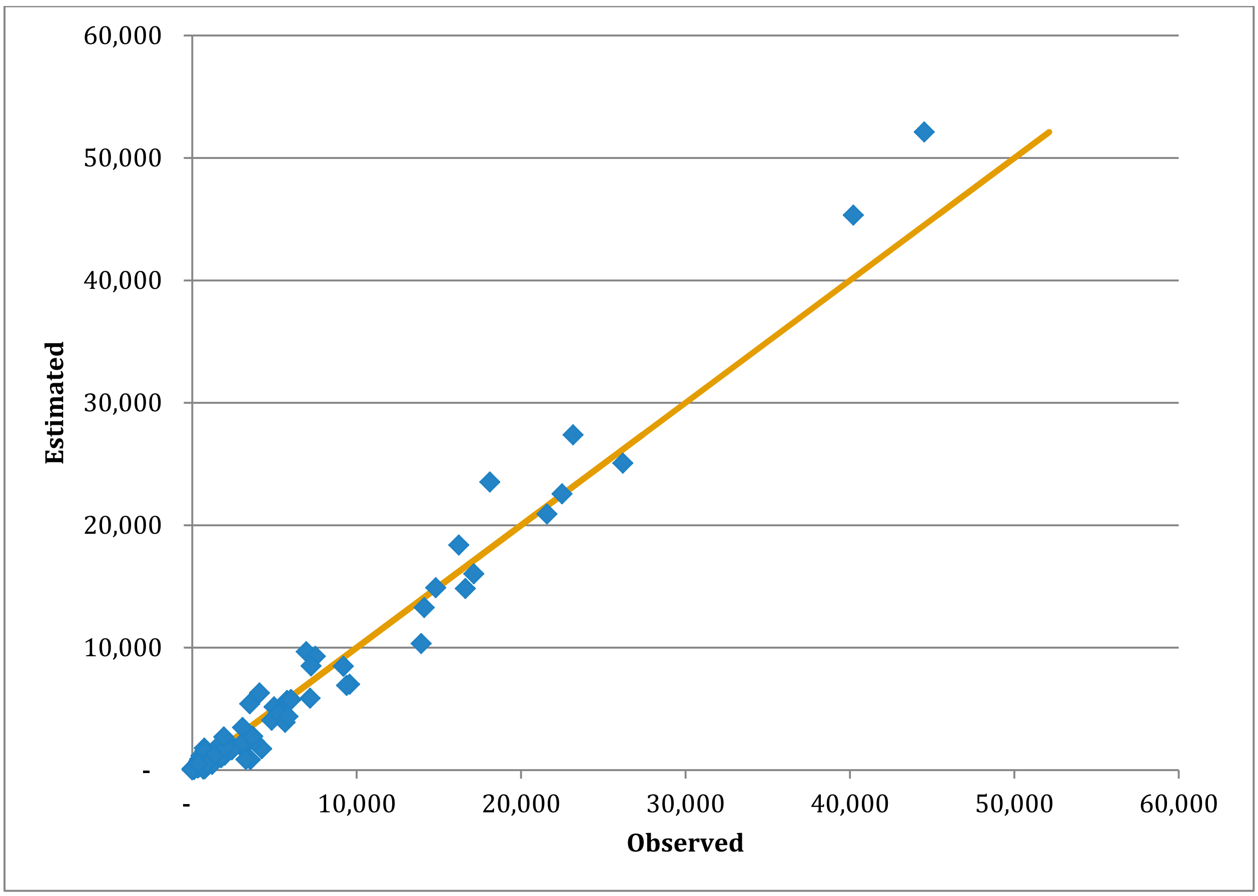
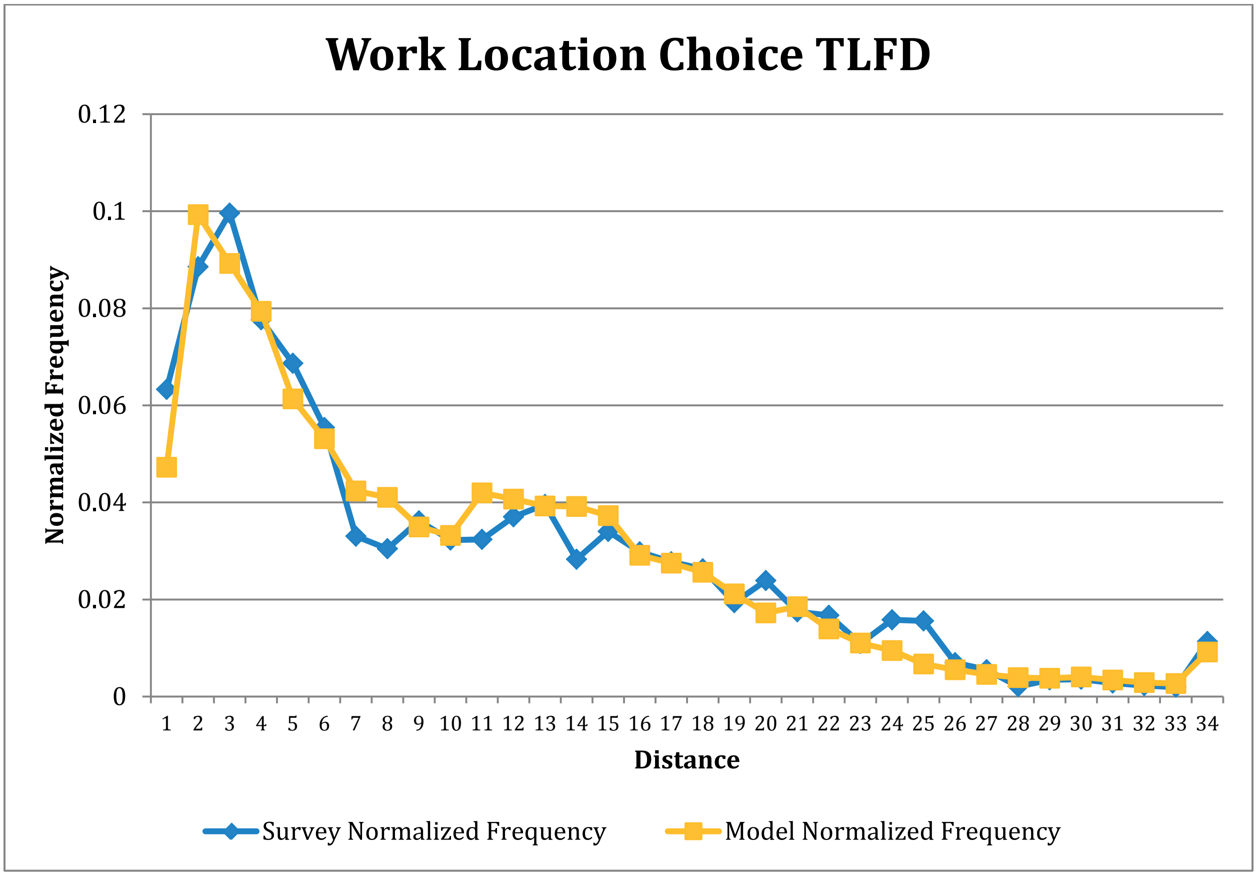


Figure 30: Trip Length Frequency Distribution for Worker Flows



School Location Results

The school destination choice model predicts the usual school location for all student types. This model is fully segmented by K-12th students and university students. Some calibration was needed as the model was not estimating enough intra district trips so intra-district constants were added as shown in Table 72

Table 72: K-12th School Location Intra-District Constants

Intra-Central Oahu/Pearl City/Aiea (District 8)	0.3995
Intra-Airport/Pearl Harbor/Salt Lake (District 9)	1.0552

After calibration, the school location models matched well to survey distributions.

Table 73 through Table 78display the district to district flows for K thru 12th grade, and university trips for the observed, estimated, and percent difference, respectively. Figure 31 and Figure 33 show this graphically and reveal that the model is predicting school locations accurately as it has a correlation coefficient of 99.9% for K through 12th grade, and 93.9% for university. The trip length frequency distributions in Figure 32 and Figure 34 also show that the estimated distribution matches the observed quite well.

Table 73: Scaled Observed Survey K-12th Grade Flows of Home District to K-12 Grade District

HOME DISTRICT	SCHOOL DISTRICT									
	1	2	3	4	5	6	7	8	9	Total
1	5,004	7,734	606	-	-	-	445	-	157	13,947
2	4,125	17,064	1,006	252	-	-	-	-	405	22,852
3	799	2,899	3,450	-	-	-	-	-	-	7,147
4	643	2,863	-	19,406	44	-	-	85	154	23,195
5	-	110	-	298	7,639	-	795	2,124	-	10,966
6	-	679	-	-	-	9,695	2,822	1,998	143	15,337
7	61	2,010	63	99	488	293	23,493	1,889	1,883	30,279
8	255	3,224	-	228	716	161	238	17,106	1,426	23,353
9	164	725	-	-	-	-	-	138	10,217	11,244
Total	**11,050**	**37,307**	**5,125**	**20,283**	**8,886**	**10,149**	**27,793**	**23,341**	**14,384**	**158,320**

Table 74: Estimated K-12th Grade Flows of Home District to K-12 Grade District

HOME DISTRICT	SCHOOL DISTRICT									
	1	2	3	4	5	6	7	8	9	Total
1	5,677	7,588	138	43	1	0	6	87	407	13,947
2	4,961	16,470	487	76	6	0	17	136	699	22,852
3	539	2,172	4,326	36	0	0	1	24	49	7,147
4	1,392	4,175	614	15,948	100	1	38	368	559	23,195
5	132	248	14	285	7,370	10	263	2,426	218	10,966
6	176	365	11	35	51	11,047	2,724	627	301	15,337
7	711	1,731	67	98	242	396	22,051	3,686	1,297	30,279
8	794	1,908	90	66	904	9	1,158	16,003	2,421	23,353
9	773	1,367	31	10	6	0	41	460	8,556	11,244
Total	**15,155**	**36,024**	**5,778**	**16,597**	**8,680**	**11,463**	**26,299**	**23,817**	**14,507**	**158,320**

Table 75: Percentage Difference between Observed and Estimated K-12th Grade Flows

HOME DISTRICT	SCHOOL DISTRICT									
	1	2	3	4	5	6	7	8	9	Total
1	13%	-2%	-77%	0%	0%	0%	-99%	0%	159%	0%
2	20%	-3%	-52%	-70%	0%	0%	0%	0%	73%	0%
3	-33%	-25%	25%	0%	0%	0%	0%	0%	0%	0%
4	116%	46%	0%	-18%	129%	0%	0%	333%	263%	0%
5	0%	125%	0%	-4%	-4%	0%	-67%	14%	0%	0%
6	0%	-46%	0%	0%	0%	14%	-3%	-69%	111%	0%
7	1075%	-14%	6%	-1%	-50%	35%	-6%	95%	-31%	0%
8	212%	-41%	0%	-71%	26%	-94%	387%	-6%	70%	0%
9	370%	89%	0%	0%	0%	0%	0%	232%	-16%	0%
Total	37%	-3%	13%	-18%	-2%	13%	-5%	2%	1%	0%

Figure 31: Scatter Plot of District to District K-12th Grade Flows (0.990 Correlation Coefficient)

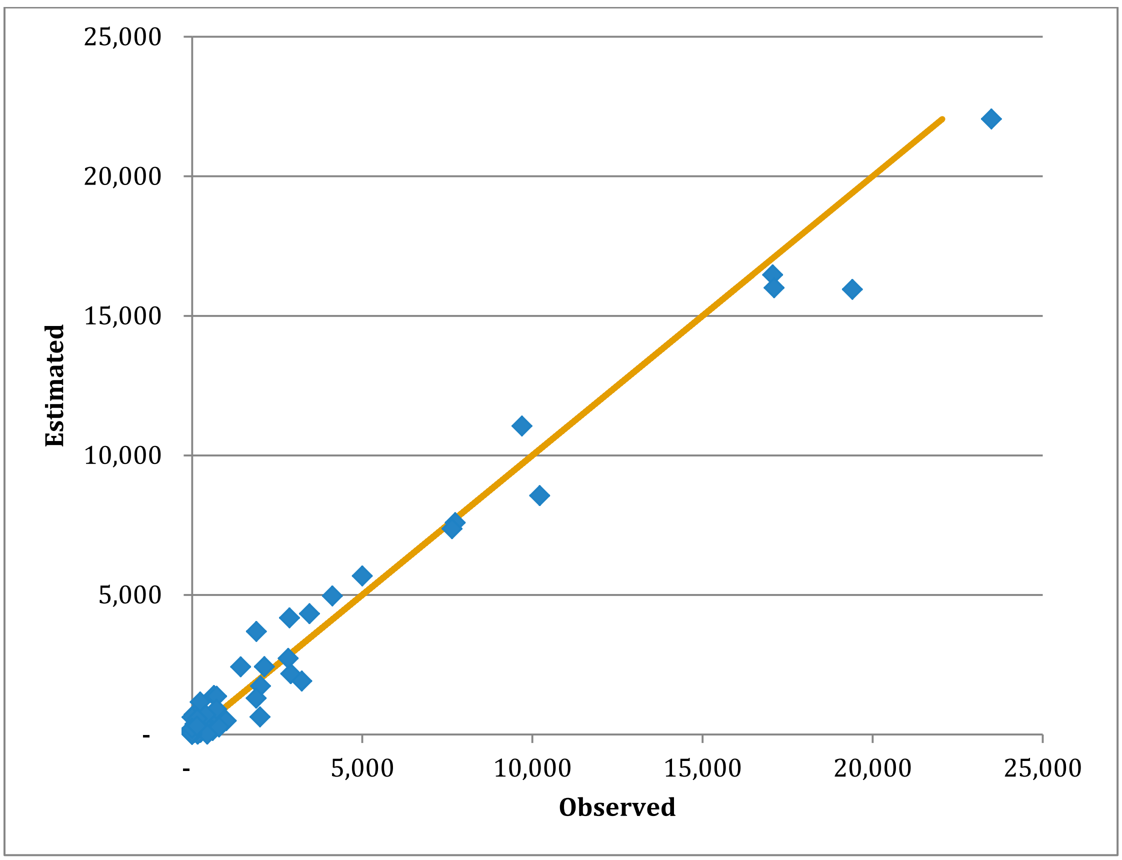


Figure 32: Trip Length Frequency Distribution K-12th Grade Flows

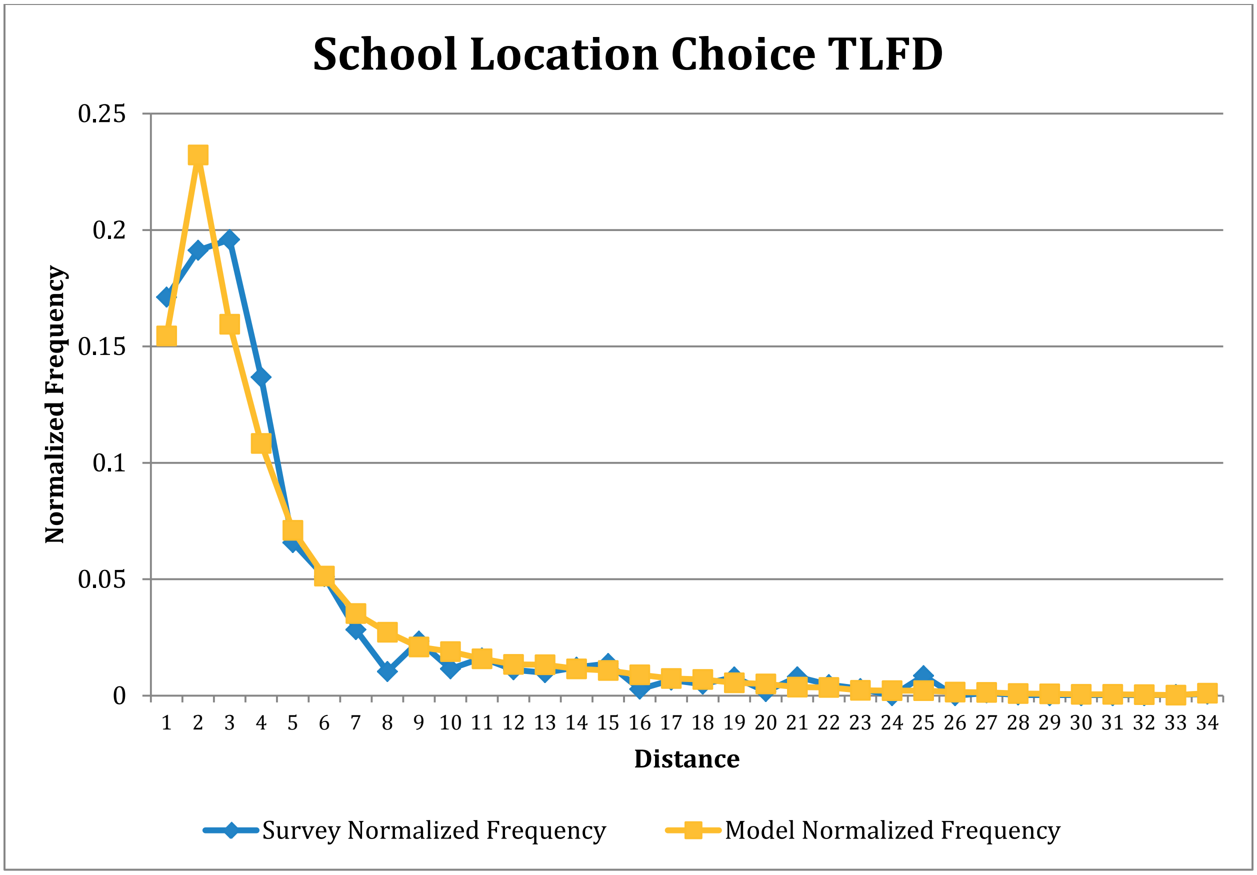


Table 76: Scaled Observed Survey University Flows of Home District to University District

HOME DISTRICT	UNIVERSITY DISTRICT									
	1	2	3	4	5	6	7	8	9	Total
1	2,692	8,928	-	134	-	-	764	-	168	12,686
2	6,010	11,682	-	258	-	75	54	130	-	18,208
3	144	2,936	316	-	-	-	111	-	-	3,507
4	944	6,025	-	4,153	-	-	-	100	98	11,320
5	325	751	-	-	707	-	2,128	752	-	4,664
6	579	1,434	62	48	-	1,301	1,182	240	-	4,846
7	1,931	3,475	-	832	-	-	4,023	255	102	10,619
8	1,299	2,118	-	1,225	124	108	5,236	1,285	178	11,573
9	738	2,730	-	111	-	-	77	-	1,041	4,696
Total	**14,662**	**40,079**	**379**	**6,760**	**831**	**1,483**	**13,575**	**2,762**	**1,587**	**82,119**

Table 77: Estimated University Flows of Home District to School District

HOME DISTRICT	UNIVERSITY DISTRICT									
	1	2	3	4	5	6	7	8	9	Total
1	3,967	7,993	69	194	11	14	209	93	136	12,686
2	4,851	12,217	121	310	16	13	316	142	222	18,208
3	726	2,544	62	63	6	3	48	24	31	3,507
4	3,165	4,221	94	3,079	47	12	395	163	144	11,320
5	1,177	1,270	31	334	101	22	1,428	220	81	4,664
6	1,431	1,532	34	149	16	80	1,371	133	100	4,846
7	2,893	3,399	66	317	56	67	3,257	335	229	10,619
8	3,313	4,225	80	337	75	51	2,855	380	257	11,573
9	1,783	2,147	34	124	14	5	360	91	138	4,696
Total	**23,306**	**39,548**	**591**	**4,907**	**342**	**267**	**10,239**	**1,581**	**1,338**	**82,119**

Table 78: Percentage Difference between Observed and Estimated University Flows

HOME DISTRICT	UNIVERSITY DISTRICT									
	1	2	3	4	5	6	7	8	9	Total
1	47%	-10%	0%	45%	0%	0%	-73%	0%	-19%	0%
2	-19%	5%	0%	20%	0%	-83%	485%	9%	0%	0%
3	403%	-13%	-80%	0%	0%	0%	-57%	0%	0%	0%
4	235%	-30%	0%	-26%	0%	0%	0%	62%	47%	0%
5	262%	69%	0%	0%	-86%	0%	-33%	-71%	0%	0%
6	147%	7%	-45%	211%	0%	-94%	16%	-45%	0%	0%
7	50%	-2%	0%	-62%	0%	0%	-19%	31%	124%	0%
8	155%	99%	0%	-72%	-40%	-53%	-45%	-70%	45%	0%
9	142%	-21%	0%	12%	0%	0%	368%	0%	-87%	0%
Total	59%	-1%	56%	-27%	-59%	-82%	-25%	-43%	-16%	0%

Figure 33: Scatter Plot of District to District University Flows (0.939 Correlation Coefficient)

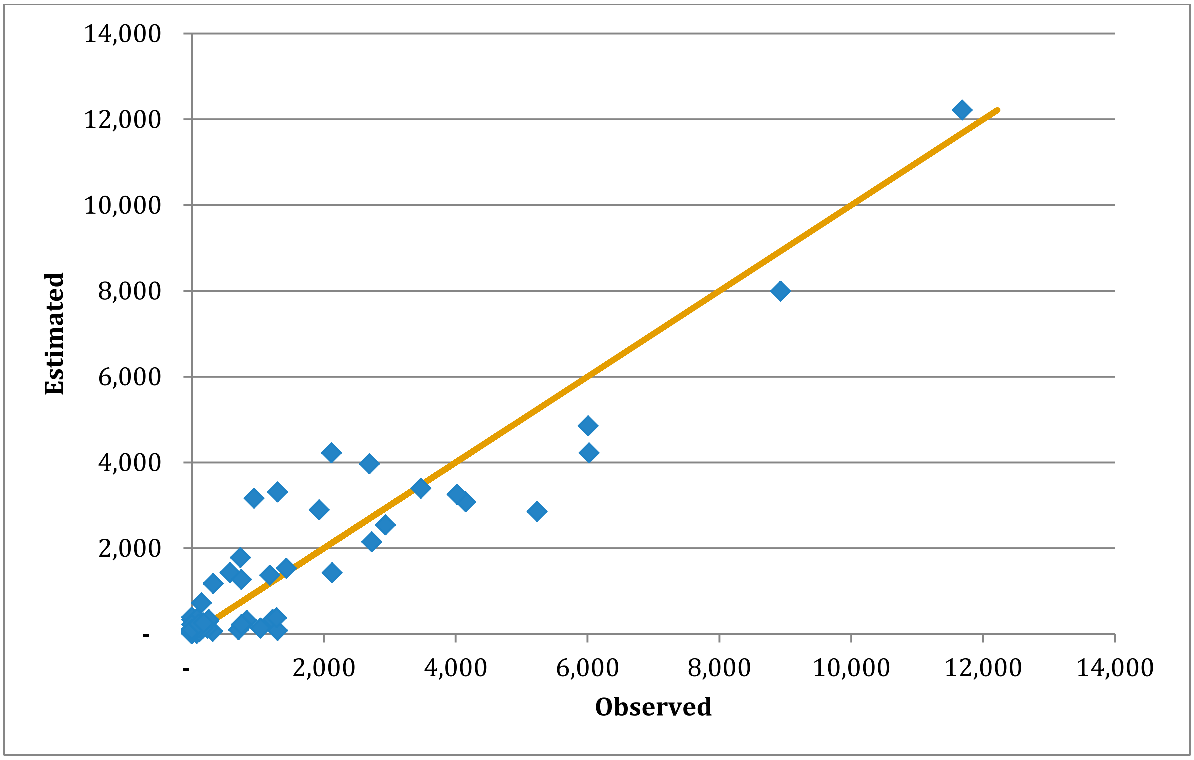
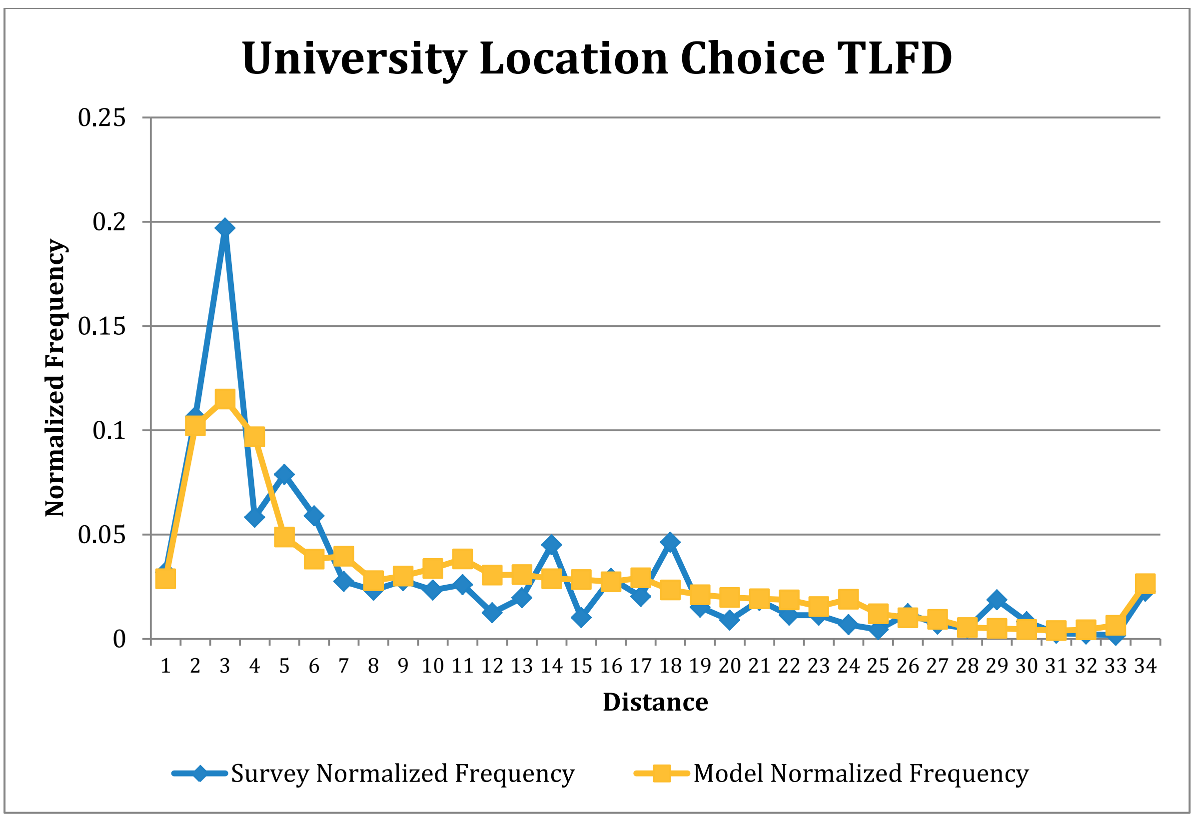


Figure 34: Trip Length Frequency Distribution University Flows



Mandatory Tour Frequency

The mandatory tour frequency choice model predicts the number of mandatory (work and school) tours for each worker and student. The model has six alternatives: no mandatory tours, one work tour, one school tour, two or more work tours, two or more school tours, one work tour plus one school tour. The base alternative for calibrating the Mandatory Tour Frequency model is the zero mandatory tour alternative. Several runs through the model were done to achieve satisfactory levels of calibration.

Mandatory Tour Frequency Results

Table 79 shows the OahuMPO household travel survey mandatory tour frequencies by person type. Table 80 shows the estimated model mandatory tour frequencies by person type. The comparison of mandatory tour frequencies by person type shows that the modeled probability of one work tour, one school tour, two or more work tours, two or more school tours, one work tour plus one school tour match closely to survey (Table 81). Table 82 shows the final adjustment factors by person type.

Table 79: Survey Mandatory Tour Frequency by Person Type

	Pattern						
Person type	0 Work, 0 School Tours	1 Work Tour	2+ Work Tours	1 School Tour	2+ School Tours	Work and School Tours	Total
Full-time worker	25.3%	72.2%	2.4%	0.0%	0.0%	0.0%	100.0%
Part-time worker	61.5%	36.5%	2.0%	0.0%	0.0%	0.0%	100.0%
University student	34.7%	27.8%	1.3%	32.2%	0.7%	3.3%	100.0%
Driving age student	18.6%	2.1%	0.3%	77.6%	1.0%	0.5%	100.0%
Pre-driving student	18.9%	0.1%	0.0%	80.0%	1.1%	0.0%	100.0%
Pre-school	69.2%	0.5%	0.0%	30.3%	0.0%	0.0%	100.0%

Table 80: Model Mandatory Tour Frequency by Person Type

Person type	Pattern						Total
	0 Work, 0 School Tours	1 Work Tour	2+ Work Tours	1 School Tour	2+ School Tours	Work and School Tours	
Full-time worker	25.3%	72.3%	2.4%	0.0%	0.0%	0.0%	100.0%
Part-time worker	61.5%	36.4%	2.0%	0.0%	0.0%	0.0%	100.0%
University student	34.7%	27.9%	1.3%	32.2%	0.7%	3.3%	100.0%
Driving age student	18.6%	2.1%	0.3%	77.6%	1.0%	0.5%	100.0%
Pre-driving student	18.9%	0.0%	0.0%	80.1%	1.1%	0.0%	100.0%
Pre-school	70.2%	0.0%	0.0%	29.8%	0.0%	0.0%	100.0%

Table 81: Difference in Probability of Mandatory Tour Frequencies for Estimated vs. Observed by Person Type

Person type	Pattern						Total
	0 Work, 0 School Tours	1 Work Tour	2+ Work Tours	1 School Tour	2+ School Tours	Work and School Tours	
Full-time worker	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Part-time worker	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
University student	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Driving age student	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Pre-driving student	0.0%	-0.1%	0.0%	0.1%	0.0%	0.0%	0.0%
Pre-school	1.0%	-0.5%	0.0%	-0.5%	0.0%	0.0%	0.0%

Table 82: Mandatory Tour Frequency Final Adjustment Factors by Person Type

Person type	Pattern					
	0 Work, 0 School Tours	1 Work Tour	2+ Work Tours	1 School Tour	2+ School Tours	Work and School Tours
Full-time worker	Base	(0.8692)	(1.7439)	-	-	-
Part-time worker	Base	(1.2409)	(2.1582)	-	-	-
University student	Base	(0.4998)	2.4804	0.5664	(3.2910)	(0.5723)
Driving age student	Base	2.0536	3.8710	0.0747	0.0409	0.4620
Pre-driving student	Base	-	-	(1.3614)	(1.8647)	-
Pre-school	Base	-	-	3.0540	-	-

Non-Mandatory Tour Frequency

The non-mandatory tour frequency model predicts the number of non-mandatory (escorting, , maintenance, and discretionary) tours by purpose for each household member. The base alternative for the calibrating the non-mandatory tour frequency model is the 0 frequency alternative for each tour purpose. Several runs through the model were done to achieve satisfactory levels of calibration.

Non-Mandatory Tour Frequency Results

Table 83 shows the OahuMPO household interview survey non-mandatory tour frequencies by person type.

Table 84 shows the estimated model non-mandatory tour frequencies by person type. The comparison of non-mandatory tour frequencies by person type shows that the modeled probability of 0, 1, and 2+ tours for each purpose match closely to survey (Table 85).

	Tour Purpose Frequency								
	Escorting			Maintenance			Discretionary		
Person Type	0	1	2+	0	1	2+	0	1	2+
Full-time worker	0%	0%	0%	0%	0%	0%	0%	0%	0%
Part-time worker	0%	0%	0%	-1%	1%	0%	-1%	1%	0%
University student	0%	0%	0%	-1%	0%	1%	0%	0%	0%
Non-working adult	0%	0%	0%	-2%	2%	0%	-1%	0%	0%
Non-working senior	0%	0%	0%	-2%	2%	0%	-2%	2%	0%
Driving age student	0%	0%	0%	-3%	0%	3%	0%	0%	0%
Pre-driving student	0%	0%	0%	-3%	0%	3%	-1%	1%	0%
Pre-school	-1%	2%	-1%	-4%	3%	1%	1%	-1%	0%

Table 86 displays the final adjustment factors by person type.

Table 83: Survey Non-Mandatory Tour Frequency by Person Type

Person Type	Tour Purpose Frequency								
	Escorting			Maintenance			Discretionary		
	0	1	2+	0	1	2+	0	1	2+
Full-time worker	93.5%	4.4%	2.2%	91.6%	7.2%	1.2%	91.9%	7.2%	0.9%
Part-time worker	78.5%	12.9%	8.6%	75.8%	21.3%	2.9%	80.4%	17.4%	2.2%
University student	91.7%	5.4%	3.0%	89.9%	9.1%	0.9%	87.2%	11.6%	1.2%
Non-working adult	86.3%	5.4%	8.3%	72.0%	23.9%	4.2%	80.6%	16.7%	2.7%
Non-working senior	94.6%	3.1%	2.3%	72.7%	24.4%	2.9%	83.0%	15.1%	1.9%
Driving age student	97.5%	1.1%	1.3%	94.3%	5.7%	0.0%	89.0%	9.5%	1.6%
Pre-driving student	97.9%	2.0%	0.2%	97.8%	2.2%	0.0%	90.5%	8.4%	1.1%
Pre-school	83.1%	7.6%	9.3%	82.0%	16.5%	1.5%	83.7%	14.1%	2.2%

Table 84: Model Non-Mandatory Tour Frequency by Person Type

Person Type	Tour Purpose Frequency								
	Escorting			Maintenance			Discretionary		
	0	1	2+	0	1	2+	0	1	2+
Full-time worker	93.5%	4.4%	2.2%	91.2%	7.6%	1.2%	91.6%	7.5%	0.9%
Part-time worker	78.5%	13.0%	8.5%	74.5%	22.6%	2.9%	79.4%	18.2%	2.4%
University student	91.7%	5.4%	3.0%	88.9%	8.9%	2.3%	87.2%	11.7%	1.1%
Non-working adult	86.3%	5.4%	8.3%	70.3%	25.5%	4.2%	80.0%	17.2%	2.9%
Non-working senior	94.6%	3.1%	2.3%	70.6%	26.2%	3.2%	80.9%	16.9%	2.1%
Driving age student	97.5%	1.1%	1.3%	91.7%	5.6%	2.7%	88.6%	9.8%	1.6%
Pre-driving student	97.9%	2.0%	0.2%	95.0%	2.4%	2.6%	89.8%	9.1%	1.1%
Pre-school	81.7%	9.6%	8.7%	78.4%	19.2%	2.4%	84.6%	13.5%	1.9%

Table 85: Difference in Probability of Non-Mandatory Tour Frequencies for Estimated vs. Observed by Person Type

	Tour Purpose Frequency								
	Escorting			Maintenance			Discretionary		
Person Type	0	1	2+	0	1	2+	0	1	2+
Full-time worker	0%	0%	0%	0%	0%	0%	0%	0%	0%
Part-time worker	0%	0%	0%	-1%	1%	0%	-1%	1%	0%
University student	0%	0%	0%	-1%	0%	1%	0%	0%	0%
Non-working adult	0%	0%	0%	-2%	2%	0%	-1%	0%	0%
Non-working senior	0%	0%	0%	-2%	2%	0%	-2%	2%	0%
Driving age student	0%	0%	0%	-3%	0%	3%	0%	0%	0%
Pre-driving student	0%	0%	0%	-3%	0%	3%	-1%	1%	0%
Pre-school	-1%	2%	-1%	-4%	3%	1%	1%	-1%	0%

Table 86: Non-Mandatory Tour Frequency Adjustment Factors by Person Type

	Tour Purpose Frequency								
	Escorting			Maintenance			Discretionary		
Person Type	0	1	2+	0	1	2+	0	1	2+
Full-time worker	base	(0.29)	(0.72)	base	(1.22)	(1.46)	base	(0.60)	(0.91)
Part-time worker	base	0.15	0.53	base	(0.75)	(1.09)	base	(0.35)	(0.67)
University student	base	0.04	(0.09)	base	(0.45)	(0.38)	base	0.07	(0.37)
Non-working adult	base	0.10	0.94	base	(0.06)	0.01	base	0.21	0.13
Non-working senior	base	(0.27)	(0.13)	base	0.22	0.21	base	(0.11)	(0.26)
Driving age student	base	(2.31)	(1.99)	base	(1.26)	N/A!	base	(0.32)	(0.14)
Pre-driving student	base	(1.99)	(4.44)	base	(2.17)	N/A!	base	(0.32)	(0.41)
Pre-school	base	(3.10)	0.19	base	(2.33)	(5.96)	base	1.02	2.33

At-Work Sub-Tour Frequency

The at-work sub-tour frequency model predicts the number of tours for each person who has at least one work tour. The model is applied after the mandatory tour frequency model. The model has three alternatives: no at-work sub tours, 1 at-work sub tour, and 2+ at-work sub tours. The base alternative for calibrating the At-Work Sub Tour frequency model is the zero tours alternative.

At-Work Sub Tour Frequency Results

Table 87 shows the observed home interview survey at-work tour frequencies by person type. Table 88 shows the estimated model at-work sub tour frequencies by person type. The comparison of at-work sub tour frequencies by person type shows that the modeled probability of no at-work sub tours, 1 at-work sub tours, and 2+ at-work sub-tours match closely to survey (Table 89). Table 90 displays the final calibrated adjustments by person type.

Table 87: Observed Survey at Work Sub Tour Frequency by Person Type

	Number of tours			
Person type	No Tours	1 at-work sub tour	2+ at-work sub tours	Total
Full-time worker	87.2%	11.2%	1.6%	100.0%
Part-time worker	92.5%	7.5%	0.0%	100.0%
University student	92.9%	6.7%	0.4%	100.0%
Driving age student	100.0%	0.0%	0.0%	100.0%

Table 88: Estimated at Work Sub Tour Frequency by Person Type

	Number of tours			
Person type	No Tours	1 at-work sub tour	2+ at-work sub tours	Total
Full-time worker	87.3%	11.1%	1.6%	100.0%
Part-time worker	92.5%	7.4%	0.0%	100.0%
University student	92.9%	6.8%	0.4%	100.0%
Driving age student	100.0%	0.0%	0.0%	100.0%

Table 89: Difference in Probability of At Work Sub Tour Frequencies for Estimated vs. Observed by Person Type

Person type	Number of tours			
	No Tours	1 at-work sub tour	2+ at-work sub tours	Total
Full-time worker	0.0%	0.0%	0.0%	0.0%
Part-time worker	0.0%	0.0%	0.0%	0.0%
University student	0.0%	0.0%	0.0%	0.0%
Driving age student	0.0%	0.0%	0.0%	0.0%

Table 90: At Work Sub Tour Frequency Final Adjustment Factors by Person Type

Person type	Number of tours		
	No Tours	1 at-work sub tour	2+ at-work sub tours
Full-time worker	Base	0.0989	0.3923
Part-time worker	Base	0.4702	N/A
University student	Base	(0.4305)	(1.1840)
Driving age student	N/A	N/A	N/A

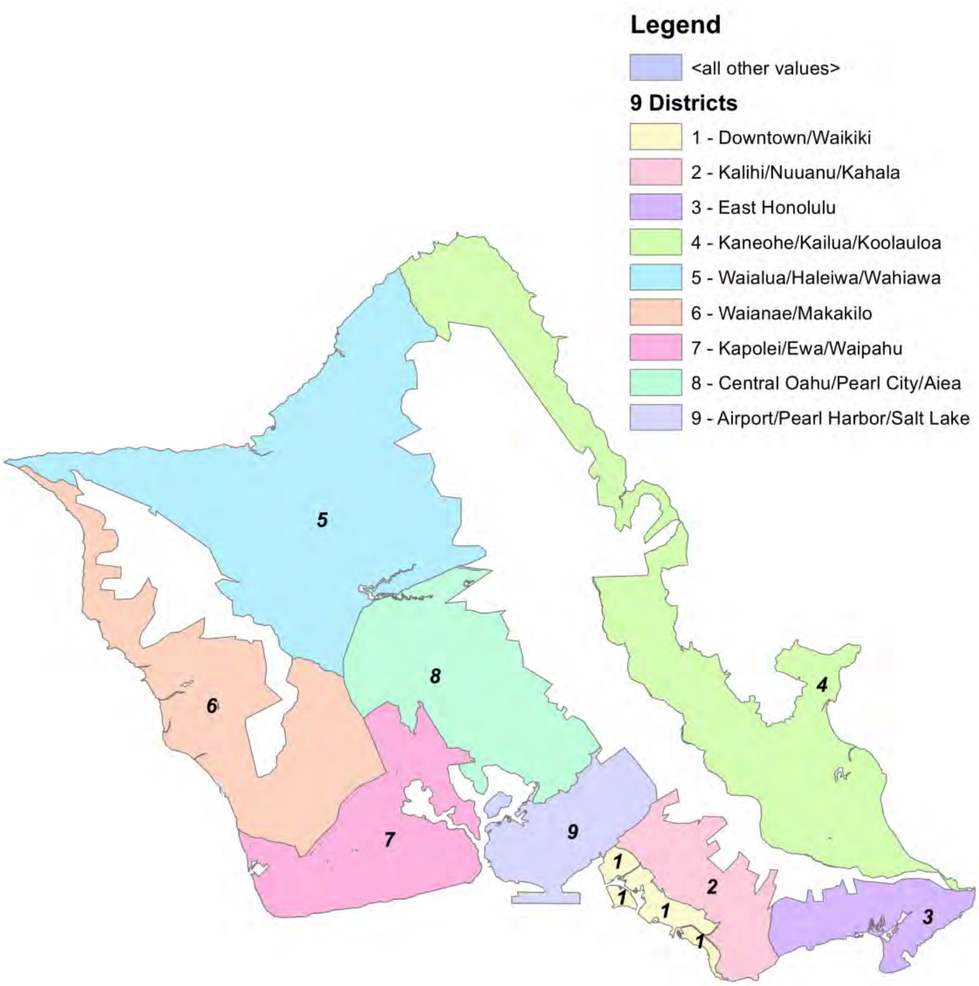
Non-Mandatory Tour Primary Destination Choice

The non-mandatory (escort, maintenance, discretionary, and at-work subtours) tour primary destination choice was calibrated to match summaries from the 2012/2013 home-interview survey (HIS). The non-mandatory tour primary destination choice model determines the location of the tour primary destination for each of the 3 non-mandatory plus at-work sub- tour purposes.

Calibration Process

Estimated versus observed comparisons were made for each tour purpose, including trip length frequencies, average distance and coincidence index (which measures the correspondence between the estimated and observed trip length frequency distribution). A coincidence index value greater than 0.80 is desired. Most of the non-mandatory purposes had coincidence index values higher than 0.80, and two were very close. This is described in the section for each purpose. Additionally, the 9-district system was used for origin to primary destination tour flow comparisons (See Figure 35 below).

Figure 35: Oahu MPO 9-District Map



Model Area Calibration Results

The model tended to underestimate some of the intra-district movements as well as over-estimate tours to the Downtown/Chinatown/Ala Moana district so constants were added to better match the observed distributions. The following table shows the constants added by tour purpose.

Table 91: Non-Mandatory Tour Destination Choice District Constants

	Escort	Maintenance	Discretionary	At-work
Intra-Kalihi/Nuuanu/Kahala (District 2)	0.2417	0.7512	0.2470	0.7302
Intra-Kaneohe/Kailua/Koolauloa (District 4)	0.2577		0.6166	
Intra-Airport/Pearl Harbor/Salt Lake (District 9)	1.1465			
Intra-Central Oahu/Pearl City/Aiea (District 8)			0.2815	
To Downtown/Chinatown/Ala Moana (District 1)	-0.8889	-0.1754	-0.5565	-0.2896

Escort Purpose Destination Choice Calibration Results

The calibrated escort model closely matches the average trip length of the survey data, as shown in Table 92. Table 92 show the summary statistics for the tour distances while Table 93 through Table 95 shows the observed, estimated and percentage difference for district to district escorting flows. Figure 36 shows the district to district flows graphically. The shape of the tour length frequency distribution (Figure 37) is also very close, and the coincidence index value is 0.80. At the very short distances (less than 3 miles), the shape of the curves is slightly different.

Table 92: Escort Tour Length Statistics

	Mean	Std Dev	Min	Max
Observed	4.15	4.14	0.18	29.00
Estimated	4.28	4.21	0.08	44.31

Table 93: Escort Observed District to District Flows Scaled to Estimated Row Totals

ORIGIN DISTRICT	DESTINATION DISTRICT									
	1	2	3	4	5	6	7	8	9	Total
1	5,397	7,292	-	63	-	-	293	-	2,212	15,256
2	7,281	12,735	630	801	-	49	-	-	1,313	22,809
3	393	1,456	3,667	20	-	-	-	55	74	5,666
4	113	1,422	-	13,791	-	-	-	46	358	15,729
5	101	-	-	358	5,637	-	242	766	49	7,153
6	49	-	-	-	-	6,529	885	1,244	42	8,749
7	560	-	-	-	239	-	14,834	1,869	1,570	19,073
8	10	1,848	221	164	1,330	213	1,428	10,162	1,500	16,878
9	795	179	-	-	-	-	262	-	5,771	7,007
Total	**14,700**	**24,932**	**4,518**	**15,198**	**7,207**	**6,792**	**17,943**	**14,142**	**12,889**	**118,320**

Table 94: Escort Estimated District to District Flows

ORIGIN DISTRICT	DESTINATION DISTRICT									
	1	2	3	4	5	6	7	8	9	Total
1	7,086	6,720	204	139	5	5	71	258	768	15,256
2	6,026	14,491	383	304	14	3	115	416	1057	22,809
3	832	1,661	2,889	119	1	2	18	44	100	5,666
4	692	1,154	179	13,183	22	3	59	187	250	15,729
5	47	58	2	218	4,753	15	369	1,631	60	7,153
6	17	25	2	4	13	6,888	1,608	142	50	8,749
7	178	285	11	38	191	621	15,068	2,270	411	19,073
8	676	934	20	90	744	81	2,449	10,220	1,664	16,878
9	578	818	13	36	9	4	144	551	4,854	7,007
Total	**16,132**	**26,146**	**3,703**	**14,131**	**5,752**	**7,622**	**19,901**	**15,719**	**9,214**	**118,320**

Table 95: Percentage Difference between Observed Survey and Estimated Escort Purpose Flows

ORIGIN DISTRICT	DESTINATION DISTRICT									
	1	2	3	4	5	6	7	8	9	Total
1	31%	-8%	0%	122%	0%	0%	-76%	0%	-65%	0%
2	-17%	14%	-39%	-62%	0%	-94%	0%	0%	-19%	0%
3	112%	14%	-21%	485%	0%	0%	0%	-20%	35%	0%
4	511%	-19%	0%	-4%	0%	0%	0%	309%	-30%	0%
5	-53%	0%	0%	-39%	-16%	0%	53%	113%	23%	0%
6	-66%	0%	0%	0%	0%	5%	82%	-89%	20%	0%
7	-68%	0%	0%	0%	-20%	0%	2%	21%	-74%	0%
8	6642%	-49%	-91%	-45%	-44%	-62%	72%	1%	11%	0%
9	-27%	357%	0%	0%	0%	0%	-45%	0%	-16%	0%
Total	10%	5%	-18%	-7%	-20%	12%	11%	11%	-29%	0%

Figure 36: Scatter Plot of District to District Escort Flows (0.986 Correlation Coefficient)

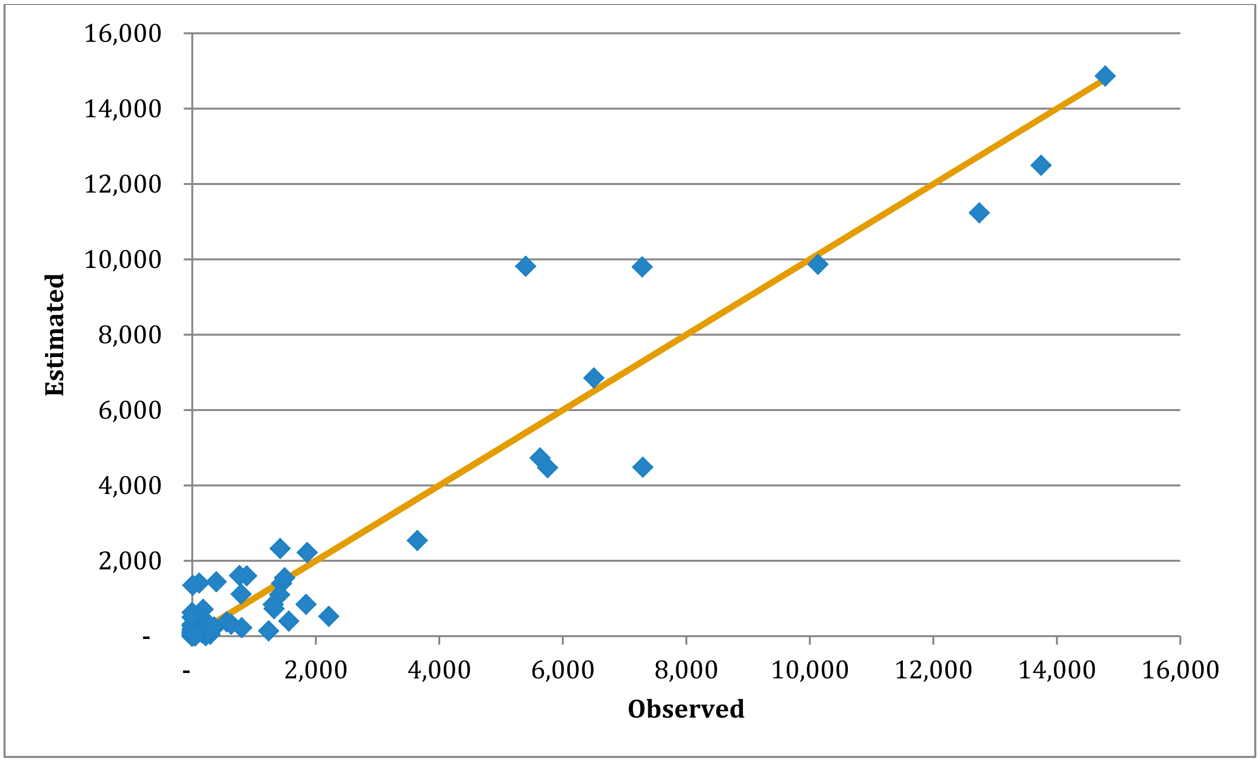
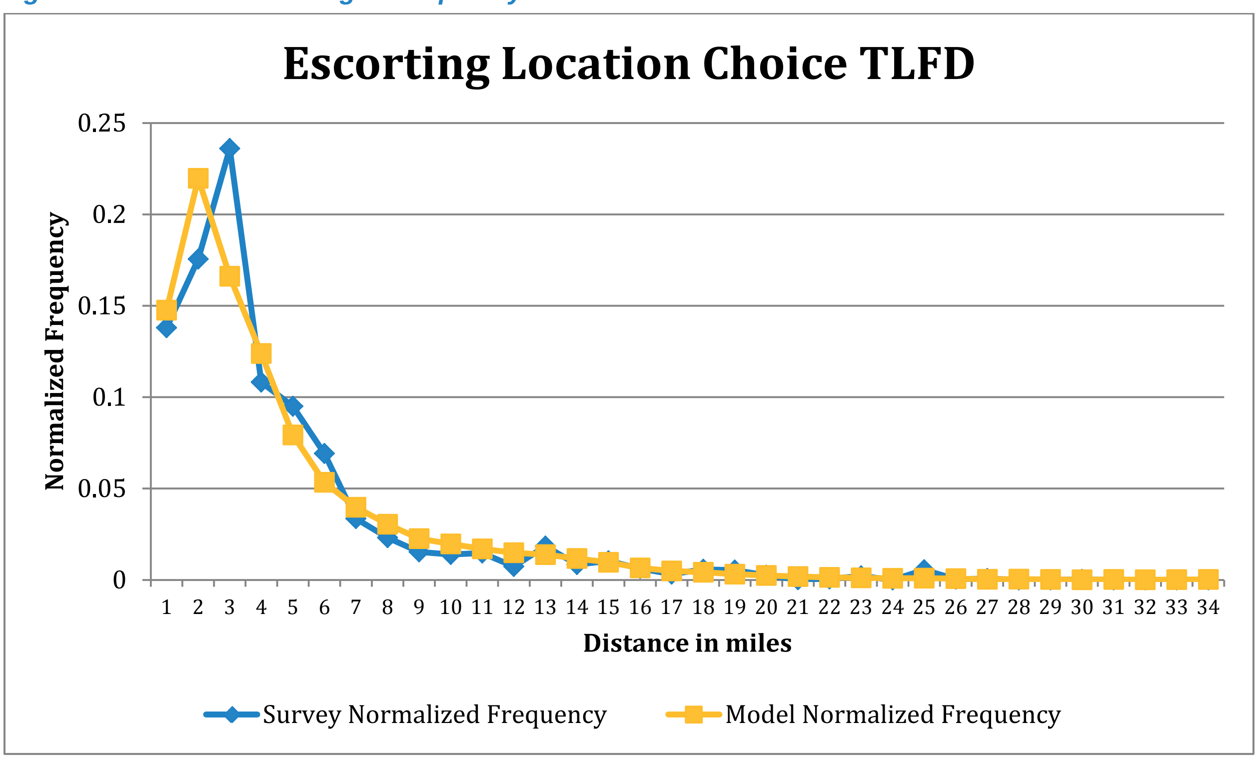


Figure 37: Escort Tour Length Frequency Distribution



Maintenance Purpose Destination Choice Calibration Results

The model slightly underestimates the average trip lengths (Table 96). This difference could be due to lumpiness in the observed curve, at higher distances. Table 97 through Table 99 shows the observed, estimated and percentage difference in district to district maintenance flows. Figure 38 shows the district to district flows graphically. Figure 39 shows that the calibrated maintenance tour length frequency distribution matches the general shape of the observed curve very well. The coincidence index value is 0.85.

Table 96: Maintenance Tour Length Statistics

	Mean	Std Dev	Min	Max
Observed	5.31	6.08	0.09	54.0
Estimated	4.88	5.34	0.05	56.64

Table 97: Maintenance Observed District to District Flows Scaled to Estimated Row Totals

ORIGIN DISTRICT	DESTINATION DISTRICT									
	1	2	3	4	5	6	7	8	9	Total
1	18,873	3,978	93	267	-	-	-	764	967	24,941
2	20,847	12,563	280	521	-	-	144	879	776	36,011
3	3,789	1,510	3,869	284	-	-	-	-	563	10,016
4	3,264	937	383	17,804	24	-	114	622	239	23,387
5	1,921	-	-	-	6,860	-	402	1,232	-	10,415
6	2,054	-	-	141	941	3,867	3,239	773	35	11,049
7	2,529	176	90	25	489	283	14,820	4,498	1,222	24,132
8	2,544	1,377	-	25	841	136	2,619	17,338	1,006	25,887
9	2,763	274	-	-	-	-	158	4,132	3,622	10,950
Total	**58,585**	**20,815**	**4,714**	**19,068**	**9,155**	**4,286**	**21,496**	**30,238**	**8,431**	**176,788**

Table 98: Maintenance Estimated District to District Flows

ORIGIN DISTRICT	DESTINATION DISTRICT									
	1	2	3	4	5	6	7	8	9	Total
1	21,940	2,003	53	68	7	5	39	166	660	24,941
2	21,235	12,459	162	226	11	8	118	398	1,394	36,011
3	4,517	2,115	2,730	212	6	4	52	122	258	10,016
4	4,239	987	159	16,515	45	9	190	506	737	23,387
5	502	119	5	364	6,956	24	635	1,612	198	10,415
6	504	105	1	34	58	6,153	3,589	406	199	11,049
7	1,628	351	21	113	307	374	17,020	3,424	894	24,132

ORIGIN DISTRICT	DESTINATION DISTRICT									
	1	2	3	4	5	6	7	8	9	Total
8	2,723	563	27	168	1,154	54	3,185	15,716	2,297	25,887
9	3,426	611	12	80	34	4	205	1,515	5,063	10,950
Total	**60,714**	**19,313**	**3,170**	**17,780**	**8,578**	**6,635**	**25,033**	**23,865**	**11,700**	**176,788**

Table 99: Percentage Difference between Observed Survey and Estimated Maintenance Flows

ORIGIN DISTRICT	DESTINATION DISTRICT									
	1	2	3	4	5	6	7	8	9	Total
1	16%	-50%	-43%	-74%	0%	0%	0%	-78%	-32%	0%
2	2%	-1%	-42%	-57%	0%	0%	-18%	-55%	80%	0%
3	19%	40%	-29%	-25%	0%	0%	0%	0%	-54%	0%
4	30%	5%	-58%	-7%	86%	0%	67%	-19%	209%	0%
5	-74%	0%	0%	0%	1%	0%	58%	31%	0%	0%
6	-75%	0%	0%	-76%	-94%	59%	11%	-47%	476%	0%
7	-36%	99%	-77%	345%	-37%	32%	15%	-24%	-27%	0%
8	7%	-59%	0%	574%	37%	-60%	22%	-9%	128%	0%
9	24%	123%	0%	0%	0%	0%	30%	-63%	40%	0%
Total	4%	-7%	-33%	-7%	-6%	55%	16%	-21%	39%	0%

Figure 38: Scatter Plot of District to District Maintenance Flows (0.985 Correlation Coefficient)

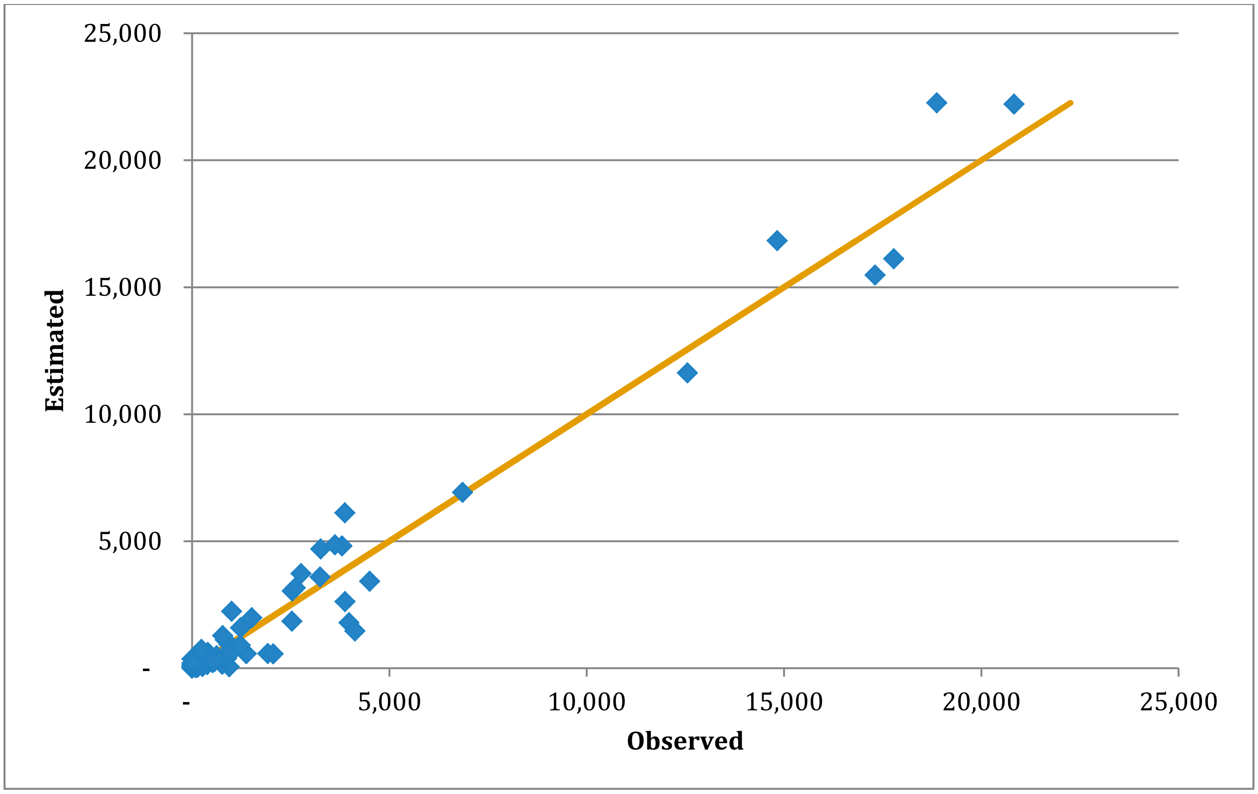
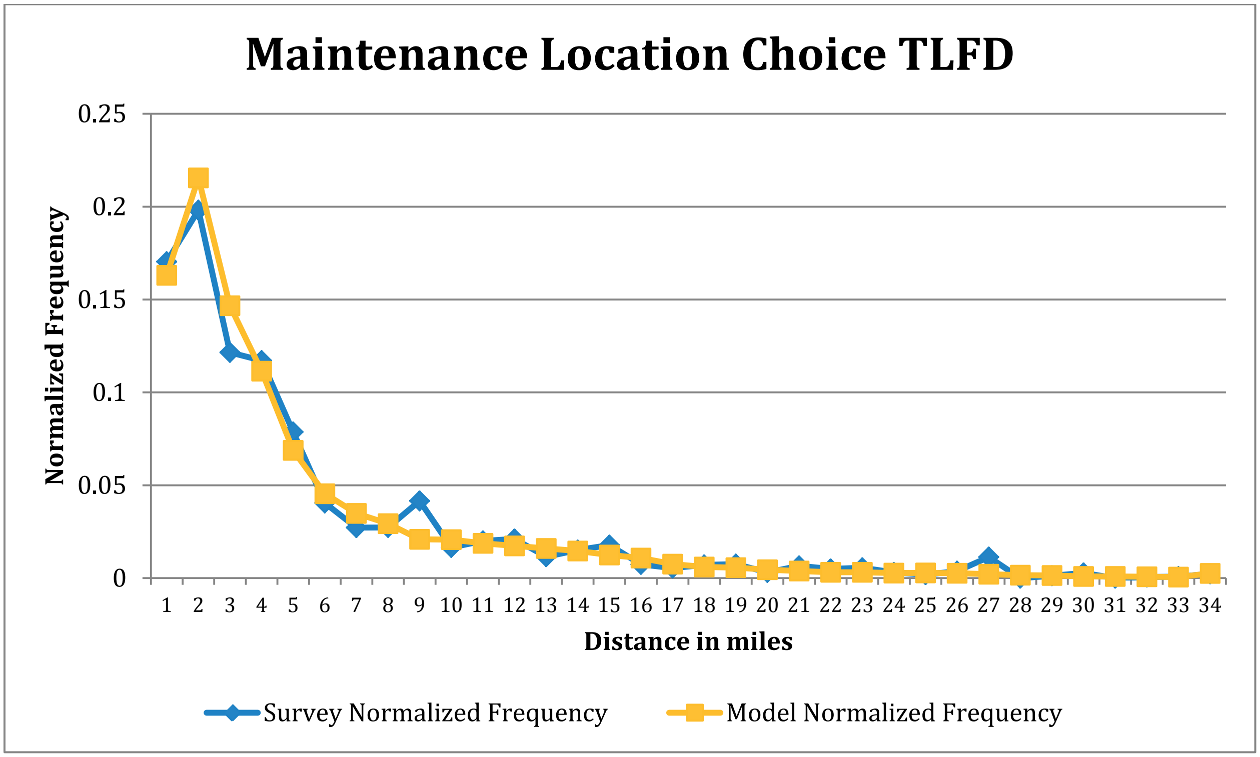


Figure 39: Maintenance Tour Length Frequency Distributions



Discretionary Purpose Destination Choice Calibration Results

The average tour length distance is close to the observed data (Table 100). Table 101 through Table 103 shows the observed, estimated and percentage difference in discretionary district to district flows. Figure 40 shows the district to district flows graphically. The calibrated discretionary choice estimated model matches the tour length frequency distribution curve very well, as shown in Figure 41. The coincidence index value is 0.81.

Table 100: Discretionary Tour Length Statistics

	Mean	Std Dev	Min	Max
Observed	5.61	5.94	0.17	43.3
Estimated	6.08	6.35	0.07	54.5

Table 101: Discretionary Observed District to District Flows Scaled to Estimated Row Totals

ORIGIN DISTRICT	DESTINATION DISTRICT									
	1	2	3	4	5	6	7	8	9	Total
1	11,399	5,565	584	839	-	-	140	108	254	18,890
2	10,606	11,309	789	1,819	105	-	194	2,407	384	27,612
3	2,952	1,158	3,392	397	-	-	63	23	55	8,039
4	2,001	916	428	14,941	-	52	481	-	-	18,820
5	216	88	-	342	5,306	29	292	2,126	107	8,506
6	278	-	-	115	49	3,390	2,948	1,909	254	8,943
7	1,626	1,073	179	-	-	1,230	12,073	3,187	679	20,048
8	984	1,418	212	664	1,141	25	1,418	13,323	2,545	21,730
9	1,379	707	-	170	-	-	296	3,617	2,946	9,115
Total	**31,442**	**22,234**	**5,586**	**19,286**	**6,600**	**4,726**	**17,905**	**26,699**	**7,225**	**141,703**

Table 102: Discretionary Estimated District to District Flows

ORIGIN DISTRICT	DESTINATION DISTRICT									
	1	2	3	4	5	6	7	8	9	Total
1	13,249	3,989	181	240	34	18	145	377	657	18,890
2	11,309	12,400	539	635	63	33	372	852	1,409	27,612
3	2,284	2,151	2,549	358	20	4	110	246	317	8,039
4	1,721	1,279	211	14,155	69	26	270	559	530	18,820
5	360	243	31	289	4,398	77	820	2,038	250	8,506
6	326	226	29	79	82	5,420	2,035	542	204	8,943
7	1,107	726	63	244	398	760	12,883	3,045	822	20,048

ORIGIN DISTRICT	DESTINATION DISTRICT									
	1	2	3	4	5	6	7	8	9	Total
8	1,777	1,151	104	362	791	194	2,547	12,986	1,818	21,730
9	1,994	1,188	67	214	61	39	407	1,520	3,625	9,115
Total	**34,127**	**23,353**	**3,774**	**16,576**	**5,916**	**6,571**	**19,589**	**22,165**	**9,632**	**141,703**

Table 103: Percentage Difference between Observed Survey and Estimated Discretionary Flows

ORIGIN DISTRICT	DESTINATION DISTRICT									
	1	2	3	4	5	6	7	8	9	Total
1	16%	-28%	-69%	-71%	0%	0%	4%	249%	158%	0%
2	7%	10%	-32%	-65%	-40%	0%	92%	-65%	267%	0%
3	-23%	86%	-25%	-10%	0%	0%	76%	980%	472%	0%
4	-14%	40%	-51%	-5%	0%	-50%	-44%	0%	0%	0%
5	66%	176%	0%	-15%	-17%	169%	180%	-4%	134%	0%
6	17%	0%	0%	-31%	67%	60%	-31%	-72%	-20%	0%
7	-32%	-32%	-65%	0%	0%	-38%	7%	-4%	21%	0%
8	81%	-19%	-51%	-45%	-31%	663%	80%	-3%	-29%	0%
9	45%	68%	0%	26%	0%	0%	37%	-58%	23%	0%
Total	9%	5%	-32%	-14%	-10%	39%	9%	-17%	33%	0%

Figure 40: Scatter Plot of District to District Discretionary Flows (0.980 Correlation Coefficient)

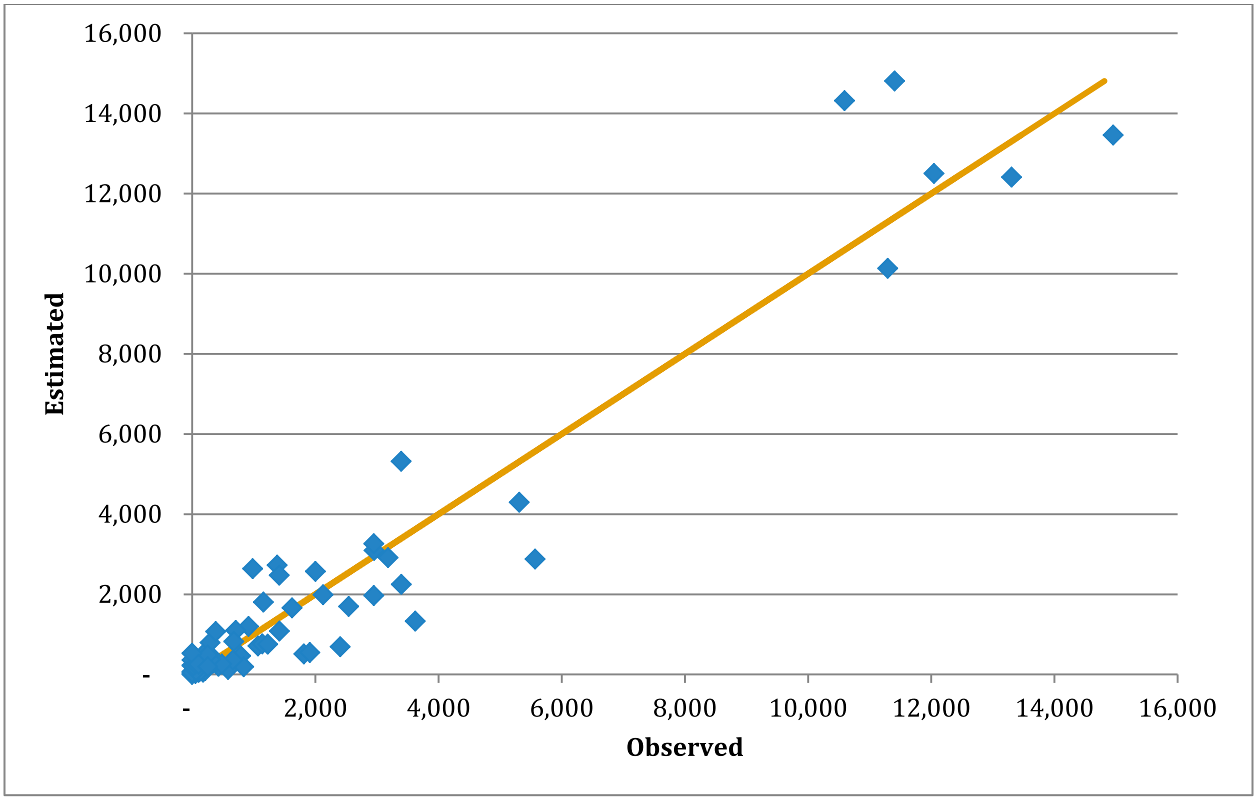
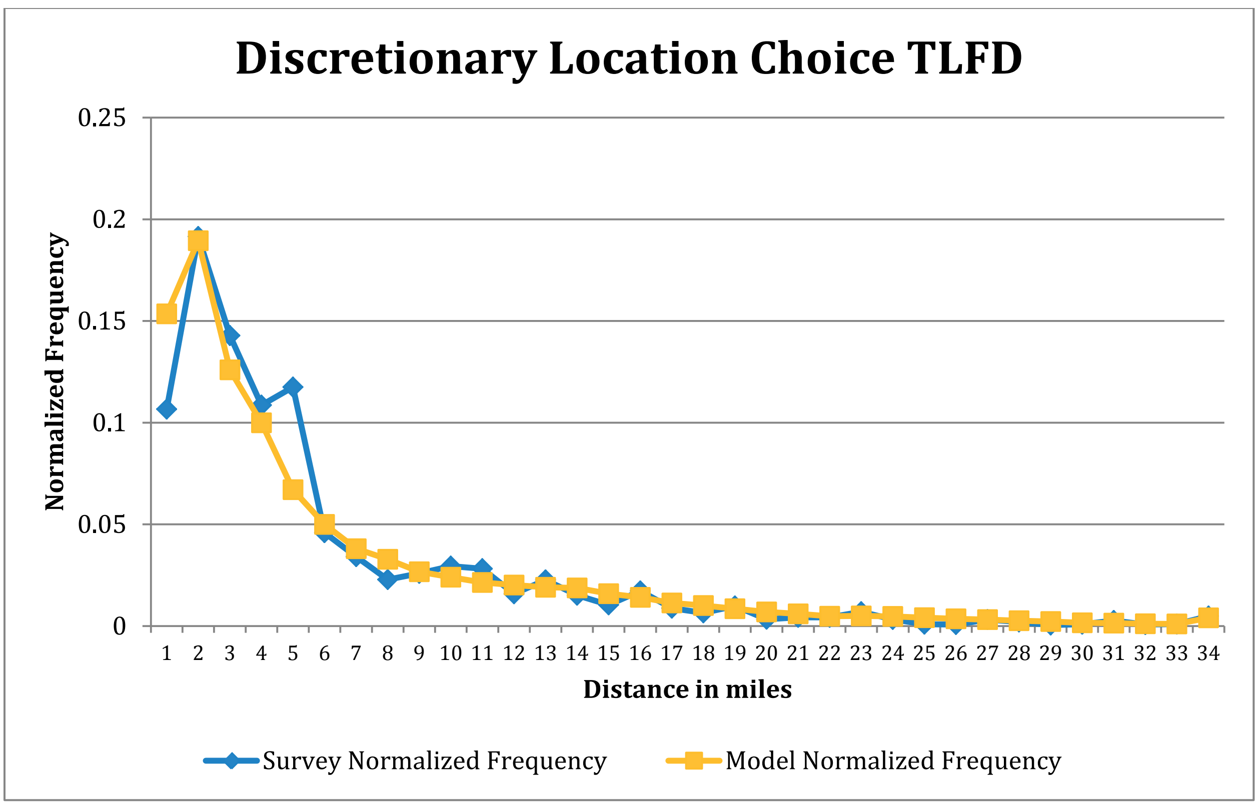


Figure 41: Discretionary Tour Length Frequency Distribution



At-Work Subtour Destination Choice Calibration Results

The average at-work tour distances match well (see Table 104). Table 105 through Table 107 shows the observed, estimated and percentage difference in at-work sub tour flows. Figure 42 shows this graphically. Figure 43 shows that the calibrated estimated tour length frequency distribution matches the general shape of the curve quite well. The coincidence index value is 0.86.

Table 104: At-Work Sub-Tour Length Statistics

	Mean	Std Dev	Min	Max
Observed	3.45	5.26	0.07	32.5
Estimated	3.18	4.51	0.06	44.3

Table 105: At Work Sub-Tour Observed District to District Flows Scaled to Estimated Row Totals

ORIGIN DISTRICT	DESTINATION DISTRICT									
	1	2	3	4	5	6	7	8	9	Total
1	16,218	1,980	46	135	-	-	695	359	769	20,202
2	1,242	3,191	209	65	-	-	67	47	46	4,867
3	-	100	325	-	-	-	-	44	-	469
4	-	190	267	1,783	-	-	-	53	-	2,294
5	-	-	-	-	912	-	-	73	-	985
6	108	-	-	-	-	202	-	-	-	310
7	249	-	-	-	-	-	1,272	125	754	2,400
8	492	78	40	78	53	15	330	1,442	213	2,741
9	1,463	-	-	317	-	-	78	764	2,757	5,379
Total	**19,772**	**5,539**	**886**	**2,378**	**965**	**217**	**2,441**	**2,908**	**4,540**	**39,647**

Table 106: At Work Sub-Tour Estimated District to District Flows

ORIGIN DISTRICT	DESTINATION DISTRICT 1	2	3	4	5	6	7	8	9	Total
1	17,092	1,840	76	134	21	9	81	179	770	20,202
2	1,938	2,468	37	52	9	0	30	79	254	4,867
3	146	103	151	24	1	0	4	7	33	469
4	310	128	23	1,604	11	3	24	59	132	2,294
5	43	18	0	19	677	3	28	161	36	985
6	25	7	0	2	9	151	80	16	20	310
7	200	72	5	24	52	114	1,537	247	149	2,400
8	294	122	9	38	210	17	220	1,409	422	2,741
9	1,235	419	30	93	31	8	93	368	3,102	5,379
Total	**21,283**	**5,177**	**331**	**1,990**	**1,021**	**305**	**2,097**	**2,525**	**4,918**	**39,647**

Table 107: Percentage Difference between Observed Survey and Estimated At Work Sub-Tour Flows

ORIGIN DISTRICT	DESTINATION DISTRICT 1	2	3	4	5	6	7	8	9	Total
1	5%	-7%	67%	-1%	0%	0%	-88%	-50%	0%	0%
2	56%	-23%	-82%	-20%	0%	0%	-55%	67%	453%	0%
3	0%	3%	-54%	0%	0%	0%	0%	-84%	0%	0%
4	0%	-33%	-91%	-10%	0%	0%	0%	11%	0%	0%
5	0%	0%	0%	0%	-26%	0%	0%	121%	0%	0%
6	-77%	0%	0%	0%	0%	-25%	0%	0%	0%	0%
7	-20%	0%	0%	0%	0%	0%	21%	97%	-80%	0%
8	-40%	57%	-77%	-51%	294%	12%	-33%	-2%	98%	0%
9	-16%	0%	0%	-71%	0%	0%	19%	-52%	13%	0%
Total	8%	-7%	-63%	-16%	6%	40%	-14%	-13%	8%	0%

Figure 42: Scatter Plot of District to District At-Work Sub-tour Flows (0.995 Correlation Coefficient)

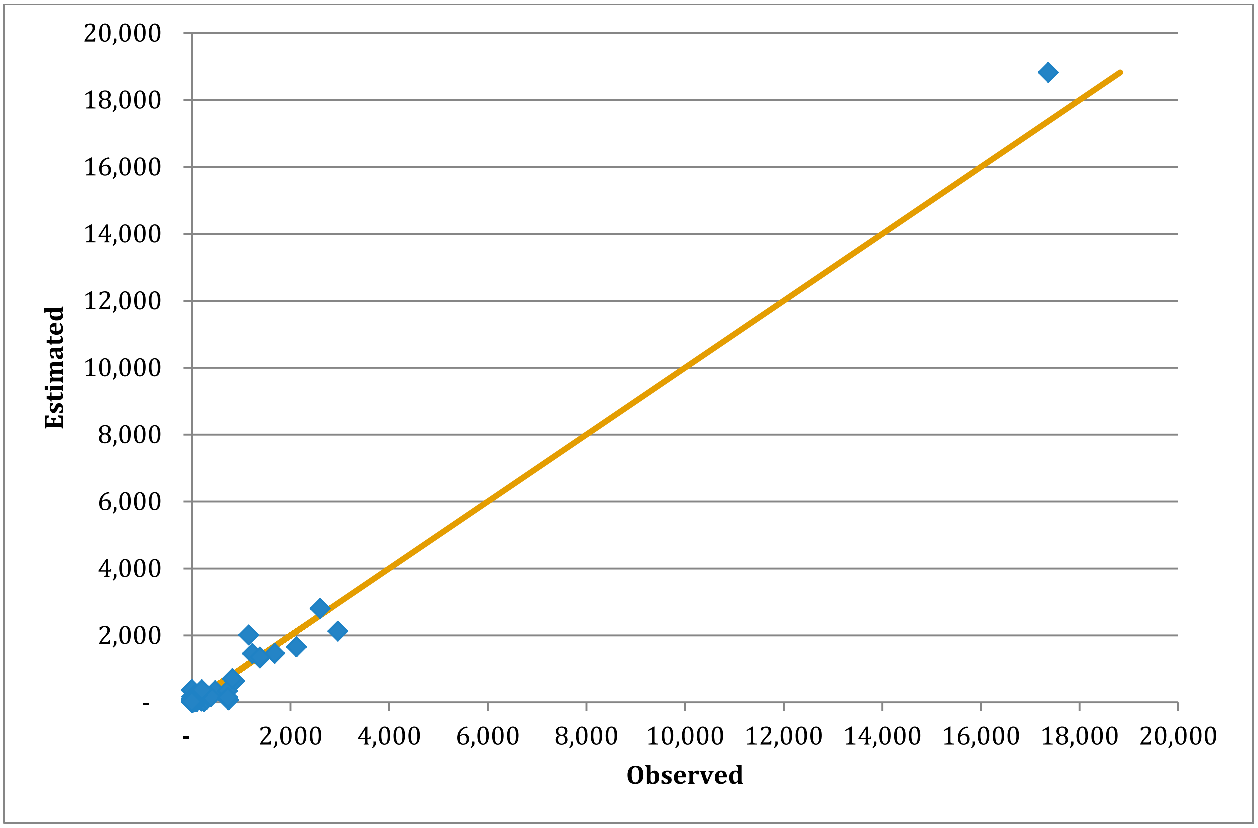
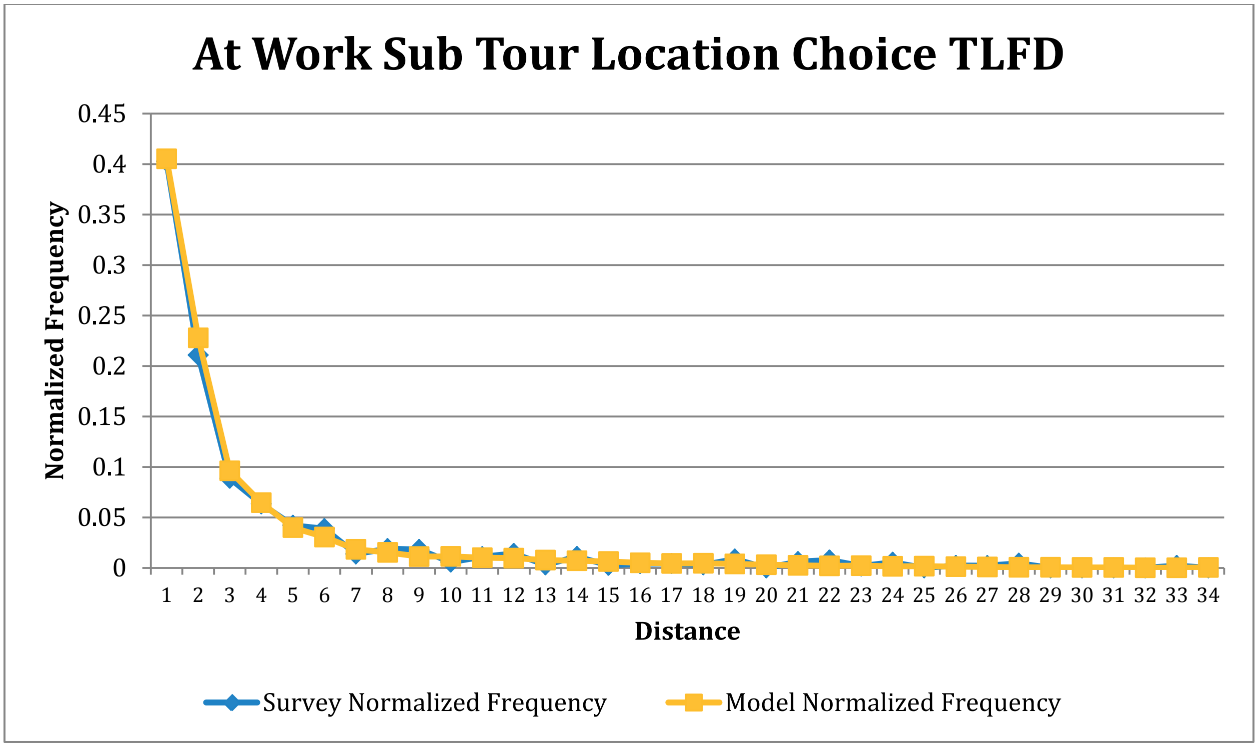


Figure 43: At-Work Sub-Tour Length Frequency Distribution



Tour Mode Choice Model

The tour mode choice model predicts the tour mode for each tour. Tour mode choice model calibration was performed by comparing estimated versus observed tours by tour purpose, auto sufficiency, and tour mode.

Calibration Targets

Calibration data for tour and trip mode choice models was assembled from both the 2012/2013 home-interview survey and the 2012 on-board survey. Transit trips from the on-board survey were substituted for transit trips from the home-interview survey, because the home-interview survey collected few transit trips. However, the transit on-board survey did not collect tour-level information, as it was a standard origin-destination survey. The following steps were used to create the calibration target values for the tour mode choice model by combining the home interview survey with the on-board survey:

The home interview survey was summarized by tour purpose, tour mode and auto sufficiency.

The resulting tables created in Step 1 was then checked for illogical tour modes. For example drive alone tours under the zero auto household market were reallocated to the auto deficient market. School bus tours for non-school purposes were reallocated to the school tour purpose.

The following method was used to estimate the number of transit tours by mode and auto sufficiency from the transit on-board survey data. First, from the home-interview survey, the average number of trips per transit tour by access mode (walk access, park and ride, and kiss and ride) was calculated across all tour purposes (since the home interview data contained few transit trips, it was not possible to calculated average transit trips per transit tour by tour purpose). Then the implied number of transit tours from the on-board survey was estimated by dividing total transit trips from the on-board survey by the average transit trips per tour for each transit access mode and tour purpose. This calculation resulted in transit tours by tour purpose and access mode that are consistent with the trips from the on-board survey and the trips per tour from the home-interview survey.

From the on-board survey, the percentage of transit trips by transit access mode, auto sufficiency and tour purpose was calculated, and these percentages were multiplied by the calculated number of transit tours by tour purpose and access mode from Step 3 to obtain number of transit tours by tour purpose, access mode and auto sufficiency.

Finally, the number of transit tours by transit access mode and auto sufficiency were held constant, and tours for the other modes were scaled up according to the total number of tours generated by tour purpose and auto sufficiency. This was done to ensure that the total number of tours matched the model generated numbers of tours by tour purpose and auto sufficiency, and account for differences in data years as well as biases in the survey data.

Calibration Method

The base alternative for calibrating the tour mode choice model was the drive alone mode, except for zero auto households, where the base alternative was the shared ride two-person mode since drive-alone is not available for households without cars. In some cases, the shared ride two-person was not available for some purposes in the zero auto household market, so another mode was chosen as the base. If this was the case, they are denoted in the tables below. Several runs through the model were done to achieve satisfactory levels of calibration.

Tour Mode Choice Results

For each purpose, a table of observed tours by mode and auto ownership is compared to the estimated tours. Another table shows the comparison of observed tour mode shares and estimated tour mode shares by auto ownership. A third table shows the difference between the observed and estimated tour mode shares by auto ownership. A fourth table shows the final adjustment factors that were needed to calibrate each purpose and the estimated constants by mode and auto ownership.

The comparison of observed versus estimated mode share tours match closely for all purposes (Table 109, Table 113, Table 117, Table 121, Table 125, Table 129, and Table 133).

The following observations can be made regarding the mode shares by tour mode and auto sufficiency:

- For the 0-auto household market, non-motorized modes and walk-transit have positive adjustment factors for the work, university and at-work sub tour purposes. This makes intuitive sense, since the lack of a car means that persons in these households rely more on non-motorized and transit modes (or perhaps in some cases choose not to own a car due to unobserved preferences for non-auto modes).
- For the auto deficient market, ride-sharing is more prevalent. Therefore, constants on shared-ride modes tend to be either positive or less negative than for the auto sufficient market.
- For the auto sufficient market, there was more driving-alone than ride-sharing, non-motorized, and transit modes except for the school and escorting purposes since these purposes naturally dominate the shared ride mode.

Table 108: Work Purpose Tour Mode Choice by Auto Ownership

Tour Mode	Observed				Estimated			
	Auto Sufficiency				Auto Sufficiency			
	No Vehicles	Vehicles< Adults	Vehicles>= Adults	Total	No Vehicles	Vehicles< Adults	Vehicles>= Adults	Total
Drive-Alone	0	66,966	98,061	165,027	0	66,954	98,071	165,025
Shared 2	2,065	33,745	31,598	67,408	2,045	33,730	31,571	67,346
Shared 3+	198	18,743	14,936	33,878	200	18,740	14,934	33,874
Walk	2,945	4,858	2,250	10,053	2,897	4,863	2,252	10,012
Bike	812	1,615	1,998	4,425	823	1,615	1,996	4,434
Walk-Transit	8,681	18,625	8,086	35,391	8,744	18,656	8,081	35,481
PNR-Transit	0	184	337	521	0	183	338	521
KNR-Transit	101	793	408	1,302	102	795	407	1,304
School Bus	0	0	0	0	0	0	0	0
Total	14,802	145,528	157,674	318,004	14,811	145,536	157,650	317,997

Table 109: Work Purpose Tour Mode Choice Shares by Auto Ownership

Tour Mode	Observed				Estimated			
	Auto Sufficiency			Total	Auto Sufficiency			Total
	No Vehicles	Vehicles< Adults	Vehicles>= Adults		No Vehicles	Vehicles< Adults	Vehicles>= Adults	
Drive-Alone	0%	46%	62%	52%	0%	46%	62%	52%
Shared 2	14%	23%	20%	21%	14%	23%	20%	21%
Shared 3+	1%	13%	9%	11%	1%	13%	9%	11%
Walk	20%	3%	1%	3%	20%	3%	1%	3%
Bike	5%	1%	1%	1%	6%	1%	1%	1%
Walk-Transit	59%	13%	5%	11%	59%	13%	5%	11%
PNR-Transit	0%	0%	0%	0%	0%	0%	0%	0%
KNR-Transit	1%	1%	0%	0%	1%	1%	0%	0%
School Bus	0%	0%	0%	0%	0%	0%	0%	0%
Total	100%	100%	100%	100%	100%	100%	100%	100%

Table 110: Difference (Estimated minus Observed) in Work Purpose Tour Mode Choice Shares by Auto Ownership

Tour Mode	Auto Sufficiency			Total
	No Vehicles	Vehicles <Adults	Vehicles>=Adults	
Drive-Alone	0%	0%	0%	0%
Shared 2	0%	0%	0%	0%
Shared 3+	0%	0%	0%	0%
Walk	0%	0%	0%	0%
Bike	0%	0%	0%	0%
Walk-Transit	0%	0%	0%	0%
PNR-Transit	0%	0%	0%	0%
KNR-Transit	0%	0%	0%	0%
School Bus	0%	0%	0%	0%
Total	0%	0%	0%	0%

Table 111: Final Adjustment Factors for Work Purpose Tour Mode Choice by Auto Ownership

Tour Mode	Final Adjustment Factors		
	Auto Sufficiency		
	No Vehicles	Vehicles <Adults	Vehicles>=Adults
Drive-Alone		base	base
Shared 2	base	0.90	0.63
Shared 3+	0.28	1.73	1.40
Walk	1.11	1.31	0.27
Bike	0.93	0.95	0.77
Walk-Transit	1.51	1.65	0.60
PNR-Transit	1.18	0.31	0.01
KNR-Transit	1.19	0.66	-0.25
School Bus	0	0	0

Table 112: University Purpose Tour Mode Choice by Auto Ownership

Tour Mode	Observed				Estimated			
	Auto Sufficiency			Total	Auto Sufficiency			Total
	No Vehicles	Vehicles< Adults	Vehicles>= Adults		No Vehicles	Vehicles< Adults	Vehicles>= Adults	
Drive-Alone	0	3,869	5,141	9,010	0	3,866	5,140	9,006
Shared 2	0	3,643	1,940	5,582	0	3,637	1,940	5,577
Shared 3+	1,398	1,117	605	3,120	1,316	1,121	604	3,041
Walk	242	566	89	897	231	564	90	885
Bike	158	196	140	495	149	198	141	488
Walk-Transit	3,014	5,546	2,819	11,379	2,969	5,549	2,816	11,334
PNR-Transit	0	45	85	129	0	45	84	129
KNR-Transit	37	219	289	545	37	215	292	544
School Bus	0	0	0	-	0	0	0	0
Total	4,850	15,200	11,108	31,158	4,702	15,195	11,107	31,004

Table 113: University Purpose Tour Mode Choice Shares by Auto Ownership

Tour Mode	Observed: Auto Sufficiency: No Vehicles	Observed: Auto Sufficiency: Vehicles< Adults	Observed: Auto Sufficiency: Vehicles>= Adults	Observed: Total	Estimated: Auto Sufficiency: No Vehicles	Estimated: Auto Sufficiency: Vehicles< Adults	Estimated: Auto Sufficiency: Vehicles>= Adults	Estimated: Total
Drive-Alone	0%	25%	46%	29%	0%	25%	46%	29%
Shared 2	0%	24%	17%	18%	0%	24%	17%	18%
Shared 3+	29%	7%	5%	10%	28%	7%	5%	10%
Walk	5%	4%	1%	3%	5%	4%	1%	3%
Bike	3%	1%	1%	2%	3%	1%	1%	2%
Walk-Transit	62%	36%	25%	37%	63%	37%	25%	37%
PNR-Transit	0%	0%	1%	0%	0%	0%	1%	0%
KNR-Transit	1%	1%	3%	2%	1%	1%	3%	2%
School Bus	0%	0%	0%	0%	0%	0%	0%	0%
Total	100%	100%	100%	100%	100%	100%	100%	100%

Table 114: Difference (Estimated minus Observed) in University Purpose Tour Mode Choice Shares by Auto Ownership

Tour Mode	Auto Sufficiency: No Vehicles	Auto Sufficiency: Vehicles <Adults	Auto Sufficiency: Vehicles> =Adults	Total
Drive-Alone	0%	0%	0%	0%
Shared 2	0%	0%	0%	0%
Shared 3+	-1%	0%	0%	0%
Walk	0%	0%	0%	0%
Bike	0%	0%	0%	0%
Walk-Transit	1%	0%	0%	0%
PNR-Transit	0%	0%	0%	0%
KNR-Transit	0%	0%	0%	0%
School Bus	0%	0%	0%	0%
Total	0%	0%	0%	0%

Table 115: Final Adjustment Factors for University Purpose Tour Mode Choice by Auto Ownership

Tour Mode	Final Adjustment Factors		
	Auto Sufficiency		
	No Vehicles	Vehicles <Adults	Vehicles>=Adults
Drive-Alone		base	base
Shared 2	N/A	1.34	0.62
Shared 3+	3.74	1.80	1.11
Walk	0.50	1.87	-1.18
Bike	-0.05	0.11	-1.39
Walk-Transit	base	2.14	1.16
PNR-Transit	N/A	0.44	0.46
KNR-Transit	0.51	1.54	1.30
School Bus	N/A	N/A	N/A

Table 116: School Purpose Tour Mode Choice by Auto Ownership

Tour Mode	Observed				Estimated			
	Auto Sufficiency			Total	Auto Sufficiency			Total
	No Vehicles	Vehicles< Adults	Vehicles>= Adults		No Vehicles	Vehicles< Adults	Vehicles>= Adults	
Drive-Alone	0	137	1,163	1,301	0	137	1,162	1,299
Shared 2	425	8,528	14,861	23,814	424	8,525	14,858	23,807
Shared 3+	850	18,657	35,534	55,041	848	18,655	35,433	54,936
Walk	1,085	9,041	5,827	15,953	1,083	9,040	5,817	15,940
Bike	312	1,261	1,697	3,270	314	1,262	1,694	3,270
Walk-Transit	566	3,102	2,857	6,526	568	3,103	2,855	6,526
PNR-Transit	0	21	128	149	0	21	132	153
KNR-Transit	31	103	250	385	31	99	242	372
School Bus	2,416	16,462	6,721	25,599	2,411	16,461	6,714	25,586
Total	5,686	57,313	69,039	132,038	5,679	57,303	68,907	131,889

Table 117: School Purpose Tour Mode Choice Shares by Auto Ownership

Tour Mode	Observed				Estimated			
	Auto Sufficiency			Total	Auto Sufficiency			Total
	No Vehicles	Vehicles< Adults	Vehicles>= Adults		No Vehicles	Vehicles< Adults	Vehicles>= Adults	
Drive-Alone	0%	0%	2%	1%	0%	0%	2%	1%
Shared 2	7%	15%	22%	18%	7%	15%	22%	18%
Shared 3+	15%	33%	51%	42%	15%	33%	51%	42%
Walk	19%	16%	8%	12%	19%	16%	8%	12%
Bike	5%	2%	2%	2%	6%	2%	2%	2%
Walk-Transit	10%	5%	4%	5%	10%	5%	4%	5%
PNR-Transit	0%	0%	0%	0%	0%	0%	0%	0%
KNR-Transit	1%	0%	0%	0%	1%	0%	0%	0%
School Bus	42%	29%	10%	19%	42%	29%	10%	19%
Total	100%	100%	100%	100%	100%	100%	100%	100%

Table 118: Difference (Estimated minus Observed) in School Purpose Tour Mode Choice Shares by Auto Ownership

Tour Mode	Auto Sufficiency			Total
	No Vehicles	Vehicles <Adults	Vehicles>=Adults	
Drive-Alone	0%	0%	0%	0%
Shared 2	0%	0%	0%	0%
Shared 3+	0%	0%	0%	0%
Walk	0%	0%	0%	0%
Bike	0%	0%	0%	0%
Walk-Transit	0%	0%	0%	0%
PNR-Transit	0%	0%	0%	0%
KNR-Transit	0%	0%	0%	0%
School Bus	0%	0%	0%	0%
Total	0%	0%	0%	0%

Table 119: Final Adjustment Factors for School Purpose Tour Mode Choice by Auto Ownership

Tour Mode	Final Adjustment Factors		
	Auto Sufficiency		
	No Vehicles	Vehicles <Adults	Vehicles>=Adults
Drive-Alone		base	base
Shared 2	base	2.37	1.15
Shared 3+	-0.72	1.71	0.51
Walk	-2.78	0.47	-0.93
Bike	-1.71	0.53	-0.16
Walk-Transit	-1.53	0.40	-1.03
PNR-Transit	0.00	0.41	-0.08
KNR-Transit	-0.74	0.06	-0.68
School Bus	1.26	2.77	-0.12

Table 120: Maintenance Purpose Tour Mode Choice by Auto Ownership

Tour Mode	Observed				Estimated			
	Auto Sufficiency			Total	Auto Sufficiency			Total
	No Vehicles	Vehicles< Adults	Vehicles>= Adults		No Vehicles	Vehicles< Adults	Vehicles>= Adults	
Drive-Alone	0	19,974	30,843	50,817	0	19,968	30,839	50,807
Shared 2	2,408	27,827	22,983	53,219	2,399	27,807	22,985	53,191
Shared 3+	2,318	18,622	16,658	37,599	2,329	18,621	16,659	37,609
Walk	5,750	9,428	2,531	17,710	5,734	9,434	2,525	17,693
Bike	871	0	222	1,092	871	13	223	1,107
Walk-Transit	6,752	5,811	3,578	16,141	6,773	5,820	3,573	16,166
PNR-Transit	0	21	37	58	0	20	39	59
KNR-Transit	20	89	45	155	20	89	43	152
School Bus	0	0	0	-	0	0	0	-
Total	18,120	81,772	76,898	176,790	18,126	81,772	76,886	176,784

Table 121: Maintenance Purpose Tour Mode Choice Shares by Auto Ownership

Tour Mode	Observed				Estimated			
	Auto Sufficiency			Total	Auto Sufficiency			Total
	No Vehicles	Vehicles <Adults	Vehicles> =Adults		No Vehicles	Vehicles< Adults	Vehicles> =Adults	
Drive-Alone	0%	24%	40%	29%	0%	24%	40%	29%
Shared 2	13%	34%	30%	30%	13%	34%	30%	30%
Shared 3+	13%	23%	22%	21%	13%	23%	22%	21%
Walk	32%	12%	3%	10%	32%	12%	3%	10%
Bike	5%	0%	0%	1%	5%	0%	0%	1%
Walk-Transit	37%	7%	5%	9%	37%	7%	5%	9%
PNR-Transit	0%	0%	0%	0%	0%	0%	0%	0%
KNR-Transit	0%	0.1%	0%	0%	0%	0%	0%	0%
School Bus	0%	0%	0%	0%	0%	0%	0%	0%
Total	100%	100%	100%	100%	100%	100%	100%	100%

Table 122: Difference (Estimated minus Observed) in Maintenance Purpose Tour Mode Choice Shares by Auto Ownership

Tour Mode	Auto Sufficiency			Total
	No Vehicles	Vehicles <Adults	Vehicles>=Adults	
Drive-Alone	0%	0%	0%	0%
Shared 2	0%	0%	0%	0%
Shared 3+	0%	0%	0%	0%
Walk	0%	0%	0%	0%
Bike	0%	0%	0%	0%
Walk-Transit	0%	0%	0%	0%
PNR-Transit	0%	0%	0%	0%
KNR-Transit	0%	0%	0%	0%
School Bus	0%	0%	0%	0%
Total	0%	0%	0%	0%

Table 123: Final Adjustment Factors for Maintenance Purpose Tour Mode Choice by Auto Ownership

Tour Mode	Final Adjustment Factors		
	Auto Sufficiency		
	No Vehicles	Vehicles <Adults	Vehicles>=Adults
Drive-Alone		base	base
Shared 2	base	0.10	-0.49
Shared 3+	0.50	0.51	-0.05
Walk	-1.24	2.48	0.86
Bike	0.60	N/A	2.23
Walk-Transit	-1.47	3.79	3.16
PNR-Transit	0.00	4.51	4.53
KNR-Transit	-0.29	5.44	4.68
School Bus	N/A	N/A	N/A

Table 124: Discretionary Purpose Tour Mode Choice by Auto Ownership

Tour Mode	Observed				Estimated			
	Auto Sufficiency			Total	Auto Sufficiency			Total
	No Vehicles	Vehicles< Adults	Vehicles>= Adults		No Vehicles	Vehicles< Adults	Vehicles>= Adults	
Drive-Alone	0	11,948	21,970	33,918	0	11,944	21,961	33,905
Shared 2	773	23,155	20,632	44,560	751	23,149	20,621	44,521
Shared 3+	4,479	17,996	15,498	37,973	4,492	17,992	15,504	37,988
Walk	2,185	6,811	4,168	13,163	2,187	6,812	4,164	13,163
Bike	509	673	377	1,559	502	670	375	1,547
Walk-Transit	3,368	4,426	2,426	10,220	3,383	4,427	2,419	10,229
PNR-Transit	0	37	64	101	0	35	63	98
KNR-Transit	36	82	99	217	37	84	102	223
School Bus	0	0	0	-	0	0	0	-
Total	11,349	65,127	65,234	141,710	11,352	65,113	65,209	141,674

Table 125: Discretionary Purpose Tour Mode Choice Shares by Auto Ownership

Tour Mode	Observed				Estimated			
	Auto Sufficiency			Total	Auto Sufficiency			Total
	No Vehicles	Vehicles< Adults	Vehicles>= Adults		No Vehicles	Vehicles< Adults	Vehicles>= Adults	
Drive-Alone	0%	18%	34%	24%	0%	18%	34%	24%
Shared 2	7%	36%	32%	31%	7%	36%	32%	31%
Shared 3+	39%	28%	24%	27%	40%	28%	24%	27%
Walk	19%	10%	6%	9%	19%	10%	6%	9%
Bike	4%	1%	1%	1%	4%	1%	1%	1%
Walk-Transit	30%	7%	4%	7%	30%	7%	4%	7%
PNR-Transit	0%	0%	0%	0%	0%	0%	0%	0%
KNR-Transit	0%	0%	0%	0%	0%	0%	0%	0%
School Bus	0%	0%	0%	0%	0%	0%	0%	0%
Total	100%	100%	100%	100%	100%	100%	100%	100%

Table 126: Difference (Estimated minus Observed) in Discretionary Purpose Tour Mode Choice Shares by Auto Ownership

Tour Mode	Auto Sufficiency			Total
	No Vehicles	Vehicles <Adults	Vehicles> =Adults	
Drive-Alone	0%	0%	0%	0%
Shared 2	0%	0%	0%	0%
Shared 3+	0%	0%	0%	0%
Walk	0%	0%	0%	0%
Bike	0%	0%	0%	0%
Walk-Transit	0%	0%	0%	0%
PNR-Transit	0%	0%	0%	0%
KNR-Transit	0%	0%	0%	0%
School Bus	0%	0%	0%	0%
Total	0%	0%	0%	0%

Table 127: Final Adjustment Factors for Discretionary Purpose Tour Mode Choice by Auto Ownership

Tour Mode	Final Adjustment Factors		
	Auto Sufficiency		
	No Vehicles	Vehicles <Adults	Vehicles> =Adults
Drive-Alone		base	base
Shared 2	base	0.63	0.03
Shared 3+	0.90	0.83	0.22
Walk	-2.07	2.72	1.89
Bike	0.40	4.28	3.31
Walk-Transit	-1.80	4.21	3.38
PNR-Transit	0.00	5.64	5.24
KNR-Transit	0.29	6.00	5.49
School Bus	N/A	N/A	N/A

Table 128: Escorting Purpose Tour Mode Choice by Auto Ownership

Tour Mode	Observed				Estimated			
	Auto Sufficiency			Total	Auto Sufficiency			Total
	No Vehicles	Vehicles <Adults	Vehicles> =Adults		No Vehicles	Vehicles< Adults	Vehicles> =Adults	
Drive-Alone	0	33	255	288	0	31	251	282
Shared 2	3,896	29,488	18,462	51,845	3,901	29,480	18,461	51,842
Shared 3+	3,328	29,051	23,918	56,297	3,327	29,052	23,922	56,301
Walk	1,364	4,434	2,249	8,047	1,363	4,436	2,255	8,054
Bike	0	796	263	1,059	0	797	264	1,061
Walk-Transit	0	0	0	-	0	0	0	0
PNR-Transit	0	0	0	-	0	0	0	0
KNR-Transit	0	0	0	-	0	0	0	0
School Bus	0	0	0	-	0	0	0	-
Total	8,587	63,802	45,147	117,536	8,591	63,796	45,153	117,540

Table 129: Escorting Purpose Tour Mode Choice Shares by Auto Ownership

Tour Mode	Observed				Estimated			
	Auto Sufficiency			Total	Auto Sufficiency			Total
	No Vehicles	Vehicles <Adults	Vehicles> =Adults		No Vehicles	Vehicles< Adults	Vehicles> =Adults	
Drive-Alone	0%	0%	1%	0%	0%	0%	1%	0%
Shared 2	45%	46%	41%	44%	45%	46%	41%	44%
Shared 3+	39%	46%	53%	48%	39%	46%	53%	48%
Walk	16%	7%	5%	7%	16%	7%	5%	7%
Bike	0%	1%	1%	1%	0%	1%	1%	1%
Walk-Transit	0%	0%	0%	0%	0%	0%	0%	0%
PNR-Transit	0%	0%	0%	0%	0%	0%	0%	0%
KNR-Transit	0%	0%	0%	0%	0%	0%	0%	0%
School Bus	0%	0%	0%	0%	0%	0%	0%	0%
Total	100%	100%	100%	100%	100%	100%	100%	100%

Table 130: Difference (Estimated minus Observed) in Joint Discretionary Purpose Tour Mode Choice Shares by Auto Ownership

Tour Mode	Auto Sufficiency			Total
	No Vehicles	Vehicles <Adults	Vehicles>=Adults	
Drive-Alone	0%	0%	0%	0%
Shared 2	0%	0%	0%	0%
Shared 3+	0%	0%	0%	0%
Walk	0%	0%	0%	0%
Bike	0%	0%	0%	0%
Walk-Transit	0%	0%	0%	0%
PNR-Transit	0%	0%	0%	0%
KNR-Transit	0%	0%	0%	0%
School Bus	0%	0%	0%	0%
Total	0%	0%	0%	0%

Table 131: Final Adjustment Factors for Escorting Purpose Tour Mode Choice by Auto Ownership

Tour Mode	Final Adjustment Factors		
	Auto Sufficiency		
	No Vehicles	Vehicles <Adults	Vehicles>= Adults
Drive-Alone	N/A	base	base
Shared 2	base	4.97	3.38
Shared 3+	-0.05	4.99	3.50
Walk	-0.61	6.12	5.08
Bike	N/A	6.66	4.91
Walk-Transit	N/A	N/A	N/A
PNR-Transit	N/A	N/A	N/A
KNR-Transit	N/A	N/A	N/A
School Bus	N/A	N/A	N/A

Table 132: At-Work Sub Tour Purpose Tour Mode Choice by Auto Ownership

Tour Mode	Observed				Estimated			
	Auto Sufficiency			Total	Auto Sufficiency			Total
	No Vehicles	Vehicles <Adults	Vehicles> =Adults		No Vehicles	Vehicles< Adults	Vehicles> =Adults	
Drive-Alone	0	5,131	11,056	16,187	0	5,127	11,057	16,184
Shared 2	460	2,590	4,118	7,168	460	2,590	4,123	7,173
Shared 3+	0	86	1,363	1,449	6	85	1,354	1,445
Walk	1,240	6,627	6,374	14,241	1,240	6,623	6,373	14,236
Bike	0	0	150	150	0	0	150	150
Walk-Transit	296	610	292	1,198	296	609	293	1,198
PNR-Transit	0	0	0	-	0	0	0	0
KNR-Transit	0	0	0	-	0	0	0	0
School Bus	0	0	0	-	0	0	0	-
Total	1,996	15,044	23,353	40,393	2,002	15,034	23,350	40,386

Table 133: At-Work Sub Tour Purpose Tour Mode Choice Shares by Auto Ownership

Tour Mode	Observed				Estimated			
	Auto Sufficiency			Total	Auto Sufficiency			Total
	No Vehicles	Vehicles <Adults	Vehicles> =Adults		No Vehicles	Vehicles< Adults	Vehicles> =Adults	
Drive-Alone	0%	34%	47%	40%	0%	34%	47%	40%
Shared 2	23%	17%	18%	18%	23%	17%	18%	18%
Shared 3+	0%	1%	6%	4%	0%	1%	6%	4%
Walk	62%	44%	27%	35%	62%	44%	27%	35%
Bike	0%	0%	1%	0%	0%	0%	1%	0%
Walk-Transit	15%	4%	1%	3%	15%	4%	1%	3%
PNR-Transit	0%	0%	0%	0%	0%	0%	0%	0%
KNR-Transit	0%	0%	0%	0%	0%	0%	0%	0%
School Bus	0%	0%	0%	0%	0%	0%	0%	0%
Total	100%	100%	100%	100%	100%	100%	100%	100%

Table 134: Difference (Estimated minus Observed) in At-Work Sub Tour Purpose Tour Mode Choice Shares by Auto Ownership

Tour Mode	Auto Sufficiency			Total
	No Vehicles	Vehicles <Adults	Vehicles>= Adults	
Drive-Alone	0%	0%	0%	0%
Shared 2	0%	0%	0%	0%
Shared 3+	0%	0%	0%	0%
Walk	0%	0%	0%	0%
Bike	0%	0%	0%	0%
Walk-Transit	0%	0%	0%	0%
PNR-Transit	0%	0%	0%	0%
KNR-Transit	0%	0%	0%	0%
School Bus	0%	0%	0%	0%
Total	0%	0%	0%	0%

Table 135: Final Adjustment Factors for At-Work Sub Tour Purpose Tour Mode Choice by Auto Ownership

Tour Mode	Final Adjustment Factors		
	Auto Sufficiency		
	No Vehicles	Vehicles <Adults	Vehicles>= Adults
Drive-Alone	N/A	base	base
Shared 2	base	0.54	0.22
Shared 3+	N/A	0.81	1.29
Walk	2.24	1.37	0.48
Bike	1.09	N/A	0.03
Walk-Transit	0.43	-0.78	-2.57
PNR-Transit	N/A	N/A	N/A
KNR-Transit	N/A	N/A	N/A
School Bus	N/A	N/A	N/A

Intermediate Stop Location Choice Model

This model predicts the location of each intermediate stop (each location other than the primary destination) on the tour. In this model, a maximum of 4 stops on the outbound and 4 stops on the inbound direction are modeled for each tour. The OahuMPO stop location model was calibrated to match distributions from the home-interview survey. Three estimated versus observed frequency distributions were created to analyze model goodness-of-fit, out of direction stop distance, stop distance from the tour primary destination, and stop distance from the tour anchor location. The results are described below.

Calibration Results

Out of Direction Stops

Table 136 shows the observed and estimated average out of direction distances by tour purpose. The normalized coincidence ratio is also shown to determine how well the estimated matched the observed out of direction distance in one mile increments. This table shows that the model's average out of direction distance matches well for the work and university purpose, but is slightly longer for the school, and non-mandatory tour purposes. .

Table 136. Observed versus Estimated Average Out of Direction Distance by Tour Purpose

Purpose	Observed Average out of direction Distance	Estimated Average out of direction Distance	Normalized Coincidence Ratio
Work	3.15	3.88	0.74
University	2.27	2.72	0.68
School	3.06	4.25	0.72
Escorting	2.89	4.90	0.71
Maintenance	2.28	4.19	0.78
Discretionary	2.28	4.11	0.69

Figure 44 through Figure 49 displays the stop location choice model out of direction stop deviation distribution for each tour purpose compared to the home interview survey. Note that this model was estimated for all tour purposes simultaneously, with some variables segmented by tour purpose to account for differences in stop location by purpose.

Figure 44: Work Tours Out of Direction Stop Location Distribution

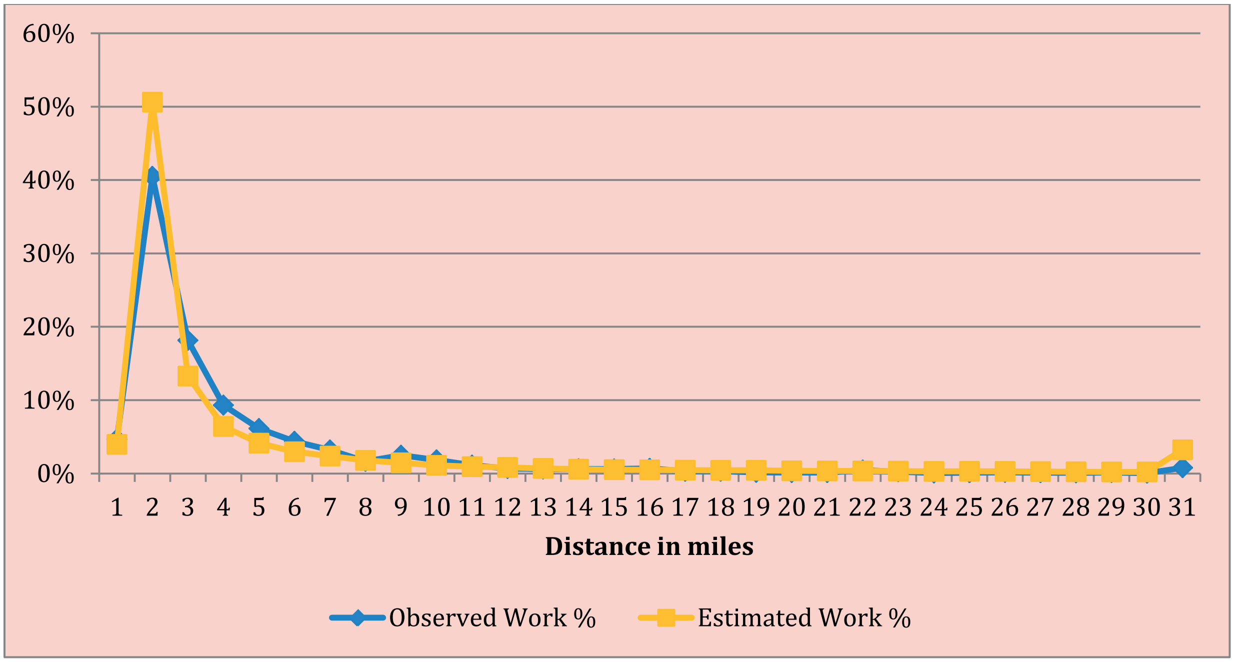


Figure 45: University Tours Out of Direction Stop Location Distribution

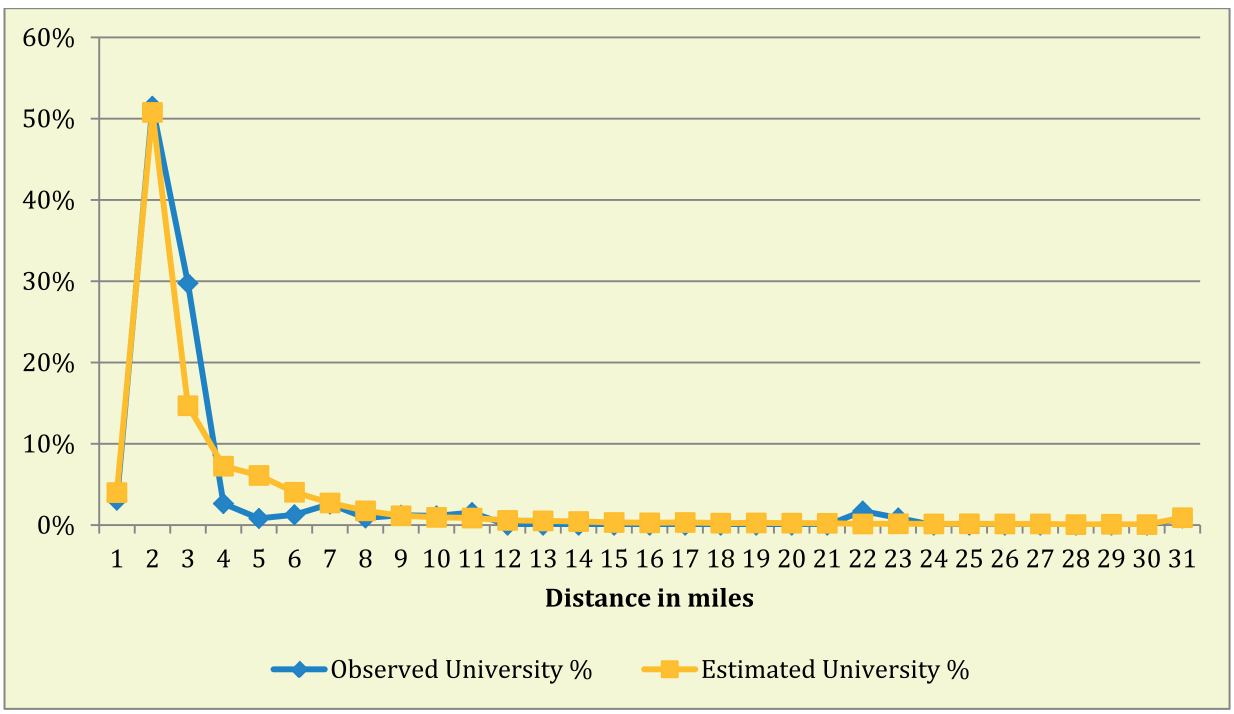


Figure 46: School Tours Out of Direction Stop Location Distribution

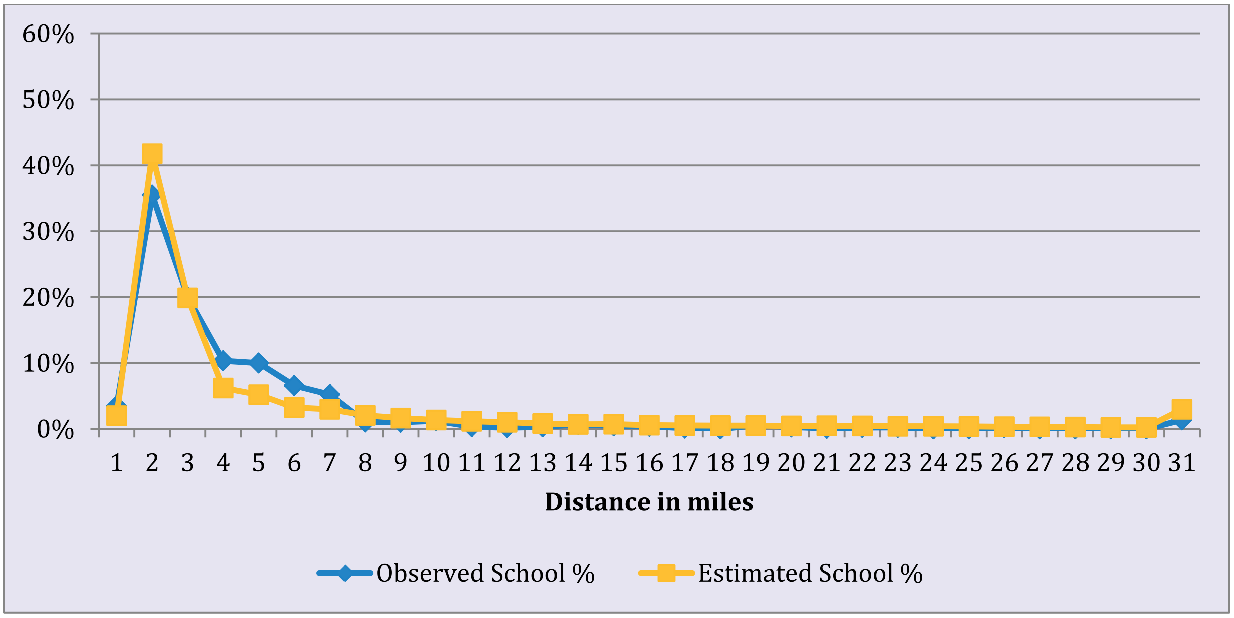


Figure 47: Escorting Tours Out of Direction Stop Location Distribution

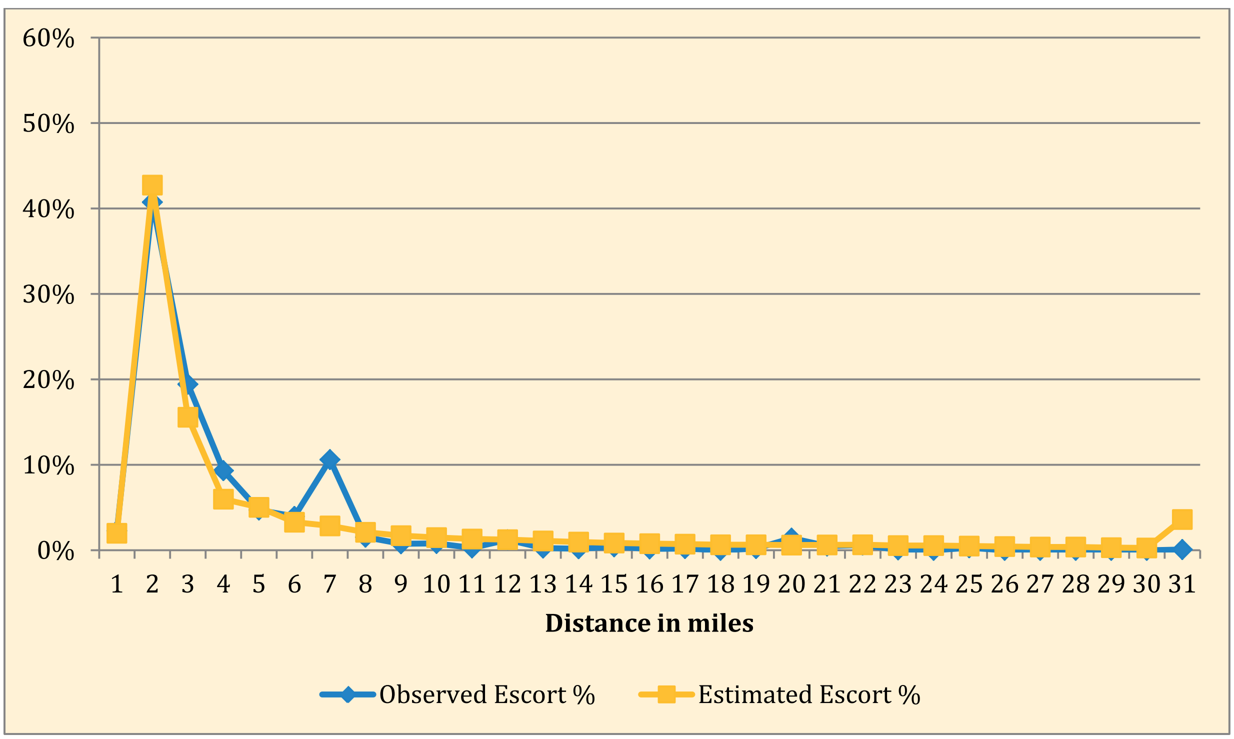


Figure 48: Maintenance Tours Out of Direction Stop Location Distribution

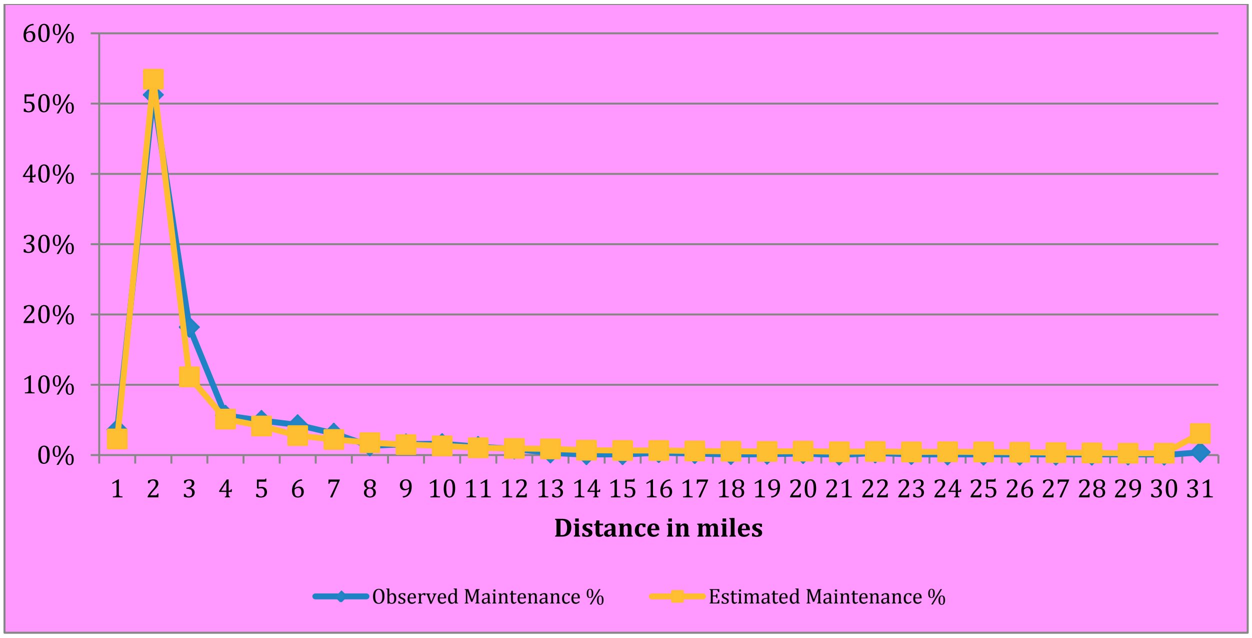
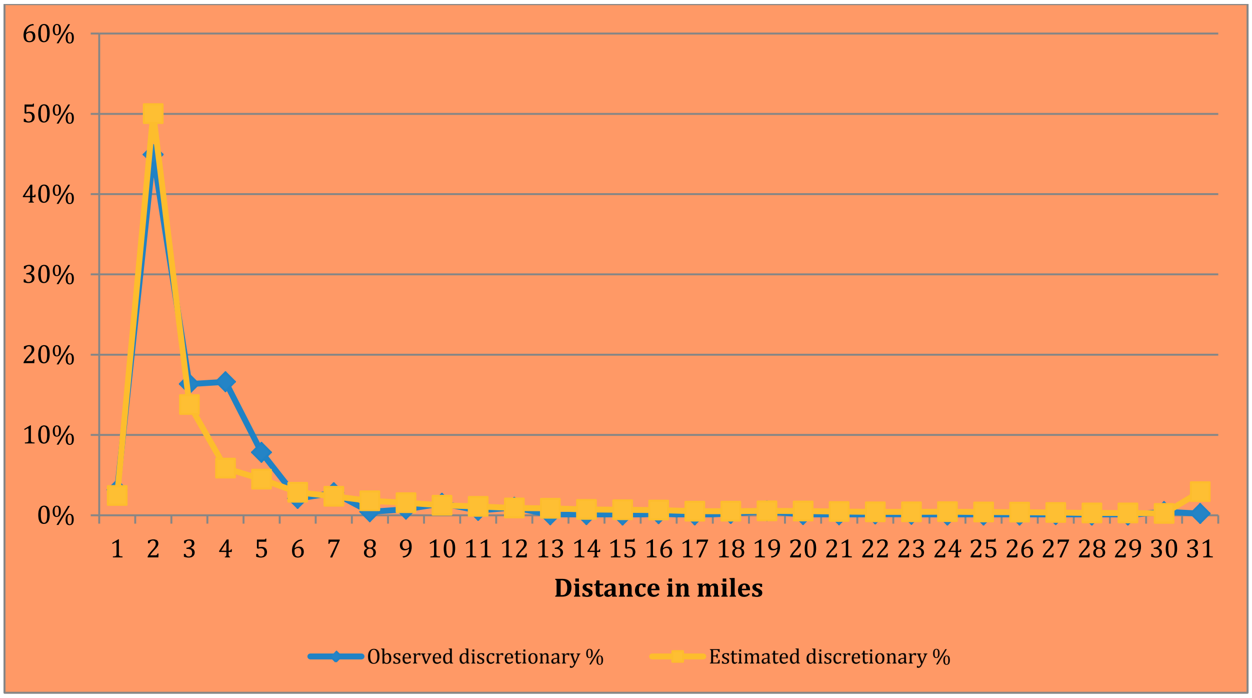


Figure 49: Discretionary Tours Out of Direction Stop Location Distribution



Distance from Anchor Location (Origin location on Tour) Stops

Table 137 shows the observed and estimated distance from anchor location by tour purpose. The normalized coincidence ratio is also shown to determine how well the estimated matched the observed distance from anchor location in one mile increments. This table shows that the model's average distance from anchor location is too long for work, school, escorting, maintenance, and discretionary tours compared to the observed.

Table 137. Observed versus Estimated Average Distance from Anchor Location by Tour Purpose

Purpose	Observed Average Distance from Anchor Location	Estimated Average Distance from Anchor Location	Normalized Coincidence Ratio
Work	7.88	9.41	0.79
University	8.57	8.90	0.53
School	5.11	6.12	0.64
Escorting	4.75	7.22	0.58
Maintenance	5.66	7.74	0.72
Discretionary	5.08	7.79	0.65

Figure 50 through Figure 55 displays the model's distance from anchor stop location frequency distribution for each tour purpose compared to the home interview survey. Most of the tour purposes' estimated frequency did not have enough short distance trips compared to the observed.

Figure 50: Work Tours Distance from Anchor Stop Location Distribution

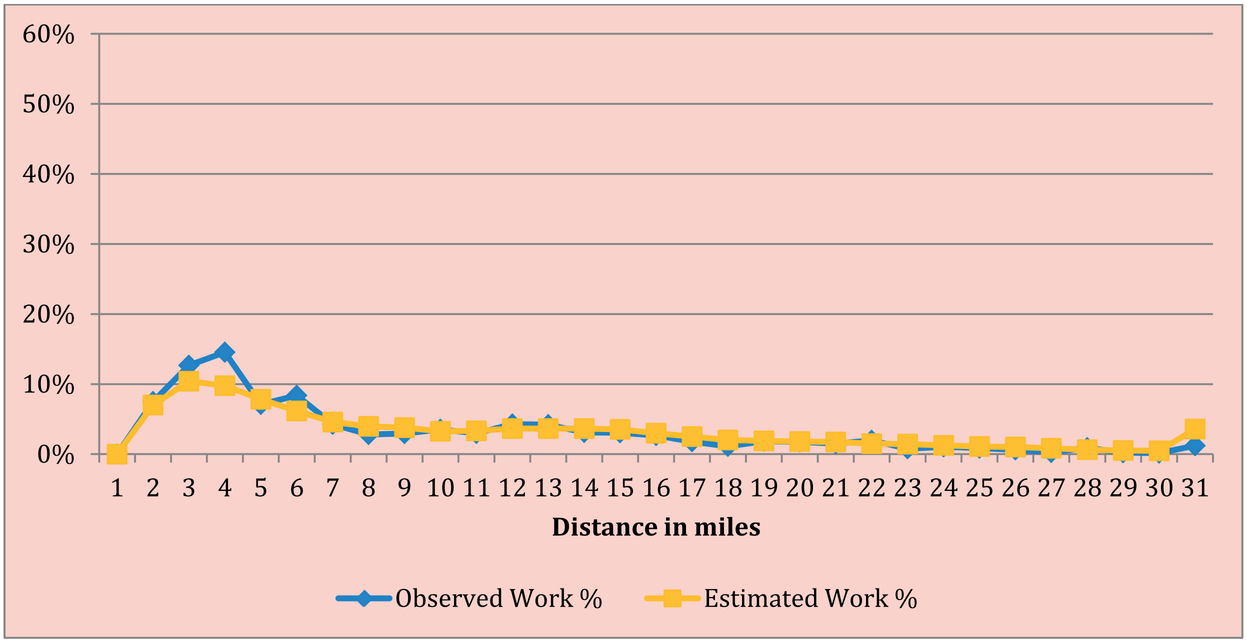


Figure 51: University Tours Distance from Anchor Stop Location Distribution

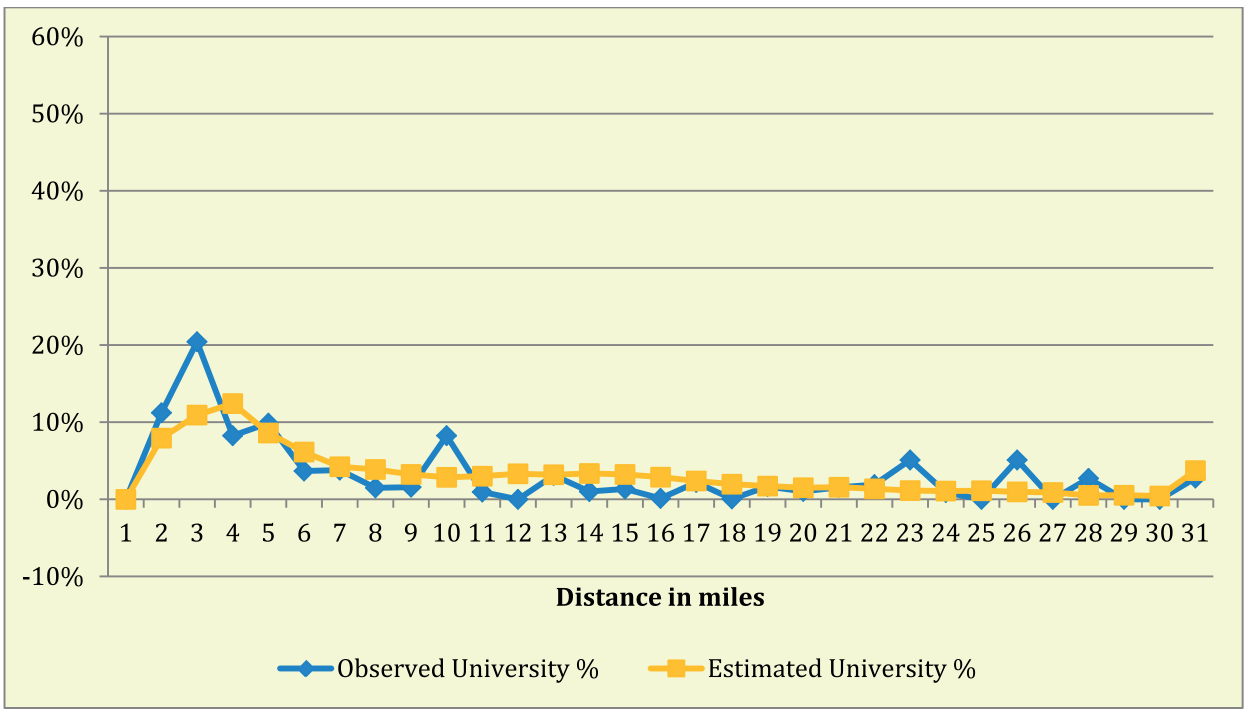


Figure 52: School Tours Distance from Anchor Stop Location Distribution

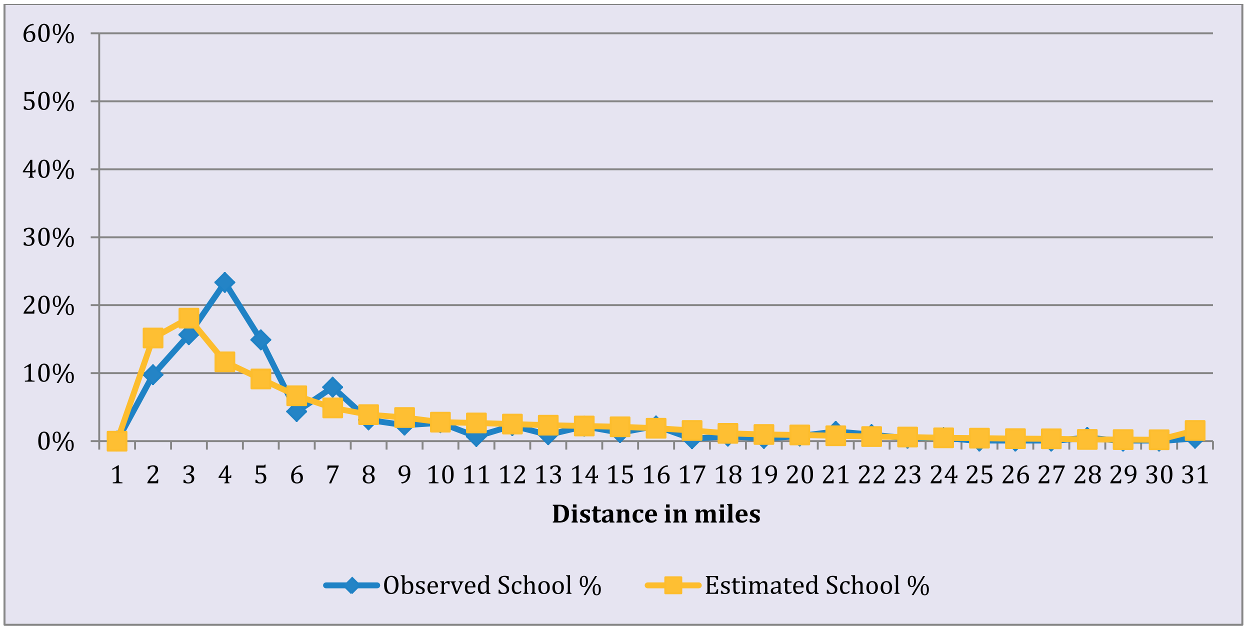


Figure 53: Escorting Tours Distance from Anchor Stop Location Distribution

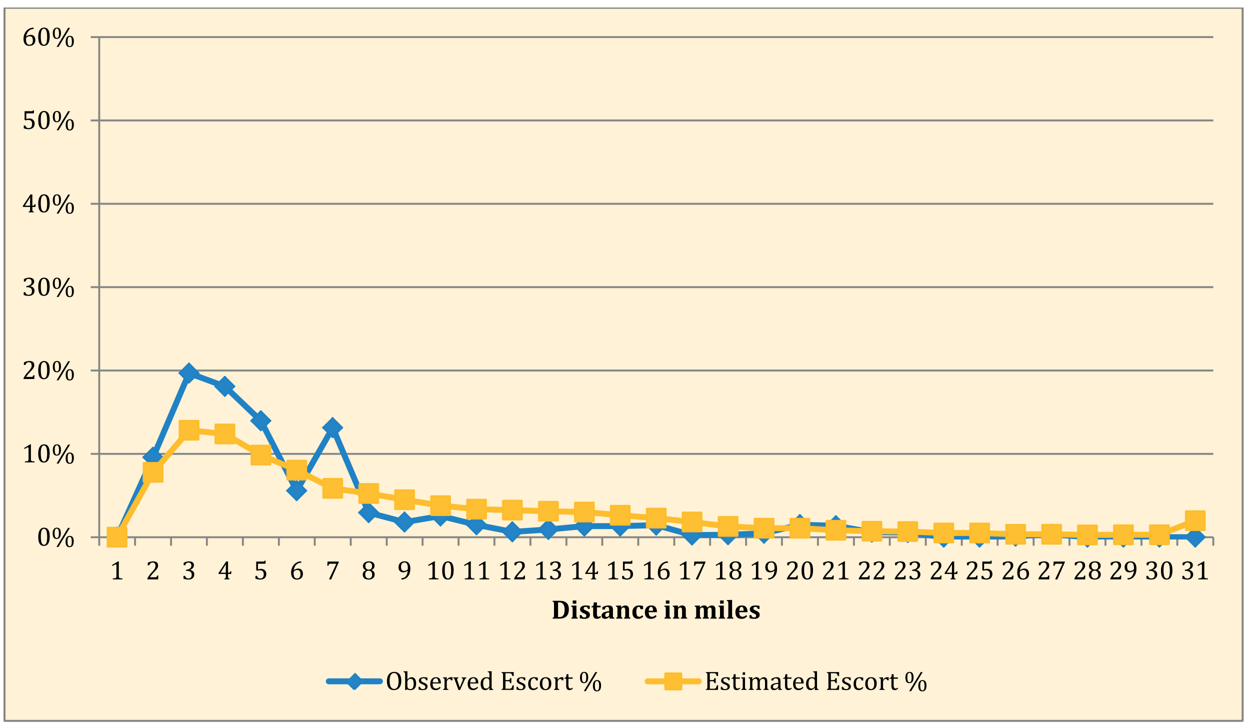


Figure 54: Maintenance Tours Distance from Anchor Stop Location Distribution

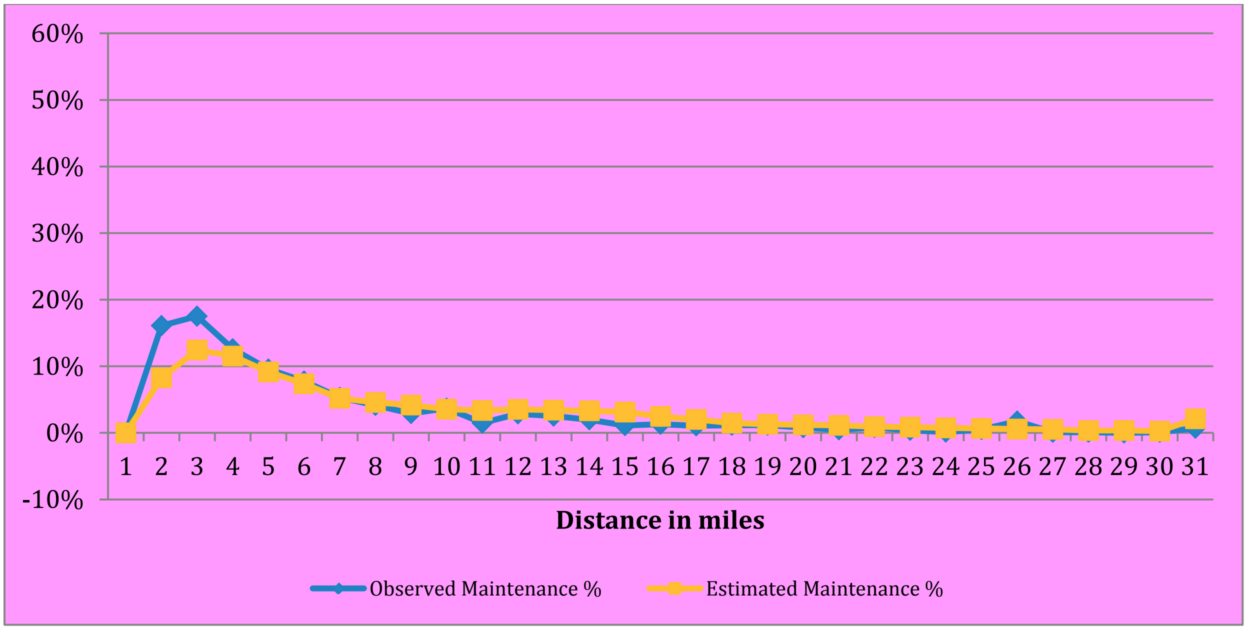
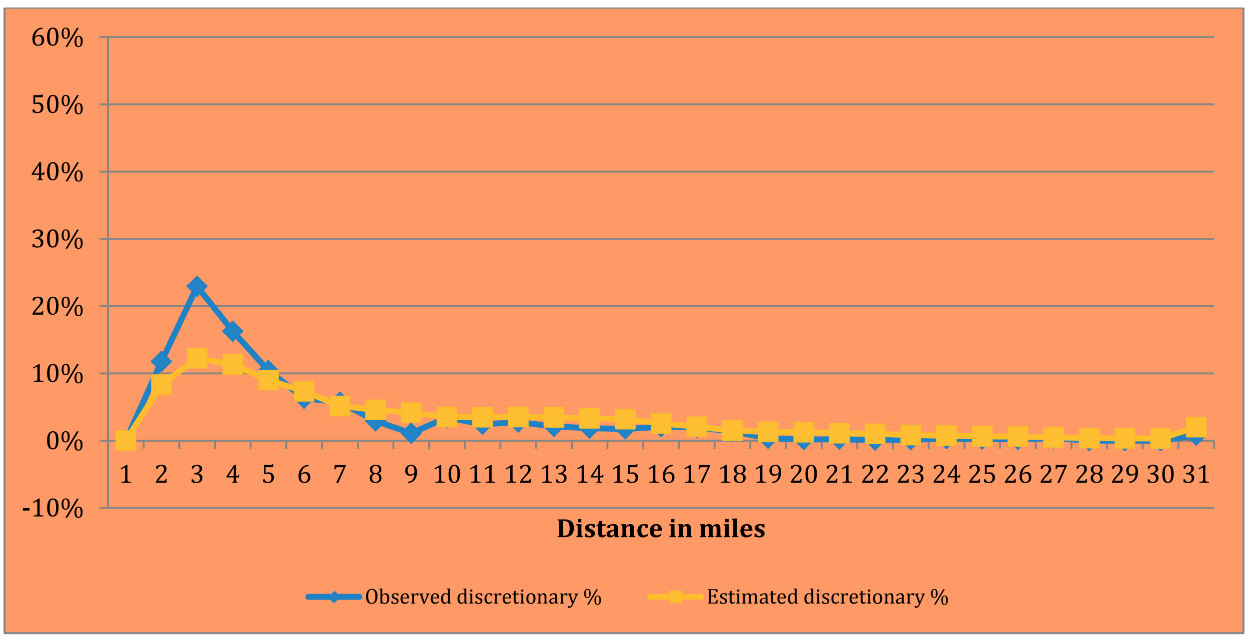


Figure 55: Discretionary Tours Distance from Anchor Stop Location Distribution



Distance to Primary Destination Location Stops

Table 138 shows the observed and estimated stop location distance to primary destination by tour purpose. The normalized coincidence ratio is also shown to determine how well the estimated matched the observed stop location distance to primary destination in one mile increments. This table shows that the model's average stop location distance to primary destination is somewhat long for all tour purposes except work and university compared to the observed. The work tour's estimated average distance from stop to primary destination matches well to observed average while the university estimated average distance from stop to primary destination is short compared to the observed.

Table 138: Observed versus Estimated Average Distance to Primary Destination Location by Tour Purpose

Purpose	Observed Average Distance to Primary Destination Location	Estimated Avg. Distance to Primary Destination Location	Normalized Coincidence Ratio
Work	6.38	6.86	0.87
University	6.21	5.54	0.54
School	4.00	5.35	0.75
Escorting	4.30	6.38	0.67
Maintenance	4.28	5.93	0.78
Discretionary	5.10	6.37	0.70

Figure 56 through Figure 61 displays the model's stop location distance to primary destination frequency distribution for each tour purpose compared to the home interview survey. All of the tour purposes' estimated frequency distributions match the observed frequency distributions quite reasonably.

Figure 56: Work Tours Stop Location Distance to Primary Destination Distribution

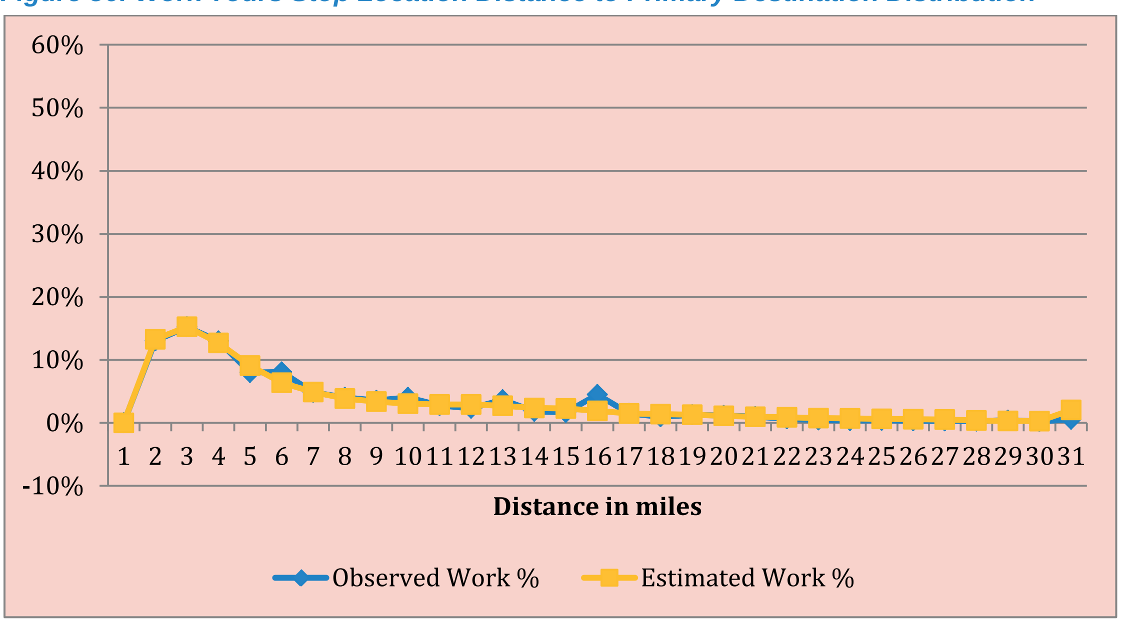


Figure 57: University Tours Stop Location Distance to Primary Destination Distribution

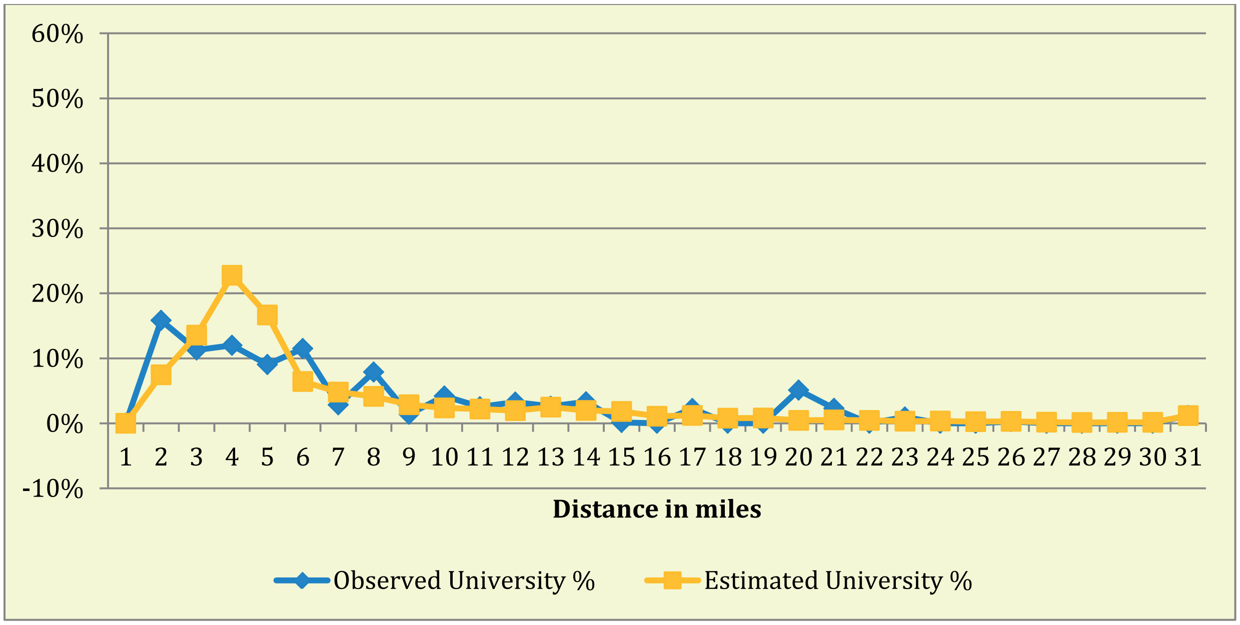


Figure 58: School Tours Stop Location Distance to Primary Destination Distribution

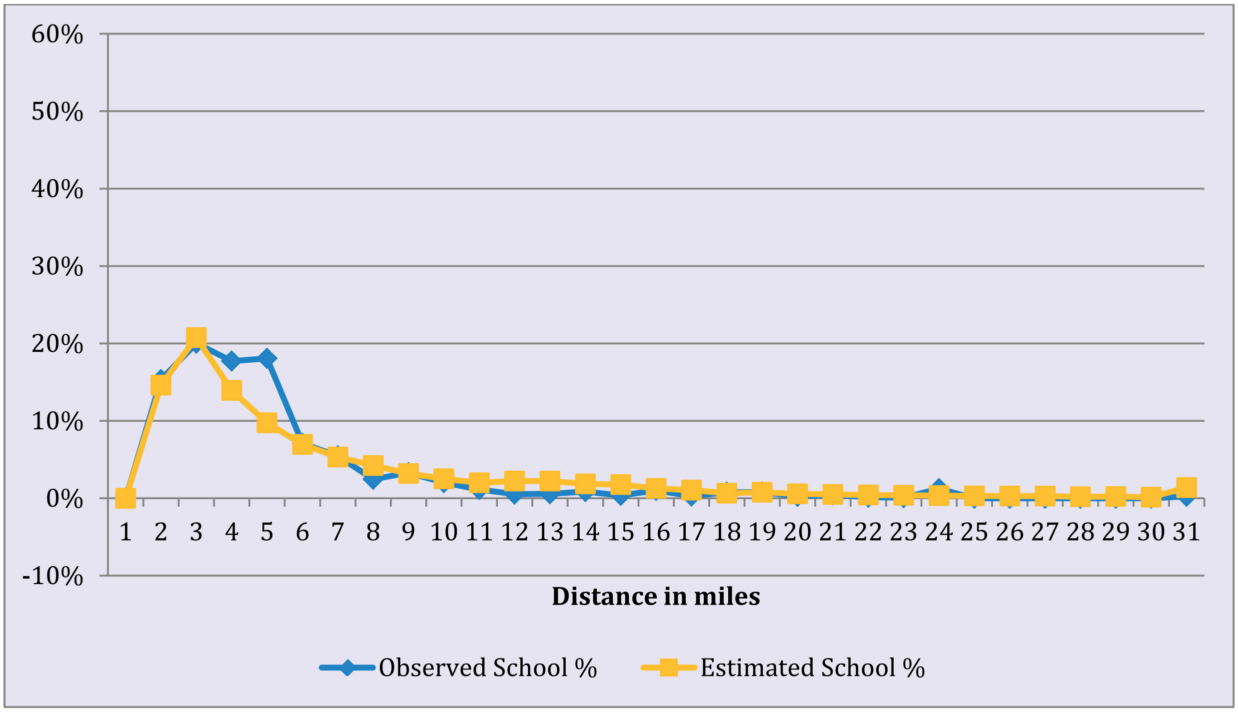


Figure 59: Escorting Tours Stop Location Distance to Primary Destination Distribution

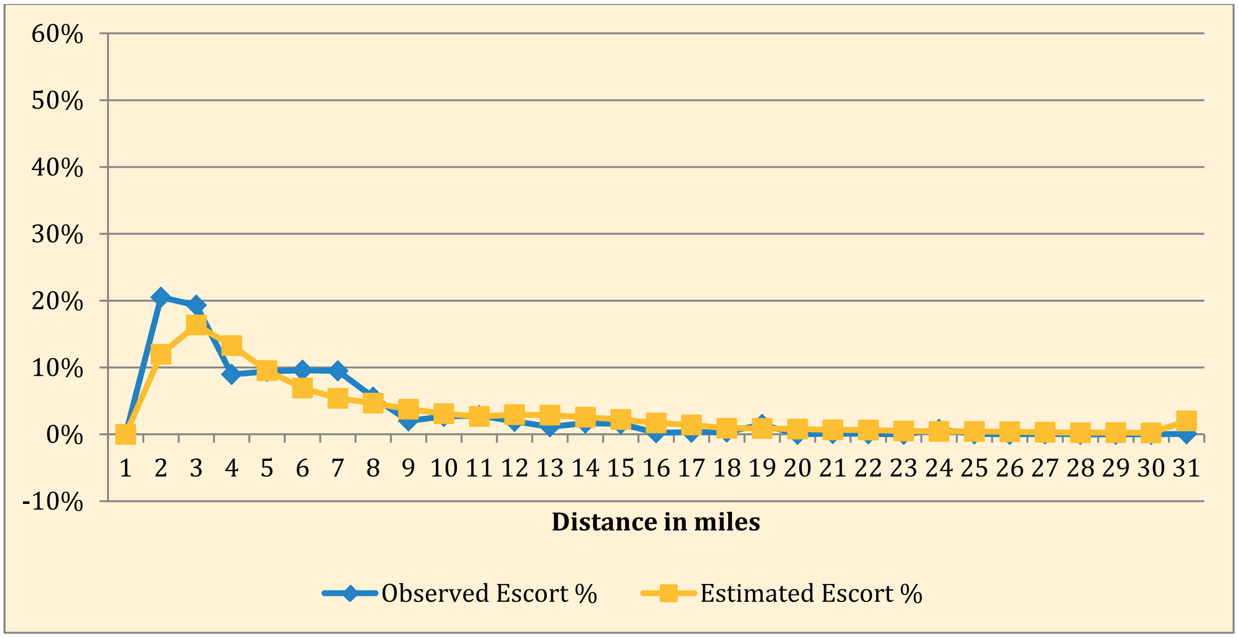


Figure 60: Maintenance Tours Stop Location Distance to Primary Destination Distribution

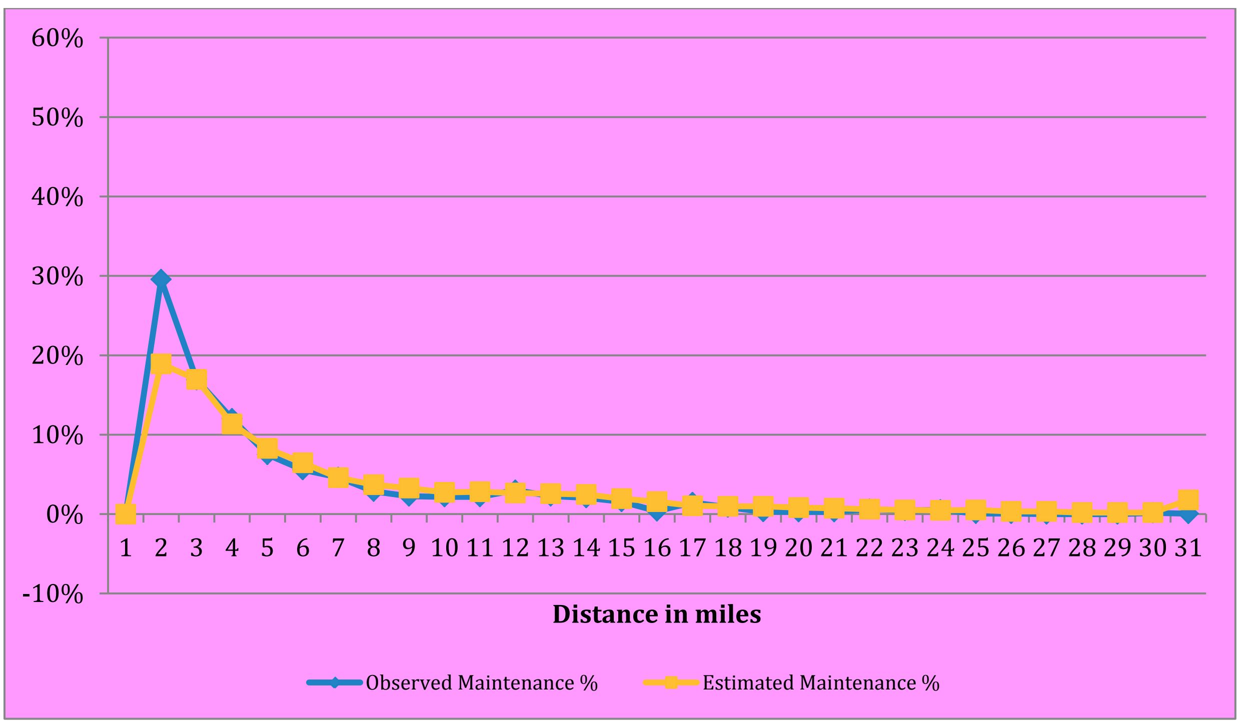
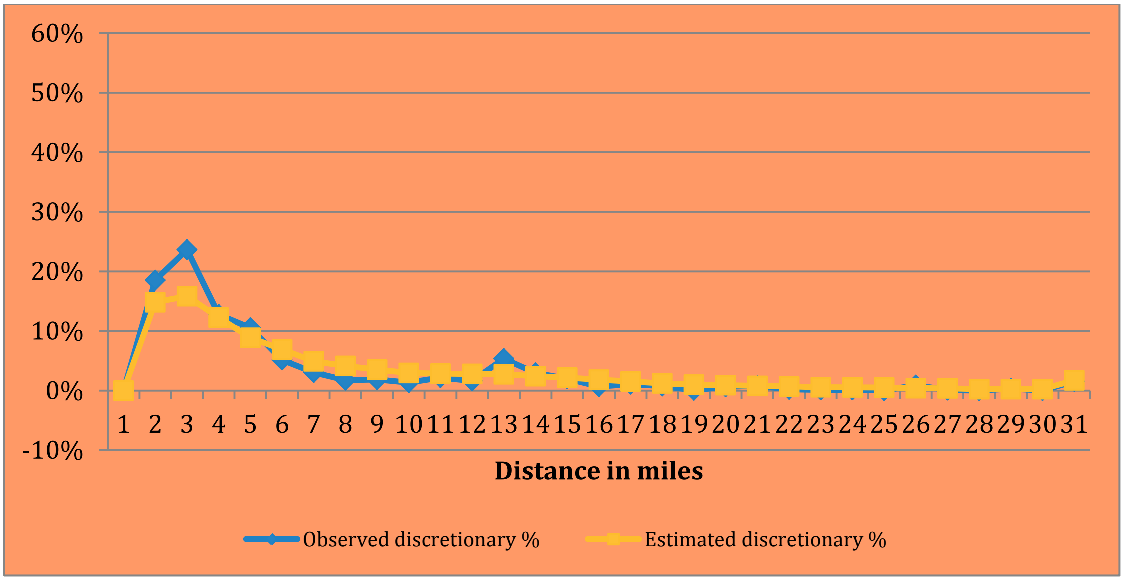


Figure 61: Discretionary Tours Stop Location Distance to Primary Destination Distribution



Next Step for Stop Location Distribution

The overall shape of the distribution of stop locations matched well, with the exception that the model produced too many longer stops for most purposes (tail end at maximum distance). The next step for this model is to better match out-of-direction, anchor location, and primary to destination stop distances better. The average out-of-direction distance, in particular, is too long for many tour purposes.

Trip Mode Choice Model

The main tour mode is chosen at the tour level but this model predicts the mode for each individual trip on the tour. It is referred to as a trip mode "switching" model because it predicts the likelihood of each trip mode constrained by the chosen tour mode[6]. The trip mode choice model was calibrated by tour purpose and tour mode, with constants applied to each trip mode.

Calibration Targets

This model was compared to the 2012 on-board survey for transit trips and the 2012/2013 OahuMPO home interview survey for all other modes. The following are the steps used to create the calibration target values for the trip mode choice model by combining the home interview survey with the on-board survey:

- The home interview survey (HIS) was summarized by tour purpose, trip mode and tour mode.

The on-board survey was then summarized by tour purpose, and trip mode. (Note: on-board survey does not have stratification by tour mode).

Step 1 was then checked for illogical tour and trip mode combinations. For example there should be no drive alone trip mode under the bike and walk tour modes. These were reallocated to the drive alone tour mode. Also, there should be no walk trip modes under the drive alone tour mode, or the bike tour mode, so these were reallocated to the walk tour mode. Also any school bus trips were reallocated to the school bus trip and tour mode under the school purpose.

Since the on-board survey is trip based, the following method was used to allocate transit trips to the transit tour modes. The observed transit trips from the on-board survey were allocated to tour modes based on HIS distribution of transit trips to tour modes. If there were no HIS transit trips for specific mode, symmetry (no mode switching) was assumed.

Calibration Method

Table 139 shows the graphic depiction of trip mode constant segmentation. In the figure, non-available trip modes for each tour mode are greyed out. Generic constants are shown in color for transit line-haul modes (blue for express bus). The thick black borders show the specific trip mode constants by tour mode (for drive-alone, shared-2, shared 3+, walk, bike, walk-transit, park-and-ride transit, and kiss-and-ride transit modes). The base trip mode is indicated for each tour mode. Several runs through the model were done to achieve satisfactory levels of calibration.

The base alternative for calibrating the trip mode choice model was as follows:

- For drive-alone tours, the base alternative was the drive alone trip mode
- For shared-ride 2 tours, the base alternative was shared-ride two-person trip mode
- For shared-ride 3+ person tours, the base alternative was the shared-ride three-plus trip mode
- For walk-transit tours, the base alternative was the walk-local bus trip mode
- For park-and-ride transit tours, the base alternative was the park-and-ride trip mode
- For kiss-and-ride transit tours, the base alternative was the kiss-and-ride trip mode.

For walk mode and bike mode tours, only walk trip mode and bike trip modes are available respectively. Therefore for these tour modes, no calibration was necessary. For the initial trip mode

[6] For more information on trip mode choice, including trip mode definitions and availability, as well as model estimation results, see *Tour Based Model Estimation: for Oahu Metropolitan Planning Organization June 2013.* .

choice calibration, certain trip modes were combined for the purposes of alternative-specific constant calibration, due to data scarcity and to ensure that the models would not be over-calibrated. For example, within each trip purpose, all express bus trips were combined to calibrate a generic express bus constant. In other words, express bus constants were not calibrated separately by tour mode or occupancy. The following modal constants were treated as generic:

- Trips by transit line-haul mode (local bus, express bus)
- Park and Ride Informal and formal)..

Table 139: Trip Mode Choice Model Calibration Scheme

	Tour Mode								
Trip Mode	**Drive-Alone**	**Shared 2**	**Shared 3+**	**Walk**	**Bike**	**Walk-Transit**	**PNR-Transit**	**KNR-Transit**	**School Bus**
Drive-Alone	Base								
Shared 2		Base							
Shared 3			Base						
Walk				Base					
Bike					Base				
Walk-Local						Base			
Walk-Express									
PNR-Informal							Base		
PNR-Formal									
KNR								Base	
School Bus									Base

Legend

Express bus constant

Park and Ride Formal constant

Trip Mode Choice Results

For each purpose, a table of observed and estimated trips by tour mode is compared. Another table shows the comparison of observed trip mode shares and estimated trip mode shares by tour mode. A third table shows the difference between the observed and estimated trip mode shares by tour mode. A fourth table shows the final adjustment factors by trip mode and tour mode that were needed to calibrate each purpose. A fifth table shows the estimated constants that the final adjustment factors will be added to in order to obtain the equivalent in-vehicle minutes of time (sixth table). Note: The bike or school bus mode cannot occur on any other tour mode but itself.

The comparison of observed versus estimated trip mode shares match closely for most purposes. . The other purposes match well except for the drive access to transit tour modes. The data is thin for the drive access tours in the non-work tour purposes so it is difficult to match the observed results closely.

The following observations can be made regarding the equivalent minutes of in-vehicle time by trip and tour mode:

- For the most tour purposes, there is considerable mode switching for the auto shared-ride modes. This makes intuitive sense, since it is likely that a person could be taking their child to school on part of the tour and when they are on their way to work, college, or school, they could be driving alone. For non-mandatory tours, a person could be sharing a ride to the doctor office and then going shopping while the family member is at the doctor's office.
- There is also some mode switching for the walk to transit modes. A person could share a ride with a family member or friend on one leg of a tour and take the bus home on the return leg of the tour.

The following observation can be made regarding equivalent minutes of in-vehicle time for transit line-haul modes (which can be compared to local bus):

- Express bus constants are generally negative and the equivalent in-vehicle minutes of time is approximately 20 minutes of disutility. These results are somewhat consistent with the current trip-based travel model calibration, and likely reflect the inconvenience of express bus due to its inconsistent availability throughout the day (express buses on Oahu currently typically run only in peak periods). Assignments with the models as currently calibrated were done and express bus boardings were evaluated (see Transit Assignment section). It may be that express bus trips require too many transfers, and a transfer penalty may be necessary to reflect the inconvenience of transferring, which would increase the express bus constant.

Table 140: Observed vs. Estimated Work Trips by Tour Mode

	Tour Mode								
OBSERVED Trip Mode	**Drive-Alone**	**Shared 2**	**Shared 3+**	**Walk**	**Bike**	**Walk-Transit**	**KNR**	**PNR**	**School Bus**
Drive Alone	462,118	73,508	27,746	0	0	0	0	47	0
Shared Ride 2	0	108,858	22,454	0	0	6,315	718	74	0
Shared ride 3+	0	0	42,686	0	0	7,734	73	50	0
Walk	0	6,026	1,661	27,814	0	11,213	0	39	0
Bike	0	0	0	0	12,317	0	0	0	0
Walk to Local	0	0	0	0	0	69,315	304	11	0
Walk to Express	0	0	0	0	0	5,006	234	48	0
Kiss and Ride	0	0	0	0	0	0	1,953	0	0
Park Ride Informal	0	0	0	0	0	0	0	856	0
Park Ride Formal	0	0	0	0	0	0	0	185	0
School Bus	0	0	0	0	0	0	0	0	0
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
		69,630		5,289			185		856

	Tour Mode								
ESTIMATED Trip Mode	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	462,223	73,527	27,807	0	0	0	0	47	
Shared Ride 2	0	108,734	22,466	0	0	6,141	718	77	
Shared ride 3+	0	0	42,707	0	0	7,420	68	49	
Walk	0	6,047	1,693	27,847	0	10,531	0	39	
Bike	0	0	0	0	12,310	0	0	0	
Walk to Local	0	0	0	0	0	70,238	311	10	
Walk to Express	0	0	0	0	0	5,071	244	50	
Kiss and Ride	0	0	0	0	0	0	1,943	0	
Park Ride Informal	0	0	0	0	0	0	0	855	
Park Ride Formal	0	0	0	0	0	0	0	185	
School Bus									
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
		70,559		5,365			185		855

Table 141: Observed vs. Estimated Work Trip Shares

OBSERVED Trip Mode	Tour Mode: Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	100.0%	39.0%	29.3%	0.0%	0.0%	0.0%	0.0%	3.6%	0.0%
Shared Ride 2	0.0%	57.8%	23.7%	0.0%	0.0%	6.3%	21.9%	5.7%	0.0%
Shared ride 3+	0.0%	0.0%	45.1%	0.0%	0.0%	7.8%	2.2%	3.8%	0.0%
Walk	0.0%	3.2%	1.8%	100.0%	0.0%	11.3%	0.0%	2.9%	0.0%
Bike	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%
Walk to Local	0.0%	0.0%	0.0%	0.0%	0.0%	69.6%	9.3%	0.9%	0.0%
Walk to Express	0.0%	0.0%	0.0%	0.0%	0.0%	5.0%	7.1%	3.7%	0.0%
Kiss and Ride	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	59.5%	0.0%	0.0%
Park Ride Informal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	65.3%	0.0%
Park Ride Formal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	14.1%	0.0%
School Bus	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
		92.9%		7.1%			17.8%		82.2%

ESTIMATED Trip Mode	Tour Mode: Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	100.0%	39.0%	29.4%	0.0%	0.0%	0.0%	0.0%	3.6%	0.0%
Shared Ride 2	0.0%	57.7%	23.7%	0.0%	0.0%	6.2%	21.9%	5.9%	0.0%
Shared ride 3+	0.0%	0.0%	45.1%	0.0%	0.0%	7.5%	2.1%	3.7%	0.0%
Walk	0.0%	3.2%	1.8%	100.0%	0.0%	10.6%	0.0%	3.0%	0.0%
Bike	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%
Walk to Local	0.0%	0.0%	0.0%	0.0%	0.0%	70.7%	9.5%	0.8%	0.0%
Walk to Express	0.0%	0.0%	0.0%	0.0%	0.0%	5.1%	7.4%	3.8%	0.0%
Kiss and Ride	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	59.2%	0.0%	0.0%
Park Ride Informal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	65.2%	0.0%
Park Ride Formal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	14.1%	0.0%
School Bus	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
		92.9%		7.1%			17.8%		82.2%

Table 142: Difference Estimated minus Observed Work Trip Mode Share

Trip Mode	Tour Mode								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Shared Ride 2	0.0%	0.0%	0.0%	0.0%	0.0%	-0.2%	0.0%	0.2%	0.0%
Shared ride 3+	0.0%	0.0%	0.0%	0.0%	0.0%	-0.3%	-0.2%	-0.1%	0.0%
Walk	0.0%	0.0%	0.0%	0.0%	0.0%	-0.7%	0.0%	0.0%	0.0%
Bike	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Walk to Local	0.0%	0.0%	0.0%	0.0%	0.0%	1.1%	0.2%	-0.1%	0.0%
Walk to Express	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.3%	0.1%	0.0%
Kiss and Ride	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.3%	0.0%	0.0%
Park Ride Informal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	0.0%
Park Ride Formal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
School Bus	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
		0.0%		0.0%			0.0%		0.0%

Table 143: Final Adjustment Factors for Work Trip Mode Choice

Trip Mode	Tour Mode								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	BASE	0.1934	0.0589					-1.0656	
Shared Ride 2		BASE	0.4355			-0.7811	-0.9282	-1.2884	
Shared ride 3+			BASE			-0.7283	0.4717	-1.0696	
Walk		1.9947	1.6965	BASE		1.0917	-0.2343	0.6934	
Bike					BASE				
Walk to Local						BASE	0.4743	-0.4032	
Walk to Express						BASE	2.0052	2.1163	
Kiss and Ride							BASE		
Park Ride Informal								BASE	
Park Ride Formal								BASE	
School Bus									BASE
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
		BASE		-0.1126			0.6652		BASE

Table 144: Estimated Constants for Work Trip Mode Choice

Trip Mode	Tour Mode								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	BASE	-0.3927	-0.4308					-2.3216	
Shared Ride 2		BASE	-0.6424			-2.5048	-1.2523	-1.8628	
Shared ride 3+			BASE			-2.5048	-3.5394	-2.2553	
Walk		-2.8939	-3.2465	BASE		-1.9308	N/A	-2.5177	
Bike					BASE				
Walk to Local						BASE	-1.5400	-2.0848	
Walk to Express						BASE	-1.5400	-2.0848	
Kiss and Ride							BASE		
Park Ride Informal								BASE	
Park Ride Formal								BASE	
School Bus									BASE

Table 145: Equivalent In-vehicle minutes for Work Trip Mode Choice

Trip Mode	Tour Mode								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	BASE	8	15					135	
Shared Ride 2		BASE	8			131	87	126	
Shared ride 3+			BASE			129	123	133	
Walk		36	62	BASE		34	39,969	73	
Bike					BASE				
Walk to Local						BASE	43	100	
Walk to Express						BASE	-19	-1	
Kiss and Ride							BASE		
Park Ride Informal								BASE	
Park Ride Formal								BASE	
School Bus									BASE
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
	BASE		5			-27		BASE	

Table 146: Observed vs. Estimated University Trips by Tour Mode

OBSERVED Trip Mode	Tour Mode: Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	24,355	3,343	1,063	0	0	0	0	48	0
Shared Ride 2	0	11,567	1,558	0	0	3,244	0	0	0
Shared ride 3+	0	0	4,671	0	0	591	0	0	0
Walk	0	114	248	2,275	0	3,721	0	0	0
Bike	0	0	0	0	1,360	0	0	0	0
Walk to Local	0	0	0	0	0	23,607	0	17	0
Walk to Express	0	0	0	0	0	290	547	0	0
Kiss and Ride	0	0	0	0	0	0	818	0	0
Park Ride Informal	0	0	0	0	0	0	0	226	0
Park Ride Formal	0	0	0	0	0	0	0	32	0
School Bus	0	0	0	0	0	0	0	0	0
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
		23,624		837			32		226

ESTIMATED Trip Mode	Tour Mode: Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	24,344	3,352	1,120	0	0	0	0	36	
Shared Ride 2	0	11,550	1,699	0	0	3,154	**170**	**42**	
Shared ride 3+	0	0	5,108	0	0	555	**183**	**35**	
Walk	0	115	284	2,412	0	3,514	**0**	**0**	
Bike	0	0	0	0	1,291	0	0	0	
Walk to Local	0	0	0	0	0	22,929	37	15	
Walk to Express	0	0	0	0	0	602	226	0	
Kiss and Ride	0	0	0	0	0	0	734	0	
Park Ride Informal	0	0	0	0	0	0	0	169	
Park Ride Formal	0	0	0	0	0	0	0	25	
School Bus									
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
		22,981		828			25		169

Table 147: Observed vs. Estimated University Trip Shares

OBSERVED Trip Mode	Tour Mode								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	100.0%	22.3%	14.1%	0.0%	0.0%	0.0%	0.0%	14.8%	0.0%
Shared Ride 2	0.0%	77.0%	20.7%	0.0%	0.0%	10.3%	0.0%	0.0%	0.0%
Shared ride 3+	0.0%	0.0%	61.9%	0.0%	0.0%	1.9%	0.0%	0.0%	0.0%
Walk	0.0%	0.8%	3.3%	100.0%	0.0%	11.8%	0.0%	0.0%	0.0%
Bike	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%
Walk to Local	0.0%	0.0%	0.0%	0.0%	0.0%	75.1%	0.0%	5.3%	0.0%
Walk to Express	0.0%	0.0%	0.0%	0.0%	0.0%	0.9%	40.1%	0.0%	0.0%
Kiss and Ride	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	59.9%	0.0%	0.0%
Park Ride Informal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	70.0%	0.0%
Park Ride Formal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	9.9%	0.0%
School Bus	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
		96.6%		3.4%			12.4%		87.6%
ESTIMATED Trip Mode	**Tour Mode**								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	100.0%	22.3%	13.6%	0.0%	0.0%	0.0%	0.0%	11.2%	0.0%
Shared Ride 2	0.0%	76.9%	20.7%	0.0%	0.0%	10.3%	12.6%	13.0%	0.0%
Shared ride 3+	0.0%	0.0%	62.2%	0.0%	0.0%	1.8%	13.6%	10.9%	0.0%
Walk	0.0%	0.8%	3.5%	100.0%	0.0%	11.4%	0.0%	0.0%	0.0%
Bike	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%
Walk to Local	0.0%	0.0%	0.0%	0.0%	0.0%	74.6%	2.7%	4.7%	0.0%
Walk to Express	0.0%	0.0%	0.0%	0.0%	0.0%	2.0%	16.7%	0.0%	0.0%
Kiss and Ride	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	54.4%	0.0%	0.0%
Park Ride Informal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	52.5%	0.0%
Park Ride Formal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	7.8%	0.0%
School Bus	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
		96.5%		3.5%			12.9%		87.1%

Table 148: Difference Estimated minus Observed University Trip Mode Share

Trip Mode	Tour Mode								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	0.0%	0.1%	-0.5%	0.0%	0.0%	0.0%	0.0%	-3.6%	0.0%
Shared Ride 2	0.0%	-0.1%	0.0%	0.0%	0.0%	-0.1%	12.6%	13.0%	0.0%
Shared ride 3+	0.0%	0.0%	0.3%	0.0%	0.0%	-0.1%	13.6%	10.9%	0.0%
Walk	0.0%	0.0%	0.2%	0.0%	0.0%	-0.4%	0.0%	0.0%	0.0%
Bike	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Walk to Local	0.0%	0.0%	0.0%	0.0%	0.0%	-0.5%	2.7%	-0.7%	0.0%
Walk to Express	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%	-23.3%	0.0%	0.0%
Kiss and Ride	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-5.6%	0.0%	0.0%
Park Ride Informal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-17.5%	0.0%
Park Ride Formal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-2.1%	0.0%
School Bus	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
		-0.1%		0.1%			0.5%		-0.5%

Table 149: Final Adjustment Factors for University Trip Mode Choice

Trip Mode	Tour Mode								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	BASE	0.4220	0.8611					-0.5507	
Shared Ride 2		BASE	0.7364			-0.4946	N/A	N/A	
Shared ride 3+			BASE			-1.1040	N/A	N/A	
Walk		1.2492	1.0230	BASE		1.6924	-0.7680	-1.9764	
Bike					BASE				
Walk to Local						BASE	N/A	0.7387	
Walk to Express						BASE	7.1963	N/A	
Kiss and Ride							BASE		
Park Ride Informal								BASE	
Park Ride Formal								BASE	
School Bus									BASE
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
		BASE		-0.5386			0.3383		BASE

Table 150: Estimated Constants for University Trip Mode Choice

Trip Mode	Tour Mode								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	BASE	-1.2413	-1.4807					-1.3823	
Shared Ride 2		BASE	-1.0979			-2.6892	-2.0000	-2.0000	
Shared ride 3+			BASE			-2.6892	-2.0000	-2.0000	
Walk		-4.6158	-2.9345	BASE		-2.5518	N/A	N/A	
Bike					BASE				
Walk to Local						BASE	-2.1140	-2.4039	
Walk to Express						BASE	-2.1140	-2.4039	
Kiss and Ride							BASE		
Park Ride Informal								BASE	
Park Ride Formal								BASE	
School Bus									BASE

Table 151: Equivalent In-vehicle minutes for University Trip Mode Choice

Trip Mode	Tour Mode								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	BASE	33	25					77	
Shared Ride 2		BASE	14			127	N/A	N/A	
Shared ride 3+			BASE			152	N/A	N/A	
Walk		135	76	BASE		34	N/A	N/A	
Bike					BASE				
Walk to Local						BASE	N/A	67	
Walk to Express						BASE	-203	N/A	
Kiss and Ride							BASE		
Park Ride Informal								BASE	
Park Ride Formal								BASE	
School Bus									BASE
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
	BASE		22			-14		BASE	

Table 152: Observed vs. Estimated School Trips by Tour Mode

OBSERVED Trip Mode	Tour Mode								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	3,365	1,606	2,784	0	0	0	0	0	0
Shared Ride 2	0	55,947	24,720	0	0	596	71	0	5,341
Shared ride 3+	0	0	105,025	0	0	2,232	86	0	8,800
Walk	0	3,134	8,491	40,973	0	140	52	0	1,719
Bike	0	0	0	0	8,441	0	0	0	0
Walk to Local	0	0	0	0	0	13,516	95	0	0
Walk to Express	0	0	0	0	0	188	26	0	0
Kiss and Ride	0	0	0	0	0	0	577	0	0
Park Ride Informal	0	0	0	0	0	0	0	0	0
Park Ride Formal	0	0	0	0	0	0	0	0	0
School Bus	0	0	0	0	0	0	20	0	49,794
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
		13,611		214			0		0
ESTIMATED Trip Mode	**Tour Mode**								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	3,370	1,612	2,766	0	0	0	0	29	0
Shared Ride 2	0	56,136	24,539	0	0	597	**196**	45	5,340
Shared ride 3+	0	0	104,239	0	0	2,216	**227**	8	8,809
Walk	0	3,143	9,219	40,969	0	146	**0**	14	1,719
Bike	0	0	0	0	8,452	0	0	0	0
Walk to Local	0	0	0	0	0	13,586	**262**	12	0
Walk to Express	0	0	0	0	0	161	**61**	0	0
Kiss and Ride	0	0	0	0	0	0	137	0	0
Park Ride Informal	0	0	0	0	0	0	0	227	0
Park Ride Formal	0	0	0	0	0	0	0	36	0
School Bus	0	0	0	0	0	0	0	0	49,810
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
		13,860		222			36		227

Table 153: Observed vs. Estimated School Trip Shares

OBSERVED Trip Mode	Tour Mode								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	100.0%	2.6%	2.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Shared Ride 2	0.0%	92.2%	17.5%	0.0%	0.0%	3.6%	7.7%	0.0%	8.1%
Shared ride 3+	0.0%	0.0%	74.5%	0.0%	0.0%	13.4%	9.3%	0.0%	13.4%
Walk	0.0%	5.2%	6.0%	100.0%	0.0%	0.8%	5.6%	0.0%	2.6%
Bike	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%
Walk to Local	0.0%	0.0%	0.0%	0.0%	0.0%	81.1%	10.3%	0.0%	0.0%
Walk to Express	0.0%	0.0%	0.0%	0.0%	0.0%	1.1%	2.8%	0.0%	0.0%
Kiss and Ride	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	62.3%	0.0%	0.0%
Park Ride Informal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Park Ride Formal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
School Bus	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.1%	0.0%	75.8%
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
		98.5%		1.5%			n/a		n/a
ESTIMATED Trip Mode	**Tour Mode**								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	100.0%	2.6%	2.0%	0.0%	0.0%	0.0%	0.0%	7.8%	0.0%
Shared Ride 2	0.0%	92.2%	17.4%	0.0%	0.0%	3.6%	22.2%	12.1%	8.1%
Shared ride 3+	0.0%	0.0%	74.1%	0.0%	0.0%	13.3%	25.7%	2.2%	13.4%
Walk	0.0%	5.2%	6.5%	100.0%	0.0%	0.9%	0.0%	3.8%	2.6%
Bike	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%
Walk to Local	0.0%	0.0%	0.0%	0.0%	0.0%	81.3%	29.7%	3.2%	0.0%
Walk to Express	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%	6.9%	0.0%	0.0%
Kiss and Ride	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	15.5%	0.0%	0.0%
Park Ride Informal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	61.2%	0.0%
Park Ride Formal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	9.7%	0.0%
School Bus	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	75.8%
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
		98.4%		1.6%			13.7%		86.3%

Table 154: Difference Estimated minus Observed School Trip Mode Share

Trip Mode	Tour Mode								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	7.8%	0.0%
Shared Ride 2	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	14.5%	12.1%	0.0%
Shared ride 3+	0.0%	0.0%	-0.4%	0.0%	0.0%	-0.1%	16.4%	2.2%	0.0%
Walk	0.0%	0.0%	0.5%	0.0%	0.0%	0.0%	-5.6%	3.8%	0.0%
Bike	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Walk to Local	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%	19.4%	3.2%	0.0%
Walk to Express	0.0%	0.0%	0.0%	0.0%	0.0%	-0.2%	4.1%	0.0%	0.0%
Kiss and Ride	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-46.8%	0.0%	0.0%
Park Ride Informal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	61.2%	0.0%
Park Ride Formal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	9.7%	0.0%
School Bus	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-2.1%	0.0%	0.0%
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
		0.0%		0.0%			n/a		n/a

Table 155: Final Adjustment Factors for School Trip Mode Choice

Trip Mode	Tour Mode								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	BASE	-1.0026	-1.1379					N/A	
Shared Ride 2		BASE	0.1364			-0.3381	-17.2331	N/A	0.7591
Shared ride 3+			BASE			0.1293	-14.8986	N/A	0.4267
Walk		1.1756	1.9037	BASE		-2.3763	-10.1108	N/A	1.2218
Bike					BASE			N/A	
Walk to Local						BASE	-16.5063	N/A	
Walk to Express						BASE	-14.4687	N/A	
Kiss and Ride							BASE		
Park Ride Informal								BASE	
Park Ride Formal								BASE	
School Bus									BASE
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
		BASE		-0.7647			N/A		BASE

Table 156: Estimated Constants for School Trip Mode Choice

Trip Mode	Tour Mode								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	BASE	-0.3927	-0.4308					-2.3216	
Shared Ride 2		BASE	-0.6424			-2.5048	-1.2523	-1.8628	-2.2325
Shared ride 3+			BASE			-2.5048	-3.5394	-2.2553	-1.7331
Walk		-2.8939	-3.2465	BASE		-1.9308	N/A	-2.5177	-3.3662
Bike					BASE				
Walk to Local						BASE	-1.5400	-2.0848	
Walk to Express						BASE	-1.5400	-2.0848	
Kiss and Ride							BASE		
Park Ride Informal								BASE	
Park Ride Formal								BASE	
School Bus									BASE

Table 157: Equivalent In-vehicle minutes for School Trip Mode Choice

Trip Mode	Tour Mode								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	BASE	140	157					N/A	
Shared Ride 2		BASE	51			284	1,849	N/A	147
Shared ride 3+			BASE			238	1,844	N/A	131
Walk		172	134	BASE		431	N/A	N/A	214
Bike					BASE			N/A	
Walk to Local						BASE	1,805	N/A	
Walk to Express						BASE	1,601	N/A	
Kiss and Ride							BASE		
Park Ride Informal								BASE	
Park Ride Formal								BASE	
School Bus									BASE
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
	BASE		76			N/A		BASE	

Table 158: Observed vs. Estimated Escorting Trips by Tour Mode

OBSERVED Trip Mode	Tour Mode								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	695	58,954	21,388	0	0	0	0	0	0
Shared Ride 2	0	65,528	33,214	0	0	0	0	0	0
Shared ride 3+	0	0	80,957	0	0	0	0	0	0
Walk	0	82	487	19,438	0	0	0	0	0
Bike	0	0	0	0	2,575	0	0	0	0
Walk to Local	0	0	0	0	0	0	0	0	0
Walk to Express	0	0	0	0	0	0	0	0	0
Kiss and Ride	0	0	0	0	0	0	0	0	0
Park Ride Informal	0	0	0	0	0	0	0	0	0
Park Ride Formal	0	0	0	0	0	0	0	0	0
School Bus	0	0	0	0	0	0	0	0	0
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
		0		0			0		0

ESTIMATED Trip Mode	Tour Mode								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	670	59,905	21,364	0	0				
Shared Ride 2	0	64,749	33,181	0	0				
Shared ride 3+	0	0	80,883	0	0				
Walk	0	80	485	19,428	0				
Bike	0	0	0	0	2,577				
Walk to Local									
Walk to Express									
Kiss and Ride									
Park Ride Informal									
Park Ride Formal									
School Bus									
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
		0		0			0		0

Table 159: Observed vs. Estimated Escorting Trip Shares

OBSERVED Trip Mode	Tour Mode								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	100.0%	47.3%	15.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Shared Ride 2	0.0%	52.6%	24.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Shared ride 3+	0.0%	0.0%	59.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Walk	0.0%	0.1%	0.4%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Bike	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%
Walk to Local	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Walk to Express	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Kiss and Ride	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Park Ride Informal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Park Ride Formal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
School Bus	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
		n/a		n/a			n/a		n/a

ESTIMATED Trip Mode	Tour Mode								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	100.0%	48.0%	15.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Shared Ride 2	0.0%	51.9%	24.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Shared ride 3+	0.0%	0.0%	59.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Walk	0.0%	0.1%	0.4%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Bike	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%
Walk to Local	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Walk to Express	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Kiss and Ride	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Park Ride Informal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Park Ride Formal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
School Bus	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
		n/a		n/a			n/a		n/a

Table 160: Difference Estimated minus Observed Escorting Trip Mode Share

Trip Mode	Tour Mode								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	0.0%	0.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Shared Ride 2	0.0%	-0.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Shared ride 3+	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Walk	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Bike	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Walk to Local	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Walk to Express	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Kiss and Ride	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Park Ride Informal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Park Ride Formal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
School Bus	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
	n/a		n/a			n/a		n/a	

Table 161: Final Adjustment Factors for Escorting Trip Mode Choice

Trip Mode	Tour Mode								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	BASE	1.3456	0.8797						
Shared Ride 2		BASE	0.9442						
Shared ride 3+			BASE						
Walk		-1.0136	0.3532	BASE					
Bike					BASE				
Walk to Local									
Walk to Express									
Kiss and Ride									
Park Ride Informal									
Park Ride Formal									
School Bus									
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
	n/a		n/a			n/a		n/a	

Table 162: Estimated Constants for Escorting Trip Mode Choice

Trip Mode	Tour Mode								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	BASE	-1.0129	-1.7298						
Shared Ride 2		BASE	-1.2534						
Shared ride 3+			BASE						
Walk		-4.8508	-4.7514	BASE					
Bike					BASE				
Walk to Local									
Walk to Express									
Kiss and Ride									
Park Ride Informal									
Park Ride Formal									
School Bus									

Table 163: Equivalent In-vehicle minutes for Escorting Trip Mode Choice

Trip Mode	Tour Mode								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	BASE	-33	85						
Shared Ride 2		BASE	31						
Shared ride 3+			BASE						
Walk		586	440	BASE					
Bike					BASE				
Walk to Local									
Walk to Express									
Kiss and Ride									
Park Ride Informal									
Park Ride Formal									
School Bus									
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
		n/a		n/a			n/a		n/a

Table 164: Observed vs. Estimated Maintenance Trips by Tour Mode

OBSERVED Trip Mode	Tour Mode								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	149,415	41,441	13,394	0	0	0	0	37	0
Shared Ride 2	0	114,116	21,567	0	0	886	109	0	0
Shared ride 3+	0	0	75,538	0	0	480	59	0	0
Walk	0	893	653	53,080	0	13,326	0	0	0
Bike	0	0	0	0	3,243	0	0	0	0
Walk to Local	0	0	0	0	0	33,816	15	0	0
Walk to Express	0	0	0	0	0	80	0	0	0
Kiss and Ride	0	0	0	0	0	0	232	0	0
Park Ride Informal	0	0	0	0	0	0	0	94	0
Park Ride Formal	0	0	0	0	0	0	0	21	0
School Bus	0	0	0	0	0	0	0	0	0
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
		33,831		80			21		94

ESTIMATED Trip Mode	Tour Mode								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	149,396	41,422	13,404	0	0	0	0	39	
Shared Ride 2	0	114,076	21,608	0	0	881	112	0	
Shared ride 3+	0	0	75,578	0	0	466	48	0	
Walk	0	893	656	53,111	0	12,853	0	0	
Bike	0	0	0	0	3,251	0	0	0	
Walk to Local	0	0	0	0	0	34,242	14	0	
Walk to Express	0	0	0	0	0	79	1	0	
Kiss and Ride	0	0	0	0	0	0	228	0	
Park Ride Informal	0	0	0	0	0	0	0	98	
Park Ride Formal	0	0	0	0	0	0	0	23	
School Bus									
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
		34,256		80			23		98

Table 165: Observed vs. Estimated Maintenance Trip Shares

OBSERVED Trip Mode	Tour Mode: Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	100.0%	26.5%	12.1%	0.0%	0.0%	0.0%	0.0%	24.3%	0.0%
Shared Ride 2	0.0%	72.9%	19.4%	0.0%	0.0%	1.8%	26.3%	0.0%	0.0%
Shared ride 3+	0.0%	0.0%	68.0%	0.0%	0.0%	1.0%	14.2%	0.0%	0.0%
Walk	0.0%	0.6%	0.6%	100.0%	0.0%	27.4%	0.0%	0.0%	0.0%
Bike	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%
Walk to Local	0.0%	0.0%	0.0%	0.0%	0.0%	69.6%	3.5%	0.0%	0.0%
Walk to Express	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.0%	0.0%	0.0%
Kiss and Ride	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	55.9%	0.0%	0.0%
Park Ride Informal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	61.8%	0.0%
Park Ride Formal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	13.8%	0.0%
School Bus	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
		99.8%		0.2%			18.3%		81.7%

ESTIMATED Trip Mode	Tour Mode: Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	100.0%	26.5%	12.0%	0.0%	0.0%	0.0%	0.0%	24.4%	0.0%
Shared Ride 2	0.0%	72.9%	19.4%	0.0%	0.0%	1.8%	27.8%	0.0%	0.0%
Shared ride 3+	0.0%	0.0%	67.9%	0.0%	0.0%	1.0%	11.9%	0.0%	0.0%
Walk	0.0%	0.6%	0.6%	100.0%	0.0%	26.5%	0.0%	0.0%	0.0%
Bike	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%
Walk to Local	0.0%	0.0%	0.0%	0.0%	0.0%	70.6%	3.5%	0.0%	0.0%
Walk to Express	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.2%	0.0%	0.0%
Kiss and Ride	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	56.6%	0.0%	0.0%
Park Ride Informal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	61.3%	0.0%
Park Ride Formal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	14.4%	0.0%
School Bus	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
		99.8%		0.2%			19.0%		81.0%

Table 166: Difference Estimated minus Observed Maintenance Trip Mode Share

Trip Mode	Tour Mode								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Shared Ride 2	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.4%	0.0%	0.0%
Shared ride 3+	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-2.3%	0.0%	0.0%
Walk	0.0%	0.0%	0.0%	0.0%	0.0%	-0.9%	0.0%	0.0%	0.0%
Bike	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Walk to Local	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%	0.0%	0.0%	0.0%
Walk to Express	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.0%	0.0%
Kiss and Ride	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.7%	0.0%	0.0%
Park Ride Informal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.6%	0.0%
Park Ride Formal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.6%	0.0%
School Bus	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
		0.0%		0.0%			0.7%		-0.7%

Table 167: Final Adjustment Factors for Maintenance Trip Mode Choice

Trip Mode	Tour Mode								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	BASE	0.5884	0.7037					0.1651	
Shared Ride 2		BASE	0.8282			-0.1703	-2.9751	0.0260	
Shared ride 3+			BASE			-0.3640	-2.6095	0.0260	
Walk		1.2080	1.0836	BASE		1.0699	-1.7734	0.0260	
Bike					BASE				
Walk to Local						BASE	-1.7661	0.0260	
Walk to Express						BASE	#NUM!	0.0260	
Kiss and Ride							BASE		
Park Ride Informal								BASE	
Park Ride Formal								BASE	
School Bus									BASE
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
	BASE			-1.0376			0.8243		BASE

Table 168: Estimated Constants for Maintenance Trip Mode Choice

Trip Mode	Tour Mode								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	BASE	-1.0129	-1.7298					-1.7311	
Shared Ride 2		BASE	-1.2534			-4.1413	0.9056	N/A	
Shared ride 3+			BASE			-4.1413	0.2900	N/A	
Walk		-4.8508	-4.7514	BASE		-1.4307	N/A	N/A	
Bike					BASE			N/A	
Walk to Local						BASE	-1.1080	N/A	
Walk to Express						BASE	-1.1080	N/A	
Kiss and Ride							BASE		
Park Ride Informal								BASE	
Park Ride Formal								BASE	
School Bus									BASE

Table 169: Equivalent In-vehicle minutes for Maintenance Trip Mode Choice

Trip Mode	Tour Mode								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	BASE	21	51					78	
Shared Ride 2		BASE	21			216	103	N/A	
Shared ride 3+			BASE			225	116	N/A	
Walk		182	183	BASE		18	N/A	N/A	
Bike					BASE			N/A	
Walk to Local						BASE	144	N/A	
Walk to Express						BASE	N/A	N/A	
Kiss and Ride							BASE		
Park Ride Informal								BASE	
Park Ride Formal								BASE	
School Bus									BASE
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
	BASE		52			-41		BASE	

Table 170: Observed vs. Estimated Discretionary Trips by Tour Mode

	Tour Mode								
OBSERVED Trip Mode	**Drive-Alone**	**Shared 2**	**Shared 3+**	**Walk**	**Bike**	**Walk-Transit**	**KNR**	**PNR**	**School Bus**
Drive Alone	87,184	10,567	3,596	0	0	0	0	0	0
Shared Ride 2	0	102,228	13,408	0	0	1,389	0	0	0
Shared ride 3+	0	0	78,273	0	0	1,429	0	0	0
Walk	0	1,527	2,447	34,364	0	2,619	0	0	0
Bike	0	0	0	0	4,032	0	0	0	0
Walk to Local	0	0	0	0	0	21,401	0	0	0
Walk to Express	0	0	0	0	0	60	0	0	0
Kiss and Ride	0	0	0	0	0	0	326	0	0
Park Ride Informal	0	0	0	0	0	0	0	184	0
Park Ride Formal	0	0	0	0	0	0	0	17	0
School Bus	0	0	0	0	0	0	0	0	0
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
		21,401		60			17		184
	Tour Mode								
ESTIMATED Trip Mode	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	87,182	10,543	3,589	0	0	0	0	62	
Shared Ride 2	0	102,244	13,818	0	0	1,362	149	0	
Shared ride 3+	0	0	78,158	0	0	1,431	147	0	
Walk	0	1,450	2,291	34,348	0	2,353	0	0	
Bike	0	0	0	0	4,034	0	0	0	
Walk to Local	0	0	0	0	0	21,645	0	0	
Walk to Express	0	0	0	0	0	60	0	0	
Kiss and Ride	0	0	0	0	0	0	233	0	
Park Ride Informal	0	0	0	0	0	0	0	159	
Park Ride Formal	0	0	0	0	0	0	0	16	
School Bus									
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
		21,645		60			16		159

Table 171: Observed vs. Estimated Discretionary Trip Shares

OBSERVED Trip Mode	Tour Mode								
	Drive-Alone	**Shared 2**	**Shared 3+**	**Walk**	**Bike**	**Walk-Transit**	**KNR**	**PNR**	**School Bus**
Drive Alone	100.0%	9.2%	3.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Shared Ride 2	0.0%	89.4%	13.7%	0.0%	0.0%	5.2%	0.0%	0.0%	0.0%
Shared ride 3+	0.0%	0.0%	80.1%	0.0%	0.0%	5.3%	0.0%	0.0%	0.0%
Walk	0.0%	1.3%	2.5%	100.0%	0.0%	9.7%	0.0%	0.0%	0.0%
Bike	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%
Walk to Local	0.0%	0.0%	0.0%	0.0%	0.0%	79.6%	0.0%	0.0%	0.0%
Walk to Express	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.0%	0.0%	0.0%
Kiss and Ride	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%
Park Ride Informal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	91.5%	0.0%
Park Ride Formal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	8.5%	0.0%
School Bus	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
		99.7%		0.3%			8.5%		91.5%

ESTIMATED Trip Mode	Tour Mode								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	100.0%	9.2%	3.7%	0.0%	0.0%	0.0%	0.0%	26.2%	0.0%
Shared Ride 2	0.0%	89.5%	14.1%	0.0%	0.0%	5.1%	28.2%	0.0%	0.0%
Shared ride 3+	0.0%	0.0%	79.9%	0.0%	0.0%	5.3%	27.8%	0.0%	0.0%
Walk	0.0%	1.3%	2.3%	100.0%	0.0%	8.8%	0.0%	0.0%	0.0%
Bike	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%
Walk to Local	0.0%	0.0%	0.0%	0.0%	0.0%	80.6%	0.0%	0.0%	0.0%
Walk to Express	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.0%	0.0%	0.0%
Kiss and Ride	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	44.0%	0.0%	0.0%
Park Ride Informal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	67.1%	0.0%
Park Ride Formal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	6.8%	0.0%
School Bus	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
		99.7%		0.3%			9.1%		90.9%

Table 172: Difference Estimated minus Observed Discretionary Trip Mode Share

Trip Mode	Tour Mode								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	26.2%	0.0%
Shared Ride 2	0.0%	0.1%	0.4%	0.0%	0.0%	-0.1%	28.2%	0.0%	0.0%
Shared ride 3+	0.0%	0.0%	-0.2%	0.0%	0.0%	0.0%	27.8%	0.0%	0.0%
Walk	0.0%	-0.1%	-0.2%	0.0%	0.0%	-1.0%	0.0%	0.0%	0.0%
Bike	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Walk to Local	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%	0.0%	0.0%	0.0%
Walk to Express	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Kiss and Ride	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-56.0%	0.0%	0.0%
Park Ride Informal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-24.5%	0.0%
Park Ride Formal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-1.7%	0.0%
School Bus	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
	0.0%		0.0%			0.7%		-0.7%	

Table 173: Final Adjustment Factors for Discretionary Trip Mode Choice

Trip Mode	Tour Mode								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	BASE	0.8947	1.1347					N/A	
Shared Ride 2		BASE	1.1701			0.0450	N/A	-0.7623	
Shared ride 3+			BASE			0.0249	N/A	-0.7623	
Walk		1.4601	1.3721	BASE		0.9443	-2.0822	-0.7623	
Bike					BASE				
Walk to Local						BASE	-2.0822	-0.7623	
Walk to Express						BASE	-2.0822	-0.7623	
Kiss and Ride							BASE		
Park Ride Informal								BASE	
Park Ride Formal								BASE	
School Bus									BASE
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
	BASE		-1.1122			0.2751		BASE	

Table 174: Estimated Constants for Discretionary Trip Mode Choice

Trip Mode	Tour Mode								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	BASE	-2.2695	-3.0803					-2.0000	
Shared Ride 2		BASE	-1.7644			-3.3906	-2.0000	N/A	
Shared ride 3+			BASE			-3.3906	-2.0000	N/A	
Walk		-4.2038	-3.4654	BASE		-2.7561	N/A	N/A	
Bike					BASE		N/A	N/A	
Walk to Local						BASE	N/A	N/A	
Walk to Express						BASE	N/A	N/A	
Kiss and Ride							BASE		
Park Ride Informal								BASE	
Park Ride Formal								BASE	
School Bus									BASE

Table 175: Equivalent In-vehicle minutes for Discretionary Trip Mode Choice

Trip Mode	Tour Mode								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	BASE	69	97					N/A	
Shared Ride 2		BASE	30			167	N/A	N/A	
Shared ride 3+			BASE			168	N/A	N/A	
Walk		137	105	BASE		91	N/A	N/A	
Bike					BASE			N/A	
Walk to Local						BASE	N/A	N/A	
Walk to Express						BASE	N/A	N/A	
Kiss and Ride							BASE		
Park Ride Informal								BASE	
Park Ride Formal								BASE	
School Bus									BASE
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
	BASE		52			-41		BASE	

Table 176: Observed vs. Estimated At Work Trips by Tour Mode

OBSERVED Trip Mode	Tour Mode								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	32,370	2,803	496	0	0	0	0	0	0
Shared Ride 2	0	11,283	224	0	0	0	0	0	0
Shared ride 3+	0	0	2,072	0	0	0	0	0	0
Walk	0	243	127	28,458	0	0	0	0	0
Bike	0	0	0	0	300	0	0	0	0
Walk to Local	0	0	0	0	0	2,498	0	0	0
Walk to Express	0	0	0	0	0	17	0	0	0
Kiss and Ride	0	0	0	0	0	0	0	0	0
Park Ride Informal	0	0	0	0	0	0	0	0	0
Park Ride Formal	0	0	0	0	0	0	0	0	0
School Bus	0	0	0	0	0	0	0	0	0
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
		2,498		17					

ESTIMATED Trip Mode	Tour Mode								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	32,368	2,799	493	0	0	0			
Shared Ride 2	0	11,310	228	0	0	0			
Shared ride 3+	0	0	2,048	0	0	0			
Walk	0	237	121	28,472	0	1			
Bike	0	0	0	0	300	0			
Walk to Local	0	0	0	0	0	2,378			
Walk to Express	0	0	0	0	0	17			
Kiss and Ride									
Park Ride Informal									
Park Ride Formal									
School Bus									
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
		2,378		17					

Table 177: Observed vs. Estimated At Work Trip Shares

OBSERVED Trip Mode	Tour Mode								
	Drive-Alone	**Shared 2**	**Shared 3+**	**Walk**	**Bike**	**Walk-Transit**	**KNR**	**PNR**	**School Bus**
Drive Alone	100.0%	19.6%	17.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Shared Ride 2	0.0%	78.7%	7.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Shared ride 3+	0.0%	0.0%	71.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Walk	0.0%	1.7%	4.3%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Bike	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%
Walk to Local	0.0%	0.0%	0.0%	0.0%	0.0%	99.2%	0.0%	0.0%	0.0%
Walk to Express	0.0%	0.0%	0.0%	0.0%	0.0%	0.7%	0.0%	0.0%	0.0%
Kiss and Ride	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Park Ride Informal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Park Ride Formal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
School Bus	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
		99.3%		0.7%			N/A		N/A

ESTIMATED Trip Mode	Tour Mode								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	100.0%	19.5%	17.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Shared Ride 2	0.0%	78.8%	7.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Shared ride 3+	0.0%	0.0%	70.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Walk	0.0%	1.7%	4.2%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Bike	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%
Walk to Local	0.0%	0.0%	0.0%	0.0%	0.0%	99.2%	0.0%	0.0%	0.0%
Walk to Express	0.0%	0.0%	0.0%	0.0%	0.0%	0.7%	0.0%	0.0%	0.0%
Kiss and Ride	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Park Ride Informal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Park Ride Formal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
School Bus	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
		99.3%		0.7%			N/A		N/A

Table 178: Difference Estimated minus Observed At Work Trip Mode Share

Trip Mode	Tour Mode								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Shared Ride 2	0.0%	0.1%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Shared ride 3+	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Walk	0.0%	0.0%	-0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Bike	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Walk to Local	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Walk to Express	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Kiss and Ride	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Park Ride Informal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Park Ride Formal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
School Bus	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
		0.0%		0.0%			N/A		N/A

Table 179: Final Adjustment Factors for At Work Trip Mode Choice

Trip Mode	Tour Mode								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	BASE	0.4485	0.3825						
Shared Ride 2		BASE	1.4505			-0.0483			
Shared ride 3+			BASE			-0.0483			
Walk		1.1081	1.0942	BASE		-5.1025			
Bike					BASE				
Walk to Local						BASE			
Walk to Express						BASE			
Kiss and Ride									
Park Ride Informal									
Park Ride Formal									
School Bus									
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
		BASE		-0.0978			N/A		N/A

Table 180: Estimated Constants for At Work Trip Mode Choice

Trip Mode	Tour Mode								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	BASE	-1.3927	-1.4304						
Shared Ride 2		BASE	-2.2262			N/A			
Shared ride 3+			BASE			N/A			
Walk		-3.8396	-2.7926	BASE		-2.0000			
Bike					BASE				
Walk to Local						BASE			
Walk to Express						BASE			
Kiss and Ride									
Park Ride Informal									
Park Ride Formal									
School Bus									

Table 181: Equivalent In-vehicle minutes for At Work Trip Mode Choice

Trip Mode	Tour Mode								
	Drive-Alone	Shared 2	Shared 3+	Walk	Bike	Walk-Transit	KNR	PNR	School Bus
Drive Alone	BASE	47	52						
Shared Ride 2		BASE	39			N/A			
Shared ride 3+			BASE			N/A			
Walk		137	85	BASE		355			
Bike					BASE				
Walk to Local						BASE			
Walk to Express						BASE			
Kiss and Ride									
Park Ride Informal									
Park Ride Formal									
School Bus									
Generic	**Local**		**Express**			**Formal PNR**		**Informal PNR**	
		BASE		5			N/A		N/A

Special Market Models

There are three special market models that are used in the OahuMPO model system. They include the following:

- Air-passenger Model: A trip-based model of trips to and from Honolulu International Airport (this model was left as it was in the trip based model and was not touched so it is not shown here).
- Visitor Model: A tour-based simulation model of travel on Oahu made by non-resident visitors (this model is actually run just after the residential model in the model stream)
- Commercial Vehicle Model: An aggregate trip-based model of commercial vehicles other than heavy trucks made on Oahu

Visitor Model

The visitor model was developed to capture the demand of visitor travel on Oahu. The model was calibrated to match summaries from the Oahu Visitor Survey and data from *the Hawaii Tourism Authority 2010 Annual Visitor Research Report*. Each model component that was calibrated is described, and the comparisons that were performed as a basis for calibration, which parameters and/or alternative-specific constants were adjusted, the final values of adjusted parameters/constants.

Visitor Destination Choice

The tour destination choice model selects the primary destination for each tour. The targets for this model are the average tour distances and the tour length frequency distributions from the visitor survey. Size term parameters were not adjusted in calibration, except in the case of special visitor attractor TAZs. These locations are unique tourist attraction sites that attract a much greater number of visitor recreation tours and trips than they would just based on employment size terms themselves. Size term adjustments for special visitor attractions are discussed in the next section.

Table 182: Destination Choice Coefficients

Variable	Work	Recreational	Shopping	Dining
Mode choice logsum	1	0.1986	0.7258	0.3098
Distance				-0.0255
Distance Squared				-0.0023
Ln (Distance)		-0.2206	-0.9292	-1.1177
Rental Car * Distance		0.0340		0.0711
Party Size * Distance		-0.0161		
Military Employment	1			
Retail Employment		1	1	1
Other Employment	0.3271		0.4527	
Hotel Employment		1.8839		2.7443

Variable	Work	Recreational	Shopping	Dining
Service Employment		1.65		0.0790
Households				0.0217

The average tour distances are quite close for the recreational, shopping, and dining purposes. The work purpose is not matching as well, but there were very few observations in the survey for the work purpose, and there is a spike at 53-54 miles which seems odd.

Table 183: Average Tour Distance by Purpose

Average Distance	Work	Recreational	Shopping	Dining
Survey	8.33	7.93	2.87	1.47
Model	5.64	7.25	3.18	1.84

The tour length frequency distributions compare fairly well, although the survey distributions are somewhat irregular and therefore difficult to match, particularly for the work purpose. The irregular distribution of the work purpose could be the reason why the average distances do not match as well for that purpose.

Figure 62: Work Purpose Tour Length Frequency Distribution

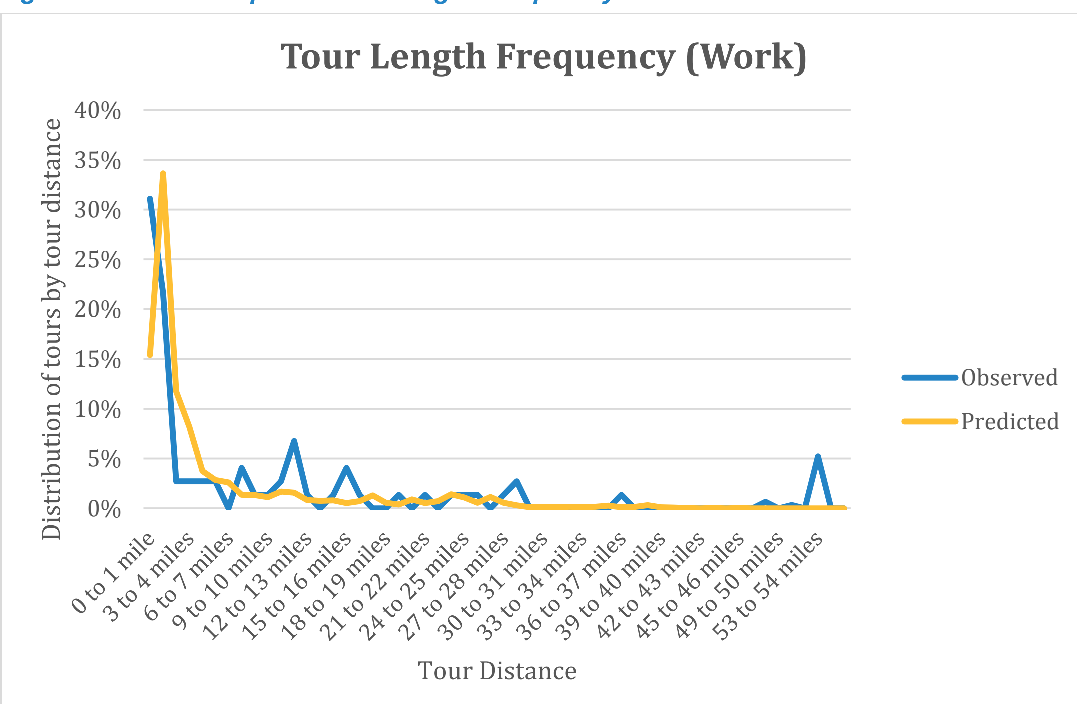


Figure 63: Recreational Purpose Tour Length Frequency Distribution

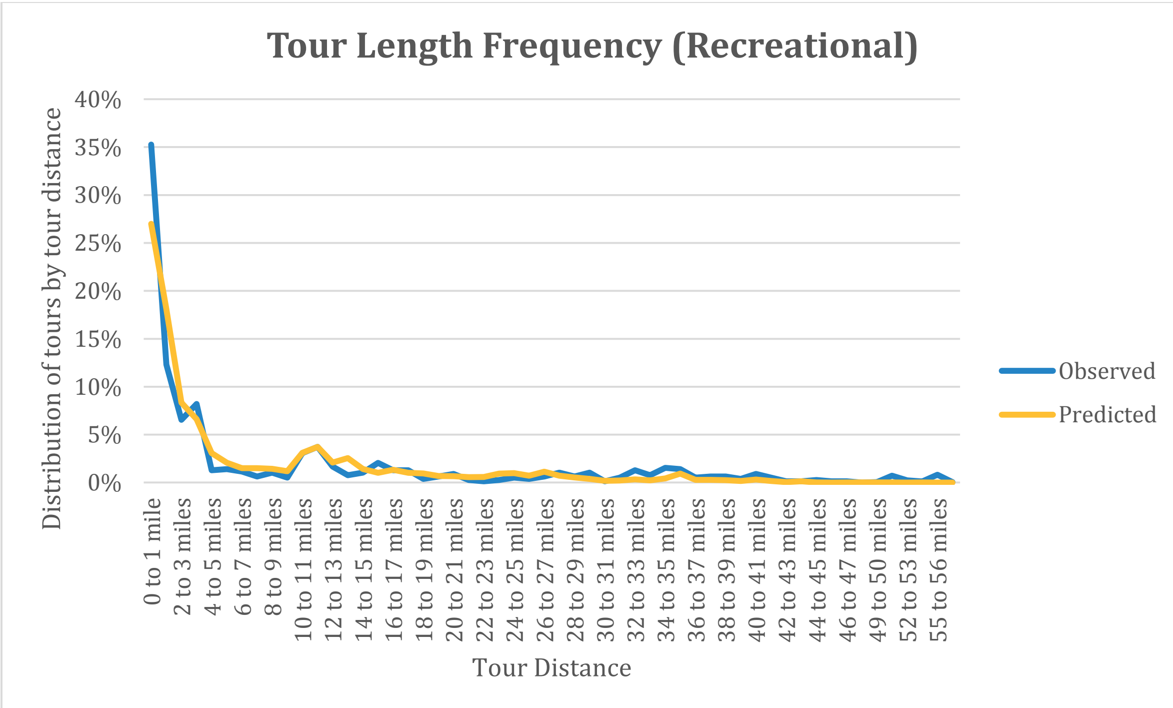


Figure 64: Shopping Purpose Tour Length Frequency Distribution

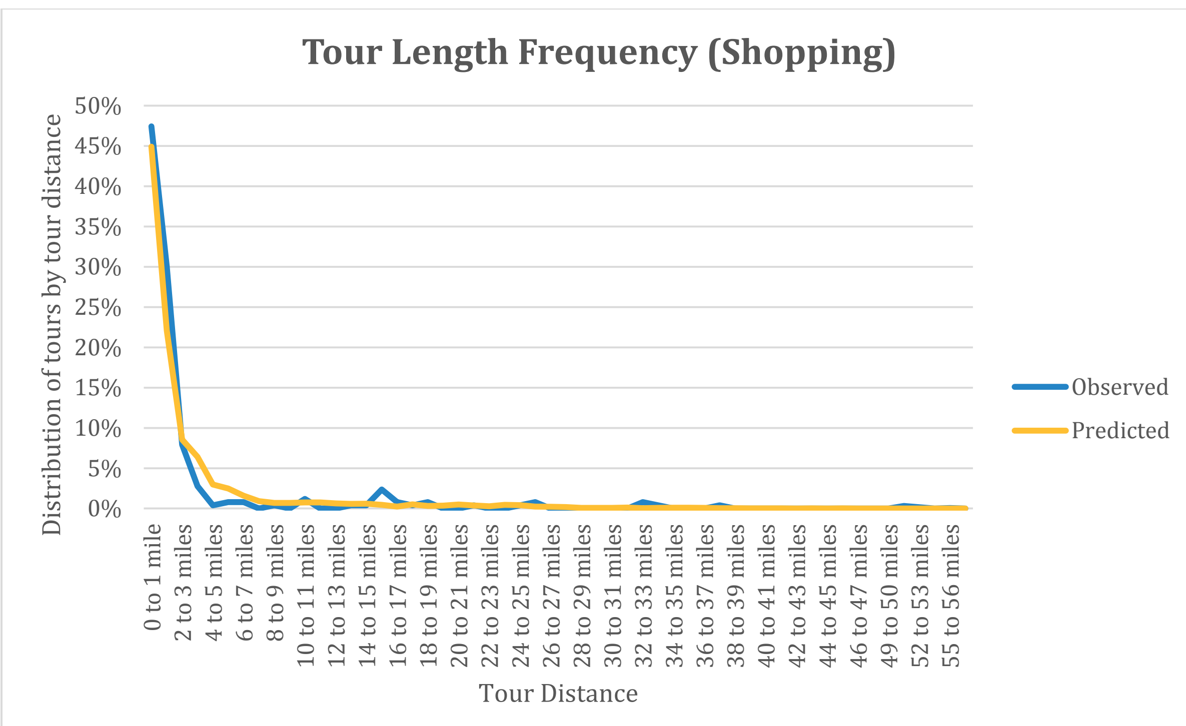
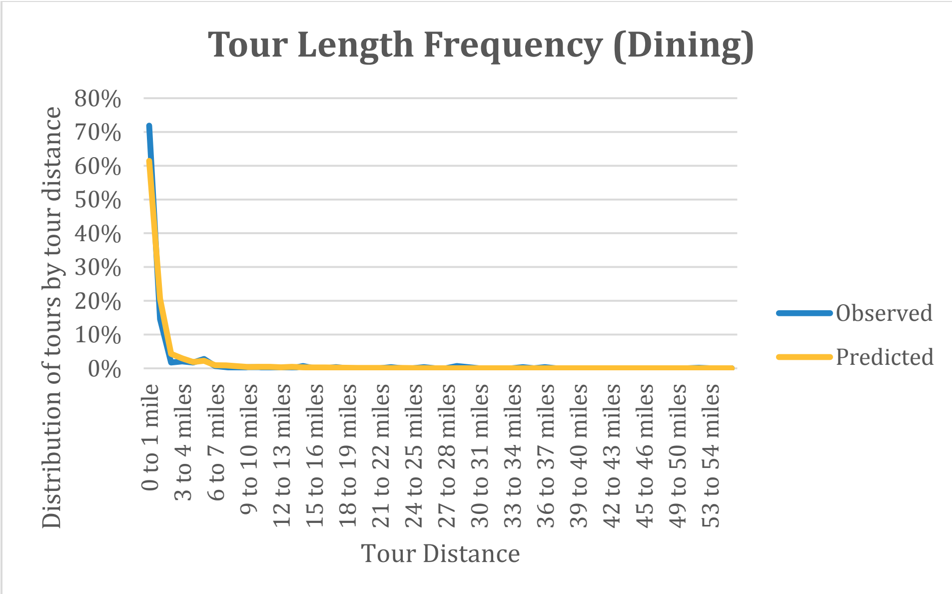


Figure 65: Dining Purpose Tour Length Frequency Distribution



Special Locations

The visitor survey contains information about the trips for each visitor during one day on Oahu. A handful of TAZs, containing popular attractions like the Honolulu Zoo, Polynesian Cultural Center, and Waikiki Aquarium attracted a large number of the visitor trips, although destinations did occur throughout the model area.

The challenge of modeling visitors to special locations is that they have varying amounts of employees in the traditional amusement categories. Since the destination choice size terms are based on the number of employees, it is impossible to capture to attractiveness of the zone just based on employees. The selected special locations are: Ala Moana Park, Bishop Museum, Diamond Head, Honolulu Zoo, Iolani Palace, Pearl Harbor/Arizona Memorial, Polynesian Cultural Center, Waikiki Aquarium, and Waimea Falls Park,.

The target data received from *the2011 State of Hawaii Data Book* included the annual attendance. The number was adjusted to a daily value (annual number divided by 365). For a few locations, the special attraction was not open 365 days a year so the annual attendance was divided by the appropriate factor. Also in most cases it was not known what the split of residents versus visitors at various attractions were so a range between 50 and 80% was used depending on the attraction place.

The special attraction zones were calibrated by adjusting a TAZ's-specific size term for each attraction. The resulting estimated numbers by attractions are quite close for most attractions. The Honolulu Zoo zone already has too many attractions because this zone has more than just the zoo. Ala Moana Park is also a difficult one to measure since both residents and visitors are attracted to this park and it's difficult to know what the split of residents versus visitors is.

Table 184: Visitors to Special Locations

Location	Annual Attendance	Observed Average Daily Attendance	Observed Average Daily Non-resident Attendance	Estimated Non-Resident Visitors	% Difference
Ala Moana Park	2,637,353	7,226	3,613	5,103	41%
Bishop Museum	442,483	1,212	849	722	-15%
Diamond Head	665,437	1,823	912	639	-30%
Honolulu Zoo	580,265	1,590	1,272	11,053	769%
Iolani Palace	93,536	256	243	299	23%
Pearl Harbor/Arizona Memorial	2,164,612	5,930	5,337	4,657	-13%
Polynesian Cultural Center	692,081	2,163	1,946	2,464	27%
Waikiki Aquarium	290,479	800	720	814	13%
Waimea Falls Park	519,268	1,423	1,138	1,282	13%

Visitor Tour Mode Choice

The tour mode choice model selects the mode for the tour. In order to calibrate this model, first the model results were compared to the survey distributions by purpose and by auto availability. In a handful of cases, there were no survey observations for a particular purpose and mode, and these are denoted with N/A. Based on the comparisons between estimated and observed distributions, constants were calculated for each mode as described previously in the document. The auto mode was selected as the base for the purposes of calibration. The model was then calibrated by calculating new constants after each model run until the results were close to the survey values. Table 185 shows the final calibrated constants for each mode.

Table 185: Calibrated Constants for Visitor Tour Mode Choice

Auto Available	Mode	Work	Recreational	Shopping	Dining
No	Auto	base	base	base	base
	Walk	(0.54)	0.87	0.25	1.97
	Bike	N/A	(2.21)	(0.76)	(2.35)
	Walk Transit	N/A	(0.17)	(0.44)	(0.56)
	Trolley	N/A	1.30	1.00	2.12
	TourBus	(0.73)	0.27	0.16	1.78
	Taxi	0.91	2.06	1.91	3.00
Yes	Auto	base	base	base	base
	Walk	(1.43)	0.21	0.08	0.48
	Bike	N/A	N/A	N/A	N/A
	Walk Transit	N/A	(0.66)	0.83	N/A
	Trolley	N/A	0.24	0.30	N/A
	TourBus	(0.36)	0.19	(0.10)	0.19
	Taxi	0.49	2.92	N/A	N/A

Table 186 compares the final model results to the survey distributions by mode. The results are quite close.

Table 186: Visitor Tour Mode Distribution by Purpose

Auto Available	Mode	Work		Recreational		Shopping		Dining	
		Observed	Estimated	Observed	Estimated	Observed	Estimated	Observed	Estimated
No	Auto	48%	33%	16%	17%	12%	13%	4%	6%
	Walk	46%	36%	46%	42%	51%	50%	90%	86%
	Bike	0%	0%	2%	4%	4%	4%	0%	0%
	Walk Transit	0%	26%	9%	10%	15%	16%	1%	1%
	Trolley	0%	1%	6%	5%	16%	14%	1%	1%
	TourBus	0%	0%	19%	20%	0%	0%	0%	0%
	Taxi	6%	3%	3%	2%	3%	3%	4%	6%
	Total	100%	100%	100%	100%	100%	100%	100%	100%
Yes	Auto	94%	91%	65%	65%	51%	51%	29%	30%
	Walk	5%	6%	25%	25%	40%	40%	71%	69%
	Bike	0%	0%	0%	0%	0%	0%	0%	0%
	Walk Transit	0%	2%	1%	1%	6%	6%	0%	0%
	Trolley	0%	0%	1%	1%	3%	3%	0%	0%
	TourBus	0%	0%	6%	6%	0%	0%	0%	0%
	Taxi	1%	1%	3%	3%	0%	0%	0	0%
	Total	100%	100%	100%	100%	100%	100%	100%	100%

Table 187: Visitor Tour Mode Distribution Differences by Purpose

Auto Available	Mode	Work	Recreational	Shopping	Dining
No	Auto	-15%	1%	1%	2%
	Walk	-10%	-4%	-1%	-4%
	Bike	0%	3%	1%	0%
	Walk Transit	26%	1%	1%	0%
	Trolley	1%	-1%	-1%	0%
	TourBus	0%	1%	0%	0%
	Taxi	-2%	0%	0%	1%
	Total	0%	0%	0%	0%
Yes	Auto	-3%	0%	0%	2%
	Walk	1%	0%	0%	-2%
	Bike	0%	0%	0%	0%
	Walk Transit	2%	0%	0%	0%
	Trolley	0%	0%	0%	0%

Auto Available	Mode	Work	Recreational	Shopping	Dining
	TourBus	0%	0%	0%	0%
	Taxi	0%	0%	0%	0%
	Total	0%	0%	0%	0%

Overall, the final differences in the observed and estimated are largest for the work tour purpose since this purpose had the fewest number of observed records in the survey so it is somewhat underrepresented. All other mode distributions by purpose are very close to the target.

Visitor Stop Location

The stop location model was asserted, based on the discretionary purpose of the resident stop location choice model. This model was calibrated to match distributions from the visitor travel survey. .The results are described below.

Calibration Results

Out of Direction Stops

Table 136 shows the observed and estimated average out of direction distances by tour purpose. The normalized coincidence ratio is also shown to determine how well the estimated matched the observed out of direction distance in one mile increments. This table shows that the model's average out of direction distance matches well for the shopping and dining, but does not match as well for work and recreational tour purposes. There were very few work tour purposes so this could be the reason for model not matching the survey well. The recreation purpose might also have an under-representation of the shorter trips in the survey made around the visitor's hotels like the beaches in front of the hotels.

Table 188. Visitor Observed versus Estimated Average Out of Direction Distance by Tour Purpose

Purpose	Observed Average out of direction Distance	Estimated Average out of direction Distance	Normalized Coincidence Ratio
Work	8.19	1.63	0.55
Recreational	4.05	2.01	0.78
Shopping	2.06	2.42	0.75
Dining	0.87	2.10	0.73

Figure 66 through Figure 69 displays the stop location choice model out of direction stop deviation distribution for each tour purpose compared to the visitor survey.

Figure 66: Visitor Work Tours Out of Direction Stop Location Distribution

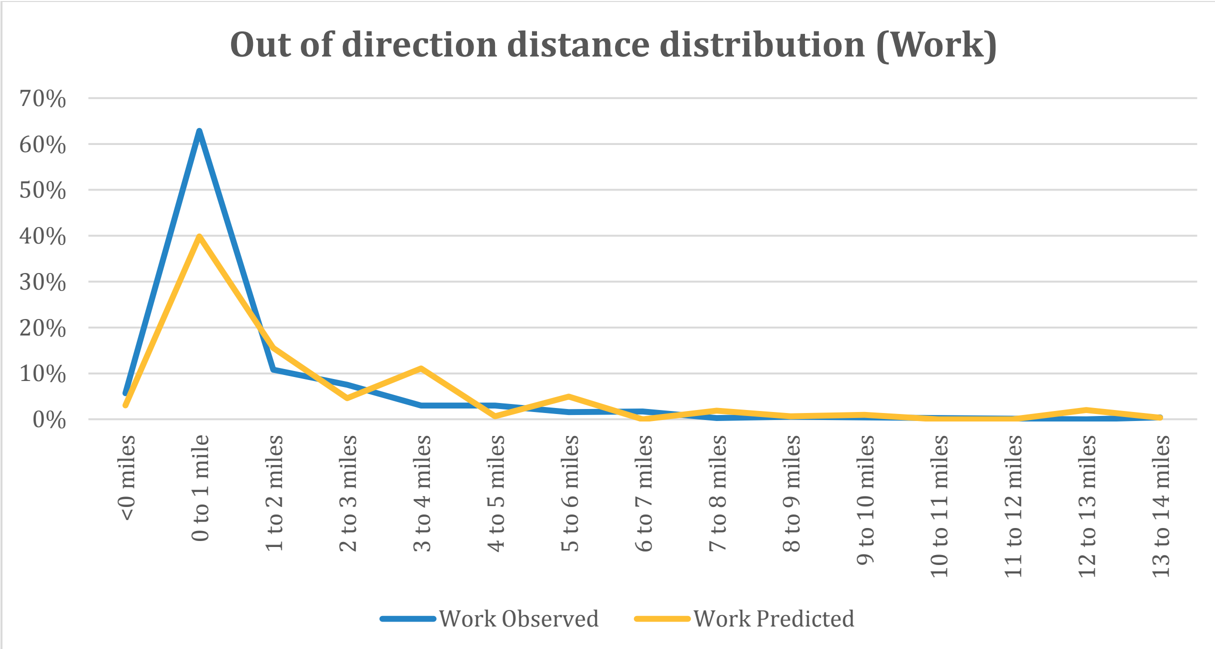


Figure 67: Visitor Recreation Tours Out of Direction Stop Location Distribution

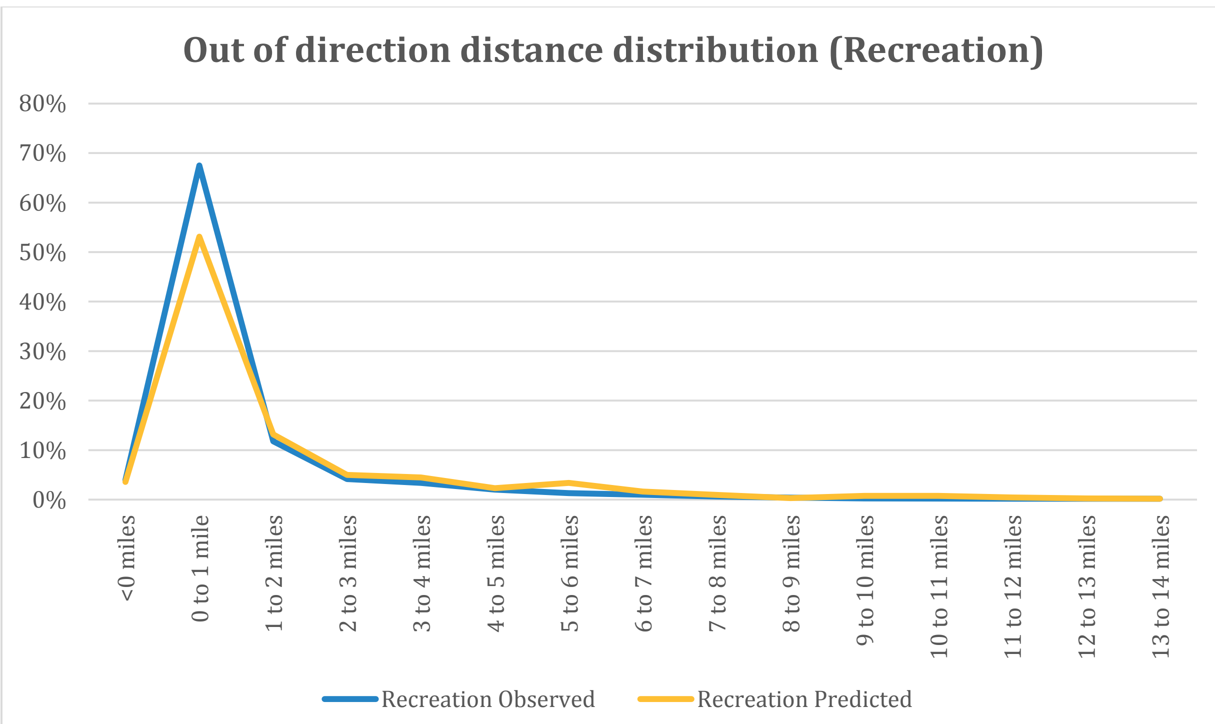


Figure 68: Visitor Shopping Tours Out of Direction Stop Location Distribution

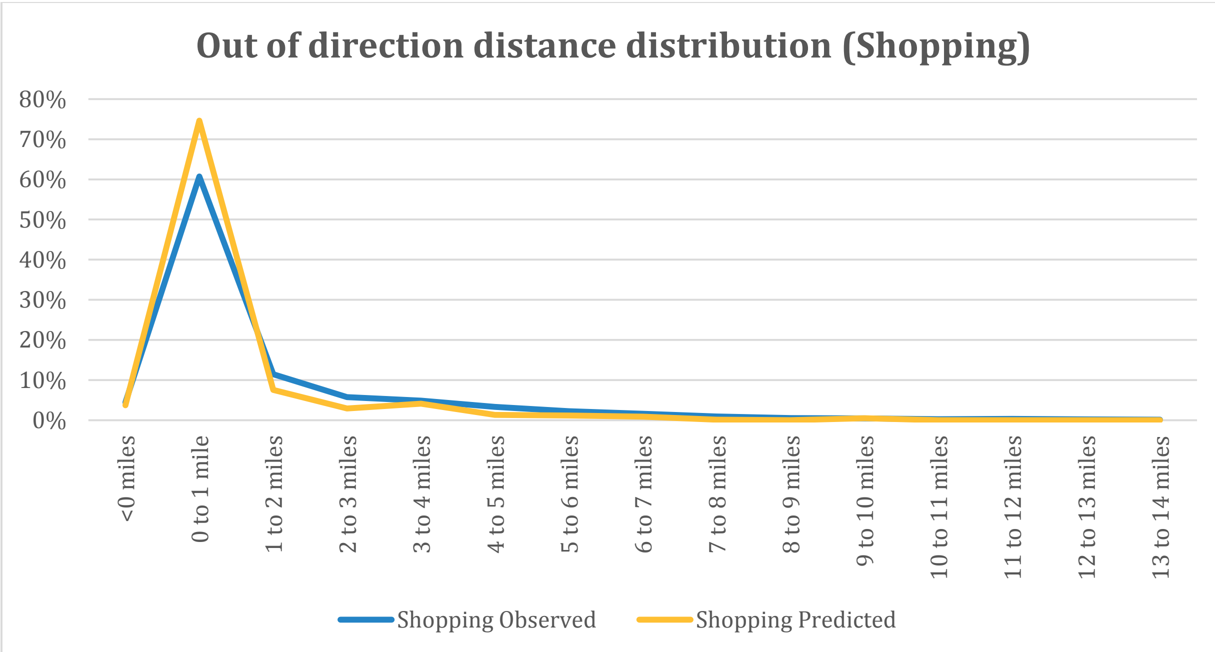
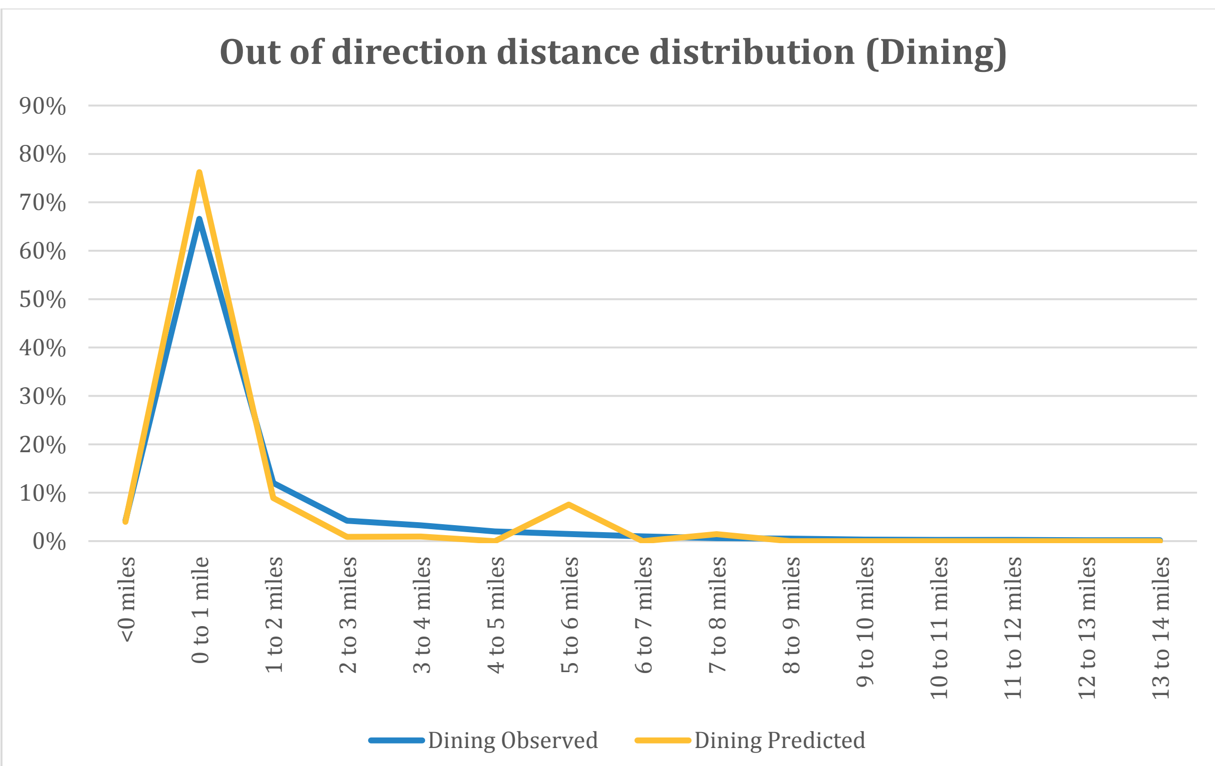


Figure 69: Visitor Dining Tours Out of Direction Stop Location Distribution



Visitor Trip Mode Choice

Like the residential model, the main tour mode is chosen at the tour level but this model predicts the mode for each individual trip on the tour. It is referred to as a trip mode "switching" model because it predicts the likelihood of each trip mode constrained by the chosen tour mode. The visitor trip mode choice model was calibrated by tour purpose and tour mode, with constants applied to each trip mode.

Visitor Trip Mode Choice Calibration Targets

This model was compared to the 2012 visitor survey. The following are the steps used to create the calibration target values for the trip mode choice model

- The visitor survey was summarized by tour purpose, trip mode and tour mode.
- Like the tour mode choice model, tour bus modes could only occur on recreational tours, so the work, shopping, and dining out tours were moved to the recreational purpose. Also auto trips are not allowed on walk-transit or trolley tours so those trips were moved into the taxi mode.

Visitor Trip Mode Choice Calibration Method

Table 139 shows the graphic depiction of trip mode constant segmentation. In the figure, non-available trip modes for each tour mode are greyed out. The base trip mode is indicated for each tour mode. Several runs through the model were done to achieve satisfactory levels of calibration.

The base alternative for calibrating the trip mode choice model was as follows:

- For auto tours, the base alternative was the auto trip mode
- For bike tours, the base alternative was the bike trip mode
- For walk-transit tours, the base alternative was the walk-transit trip mode
- For trolley tours, the base alternative was the trolley trip mode
- For tour bus tours, the base alternative was the tour bus trip mode.
- For taxi tours, the base alternative was the taxi trip mode

For walk mode tours, only the walk trip mode is available. Therefore for this tour mode, no calibration was necessary.

Table 189: Trip Mode Choice Model Calibration Scheme

	Tour Mode						
Trip Mode	**Auto**	**Walk**	**bike**	**Walk-Transit**	**Trolley**	**Tour Bus**	**Taxi**
Auto	BASE						
Walk		BASE					
bike			BASE				
Walk-Transit				BASE			
Trolley					BASE		
TourBus						BASE	
Taxi							BASE

Visitor Trip Mode Choice Results

For each purpose, a table of observed and estimated trips by tour mode is compared. Another table shows the comparison of observed trip mode shares and estimated trip mode shares by tour mode. A third table shows the difference between the observed and estimated trip mode shares by tour mode. A fourth table shows the final adjustment factors by trip mode and tour mode that were needed to calibrate each purpose. Some of the cells in the observed tables had a value of 1 so negative constants could be added to make those modes less attractive (i.e. these modes are allowed but the survey did not observe any trips (they are denoted with a red 1).

The comparison of observed versus estimated trip mode shares match closely for most purposes as seen in the difference in shares by purpose. The work purpose did not match well for the transit and trolley tour modes since there were no observed trips for these modes as there were few work tours in the visitor survey.

Table 190: Visitor Observed vs. Estimated Work Trips by Tour Mode

Observed Trip Mode	Tour Mode						
	Auto	Walk	bike	Walk-Transit	Trolley	Tour Bus	Taxi
Auto	10,726	-	-	-	-	-	1
Walk	1,307	4,007	-	-	-	-	179
bike	-	-	-	-	-	-	-
Walk-Transit	-	-	-	-	-	-	-
Trolley	-	-	-	-	-	-	-
TourBus	-	-	-	-	-	-	-
Taxi	-	-	-	-	-	-	355
Esimated Trip Mode	**Tour Mode**						
	Auto	**Walk**	**bike**	**Walk-Transit**	**Trolley**	**Tour Bus**	**Taxi**
Auto	18,108	-		-	-		-
Walk	2,435	8,553	-	2,553	190		367
bike							
Walk-Transit	-	-		2,594	-		-
Trolley	-	-		143	55		-
TourBus							
Taxi	-	-		221	2		484

Table 191: Visitor Observed vs. Estimated Shares for Work Trips by Tour Mode

Observed Trip Mode	Tour Mode						
	Auto	Walk	bike	Walk-Transit	Trolley	Tour Bus	Taxi
Auto	89%	0%	0%	0%	0%	0%	0%
Walk	11%	100%	0%	0%	0%	0%	33%
bike	0%	0%	0%	0%	0%	0%	0%
Walk-Transit	0%	0%	0%	0%	0%	0%	0%
Trolley	0%	0%	0%	0%	0%	0%	0%
TourBus	0%	0%	0%	0%	0%	0%	0%
Taxi	0%	0%	0%	0%	0%	0%	66%
Esimated Trip Mode	**Tour Mode**						
	Auto	**Walk**	**bike**	**Walk-Transit**	**Trolley**	**Tour Bus**	**Taxi**
Auto	88%	0%	0%	0%	0%	0%	0%
Walk	12%	100%	0%	46%	77%	0%	43%
bike	0%	0%	0%	0%	0%	0%	0%
Walk-Transit	0%	0%	0%	47%	0%	0%	0%
Trolley	0%	0%	0%	3%	22%	0%	0%
TourBus	0%	0%	0%	0%	0%	0%	0%
Taxi	0%	0%	0%	4%	1%	0%	57%

Table 192: Visitor Difference Estimated and Observed Shares for Work Trips by Tour Mode

Observed Trip Mode	Tour Mode						
	Auto	Walk	bike	Walk-Transit	Trolley	Tour Bus	Taxi
Auto	-1%	0%	0%	0%	0%	0%	0%
Walk	1%	0%	0%	46%	77%	0%	10%
bike	0%	0%	0%	0%	0%	0%	0%
Walk-Transit	0%	0%	0%	47%	0%	0%	0%
Trolley	0%	0%	0%	3%	22%	0%	0%
TourBus	0%	0%	0%	0%	0%	0%	0%
Taxi	0%	0%	0%	4%	1%	0%	-10%

Table 193: Visitor Final Adjustments for Work Trips by Tour Mode

Observed Trip Mode	Tour Mode						
	Auto	Walk	bike	Walk-Transit	Trolley	Tour Bus	Taxi
Auto	BASE					-	(7.934)
Walk	(1.242)	BASE		-	-	-	(2.689)
bike			BASE				
Walk-Transit				BASE			
Trolley				-	BASE		
TourBus					-	BASE	
Taxi				-	-	-	BASE

Table 194: Visitor Observed vs. Estimated Recreational Trips by Tour Mode

Observed Trip Mode	Tour Mode						
	Auto	Walk	bike	Walk-Transit	Trolley	Tour Bus	Taxi
Auto	90,223	-	-	-	-	2,090	234
Walk	10,606	103,671		6,386	6,438	4,913	3,130
bike	-	-	5347	-	-	93	-
Walk-Transit	-	-	-	10,888	-	-	-
Trolley	-	-	-	907	7,440	-	-
TourBus	-	-	-	-	1,045	30,734	-
Taxi	-	-	-	512	349	385	4,217
Esimated Trip Mode	**Tour Mode**						
	Auto	**Walk**	**bike**	**Walk-Transit**	**Trolley**	**Tour Bus**	**Taxi**
Auto	107,462	-	-	-	-	3,041	342
Walk	13,848	129,352	-	7,949	5,496	7,531	4,403
bike	-	-	9,069	-	-	-	-
Walk-Transit	-	-	-	13,156	-	-	-
Trolley	-	-	-	1,089	6,034	-	-
TourBus	-	-	-	-	932	40,840	-
Taxi	-	-	-	618	281	543	4,525

Table 195: Visitor Observed vs. Estimated Shares for Recreational Trips by Tour Mode

Observed Trip Mode	Tour Mode						
	Auto	Walk	bike	Walk-Transit	Trolley	Tour Bus	Taxi
Auto	89%	0%	0%	0%	0%	5%	3%
Walk	11%	100%	0%	34%	42%	13%	41%
bike	0%	0%	100%	0%	0%	0%	0%
Walk-Transit	0%	0%	0%	58%	0%	0%	0%
Trolley	0%	0%	0%	5%	49%	0%	0%
TourBus	0%	0%	0%	0%	7%	80%	0%
Taxi	0%	0%	0%	3%	2%	1%	56%
Esimated Trip Mode	**Tour Mode**						
	Auto	**Walk**	**bike**	**Walk-Transit**	**Trolley**	**Tour Bus**	**Taxi**
Auto	89%	0%	0%	0%	0%	6%	4%
Walk	11%	100%	0%	35%	43%	14%	47%
bike	0%	0%	100%	0%	0%	0%	0%
Walk-Transit	0%	0%	0%	58%	0%	0%	0%
Trolley	0%	0%	0%	5%	47%	0%	0%
TourBus	0%	0%	0%	0%	7%	79%	0%
Taxi	0%	0%	0%	3%	2%	1%	49%

Table 196: Visitor Difference Estimated and Observed Shares for Recreational Trips by Tour Mode

Observed Trip Mode	Tour Mode						
	Auto	Walk	bike	Walk-Transit	Trolley	Tour Bus	Taxi
Auto	-1%	0%	0%	0%	0%	0%	1%
Walk	1%	0%	0%	1%	1%	2%	6%
bike	0%	0%	0%	0%	0%	0%	0%
Walk-Transit	0%	0%	0%	-1%	0%	0%	0%
Trolley	0%	0%	0%	0%	-1%	0%	0%
TourBus	0%	0%	0%	0%	0%	-2%	0%
Taxi	0%	0%	0%	0%	0%	0%	-7%

Table 197: Visitor Final Adjustments for Recreational Trips by Tour Mode

Observed Trip Mode	Tour Mode						
	Auto	Walk	bike	Walk-Transit	Trolley	Tour Bus	Taxi
Auto	BASE					(2.698)	(6.633)
Walk	(1.566)	BASE		(1.000)	(1.539)	(1.856)	(2.912)
bike			BASE				
Walk-Transit				BASE			
Trolley				(0.536)	BASE		
TourBus					(2.317)	BASE	
Taxi				(0.058)	(0.238)	(0.708)	BASE

Table 198: Visitor Observed vs. Estimated Shopping Trips by Tour Mode

Observed Trip Mode	Tour Mode						
	Auto	Walk	bike	Walk-Transit	Trolley	Tour Bus	Taxi
Auto	14,328	-	-	-	-	-	**1**
Walk	2,289	36,389		2,638	4,060	-	1,015
bike	-	-	2,168	-	-	-	-
Walk-Transit	-	-	-	5,890	-	-	-
Trolley	-	-	-	189	5,620	-	-
TourBus	-	-	-	-	160	-	-
Taxi	-	-	-	437	853	-	879
Esimated Trip Mode	**Tour Mode**						
	Auto	**Walk**	**bike**	**Walk-Transit**	**Trolley**	**Tour Bus**	**Taxi**
Auto	19,909	-	-	-	-		4
Walk	3,542	48,083	-	3,923	4,542		1,159
bike	-	-	2,841	-	-		-
Walk-Transit	-	-	-	7,681	-		-
Trolley	-	-	-	304	5,913		-
TourBus							
Taxi	-	-	-	578	877		1,041

Table 199: Visitor Observed vs. Estimated Shares for Shopping Trips by Tour Mode

Observed Trip Mode	Tour Mode						
	Auto	Walk	bike	Walk-Transit	Trolley	Tour Bus	Taxi
Auto	86%	0%	0%	0%	0%	0%	0%
Walk	14%	100%	0%	29%	38%	0%	54%
bike	0%	0%	100%	0%	0%	0%	0%
Walk-Transit	0%	0%	0%	64%	0%	0%	0%
Trolley	0%	0%	0%	2%	53%	0%	0%
TourBus	0%	0%	0%	0%	1%	0%	0%
Taxi	0%	0%	0%	5%	8%	0%	46%
Esimated Trip Mode	**Tour Mode**						
	Auto	**Walk**	**bike**	**Walk-Transit**	**Trolley**	**Tour Bus**	**Taxi**
Auto	85%	0%	0%	0%	0%	0%	0%
Walk	15%	100%	0%	31%	40%	0%	53%
bike	0%	0%	100%	0%	0%	0%	0%
Walk-Transit	0%	0%	0%	62%	0%	0%	0%
Trolley	0%	0%	0%	2%	52%	0%	0%
TourBus	0%	0%	0%	0%	0%	0%	0%
Taxi	0%	0%	0%	5%	8%	0%	47%

Table 200: Visitor Difference Estimated and Observed Shares for Shopping Trips by Tour Mode

Observed Trip Mode	Tour Mode						
	Auto	Walk	bike	Walk-Transit	Trolley	Tour Bus	Taxi
Auto	-1%	0%	0%	0%	0%	0%	0%
Walk	1%	0%	0%	3%	2%	0%	-1%
bike	0%	0%	0%	0%	0%	0%	0%
Walk-Transit	0%	0%	0%	-3%	0%	0%	0%
Trolley	0%	0%	0%	0%	0%	0%	0%
TourBus	0%	0%	0%	0%	-1%	0%	0%
Taxi	0%	0%	0%	0%	0%	0%	1%

Table 201: Visitor Final Adjustments for Shopping Trips by Tour Mode

Observed Trip Mode	Tour Mode						
	Auto	Walk	bike	Walk-Transit	Trolley	Tour Bus	Taxi
Auto	BASE					-	(9.251)
Walk	(1.540)	BASE		(1.212)	(1.265)	-	(1.748)
bike			BASE				
Walk-Transit				BASE			
Trolley				(1.473)	BASE		
TourBus					(0.778)	BASE	
Taxi				0.475	1.614	-	BASE

Table 202: Visitor Observed vs. Estimated Dining Trips by Tour Mode

Observed Trip Mode	Tour Mode						
	Auto	Walk	bike	Walk-Transit	Trolley	Tour Bus	Taxi
Auto	7,518	-	-	-	-	-	33
Walk	169	52,691	-	34	21	-	93
bike	-	-	98	-	-	-	-
Walk-Transit	-	-	-	167	-	-	-
Trolley	-	-	-	-	214	-	-
TourBus	-	-	-	-	-	-	-
Taxi	-	-	-	69	172	-	1,763
Esimated Trip Mode	**Tour Mode**						
	Auto	**Walk**	**bike**	**Walk-Transit**	**Trolley**	**Tour Bus**	**Taxi**
Auto	10,679	-	-	-	-		64
Walk	292	65,360	-	105	30		261
bike	-	-	239	-	-		-
Walk-Transit	-	-	-	344	-		-
Trolley	-	-	-	6	291		-
TourBus							
Taxi	-	-	-	153	206		2,877

Table 203: Visitor Observed vs. Estimated Shares for Dining Trips by Tour Mode

Observed Trip Mode	Tour Mode						
	Auto	Walk	bike	Walk-Transit	Trolley	Tour Bus	Taxi
Auto	98%	0%	0%	0%	0%	0%	2%
Walk	2%	100%	0%	13%	5%	0%	5%
bike	0%	0%	100%	0%	0%	0%	0%
Walk-Transit	0%	0%	0%	62%	0%	0%	0%
Trolley	0%	0%	0%	0%	53%	0%	0%
TourBus	0%	0%	0%	0%	0%	0%	0%
Taxi	0%	0%	0%	25%	42%	0%	93%
Esimated Trip Mode	Tour Mode						
	Auto	Walk	bike	Walk-Transit	Trolley	Tour Bus	Taxi
Auto	97%	0%	0%	0%	0%	0%	2%
Walk	3%	100%	0%	17%	6%	0%	8%
bike	0%	0%	100%	0%	0%	0%	0%
Walk-Transit	0%	0%	0%	57%	0%	0%	0%
Trolley	0%	0%	0%	1%	55%	0%	0%
TourBus	0%	0%	0%	0%	0%	0%	0%
Taxi	0%	0%	0%	25%	39%	0%	90%

Table 204: Visitor Difference Estimated and Observed Shares for Dining Trips by Tour Mode

Observed Trip Mode	Tour Mode						
	Auto	Walk	bike	Walk-Transit	Trolley	Tour Bus	Taxi
Auto	0%	0%	0%	0%	0%	0%	0%
Walk	0%	0%	0%	5%	1%	0%	3%
bike	0%	0%	0%	0%	0%	0%	0%
Walk-Transit	0%	0%	0%	-5%	0%	0%	0%
Trolley	0%	0%	0%	1%	3%	0%	0%
TourBus	0%	0%	0%	0%	0%	0%	0%
Taxi	0%	0%	0%	0%	-3%	0%	-3%

Table 205: Visitor Final Adjustments for Dining Trips by Tour Mode

Observed Trip Mode	Tour Mode						
	Auto	Walk	bike	Walk-Transit	Trolley	Tour Bus	Taxi
Auto	BASE					-	(6.869)
Walk	(3.740)	BASE		(3.089)	(4.448)	-	(6.045)
bike			BASE				
Walk-Transit				BASE			
Trolley				-	BASE		
TourBus					(1.321)	BASE	
Taxi				1.162	1.858	-	BASE

Assignment and Validation

Highway Assignment 2012 Validation

The base year highway assignment model is developed for the year 2012. The model was calibrated and validated against traffic counts from the Hawaii Department of Transportation (HDOT) traffic database. The HDOT database is a rich source of disaggregate traffic data with traffic recorded at 15 minute intervals for over 1000 count locations. For stations not present in the 2011 database, a traffic count was borrowed from the 2010 database.

The validation exercise demonstrates the effectiveness of the model in replicating the base year traffic conditions. The results established that the model can lend itself as a robust tool for forecasting traffic under different policy scenarios.

The Oahu Tour Based Model uses a multi-user multi class user equilibrium to assign traffic on the highway network with the different user classes being: single occupant non-toll, shared ride two person non-toll, shared ride three-plus person non-toll, truck non-toll, single occupant toll (if applicable), shared ride two person toll (if applicable), shared ride three-plus toll (if applicable) and truck toll (if applicable). Equilibrium is achieved using a bi-conjugate Frank-Wolfe (BFW) algorithm to shift flows between routes at each iteration. The traditional Frank-Wolfe algorithm uses the direction of the steepest descent (pure gradient) as the search. However, the BFW approach uses a conjugate search method where, instead of going along the direction of steepest descent, the search is performed along the conjugate direction – which is the direction that is dependent on the previous search direction. This method has a low memory requirement and strong convergence properties with convergence times comparable to the origin based family of algorithms.[7]

In order to effectively capture the temporal pattern of metropolitan traffic the model assignment is carried out for five time-of-day networks. The five time periods are defined as: *Early AM* – 3:00 AM to 5:59 AM; *AM Peak* – 6:00 AM to 8:59 AM; *Mid-day* – 9:00 AM to 2:59 PM; *PM Peak* – 3:00 PM to 6:59 PM; *Evening* – 7:00 PM to 2:59 AM. The origin-destination matrix for each combination of the mode and time segment is generated by aggregating the trips that are predicted by different demand model components (residential, commercial and visitor).

The traffic counts from the HDOT database were processed and aggregated into the five time periods modeled and the average daily traffic was computed. Only complete weekday count records were considered. The stations were geocoded onto the highway network and the volumes were compared at link level.

Calibration and Validation approach

The traffic assignment results were evaluated based on the following criterions:

- Scatter plots of observed vs. predicted flows
- Summary statistics
- Screenline summaries

A systematic approach was used to calibrate the model system. First, a scatter plot was developed for the 24-hour period and each of the 5 time periods. These plots helped identify outliers

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[7] Mitradjieva, M., & Lindberg, P. O. (2012). The Stiff Is Moving--Conjugate Direction Frank-Wolfe Methods with Applications to Traffic Assignment. *Transportation Science*, 47(2), 280–293. doi:10.1287/trsc.1120.0409

(locations where the observed flows and modeled flows were significantly different). The points were also color-coded by facility type to isolate any systematic deviation of the modeled volumes by facility type. The initial rounds of assignment revealed some outliers. These were primarily network coding issues such as turning movement restrictions. Second, several summary statistics were developed. These included absolute difference in volumes, percentage difference in volumes and percent root mean square error (RMSE). Summaries were prepared by:

1. Time-of-day
2. Link volume groups
3. District, facility types and time-of-day

At this stage, it was noticed from the time-of-day summaries that the midday volumes were considerably lower than the observed volumes. The AM Peak volumes were also slightly high compared to observed. The inconsistencies in the time-of-day distribution could only be attributed to the commercial vehicle model as both the residential and the visitor model segments are based on observed time-of-day distributions. Further, the Oahu truck model used commercial vehicle rates and time-of-day factors from the San Francisco Bay Area Metropolitan Transportation Commission (MTC) model, which may not accurately reflect the actual commercial vehicle trip rates and the time-of-day behavior of commercial vehicles on Oahu.

The district by facility type summaries showed that limited access facility types were overestimated which suggested that truck trips were traveling too far and therefore too many trips were assigned to freeways/expressways instead of locals/arterials. Additionally, overestimates on certain key screenlines (1 and 4 in particular) indicated that there were too many trips attracted to downtown Honolulu. The reasons for this could be twofold: (a) the commercial vehicle productions rates are solely based on employment. In such a framework, the downtown district – being the central business district – invariably attracts a lot of these trips owing to presence of higher employment numbers. Another artifact of using this specification is that the residential zones do not attract any commercial vehicle trips, when in fact they do should attract commercial vehicle trips (for example, FedEx/UPS deliveries, plumbers, cable and electricians, etc.). Such vehicles are of the non-garage two axle (NG2) vehicle class. (b) The total employment in district 1 (which includes downtown Honolulu) is higher than the number of expanded workers in district 1 by about 30,000.[8] However, the household survey under-estimates the number of transit trips on Oahu, so we would expect the survey to under-estimate workers to downtown Honolulu somewhat.

In light of these observations, three modifications were incorporated into the commercial vehicle model. First, a production rate based on housing units was added to the trip generation model – this accounts for the residential based commercial vehicle trips. Second, the trip production rates were increased for the military employment, construction employment, and industrial employment to better match the observed VMT. Third, in the course of model calibration, the truck time-of-day factors for NG2 class were adjusted to follow the observed TOD trend. Though these modifications fixed the issue, a commercial vehicle model based upon observed data for Oahu would help better reflect the true behavior of commercial vehicle traffic. Also, we recommend that Census 2005-2009

[8] A destination district based constant was later added to partially mitigate this difference – the net difference was approximately 15,000 after the final round of model calibration. See the discussion below on district based constants for more details.

journey-to-work summaries be used to compare to the employment data estimates when such data becomes available.[9]

Screenline summaries were analyzed to compare the predicted volumes and observed volumes. Screenline summaries are used to analyze flows across geographic subareas and major corridors. This helps explain the differences in observed flows versus estimated flows. For example, the difference could be a distributional problem (where too many/ too less trips are being attracted to certain geographic pockets) or an assignment problem (where not enough traffic is being assigned to certain parallel corridors). The district level summaries and the screenline summaries indicated that there were too many intra-district trips in four districts, Kalihi-Manoa-Kahala, Windward Oahu, Central-Pearl City-Aiea and Moanalua-Hālawa-Airport-Pearl Harbor. Hence, intra-district constants were introduced in the destination choice model for these districts. As noted above, the downtown district (Chinatown-Downtown-Ala Moana) was also attracting too many trips, so a district based constant was introduced in the destination choice model. Note that this attraction constant will only work with shadow pricing turned off as the destination choice for work tours would otherwise be doubly constrained to match the employment in each TAZ.

Once the distributional differences were accounted for, summaries for screenline 9 (Kamehameha Highway and H-2) and screenline 10 (Pali Highway, Likelike Highway and H-3) showed too many vehicles being assigned to the expressways (Kamehameha, Pali, Likelike). Retail land use developments along the Kamehameha corridor in Waipio and Mililani have level of service that is more similar to a Class I arterial. Also, the Makai end of Pali and Likelike highways near Downtown have level of services similar to a Class I arterial. Based on this evaluation Kamehameha Highway in Waipio and Mililani and portions of Pali and Likelike highways were converted to Class I arterials.

The calibration approach discussed above was an iterative process involving multiple rounds of adjusting the network, destination choice model and the commercial vehicle model.

Validation Results

Table 206 summarizes the final traffic assignment results by the different time periods. Overall, the model closely predicts the observed traffic volumes (difference 7%). Both the AM and the PM Peak volumes are within 5%. The mid-day and the evening volumes are off by about 10% while the Early AM volume is predicted within 2% difference.

A comparison of the observed and the predicted traffic volumes for different volume groups is presented in Table 207. The RMSE is an indicator of the proximity of predicted and observed traffic volumes. A lower RMSE value indicates that the model is performing better.[10] First, it is observed that as the volume group increases the RMSE value decreases (this is a desirable result as higher error in larger volume groups indicates an error of larger magnitudes). The high RMSE value of 148% for the lowest volume group could be attributed to the coarse resolution for TAZs and local streets – a more disaggregate TAZ system would result in better loading to local streets and

[9] Please note that the Census work location data was not available at the time of the preparation of this document.

[10] The RMSE is a scale-dependent measure of forecast accuracy. It should only be used to compare forecasting errors for a particular segment and not across segments. For example, it is not valid to compare the RMSEs of two volume groups – say A and B – and conclude that the model is performing better for the volume group A owing to its lower RMSE.

substantially improve these results. Second, the model seems to be over predicting traffic on higher volume facilities while under-predicting traffic on the lower volume facilities. This may also be correlated with the problem of spatial aggregation.

Next, Table 208 presents the summary statistics developed by time-of-day for the each facility-type and district combination. Summaries include difference in observed and predicted counts, percentage difference, percentage RMSE and number of non-zero observed data points. Caution should be exercised when using the RMSEs to measure model performance for facility type by district segments as there were not enough count data points in each category to effectively capture residual variance.

Several important observations on model performance can be made from these tables. First, the model is performing well in capturing flows at the district level. This was evident as the percentage differences for 24-hour-period were all within 15% (within 10% for 7 of the 9 districts). The time-of-day assignment results are also reasonably good at the district level. Second, the model is performing extremely well for freeways with traffic prediction within 5% of the observed for 24-hour totals. The time-of-day distribution of traffic is also well captured with the percentage differences begin 11%, 2%, 3%, 17% and 1% for Early AM, AM Peak, Mid-day, PM Peak and Evening respectively. This shows that the model is predicting traffic behavior on H1, H2 and H3 exceptionally well. The same can be said of Class I and Class II arterials. Third, the model is loading more traffic on the expressways and less traffic on the lower speed facilities (Class III arterial and local streets). The problem could be because the route choice algorithm is choosing a faster facility based on its generalized cost – whereas, in reality, there might be certain aspects of the route (such as hilly terrain and queue spillbacks near ramps) that are not factored into the generalized cost for the link. It could also be that some of the links might need to be downgraded to a Class I arterial as the level of service offered might not be equal to that of an expressway. These disparities could be scrutinized further and adjustments could be made to the generalized cost of the link/ facility type as necessary. Additionally, a dynamic traffic assignment model should be considered as it can capture queue spillbacks. Figure 70 through Figure 75 shows the scatterplots of modeled traffic volumes versus the observed traffic volumes by time of day. These scatter plots supports the model performance results discussed earlier – as there is no systematic pattern of deviation from the 45-degree line which shows that the model is estimating volumes on the links well.

Finally,Table 209 shows the screenline comparison between modeled flows and observed counts. Figure 76 shows a map of the screenline locations. Overall, the model is performing very well with respect to screenlines. Of the 22 screenlines, the model predicts within 15% for 14 and within 25% for 18 screenlines. There seems to be a large difference (>25%) in counts for screenlines 8 and 9. However, for these screenlines the traffic count data for some of the links were sourced from count locations at a considerable distance from the screenline location, and hence is not a very reliable indicator of actual volumes. The highest percentage differences are for the lower volume screenlines. For screenlines 12 and 15 – even though the percentage difference seems to be on the higher side – the magnitude of the difference is trivial.

Screenlines 1 and 4 were used to evaluate traffic flow in and across the Chinatown-Downtown-Ala Moana district. From these screenlines we can see that the model is consistently over predicting traffic on H1 west of downtown. As discussed earlier, the higher employment in district 1 could be partially contributing to this issue. This would naturally translate into work tours (both inbound and outbound) which could be playing a part in traffic being over predicted. We investigated the observed data on these screenlines further to spot any existing trends that the model is unable to capture. The eastbound and the westbound flow for each link in screenline 4 and 5 is presented in Table 210. Figure 77 shows the map locations of these counts and links in Oahu. We can clearly see from the diurnal traffic data for these links that the east-bound traffic is on average about 20,000 lower than the west-bound traffic. The higher west-bound traffic on facilities such as H1, Nimitz Highway and King St. is only marginally accounted for in the east-bound direction in facilities such as Vineyard Blvd., Hotel St., and School St. It is not clear why this level of asymmetry exists in the counts; the only plausible explanation is that a significant number of travelers make loop trips around Oahu and therefore only pass these screenlines in one direction in a 24-hour period. However, it is more likely that there is some error in the traffic counts. The tour-based model does not replicate this asymmetry, resulting in an over-estimate of traffic at these screenlines. Due to uncertainty regarding the employment estimates and the traffic counts, no further adjustments beyond those made as part of this effort are recommended at this time.

Table 206: Percentage RMSE by Time of Day

	EARLY AM	AM	MID-DAY	PM	EVENING	DAILY
Observed	964,756	3,924,299	7,289,563	5,862,952	3,392,167	21,433,738
Predicted	987,263	3,753,719	6,587,729	5,588,720	3,005,830	19,923,260
Difference	22,507	-170,581	-701,834	-274,231	-386,338	-1,510,477
% Difference	2%	-4%	-10%	-5%	-11%	-7%
Number of counts	1066	1066	1066	1066	1066	1066
%RMSE	102%	60%	53%	51%	68%	49%

Table 207: Percentage RMSE by Volume Groups

Vol. Low (≥)	0	5000	10000	20,000	30,000	40,000	60,000	100,000	Total
Vol. High (<)	5000	10000	20,000	30,000	40,000	60,000	100,000	9,999,999	
Observed	432,213	1,686,734	4,165,746	4,100,060	3,441,433	3,678,265	2,911,676	1,017,610	21,433,738
Predicted	630,395	1,875,617	3,241,290	3,449,593	2,476,424	3,482,215	3,544,704	1,223,023	19,923,260
Difference	198,182	188,883	-924,457	-650,468	-965,009	-196,050	633,028	205,414	-1,510,477
% Difference	46%	11%	-22%	-16%	-28%	-5%	22%	20%	-7%
Number of counts	156	224	291	167	101	77	41	9	1066
%RMSE	144%	58%	54%	46%	44%	33%	25%	18%	49%

Table 208: Highway counts by Period, District and Facility Type

Volume

24 Hour Period

District		*Access Restricted*		*Arterials*			*Collectors*			*Ramps*		
		Freeways	**Express ways**	**Class I**	**Class II**	**Class III**	**Class I**	**Class II**	**Local Streets**	**High Speed**	**Low Speed**	**Total**
		1	2	3	4	5	6	7	8	9	10	
Chinatown-Downtown-Ala Moana	Observed	885,416	0	1,531,945	1,642,563	713,567	258,695	241,240	8,418	113,523	129,313	**5,524,677**
	Predicted	1,110,868	0	1,291,332	1,603,066	593,626	229,470	194,610	2,457	104,990	105,547	**5,235,965**
Kalihi-Manoa-Kahala	Observed	456,006	70,574	595,529	440,725	292,305	506,757	859,640	15,278	84,265	294,376	**3,615,453**
	Predicted	458,332	114,051	745,429	264,813	172,444	327,985	662,546	10,494	117,356	193,403	**3,066,855**
Ainokoa-East Honolulu	Observed	0	212,004	270,961	31,101	115,667	39,538	42,501	35,774	0	0	**747,543**
	Predicted	0	246,979	240,492	17,677	83,870	10,160	43,681	15,578	0	0	**658,437**
Windward Oahu	Observed	100,049	183,671	569,886	377,066	133,465	198,600	233,400	30,909	41,875	22,443	**1,891,361**
	Predicted	89,681	233,196	592,174	355,951	94,733	132,765	148,841	17,495	46,221	20,191	**1,731,247**
North Shore-Haleiwa-Wahiawa	Observed	15,109	0	169,945	148,435	138,882	50,161	96,413	1,268	0	0	**620,212**
	Predicted	20,645	0	204,028	178,836	181,187	48,884	65,018	1,838	0	0	**700,437**
Waianae-Makakilo	Observed	60,528	92,960	272,383	10,982	50,507	1,391	48,594	0	9,770	54,134	**601,247**
	Predicted	73,423	117,628	288,308	5,163	56,076	1,005	43,398	0	8,704	33,297	**627,003**
Kapolei-Ewa-Waipahu	Observed	393,775	52,807	1,018,552	180,146	131,243	109,862	139,527	0	205,400	165,581	**2,396,892**
	Predicted	402,928	63,087	1,124,478	196,954	114,078	106,792	97,769	0	201,527	105,587	**2,413,199**
Central-Pearl City-Aiea	Observed	1,499,859	0	579,012	83,528	780,731	166,644	167,147	29,329	257,463	228,947	**3,792,657**
	Predicted	1,368,218	0	876,378	32,425	585,036	115,626	132,402	35,067	184,644	133,340	**3,463,136**
Moanalua-Hālawa-Airport-Pearl Harbor	Observed	622,067	74,283	366,151	115,559	235,430	181,941	59,813	31,998	244,138	312,317	**2,243,696**
	Predicted	692,805	110,600	365,933	67,632	183,725	145,777	57,807	26,299	215,124	161,280	**2,026,982**
Total	**Observed**	**4,032,808**	**686,297**	**5,374,362**	**3,030,103**	**2,591,794**	**1,513,587**	**1,888,272**	**152,972**	**956,433**	**1,207,110**	**21,433,738**
	Predicted	**4,216,901**	**885,541**	**5,728,552**	**2,722,518**	**2,064,775**	**1,118,464**	**1,446,072**	**109,227**	**878,567**	**752,645**	**19,923,260**

Difference in Volume (Modeled minus Observed)

24 Hour Period

District		*Access Restricted*		*Arterials*			*Collectors*			*Ramps*		
		Freeways	**Express ways**	**Class I**	**Class II**	**Class III**	**Class I**	**Class II**	**Local Streets**	**High Speed**	**Low Speed**	**Total**
		1	2	3	4	5	6	7	8	9	10	
Chinatown-Downtown-Ala Moana	Diff	225,453	0	-240,613	-39,498	-119,941	-29,225	-46,629	-5,960	-8,533	-23,766	-288,713
	% Diff	25%		-16%	-2%	-17%	-11%	-19%	-71%	-8%	-18%	**-5%**
Kalihi-Manoa-Kahala	Diff	2,326	43,477	149,900	-175,912	-119,860	-178,772	-197,094	-4,784	33,092	-100,972	-548,598
	% Diff	1%	62%	25%	-40%	-41%	-35%	-23%	-31%	39%	-34%	**-15%**
Ainokoa-East Honolulu	Diff	0	34,976	-30,468	-13,424	-31,797	-29,377	1,180	-20,196	0	0	-89,106
	% Diff		16%	-11%	-43%	-27%	-74%	3%	-56%			**-12%**
Windward Oahu	Diff	-10,368	49,525	22,288	-21,114	-38,732	-65,834	-84,559	-13,413	4,346	-2,251	-160,114
	% Diff	-10%	27%	4%	-6%	-29%	-33%	-36%	-43%	10%	-10%	**-8%**
North Shore-Haleiwa-Wahiawa	Diff	5,536	0	34,083	30,402	42,306	-1,277	-31,394	570	0	0	**80,225**
	% Diff	37%		20%	20%	30%	-3%	-33%	45%			**13%**
Waianae-Makakilo	Diff	12,894	24,668	15,925	-5,819	5,570	-386	-5,195	0	-1,065	-20,837	**25,756**
	% Diff	21%	27%	6%	-53%	11%	-28%	-11%		-11%	-38%	**4%**
Kapolei-Ewa-Waipahu	Diff	9,153	10,280	105,926	16,808	-17,165	-3,070	-41,758	0	-3,873	-59,994	**16,307**
	% Diff	2%	19%	10%	9%	-13%	-3%	-30%		-2%	-36%	**1%**
Central-Pearl City-Aiea	Diff	-131,640	0	297,367	-51,102	-195,694	-51,017	-34,745	5,738	-72,819	-95,607	-329,521
	% Diff	-9%		51%	-61%	-25%	-31%	-21%	20%	-28%	-42%	**-9%**
Moanalua-Hālawa-Airport-Pearl Harbor	Diff	70,738	36,317	-218	-47,926	-51,705	-36,164	-2,005	-5,699	-29,014	-151,037	-216,713
	% Diff	11%	49%	0%	-41%	-22%	-20%	-3%	-18%	-12%	-48%	**-10%**
Total	**Diff**	**184,093**	**199,244**	**354,190**	-307,586	-527,019	-395,123	-442,200	-43,745	-77,865	-454,465	-1,510,477
	% Diff	**5%**	**29%**	**7%**	**-10%**	**-20%**	**-26%**	**-23%**	**-29%**	**-8%**	**-38%**	**-7%**

% RMSE by District and Facility Type

24 Hour Period

District		*Access Restricted* Freeways	Express ways	*Arterials* Class I	Class II	Class III	*Collectors* Class I	Class II	Local Streets	*Ramps* High Speed	Low Speed	Total
		1	2	3	4	5	6	7	8	9	10	
Chinatown-Downtown-Ala Moana	%RMSE	30%	-	39%	42%	57%	62%	59%	-	26%	48%	**45%**
	N	11	0	43	62	30	25	24	1	6	10	**212**
Kalihi-Manoa-Kahala	%RMSE	9%	79%	49%	55%	60%	55%	65%	82%	75%	59%	**57%**
	N	7	3	15	15	14	30	100	3	9	28	**224**
Ainokoa-East Honolulu	%RMSE	-	22%	17%	53%	41%	137%	68%	76%	-	-	**38%**
	N	0	3	6	3	6	2	14	3	0	0	**37**
Windward Oahu	%RMSE	43%	33%	24%	35%	33%	50%	78%	54%	60%	52%	**41%**
	N	8	4	19	21	10	14	42	4	7	6	**135**
North Shore-Haleiwa-Wahiawa	%RMSE	-	-	48%	45%	47%	41%	62%	-	-	-	**53%**
	N	1	0	9	14	5	7	18	1	0	0	**55**
Waianae-Makakilo	%RMSE	41%	37%	49%	-	18%	-	54%	-	-	82%	**50%**
	N	2	4	11	1	2	1	12	0	1	4	**38**
Kapolei-Ewa-Waipahu	%RMSE	18%	28%	48%	59%	45%	55%	53%	-	29%	49%	**48%**
	N	8	2	26	11	7	9	17	0	10	19	**109**
Central-Pearl City-Aiea	%RMSE	25%	-	63%	82%	42%	38%	69%	72%	44%	61%	**45%**
	N	25	0	17	3	29	13	21	4	12	22	**146**
Moanalua-Hālawa-Airport-Pearl Harbor	%RMSE	26%	70%	65%	67%	44%	51%	65%	61%	55%	80%	**52%**
	N	13	2	16	5	10	13	8	3	16	24	**110**
Total	**%RMSE**	**25%**	**34%**	**45%**	**47%**	**48%**	**56%**	**66%**	**63%**	**45%**	**65%**	**49%**
	N	**75.00**	**18.00**	**162.00**	**135.00**	**113.00**	**114.00**	**256.00**	**19.00**	**61.00**	**113.00**	**1066.00**

Volume

Early AM Time Period 3:00AM – 5:59AM

District		*Access Restricted*		*Arterials*			*Collectors*			*Ramps*		
		Freeways	Express ways	Class I	Class II	Class III	Class I	Class II	Local Streets	High Speed	Low Speed	Total
		1	2	3	4	5	6	7	8	9	10	
Chinatown-Downtown-Ala Moana	Observed	48,230	0	44,143	48,117	23,463	6,426	5,326	498	5,067	5,358	**186,626**
	Predicted	82,582	0	23,667	59,277	30,942	7,807	9,601	84	6,730	8,985	**229,676**
Kalihi-Manoa-Kahala	Observed	17,008	4,065	23,245	16,331	6,651	14,202	21,221	546	3,196	10,195	**116,658**
	Predicted	25,310	6,750	39,837	9,057	6,045	12,743	28,355	425	5,878	15,143	**149,542**
Ainokoa-East Honolulu	Observed	0	6,725	8,829	623	3,046	909	1,152	941	0	0	**22,224**
	Predicted	0	12,017	11,255	589	4,000	480	2,021	706	0	0	**31,067**
Windward Oahu	Observed	5,542	8,976	27,261	12,945	2,720	5,340	6,507	1,092	2,799	1,239	**74,419**
	Predicted	3,811	13,353	31,145	17,262	3,025	5,725	6,728	813	2,417	1,066	**85,344**
North Shore-Haleiwa-Wahiawa	Observed	514	0	9,628	9,453	8,222	2,073	3,141	37	0	0	**33,068**
	Predicted	867	0	8,630	8,009	9,383	2,311	2,885	90	0	0	**32,175**
Waianae-Makakilo	Observed	2,587	8,004	16,897	502	3,352	31	2,308	0	347	1,868	**35,895**
	Predicted	3,072	4,976	14,744	14	2,540	33	2,183	0	526	1,229	**29,316**
Kapolei-Ewa-Waipahu	Observed	31,223	4,438	67,527	9,637	5,970	5,575	7,586	0	17,715	8,248	**157,918**
	Predicted	27,307	4,919	61,453	6,261	4,566	4,263	3,562	0	17,198	4,617	**134,146**
Central-Pearl City-Aiea	Observed	106,042	0	28,854	2,605	29,325	7,048	6,579	1,445	16,262	14,520	**212,677**
	Predicted	82,819	0	49,641	1,071	24,810	6,314	6,141	1,627	8,225	6,221	**186,868**
Moanalua-Hālawa-Airport-Pearl Harbor	Observed	34,449	3,314	17,383	6,096	12,797	6,754	2,680	1,408	18,816	21,578	**125,273**
	Predicted	47,531	6,178	11,614	2,394	6,908	6,026	2,233	1,406	15,584	9,254	**109,127**
Total	**Observed**	**245,595**	**35,521**	**243,765**	**106,309**	**95,544**	**48,357**	**56,498**	**5,965**	**64,200**	**63,003**	964,756
	Predicted	**273,299**	**48,193**	**251,985**	**103,935**	**92,219**	**45,702**	**63,709**	**5,151**	**56,558**	**46,514**	987,263

Difference in Volume (Modeled minus Observed)

Early AM Time Period 3:00AM – 5:59AM

District		*Access Restricted* Freeways	Express ways	*Arterials* Class I	Class II	Class III	*Collectors* Class I	Class II	Local Streets	*Ramps* High Speed	Low Speed	Total
		1	2	3	4	5	6	7	8	9	10	
Chinatown-Downtown-Ala Moana	Diff	34,352	0	-20,476	11,160	7,480	1,381	4,276	-414	1,664	3,628	**43,050**
	% Diff	71%		-46%	23%	32%	21%	80%	-83%	33%	68%	**23%**
Kalihi-Manoa-Kahala	Diff	8,302	2,686	16,592	-7,274	-606	-1,459	7,135	-121	2,682	4,948	**32,885**
	% Diff	49%	66%	71%	-45%	-9%	-10%	34%	-22%	84%	49%	**28%**
Ainokoa-East Honolulu	Diff	0	5,292	2,426	-34	954	-429	869	-234	0	0	**8,843**
	% Diff		79%	27%	-5%	31%	-47%	75%	-25%			**40%**
Windward Oahu	Diff	-1,732	4,377	3,884	4,317	306	385	222	-279	-382	-173	**10,926**
	% Diff	-31%	49%	14%	33%	11%	7%	3%	-26%	-14%	-14%	**15%**
North Shore-Haleiwa-Wahiawa	Diff	353	0	-998	-1,445	1,161	239	-256	53	0	0	**-893**
	% Diff	69%		-10%	-15%	14%	12%	-8%	144%			**-3%**
Waianae-Makakilo	Diff	485	-3,028	-2,154	-488	-811	2	-125	0	179	-639	**-6,579**
	% Diff	19%	-38%	-13%	-97%	-24%	6%	-5%		52%	-34%	**-18%**
Kapolei-Ewa-Waipahu	Diff	-3,916	481	-6,074	-3,376	-1,404	-1,312	-4,024	0	-517	-3,631	**-23,771**
	% Diff	-13%	11%	-9%	-35%	-24%	-24%	-53%		-3%	-44%	**-15%**
Central-Pearl City-Aiea	Diff	-23,223	0	20,787	-1,534	-4,515	-734	-438	182	-8,037	-8,299	**-25,809**
	% Diff	-22%		72%	-59%	-15%	-10%	-7%	13%	-49%	-57%	**-12%**
Moanalua-Hālawa-Airport-Pearl Harbor	Diff	13,082	2,865	-5,769	-3,702	-5,889	-728	-447	-2	-3,232	-12,323	**-16,145**
	% Diff	38%	86%	-33%	-61%	-46%	-11%	-17%	0%	-17%	-57%	**-13%**
Total	**Diff**	**27,703**	**12,672**	**8,220**	**-2,374**	**-3,325**	**-2,655**	**7,211**	**-814**	**-7,642**	**-16,490**	**22,507**
	% Diff	**11%**	**36%**	**3%**	**-2%**	**-3%**	**-5%**	**13%**	**-14%**	**-12%**	**-26%**	**2%**

% RMSE by District and Facility Type

Early AM Time Period 3:00AM – 5:59AM

District		*Access Restricted*		*Arterials*			*Collectors*			*Ramps*		
		Freeways	**Express ways**	**Class I**	**Class II**	**Class III**	**Class I**	**Class II**	**Local Streets**	**High Speed**	**Low Speed**	**Total**
		1	2	3	4	5	6	7	8	9	10	
Chinatown-Downtown-Ala Moana	%RMSE	96%	-	85%	92%	83%	134%	252%	-	89%	132%	**129%**
	N	11	0	43	62	30	25	24	1	6	10	**212**
Kalihi-Manoa-Kahala	%RMSE	62%	92%	92%	98%	66%	58%	111%	80%	123%	101%	**111%**
	N	7	3	15	15	14	30	100	3	9	28	**224**
Ainokoa-East Honolulu	%RMSE	-	100%	41%	38%	89%	165%	140%	58%	-	-	**103%**
	N	0	3	6	3	6	2	14	3	0	0	**37**
Windward Oahu	%RMSE	62%	60%	27%	55%	47%	61%	90%	39%	100%	75%	**59%**
	N	8	4	19	21	10	14	42	4	7	6	**135**
North Shore-Haleiwa-Wahiawa	%RMSE	-	-	52%	60%	25%	62%	73%	-	-	-	**55%**
	N	1	0	9	14	5	7	18	1	0	0	**55**
Waianae-Makakilo	%RMSE	34%	76%	64%	-	38%	-	66%	-	-	110%	**75%**
	N	2	4	11	1	2	1	12	0	1	4	**38**
Kapolei-Ewa-Waipahu	%RMSE	34%	86%	69%	84%	50%	50%	70%	-	52%	75%	**71%**
	N	8	2	26	11	7	9	17	0	10	19	**109**
Central-Pearl City-Aiea	%RMSE	44%	-	122%	80%	55%	87%	77%	76%	94%	99%	**79%**
	N	25	0	17	3	29	13	21	4	12	22	**146**
Moanalua-Hālawa-Airport-Pearl Harbor	%RMSE	120%	124%	85%	73%	109%	71%	92%	127%	83%	124%	**121%**
	N	13	2	16	5	10	13	8	3	16	24	**110**
Total	**%RMSE**	**72%**	**71%**	**81%**	**86%**	**73%**	**76%**	**119%**	**84%**	**83%**	**118%**	**102%**
	N	**75.00**	**18.00**	**162.00**	**135.00**	**113.00**	**114.00**	**256.00**	**19.00**	**61.00**	**113.00**	**1066.00**

Volume

AM Peak Period 6:00AM – 8:59AM

District		*Access Restricted*		*Arterials*			*Collectors*			*Ramps*		
		Freeways	Express ways	Class I	Class II	Class III	Class I	Class II	Local Streets	High Speed	Low Speed	Total
		1	2	3	4	5	6	7	8	9	10	
Chinatown-Downtown-Ala Moana	Observed	160,693	0	275,014	287,603	108,027	40,142	33,239	1,546	22,558	22,280	**951,100**
	Predicted	182,530	0	262,789	285,682	88,847	35,606	25,724	503	14,626	15,816	**912,122**
Kalihi-Manoa-Kahala	Observed	81,463	13,669	121,438	80,259	58,177	90,189	161,552	2,771	17,429	59,377	**686,323**
	Predicted	81,550	22,449	136,523	45,899	35,709	59,893	124,690	2,266	17,941	33,992	**560,911**
Ainokoa-East Honolulu	Observed	0	40,157	47,318	4,518	19,682	7,148	9,235	6,628	0	0	**134,684**
	Predicted	0	47,680	48,026	4,516	15,438	1,978	8,464	3,076	0	0	**129,177**
Windward Oahu	Observed	22,463	37,039	110,805	65,867	23,510	33,992	41,790	5,376	8,784	5,141	**354,765**
	Predicted	14,549	46,467	119,031	70,260	17,416	25,260	31,424	3,607	8,828	3,445	**340,288**
North Shore-Haleiwa-Wahiawa	Observed	1,994	0	29,982	28,570	24,831	9,307	13,716	195	0	0	**108,594**
	Predicted	5,495	0	39,882	36,803	32,319	10,373	13,579	495	0	0	**138,946**
Waianae-Makakilo	Observed	10,365	17,746	45,353	1,951	9,256	132	6,171	0	1,265	7,763	**100,002**
	Predicted	10,653	19,906	63,067	1,333	11,531	184	8,640	0	2,029	4,147	**121,489**
Kapolei-Ewa-Waipahu	Observed	69,586	10,328	186,054	33,266	22,325	20,147	25,629	0	43,481	28,493	**439,308**
	Predicted	88,375	17,846	222,099	44,405	20,196	22,582	23,592	0	34,562	16,659	**490,316**
Central-Pearl City-Aiea	Observed	307,076	0	100,176	15,757	133,245	31,858	30,642	6,262	56,006	43,774	**724,795**
	Predicted	282,201	0	158,616	6,323	131,491	22,973	27,992	6,769	35,241	25,542	**697,148**
Moanalua-Hālawa-Airport-Pearl Harbor	Observed	117,372	15,491	68,251	22,858	43,976	35,325	12,049	6,518	49,668	53,220	**424,729**
	Predicted	122,610	21,324	59,976	15,722	38,754	25,491	8,670	5,420	39,959	25,398	**363,322**
Total	**Observed**	**771,013**	**134,430**	**984,390**	**540,648**	**443,027**	**268,239**	**334,022**	**29,294**	**199,189**	**220,047**	**3,924,299**
	Predicted	**787,961**	**175,672**	**1,110,008**	**510,944**	**391,700**	**204,339**	**272,775**	**22,137**	**153,185**	**124,998**	**3,753,719**

Difference in Volume (Modeled minus Observed)

AM Peak Period 6:00AM – 8:59AM

District		*Access Restricted*		*Arterials*			*Collectors*		Local Streets	*Ramps*		Total
		Freeways	Express ways	Class I	Class II	Class III	Class I	Class II		High Speed	Low Speed	
		1	2	3	4	5	6	7	8	9	10	
Chinatown-Downtown-Ala Moana	Diff	21,837	0	-12,226	-1,921	-19,180	-4,536	-7,515	-1,042	-7,932	-6,464	-38,978
	% Diff	14%		-4%	-1%	-18%	-11%	-23%	-67%	-35%	-29%	**-4%**
Kalihi-Manoa-Kahala	Diff	86	8,780	15,086	-34,361	-22,468	-30,296	-36,861	-505	512	-25,385	-125,412
	% Diff	0%	64%	12%	-43%	-39%	-34%	-23%	-18%	3%	-43%	**-18%**
Ainokoa-East Honolulu	Diff	0	7,523	708	-2	-4,244	-5,169	-771	-3,551	0	0	-5,507
	% Diff		19%	1%	0%	-22%	-72%	-8%	-54%			**-4%**
Windward Oahu	Diff	-7,914	9,428	8,225	4,394	-6,093	-8,731	-10,365	-1,768	45	-1,696	-14,477
	% Diff	-35%	25%	7%	7%	-26%	-26%	-25%	-33%	1%	-33%	**-4%**
North Shore-Haleiwa-Wahiawa	Diff	3,501	0	9,901	8,233	7,488	1,066	-138	301	0	0	**30,351**
	% Diff	176%		33%	29%	30%	11%	-1%	155%			**28%**
Waianae-Makakilo	Diff	287	2,160	17,714	-618	2,276	52	2,469	0	764	-3,616	**21,487**
	% Diff	3%	12%	39%	-32%	25%	39%	40%		60%	-47%	**21%**
Kapolei-Ewa-Waipahu	Diff	18,789	7,518	36,045	11,139	-2,129	2,435	-2,037	0	-8,918	-11,834	**51,008**
	% Diff	27%	73%	19%	33%	-10%	12%	-8%		-21%	-42%	**12%**
Central-Pearl City-Aiea	Diff	-24,875	0	58,440	-9,433	-1,754	-8,885	-2,650	507	-20,765	-18,232	-27,647
	% Diff	-8%		58%	-60%	-1%	-28%	-9%	8%	-37%	-42%	**-4%**
Moanalua-Hālawa-Airport-Pearl Harbor	Diff	5,237	5,833	-8,275	-7,136	-5,222	-9,834	-3,379	-1,098	-9,709	-27,822	-61,407
	% Diff	4%	38%	-12%	-31%	-12%	-28%	-28%	-17%	-20%	-52%	**-14%**
Total	**Diff**	**16,948**	**41,242**	**125,618**	-29,705	-51,327	-63,899	-61,248	-7,157	-46,004	-95,049	-170,581
	% Diff	**2%**	**31%**	**13%**	**-5%**	**-12%**	**-24%**	**-18%**	**-24%**	**-23%**	**-43%**	**-4%**

% RMSE by District and Facility Type

AM Peak Period 6:00AM – 8:59AM

District		*Access Restricted*		*Arterials*			*Collectors*			*Ramps*		
		Freeways	Express ways	Class I	Class II	Class III	Class I	Class II	Local Streets	High Speed	Low Speed	Total
		1	2	3	4	5	6	7	8	9	10	
Chinatown-Downtown-Ala Moana	%RMSE	27%	-	44%	48%	59%	68%	53%	-	57%	59%	**49%**
	N	11	0	43	62	30	25	24	1	6	10	**212**
Kalihi-Manoa-Kahala	%RMSE	10%	90%	40%	71%	66%	53%	69%	78%	20%	81%	**60%**
	N	7	3	15	15	14	30	100	3	9	28	**224**
Ainokoa-East Honolulu	%RMSE	-	23%	7%	7%	30%	133%	68%	75%	-	-	**34%**
	N	0	3	6	3	6	2	14	3	0	0	**37**
Windward Oahu	%RMSE	55%	31%	22%	49%	31%	41%	70%	41%	76%	64%	**42%**
	N	8	4	19	21	10	14	42	4	7	6	**135**
North Shore-Haleiwa-Wahiawa	%RMSE	-	-	65%	49%	52%	41%	61%	-	-	-	**67%**
	N	1	0	9	14	5	7	18	1	0	0	**55**
Waianae-Makakilo	%RMSE	38%	55%	74%	-	37%	-	105%	-	-	84%	**71%**
	N	2	4	11	1	2	1	12	0	1	4	**38**
Kapolei-Ewa-Waipahu	%RMSE	61%	111%	56%	78%	45%	77%	57%	-	51%	55%	**67%**
	N	8	2	26	11	7	9	17	0	10	19	**109**
Central-Pearl City-Aiea	%RMSE	50%	-	67%	82%	41%	45%	60%	88%	64%	73%	**64%**
	N	25	0	17	3	29	13	21	4	12	22	**146**
Moanalua-Hālawa-Airport-Pearl Harbor	%RMSE	44%	55%	64%	77%	62%	52%	95%	35%	85%	80%	**63%**
	N	13	2	16	5	10	13	8	3	16	24	**110**
Total	**%RMSE**	**44%**	**39%**	**49%**	**57%**	**51%**	**57%**	**69%**	**60%**	**66%**	**74%**	**60%**
	N	**75.00**	**18.00**	**162.00**	**135.00**	**113.00**	**114.00**	**256.00**	**19.00**	**61.00**	**113.00**	**1066.00**

Volume

Midday Time Period 9:00AM – 2:59PM

District		Access Restricted		Arterials			Collectors			Ramps		Total
		Freeways	Express ways	Class I	Class II	Class III	Class I	Class II	Local Streets	High Speed	Low Speed	
		1	2	3	4	5	6	7	8	9	10	
Chinatown-Downtown-Ala Moana	Observed	312,074	0	553,776	589,055	262,172	94,470	90,426	3,676	37,079	44,330	**1,987,057**
	Predicted	361,737	0	431,380	572,890	218,233	82,348	68,178	778	33,334	34,356	**1,803,234**
Kalihi-Manoa-Kahala	Observed	154,034	21,618	191,328	148,109	99,195	173,657	282,693	4,871	27,803	100,153	**1,203,459**
	Predicted	150,030	35,144	249,510	93,740	58,980	110,337	224,184	3,540	39,709	62,560	**1,027,734**
Ainokoa-East Honolulu	Observed	0	70,772	96,070	13,822	36,492	13,254	13,657	12,184	0	0	**256,249**
	Predicted	0	81,002	78,471	5,373	28,101	3,444	14,814	5,265	0	0	**216,472**
Windward Oahu	Observed	30,653	59,154	190,383	136,564	49,833	69,395	78,445	10,053	12,912	6,812	**644,201**
	Predicted	34,561	73,207	192,414	115,375	36,020	45,069	47,841	5,785	15,566	6,768	**572,606**
North Shore-Haleiwa-Wahiawa	Observed	5,366	0	61,989	49,396	47,047	17,110	36,891	448	0	0	**218,245**
	Predicted	7,638	0	69,213	59,748	63,681	15,826	21,160	569	0	0	**237,835**
Waianae-Makakilo	Observed	18,504	28,581	85,805	3,457	13,582	568	15,900	0	3,274	16,243	**185,912**
	Predicted	21,412	34,301	87,472	1,491	18,990	356	14,505	0	3,439	10,797	**192,764**
Kapolei-Ewa-Waipahu	Observed	123,298	16,561	320,001	64,123	46,573	35,471	45,230	0	63,167	56,942	**771,365**
	Predicted	115,061	19,389	362,202	64,266	43,858	34,734	28,207	0	63,374	35,267	**766,358**
Central-Pearl City-Aiea	Observed	482,258	0	203,616	30,168	275,594	57,072	54,287	10,639	82,520	78,413	**1,274,566**
	Predicted	394,869	0	289,256	11,327	174,081	36,940	42,779	12,161	62,172	46,057	**1,069,642**
Moanalua-Hālawa-Airport-Pearl Harbor	Observed	208,487	22,760	132,599	38,245	80,571	61,675	23,195	12,604	79,755	88,620	**748,509**
	Predicted	215,917	34,605	144,562	22,078	66,788	55,680	24,086	8,924	70,848	57,599	**701,085**
Total	**Observed**	**1,334,674**	**219,445**	**1,835,566**	**1,072,939**	**911,056**	**522,669**	**640,723**	**54,474**	**306,509**	**391,511**	7,289,563
	Predicted	**1,301,225**	**277,648**	**1,904,479**	**946,288**	**708,731**	**384,734**	**485,755**	**37,022**	**288,442**	**253,405**	6,587,729

Difference in Volume (Modeled minus Observed)

Midday Time Period 9:00AM – 2:59PM

District		*Access Restricted*		*Arterials*			*Collectors*			*Ramps*		
		Freeways	Express ways	Class I	Class II	Class III	Class I	Class II	Local Streets	High Speed	Low Speed	Total
		1	2	3	4	5	6	7	8	9	10	
Chinatown-Downtown-Ala Moana	Diff	49,663	0	-122,396	-16,165	-43,939	-12,122	-22,248	-2,898	-3,745	-9,974	-183,824
	% Diff	16%		-22%	-3%	-17%	-13%	-25%	-79%	-10%	-22%	-9%
Kalihi-Manoa-Kahala	Diff	-4,004	13,526	58,183	-54,369	-40,215	-63,320	-58,510	-1,330	11,906	-37,593	-175,725
	% Diff	-3%	63%	30%	-37%	-41%	-36%	-21%	-27%	43%	-38%	-15%
Ainokoa-East Honolulu	Diff	0	10,230	-17,598	-8,448	-8,390	-9,809	1,158	-6,919	0	0	-39,777
	% Diff		14%	-18%	-61%	-23%	-74%	8%	-57%			-16%
Windward Oahu	Diff	3,908	14,054	2,031	-21,190	-13,813	-24,325	-30,603	-4,268	2,654	-43	-71,595
	% Diff	13%	24%	1%	-16%	-28%	-35%	-39%	-42%	21%	-1%	-11%
North Shore-Haleiwa-Wahiawa	Diff	2,273	0	7,224	10,352	16,635	-1,284	-15,731	121	0	0	19,590
	% Diff	42%		12%	21%	35%	-8%	-43%	27%			9%
Waianae-Makakilo	Diff	2,909	5,720	1,666	-1,966	5,408	-211	-1,395	0	166	-5,445	6,852
	% Diff	16%	20%	2%	-57%	40%	-37%	-9%		5%	-34%	4%
Kapolei-Ewa-Waipahu	Diff	-8,237	2,828	42,201	143	-2,714	-737	-17,023	0	207	-21,675	-5,007
	% Diff	-7%	17%	13%	0%	-6%	-2%	-38%		0%	-38%	-1%
Central-Pearl City-Aiea	Diff	-87,390	0	85,640	-18,841	-101,512	-20,132	-11,508	1,522	-20,348	-32,355	-204,925
	% Diff	-18%		42%	-62%	-37%	-35%	-21%	14%	-25%	-41%	-16%
Moanalua-Hālawa-Airport-Pearl Harbor	Diff	7,430	11,846	11,963	-16,167	-13,783	-5,995	891	-3,680	-8,907	-31,021	-47,423
	% Diff	4%	52%	9%	-42%	-17%	-10%	4%	-29%	-11%	-35%	-6%
Total	**Diff**	**-33,448**	**58,203**	**68,914**	**-126,651**	**-202,324**	**-137,935**	**-154,968**	**-17,452**	**-18,067**	**-138,106**	**-701,834**
	% Diff	**-3%**	**27%**	**4%**	**-12%**	**-22%**	**-26%**	**-24%**	**-32%**	**-6%**	**-35%**	**-10%**

% RMSE by District and Facility Type

Midday Time Period 9:00AM – 2:59PM

District		*Access Restricted*		*Arterials*			*Collectors*			*Ramps*		Total
		Freeways	**Express ways**	**Class I**	**Class II**	**Class III**	**Class I**	**Class II**	**Local Streets**	**High Speed**	**Low Speed**	
		1	2	3	4	5	6	7	8	9	10	
Chinatown-Downtown-Ala Moana	%RMSE	20%	-	44%	44%	65%	63%	59%	-	23%	56%	**47%**
	N	11	0	43	62	30	25	24	1	6	10	**212**
Kalihi-Manoa-Kahala	%RMSE	9%	80%	56%	52%	60%	56%	66%	111%	78%	61%	**59%**
	N	7	3	15	15	14	30	100	3	9	28	**224**
Ainokoa-East Honolulu	%RMSE	-	24%	23%	75%	38%	134%	75%	75%	-	-	**41%**
	N	0	3	6	3	6	2	14	3	0	0	**37**
Windward Oahu	%RMSE	62%	32%	24%	34%	37%	57%	84%	61%	86%	75%	**43%**
	N	8	4	19	21	10	14	42	4	7	6	**135**
North Shore-Haleiwa-Wahiawa	%RMSE	-	-	44%	63%	50%	52%	77%	-	-	-	**58%**
	N	1	0	9	14	5	7	18	1	0	0	**55**
Waianae-Makakilo	%RMSE	43%	30%	46%	-	57%	-	55%	-	-	79%	**49%**
	N	2	4	11	1	2	1	12	0	1	4	**38**
Kapolei-Ewa-Waipahu	%RMSE	24%	25%	53%	57%	51%	57%	65%	-	37%	55%	**53%**
	N	8	2	26	11	7	9	17	0	10	19	**109**
Central-Pearl City-Aiea	%RMSE	35%	-	63%	83%	52%	51%	73%	71%	37%	70%	**54%**
	N	25	0	17	3	29	13	21	4	12	22	**146**
Moanalua-Hālawa-Airport-Pearl Harbor	%RMSE	26%	74%	76%	66%	38%	45%	64%	55%	66%	70%	**54%**
	N	13	2	16	5	10	13	8	3	16	24	**110**
Total	**%RMSE**	**28%**	**34%**	**49%**	**48%**	**54%**	**58%**	**69%**	**65%**	**49%**	**64%**	**53%**
	N	**75.00**	**18.00**	**162.00**	**135.00**	**113.00**	**114.00**	**256.00**	**19.00**	**61.00**	**113.00**	**1066.00**

Volume

PM Peak Period 3:00PM – 6:59PM

District		Access Restricted: Freeways 1	Access Restricted: Express ways 2	Arterials: Class I 3	Arterials: Class II 4	Arterials: Class III 5	Collectors: Class I 6	Collectors: Class II 7	Local Streets 8	Ramps: High Speed 9	Ramps: Low Speed 10	Total
Chinatown-Downtown-Ala Moana	Observed	191,580	0	450,748	452,935	184,858	73,234	69,476	1,871	31,324	33,916	**1,489,939**
	Predicted	262,259	0	465,926	470,221	150,457	66,208	49,110	874	25,404	20,702	**1,511,160**
Kalihi-Manoa-Kahala	Observed	118,690	18,749	166,892	115,915	83,070	142,008	251,672	4,176	22,927	76,833	**1,000,930**
	Predicted	118,810	30,611	203,207	80,123	49,847	100,519	186,040	2,914	33,079	38,878	**844,027**
Ainokoa-East Honolulu	Observed	0	59,868	76,676	9,427	36,807	12,273	11,667	10,601	0	0	**217,316**
	Predicted	0	69,672	68,023	5,688	23,460	2,754	11,973	4,209	0	0	**185,779**
Windward Oahu	Observed	28,631	52,702	162,635	109,817	39,830	60,901	71,811	9,405	12,183	6,507	**554,420**
	Predicted	24,569	64,942	165,344	99,298	26,711	36,769	41,636	4,814	13,257	5,208	**482,548**
North Shore-Haleiwa-Wahiawa	Observed	5,100	0	48,339	43,299	35,892	14,026	28,361	421	0	0	**175,436**
	Predicted	5,084	0	55,858	50,747	48,000	13,502	18,408	473	0	0	**192,072**
Waianae-Makakilo	Observed	17,630	24,414	74,618	3,260	15,287	406	13,880	0	3,247	17,293	**170,033**
	Predicted	24,782	39,000	82,585	2,231	15,270	284	10,886	0	1,181	9,478	**185,697**
Kapolei-Ewa-Waipahu	Observed	102,446	13,567	274,362	47,175	36,876	31,416	38,743	0	50,771	47,189	**642,543**
	Predicted	113,237	13,839	294,609	55,389	29,010	30,686	30,736	0	54,157	27,930	**649,593**
Central-Pearl City-Aiea	Observed	373,517	0	157,577	23,488	222,854	46,337	47,699	7,956	68,568	61,726	**1,009,721**
	Predicted	415,629	0	225,785	9,621	181,968	32,803	35,653	9,384	47,107	38,138	**996,088**
Moanalua-Hālawa-Airport-Pearl Harbor	Observed	148,703	21,224	107,392	32,452	66,169	53,103	15,510	8,317	59,457	90,289	**602,614**
	Predicted	187,494	31,308	100,170	17,277	45,476	38,913	14,570	6,392	60,108	40,049	**541,757**
Total	**Observed**	**986,297**	**190,522**	**1,519,238**	**837,765**	**721,640**	**433,702**	**548,816**	**42,746**	**248,474**	**333,751**	**5,862,952**
	Predicted	**1,151,865**	**249,373**	**1,661,506**	**790,594**	**570,198**	**322,438**	**399,012**	**29,059**	**234,293**	**180,382**	**5,588,720**

Difference in Volume (Modeled minus Observed)

PM Peak Period 3:00PM – 6:59PM

District		*Access Restricted* Freeways	*Access Restricted* Express ways	*Arterials* Class I	*Arterials* Class II	*Arterials* Class III	*Collectors* Class I	*Collectors* Class II	Local Streets	*Ramps* High Speed	*Ramps* Low Speed	Total
		1	2	3	4	5	6	7	8	9	10	
Chinatown-Downtown-Ala Moana	Diff	70,680	0	15,178	17,286	-34,401	-7,026	-20,366	-997	-5,919	-13,214	**21,221**
	% Diff	37%		3%	4%	-19%	-10%	-29%	-53%	-19%	-39%	**1%**
Kalihi-Manoa-Kahala	Diff	120	11,862	36,315	-35,792	-33,223	-41,488	-65,632	-1,262	10,152	-37,955	**-156,903**
	% Diff	0%	63%	22%	-31%	-40%	-29%	-26%	-30%	44%	-49%	**-16%**
Ainokoa-East Honolulu	Diff	0	9,805	-8,653	-3,739	-13,346	-9,519	306	-6,391	0	0	**-31,537**
	% Diff		16%	-11%	-40%	-36%	-78%	3%	-60%			**-15%**
Windward Oahu	Diff	-4,062	12,241	2,709	-10,518	-13,119	-24,133	-30,175	-4,591	1,075	-1,299	**-71,872**
	% Diff	-14%	23%	2%	-10%	-33%	-40%	-42%	-49%	9%	-20%	**-13%**
North Shore-Haleiwa-Wahiawa	Diff	-16	0	7,520	7,448	12,108	-524	-9,953	52	0	0	**16,636**
	% Diff	0%		16%	17%	34%	-4%	-35%	12%			**9%**
Waianae-Makakilo	Diff	7,152	14,586	7,966	-1,029	-17	-122	-2,994	0	-2,065	-7,815	**15,664**
	% Diff	41%	60%	11%	-32%	0%	-30%	-22%		-64%	-45%	**9%**
Kapolei-Ewa-Waipahu	Diff	10,791	272	20,247	8,215	-7,866	-730	-8,008	0	3,386	-19,258	**7,050**
	% Diff	11%	2%	7%	17%	-21%	-2%	-21%		7%	-41%	**1%**
Central-Pearl City-Aiea	Diff	42,112	0	68,208	-13,867	-40,886	-13,534	-12,045	1,428	-21,460	-23,588	**-13,632**
	% Diff	11%		43%	-59%	-18%	-29%	-25%	18%	-31%	-38%	**-1%**
Moanalua-Hālawa-Airport-Pearl Harbor	Diff	38,791	10,085	-7,223	-15,175	-20,692	-14,190	-940	-1,925	651	-50,240	**-60,857**
	% Diff	26%	48%	-7%	-47%	-31%	-27%	-6%	-23%	1%	-56%	**-10%**
Total	**Diff**	**165,568**	**58,851**	**142,269**	**-47,171**	**-151,442**	**-111,265**	**-149,805**	**-13,687**	**-14,181**	**-153,368**	**-274,231**
	% Diff	**17%**	**31%**	**9%**	**-6%**	**-21%**	**-26%**	**-27%**	**-32%**	**-6%**	**-46%**	**-5%**

% RMSE by District and Facility Type

PM Peak Period 3:00PM – 6:59PM

District		*Access Restricted* Freeways	Express ways	*Arterials* Class I	Class II	Class III	*Collectors* Class I	Class II	Local Streets	*Ramps* High Speed	Low Speed	Total
		1	2	3	4	5	6	7	8	9	10	
Chinatown-Downtown-Ala Moana	%RMSE	43%	-	40%	40%	55%	57%	66%	-	37%	53%	**48%**
	N	11	0	43	62	30	25	24	1	6	10	**212**
Kalihi-Manoa-Kahala	%RMSE	15%	80%	45%	47%	59%	55%	68%	67%	84%	77%	**57%**
	N	7	3	15	15	14	30	100	3	9	28	**224**
Ainokoa-East Honolulu	%RMSE	-	22%	19%	49%	48%	141%	70%	84%	-	-	**41%**
	N	0	3	6	3	6	2	14	3	0	0	**37**
Windward Oahu	%RMSE	39%	29%	26%	38%	37%	51%	80%	61%	50%	45%	**42%**
	N	8	4	19	21	10	14	42	4	7	6	**135**
North Shore-Haleiwa-Wahiawa	%RMSE	-	-	44%	41%	55%	44%	64%	-	-	-	**52%**
	N	1	0	9	14	5	7	18	1	0	0	**55**
Waianae-Makakilo	%RMSE	61%	91%	52%	-	6%	-	55%	-	-	88%	**64%**
	N	2	4	11	1	2	1	12	0	1	4	**38**
Kapolei-Ewa-Waipahu	%RMSE	23%	26%	48%	64%	51%	65%	46%	-	39%	61%	**50%**
	N	8	2	26	11	7	9	17	0	10	19	**109**
Central-Pearl City-Aiea	%RMSE	31%	-	50%	79%	37%	35%	72%	74%	51%	53%	**45%**
	N	25	0	17	3	29	13	21	4	12	22	**146**
Moanalua-Hālawa-Airport-Pearl Harbor	%RMSE	47%	69%	60%	72%	46%	58%	73%	65%	61%	84%	**61%**
	N	13	2	16	5	10	13	8	3	16	24	**110**
Total	**%RMSE**	**35%**	**38%**	**43%**	**45%**	**46%**	**57%**	**69%**	**66%**	**52%**	**72%**	51%
	N	**75.00**	**18.00**	**162.00**	**135.00**	**113.00**	**114.00**	**256.00**	**19.00**	**61.00**	**113.00**	1066.00

Volume

Evening/Night Time Period 7:00PM – 2:59AM

District		*Access Restricted* Freeways 1	*Access Restricted* Express ways 2	*Arterials* Class I 3	*Arterials* Class II 4	*Arterials* Class III 5	*Collectors* Class I 6	*Collectors* Class II 7	Local Streets 8	*Ramps* High Speed 9	*Ramps* Low Speed 10	Total
Chinatown-Downtown-Ala Moana	Observed	172,838	0	208,264	264,854	135,048	44,424	42,774	828	17,496	23,431	**909,955**
	Predicted	221,760	0	107,570	214,995	105,147	37,501	41,997	219	24,896	25,688	**779,772**
Kalihi-Manoa-Kahala	Observed	84,811	12,473	92,627	80,112	45,213	86,702	142,503	2,915	12,910	47,818	**608,083**
	Predicted	82,632	19,097	116,352	35,995	21,865	44,493	99,276	1,349	20,749	42,832	**484,640**
Ainokoa-East Honolulu	Observed	0	34,482	42,070	2,712	19,641	5,955	6,791	5,421	0	0	**117,071**
	Predicted	0	36,608	34,718	1,511	12,871	1,504	6,410	2,321	0	0	**95,942**
Windward Oahu	Observed	12,759	25,801	78,802	51,873	17,574	28,972	34,849	4,984	5,199	2,745	**263,557**
	Predicted	12,191	35,226	84,240	53,756	11,561	19,943	21,211	2,477	6,153	3,704	**250,461**
North Shore-Haleiwa-Wahiawa	Observed	2,136	0	20,008	17,717	22,891	7,645	14,304	168	0	0	**84,869**
	Predicted	1,562	0	30,445	23,530	27,805	6,872	8,987	209	0	0	**99,410**
Waianae-Makakilo	Observed	11,442	14,216	49,709	1,812	9,031	255	10,335	0	1,638	10,969	**109,405**
	Predicted	13,504	19,446	40,442	94	7,745	148	7,184	0	1,529	7,646	**97,737**
Kapolei-Ewa-Waipahu	Observed	67,222	7,913	170,609	25,946	19,500	17,253	22,339	0	30,267	24,710	**385,758**
	Predicted	58,948	7,094	184,115	26,632	16,448	14,526	11,673	0	32,236	21,114	**372,786**
Central-Pearl City-Aiea	Observed	230,965	0	88,790	11,511	119,713	24,329	27,941	3,028	34,108	30,515	**570,898**
	Predicted	192,701	0	153,081	4,084	72,686	16,597	19,836	5,125	31,900	17,382	**513,391**
Moanalua-Hālawa-Airport-Pearl Harbor	Observed	113,056	11,495	40,526	15,908	31,918	25,085	6,379	3,152	36,443	58,612	**342,572**
	Predicted	119,253	17,185	49,612	10,162	25,800	19,667	8,249	4,158	28,626	28,980	**311,691**
Total	**Observed**	**695,230**	**106,380**	**791,404**	**472,442**	**420,528**	**240,619**	**308,213**	**20,494**	**138,061**	**198,798**	**3,392,167**
	Predicted	**702,551**	**134,655**	**800,574**	**370,758**	**301,926**	**161,251**	**224,822**	**15,859**	**146,088**	**147,346**	**3,005,830**

Difference in Volume (Modeled minus Observed)

Evening/Night Time Period 7:00PM – 2:59AM

District		*Access Restricted*		*Arterials*			*Collectors*			*Ramps*		
		Freeways	**Express ways**	**Class I**	**Class II**	**Class III**	**Class I**	**Class II**	**Local Streets**	**High Speed**	**Low Speed**	**Total**
		1	2	3	4	5	6	7	8	9	10	
Chinatown-Downtown-Ala Moana	Diff	48,922	0	-100,694	-49,858	-29,901	-6,923	-777	-609	7,400	2,258	-130,183
	% Diff	28%		-48%	-19%	-22%	-16%	-2%	-74%	42%	10%	**-14%**
Kalihi-Manoa-Kahala	Diff	-2,179	6,624	23,725	-44,117	-23,348	-42,209	-43,226	-1,565	7,839	-4,986	-123,442
	% Diff	-3%	53%	26%	-55%	-52%	-49%	-30%	-54%	61%	-10%	**-20%**
Ainokoa-East Honolulu	Diff	0	2,126	-7,351	-1,201	-6,770	-4,451	-381	-3,100	0	0	-21,129
	% Diff		6%	-17%	-44%	-34%	-75%	-6%	-57%			**-18%**
Windward Oahu	Diff	-568	9,425	5,438	1,883	-6,013	-9,030	-13,638	-2,507	954	960	-13,096
	% Diff	-4%	37%	7%	4%	-34%	-31%	-39%	-50%	18%	35%	**-5%**
North Shore-Haleiwa-Wahiawa	Diff	-574	0	10,437	5,813	4,914	-773	-5,317	42	0	0	**14,541**
	% Diff	-27%		52%	33%	21%	-10%	-37%	25%			**17%**
Waianae-Makakilo	Diff	2,061	5,230	-9,267	-1,718	-1,286	-106	-3,151	0	-109	-3,323	-11,669
	% Diff	18%	37%	-19%	-95%	-14%	-42%	-30%		-7%	-30%	**-11%**
Kapolei-Ewa-Waipahu	Diff	-8,274	-819	13,506	686	-3,052	-2,727	-10,666	0	1,969	-3,596	-12,973
	% Diff	-12%	-10%	8%	3%	-16%	-16%	-48%		7%	-15%	**-3%**
Central-Pearl City-Aiea	Diff	-38,264	0	64,291	-7,427	-47,027	-7,732	-8,105	2,098	-2,208	-13,133	-57,507
	% Diff	-17%		72%	-65%	-39%	-32%	-29%	69%	-6%	-43%	**-10%**
Moanalua-Hālawa-Airport-Pearl Harbor	Diff	6,197	5,690	9,086	-5,746	-6,118	-5,418	1,870	1,007	-7,817	-29,631	-30,881
	% Diff	5%	49%	22%	-36%	-19%	-22%	29%	32%	-21%	-51%	**-9%**
Total	**Diff**	**7,321**	**28,276**	**9,170**	-101,685	-118,602	-79,369	-83,390	-4,635	**8,028**	-51,452	-386,338
	% Diff	**1%**	**27%**	**1%**	**-22%**	**-28%**	**-33%**	**-27%**	**-23%**	**6%**	**-26%**	**-11%**

% RMSE by District and Facility Type

Evening/Night Time Period 7:00PM – 2:59AM

District		*Access Restricted* Freeways 1	Express ways 2	*Arterials* Class I 3	Class II 4	Class III 5	*Collectors* Class I 6	Class II 7	Local Streets 8	*Ramps* High Speed 9	Low Speed 10	Total
Chinatown-Downtown-Ala Moana	%RMSE	38%	-	72%	60%	64%	93%	104%	-	72%	56%	**66%**
	N	11	0	43	62	30	25	24	1	6	10	**212**
Kalihi-Manoa-Kahala	%RMSE	24%	70%	57%	66%	69%	76%	76%	78%	154%	47%	**70%**
	N	7	3	15	15	14	30	100	3	9	28	**224**
Ainokoa-East Honolulu	%RMSE	-	8%	26%	56%	54%	140%	70%	79%	-	-	**40%**
	N	0	3	6	3	6	2	14	3	0	0	**37**
Windward Oahu	%RMSE	49%	42%	34%	38%	38%	62%	80%	59%	75%	99%	**50%**
	N	8	4	19	21	10	14	42	4	7	6	**135**
North Shore-Haleiwa-Wahiawa	%RMSE	-	-	94%	61%	39%	48%	65%	-	-	-	**69%**
	N	1	0	9	14	5	7	18	1	0	0	**55**
Waianae-Makakilo	%RMSE	32%	95%	49%	-	23%	-	58%	-	-	82%	**60%**
	N	2	4	11	1	2	1	12	0	1	4	**38**
Kapolei-Ewa-Waipahu	%RMSE	37%	42%	59%	60%	37%	39%	76%	-	47%	47%	**61%**
	N	8	2	26	11	7	9	17	0	10	19	**109**
Central-Pearl City-Aiea	%RMSE	35%	-	98%	89%	55%	38%	81%	102%	61%	72%	**65%**
	N	25	0	17	3	29	13	21	4	12	22	**146**
Moanalua-Hālawa-Airport-Pearl Harbor	%RMSE	44%	71%	91%	55%	36%	80%	129%	162%	90%	151%	**82%**
	N	13	2	16	5	10	13	8	3	16	24	**110**
Total	**%RMSE**	**38%**	**40%**	**66%**	**63%**	**57%**	**75%**	**85%**	**84%**	**76%**	**106%**	**68%**
	N	**75.00**	**18.00**	**162.00**	**135.00**	**113.00**	**114.00**	**256.00**	**19.00**	**61.00**	**113.00**	**1066.00**

Figure 70: Scatter plot of Modeled versus Observed Daily Traffic Volume

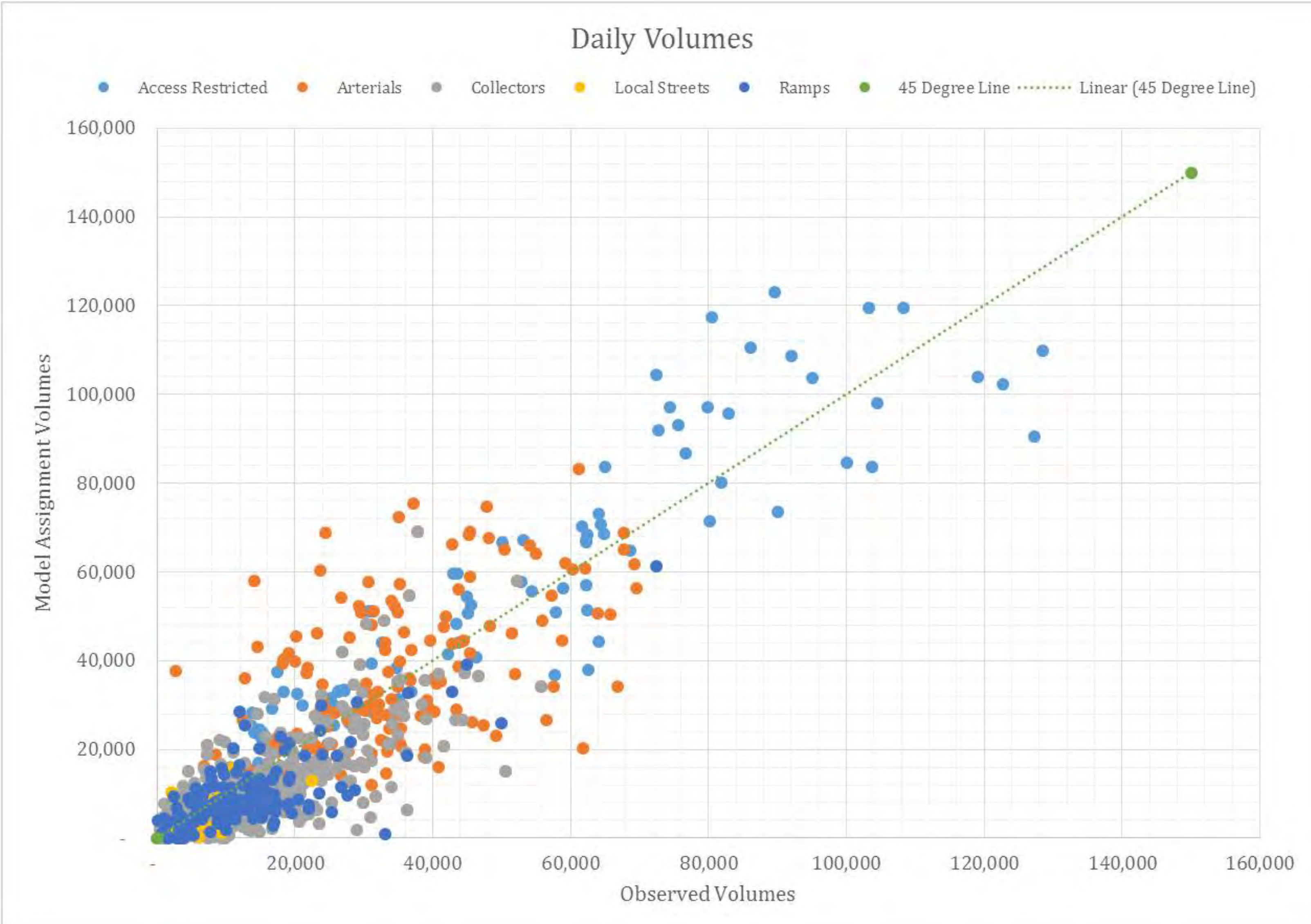


Figure 71: Scatter plot of Modeled versus Observed Early AM Traffic Volume

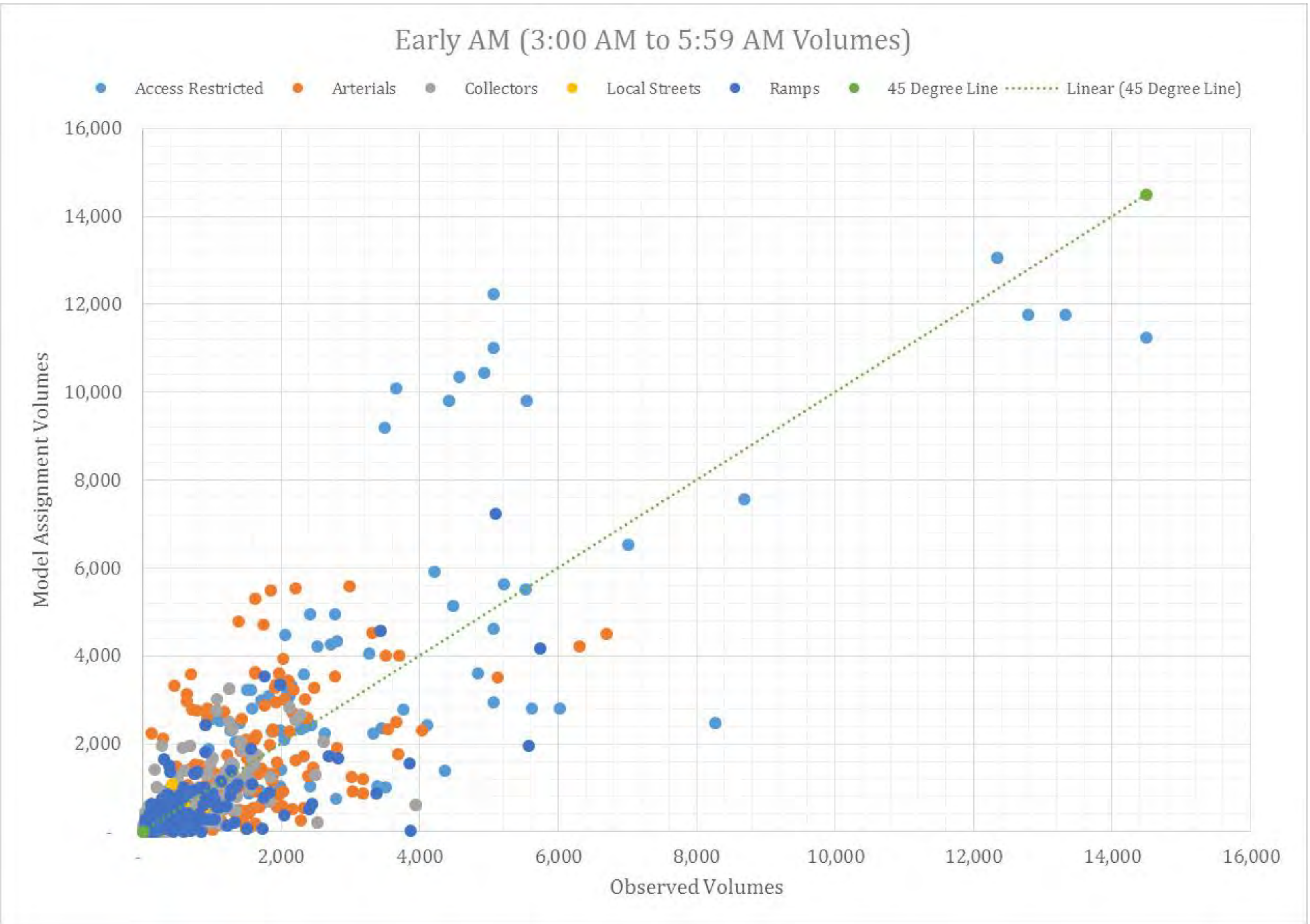


Figure 72: Scatter plot of Modeled versus Observed AM Traffic Volume

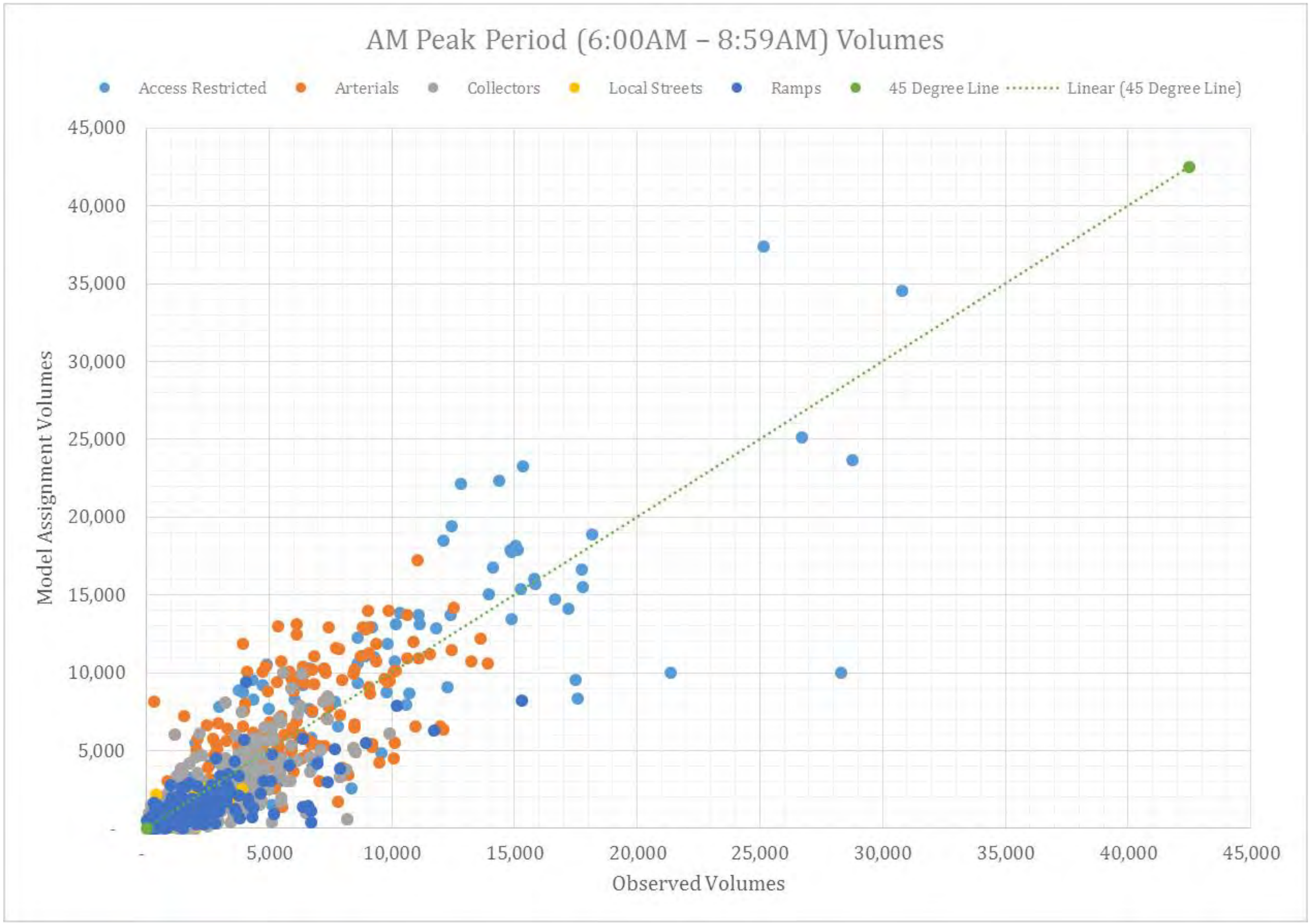


Figure 73: Scatter plot of Modeled versus Observed Mid-day Traffic Volume

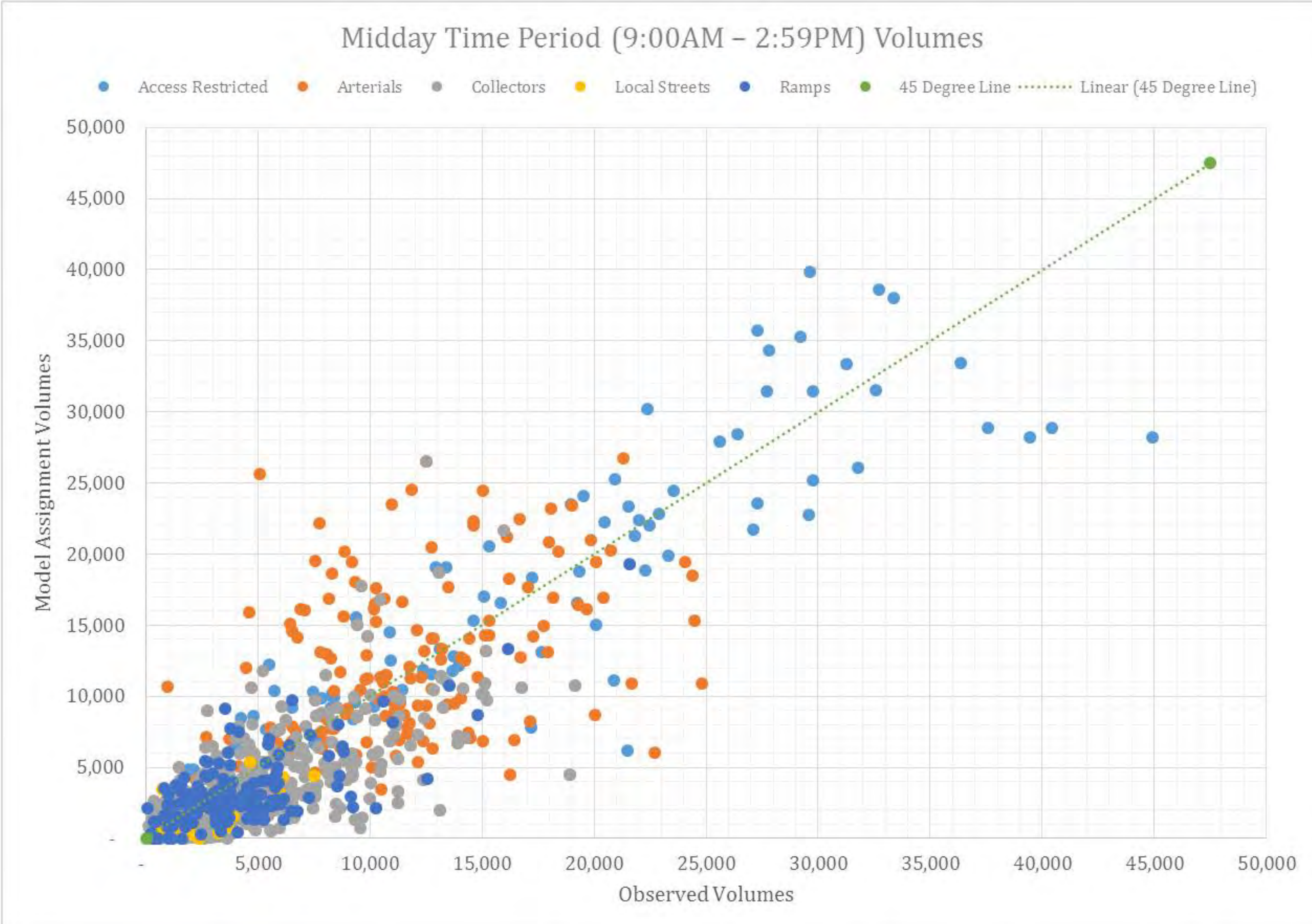


Figure 74: Scatter plot of Modeled versus Observed PM Traffic Volume

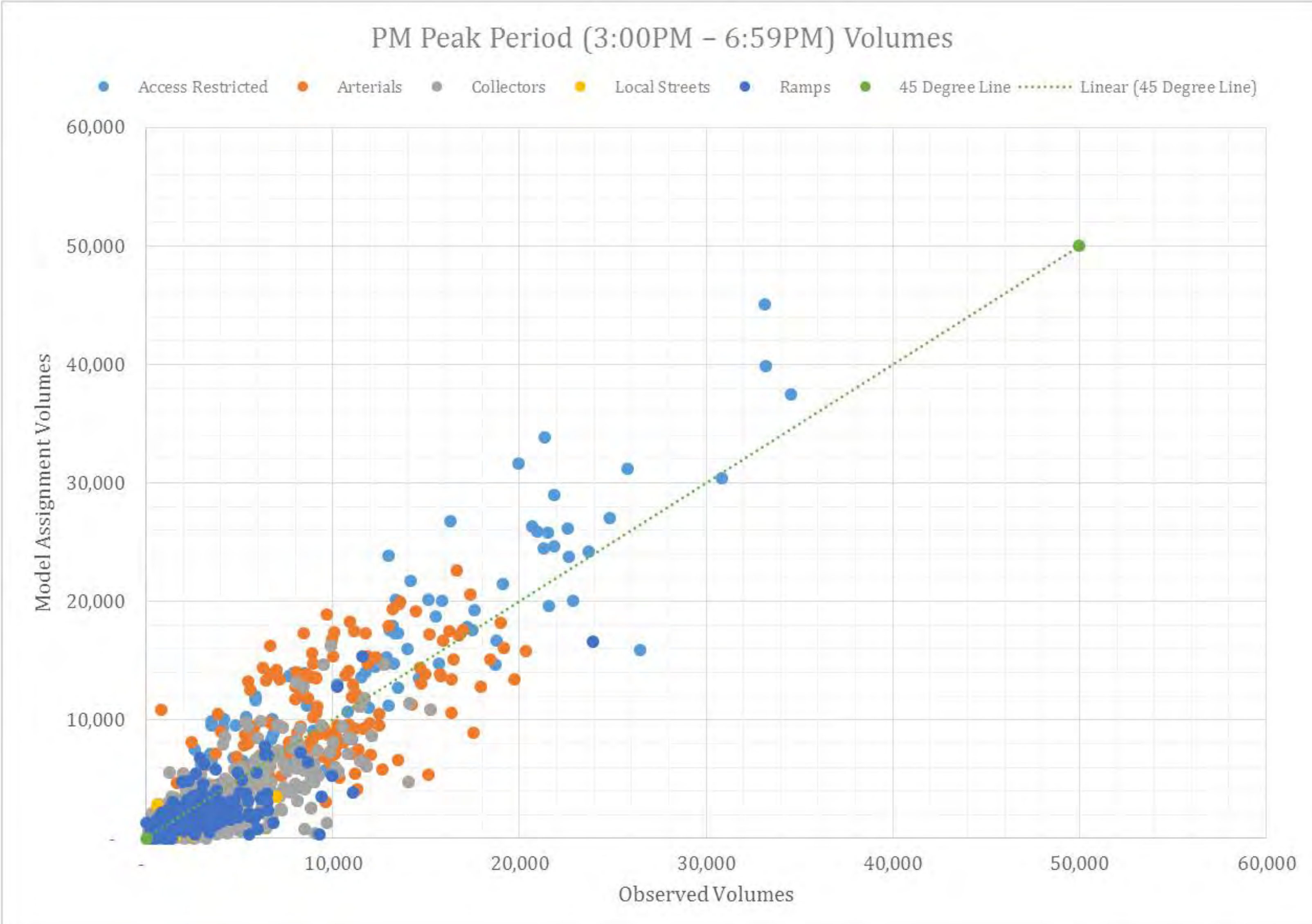


Figure 75: Scatterplot of Modeled versus Observed Evening Traffic Volume

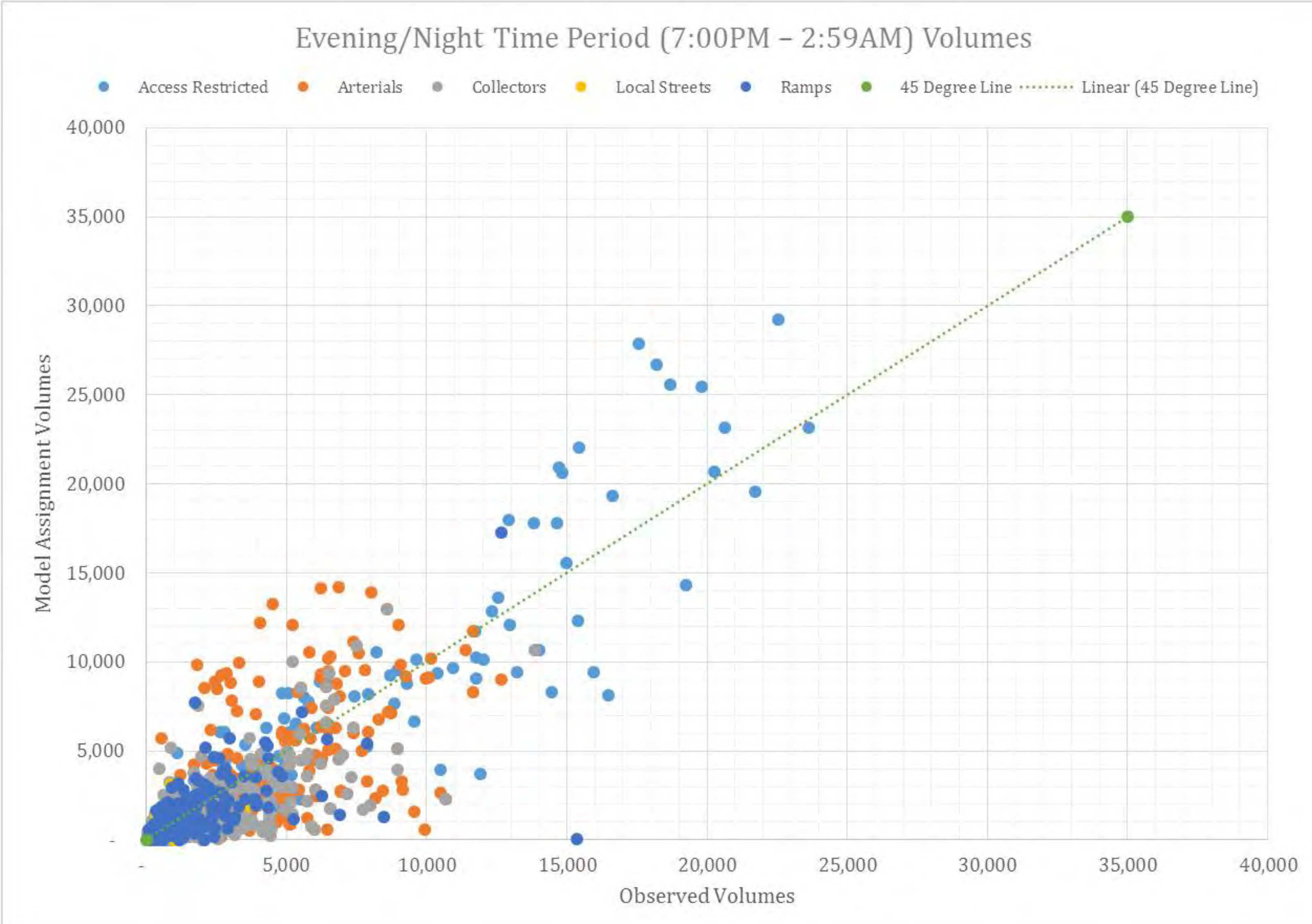


Table 209: Screenline Volumes by Time of day Periods

Screenline	Observed						Predicted					
	EARLYAM	AM	MID-DAY	PM	EVENING	DAILY	EARLYAM	AM	MID-DAY	PM	EVENING	DAILY
1	14,320	63,692	125,783	87,116	55,702	346,613	20,601	71,715	130,183	111,819	62,341	396,659
2	8,483	51,233	100,396	81,844	57,064	299,020	11,894	46,740	93,564	75,793	39,985	267,977
3	5,598	38,825	80,012	66,048	34,623	225,107	5,305	35,803	71,489	65,623	23,989	202,209
4	15,058	61,494	125,228	83,771	56,190	341,740	20,950	71,759	124,277	109,407	61,336	387,729
5	23,264	75,651	112,510	81,314	47,344	340,082	19,766	68,093	89,394	95,446	47,055	319,754
6	12,960	33,820	65,292	54,414	36,792	203,277	11,509	42,454	59,208	58,595	29,772	201,538
7	3,769	7,528	13,289	11,195	7,000	42,781	2,915	11,237	14,339	15,014	7,272	50,777
8	7,305	19,064	31,041	25,561	14,027	96,998	6,154	28,028	35,188	38,719	16,772	124,861
9	5,766	25,149	37,290	34,462	18,196	120,863	8,476	29,988	47,326	43,565	22,516	151,871
10	13,043	42,015	75,632	66,941	40,646	238,275	11,750	45,358	70,859	64,175	33,056	225,198
11	5,242	19,449	34,406	29,232	16,119	104,447	5,476	22,630	42,705	32,514	17,821	121,145
12	1,451	3,854	8,483	6,996	3,162	23,945	1,620	6,436	9,126	8,662	4,323	30,167
13	704	1,953	5,322	4,176	2,093	14,247	700	2,807	3,811	3,763	1,790	12,871
14	454	1,912	4,621	3,606	2,158	12,749	663	3,017	4,677	4,205	2,093	14,656
15	917	3,236	6,719	5,490	2,840	19,200	1,393	5,257	7,284	7,415	3,641	24,990
16	2,487	15,258	27,098	22,385	10,196	77,422	3,972	14,614	30,548	22,146	12,808	84,089
17	2,093	8,585	15,817	13,287	5,759	45,540	3,091	10,981	17,036	15,288	7,997	54,394
18	193	1,365	4,117	2,836	790	9,301	300	1,849	2,466	2,349	853	7,818
19	991	4,425	7,895	6,258	3,043	22,611	1,035	4,081	6,751	5,493	2,833	20,192
20	2,514	14,125	26,403	21,315	12,325	76,681	4,219	16,745	28,420	24,504	12,871	86,759
21	19,989	62,945	110,872	83,659	50,995	328,460	17,969	62,058	97,610	93,443	47,717	318,797
22	11,567	29,887	48,454	40,161	23,280	153,349	7,616	30,666	49,529	42,431	21,907	152,149

Difference in Volume (Modeled minus Observed)

Screenline	Difference						Percentage Difference					
	EARLYAM	AM	MID-DAY	PM	EVENING	DAILY	EARLYAM	AM	MID-DAY	PM	EVENING	DAILY
1	6,281	8,023	4,400	24,703	6,639	50,047	44%	13%	3%	28%	12%	14%
2	3,411	(4,493)	(6,832)	(6,051)	(17,079)	(31,043)	40%	-9%	-7%	-7%	-30%	-10%
3	(294)	(3,021)	(8,523)	(425)	(10,635)	(22,898)	-5%	-8%	-11%	-1%	-31%	-10%
4	5,892	10,265	(951)	25,636	5,147	45,989	39%	17%	-1%	31%	9%	13%
5	(3,498)	(7,558)	(23,115)	14,132	(289)	(20,327)	-15%	-10%	-21%	17%	-1%	-6%
6	(1,451)	8,634	(6,083)	4,182	(7,020)	(1,739)	-11%	26%	-9%	8%	-19%	-1%
7	(854)	3,709	1,050	3,819	272	7,995	-23%	49%	8%	34%	4%	19%
8	(1,151)	8,964	4,147	13,159	2,745	27,864	-16%	47%	13%	51%	20%	29%
9	2,710	4,839	10,036	9,103	4,320	31,009	47%	19%	27%	26%	24%	26%
10	(1,292)	3,344	(4,773)	(2,765)	(7,590)	(13,077)	-10%	8%	-6%	-4%	-19%	-5%
11	234	3,181	8,299	3,282	1,702	16,698	4%	16%	24%	11%	11%	16%
12	169	2,582	643	1,666	1,162	6,222	12%	67%	8%	24%	37%	26%
13	(3)	854	(1,511)	(413)	(303)	(1,376)	0%	44%	-28%	-10%	-14%	-10%
14	210	1,106	57	599	(64)	1,907	46%	58%	1%	17%	-3%	15%
15	476	2,022	566	1,925	801	5,790	52%	62%	8%	35%	28%	30%
16	1,486	(644)	3,450	(238)	2,613	6,667	60%	-4%	13%	-1%	26%	9%
17	999	2,396	1,220	2,001	2,239	8,854	48%	28%	8%	15%	39%	19%
18	107	485	(1,651)	(487)	63	(1,482)	55%	36%	-40%	-17%	8%	-16%
19	44	(344)	(1,144)	(765)	(210)	(2,418)	4%	-8%	-14%	-12%	-7%	-11%
20	1,705	2,621	2,018	3,189	546	10,079	68%	19%	8%	15%	4%	13%
21	(2,020)	(887)	(13,262)	9,784	(3,277)	(9,663)	-10%	-1%	-12%	12%	-6%	-3%
22	(3,950)	779	1,075	2,270	(1,373)	(1,200)	-34%	3%	2%	6%	-6%	-1%

Figure 76: Map of Screenline Locations

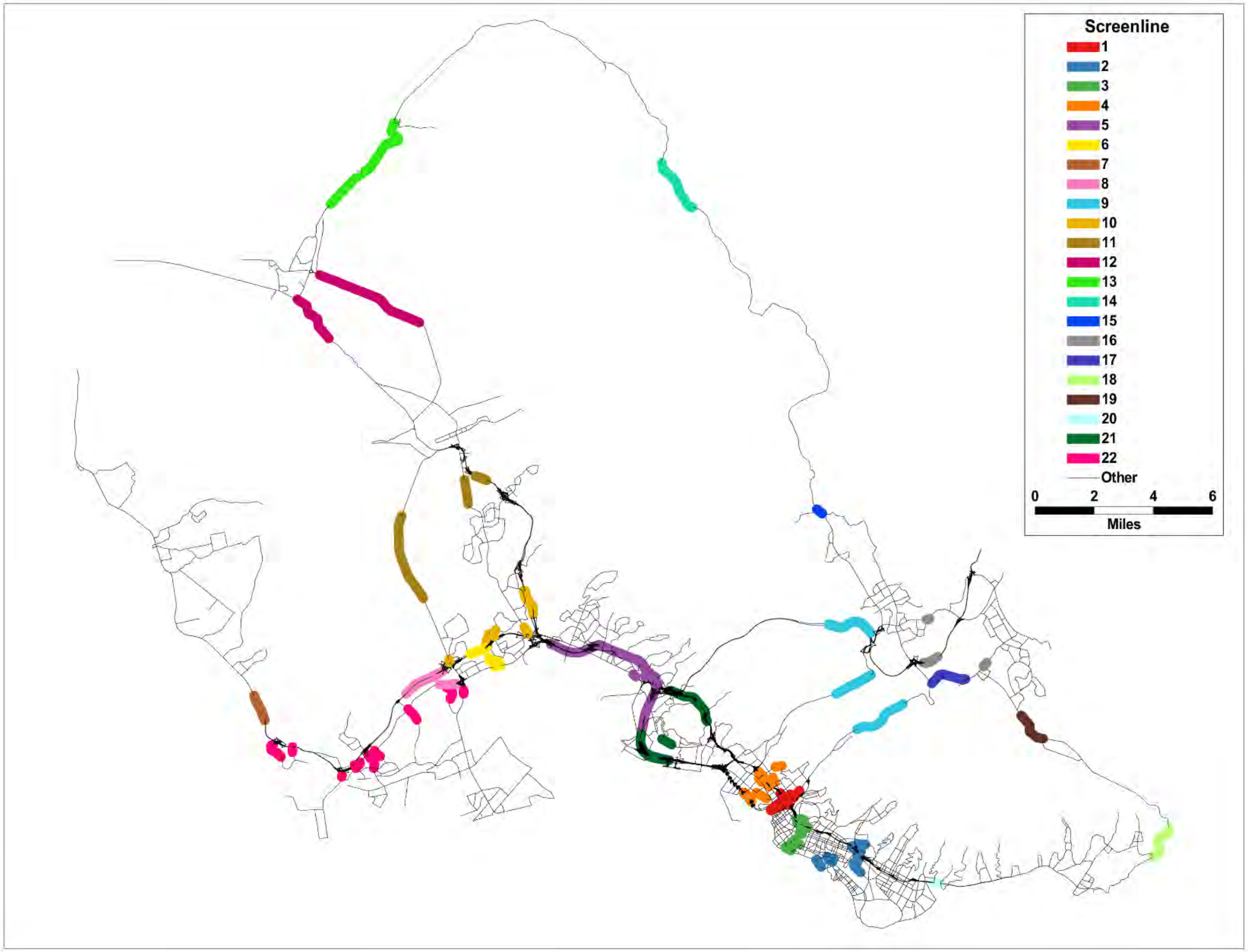
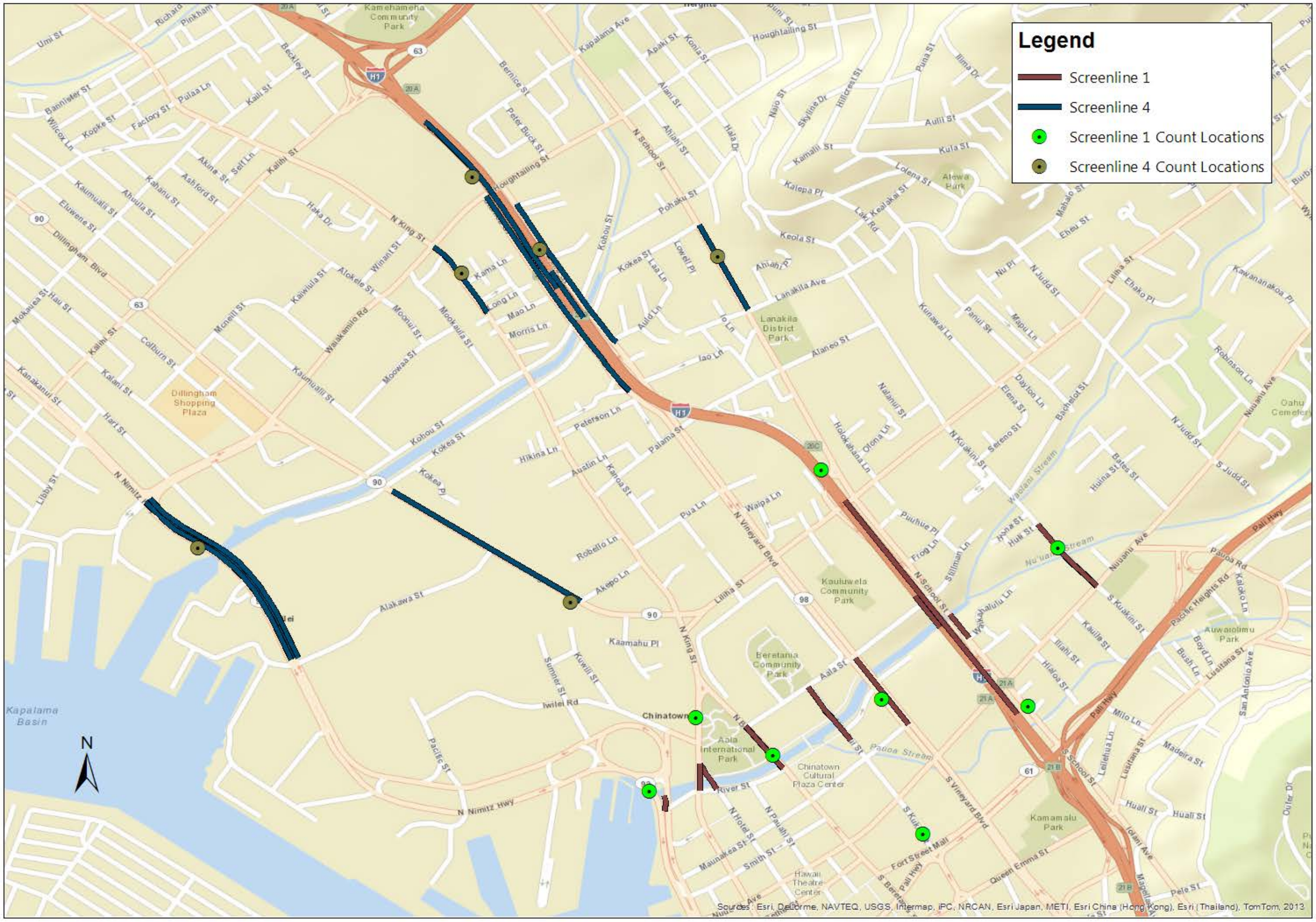


Table 210: Observed Counts for Screenline 1 and 4 split by facility and direction

	Traffic count station*	Eastbound	Westbound
Screenline – 1			
H-1	B72000102021	74,955	85,591
Hotel St.	B72740200120	22,486	10,092
King St.	B72750200300	4,384	22,139
Kuakini St.	B72754200034	5,116	8,122
Kukui St.	B72752000000	6,141	6,956
Nimitz Highway	B72009200586	31,250	34,345
School St.	B72741400013	2,099	8,960
Vineyard Blvd.	B72009800050	12,651	8,956
Total		159,082	185,161
Screenline – 4			
Dillingham Blvd.	B72740100133	20,614	20,545
H1	B72000101963	78,652	103,384
Nimitz Highway	B72009200468	35338	31136
North King St.	B72740200030	9,604	10,967
School St.	B72741400075	12,135	6,190
Total		156,343	172,222

* Traffic data can be retrieved for the stations using the traffic count PDFs available online at: http://hwypgis.dot.hawaii.gov/infostructure/index_files/Page326.htm

Figure 77: Screenline 1 and 4 Links and Count Locations



Transit Assignment

After all iterations of the travel demand and highway assignment are complete (i.e. speeds have reached equilibrium), transit trips are loaded onto transit routes using a single best path search method. Transit modes ranked lower in the hierarchy (Local Bus – Express Bus – Fixed Guideway) are allowed in the paths with a primary mode ranked higher in the hierarchy to allow feeder service and intermodal transfers. However, the in-vehicle time on feeder modes (local) is weighted as *X* times the in-vehicle time on the main mode in the generalized cost criterion for the best path search as shown in Table 211. Initial wait, and transfer times are weighted by *X* times in-vehicle time on the primary mode according to the table below. By using a biased search, paths which contain the primary mode are revealed most frequently.

Table 211: Weights by Primary Mode and Skim Weight

Primary Mode	Main Mode				
	Local Bus	Express Bus	Fixed Guideway	Initial Wait	Transfer Wait
Local Bus	1.1	1.1	1.2	2	2
Express Bus	N/A	1	1.2	1.2	1.2
Fixed Guideway	N/A	N/A	1	2	2
Limited Bus	1	1.1	1.2	2	2
Ferry	N/A	1.1	1.2	2	2

The total number of daily boardings by mode appears in Table 212. The tour mode choice and trip mode choice models were calibrated in tandem with the transit assignment validation to achieve a compromise between matching the household survey, matching the number of transfers, matching the number of boardings, and obtaining alternative-specific constants within reasonable ranges. Therefore, even these aggregate results should not be expected to match exactly.

Overall, boardings are within 8% of the observed amount. The estimated boardings matched well for the local and limited stop modes, and were low on express bus.

Table 212: Total Transit Boardings by Mode

Aggregate Mode	Observed Boardings	Modeled Boardings	Difference	% Difference
Local	176,552	167,497	-9,055	-5%
Express	10,680	6,953	-3,728	-35%
Limited Stop	36,638	31,720	-4,918	-13%
Total	**223,871**	**206,170**	**-17,701**	**-8%**

Table 213 shows the comparison of observed versus estimated boardings by peak and off-peak periods. This shows a similar observation to the total in that the local bus boardings match well for both peak and off-peak, but the express bus boardings are under-estimated in both peak and off-peak. The limited stop is under-estimated in the off-peak but matches well for the peak periods.

Table 213: Comparison of Transit Boardings by Mode

Aggregate Mode	Observed Boardings		Modeled Boardings		Difference		% Difference	
	Peak	Off Peak	Peak	Off Peak	Peak	Off Peak	Peak	Off Peak
Local	93,082	83,471	88,837	78,660	(4,244)	(4,811)	-5%	-6%
Express	7,015	3,666	5,756	1,196	(1,258)	(2,470)	-18%	-67%
Limited Stop	18,847	17,792	18,344	13,377	(503)	(4,415)	-3%	-25%
Total	118,943	104,928	112,937	93,233	(6,005)	(11,695)	-5%	-11%

This resulting transfer rates (See Table 214) between model and the on-board survey by access mode and trip table line haul mode matches well for all except the kiss and ride and formal park and ride modes. There were very few formal park and ride trips in the survey so it's difficult to make a fair comparison for this mode. The observed kiss and ride transfer rate also seems a bit high since most riders who are dropped off would be dropped off at a stop that would not require too many transfers.

Table 214: Comparison of Estimated and Observed Boardings, Transit Trips, and Transfer Rate by Access Mode and Line Haul Mode

Access Mode and Trip Table Line Haul Mode	Estimated			Observed (On-Board Survey)		
	Transit Boardings	Transit Trips	Transfer Rate	Transit Boardings	Transit Trips	Transfer Rate
1-Walk Access	200,918	178,572	1.13	218,468	183,466	1.19
1-Local/Limited Stop	191,211	171,198	1.12	208,809	175,466	1.19
2-Express	9,708	7,374	1.32	9,659	8,000	1.21
2-Park and Ride Formal	328	281	1.17	115	106	1.09
2-Park and Ride Informal	1,555	1,476	1.05	1,035	950	1.09
3-Kiss and Ride	3,368	3,217	1.05	4,252	3,649	1.17
Total	206,170	183,546	1.12	223,871	188,170	1.19

Transit boardings by route name and mode are in Table 215. As seen in Table 214, the transfer rate is high for premium modes (express, light rail and commuter rail), so naturally the estimated local bus boardings shown in Table 215 is much higher than observed. The commuter rail (Coaster) is under-estimated by 19%. The light rail route, Sprinter (Route 399), is over-estimated by 34%, while the trolleys, (Route 510 and 520) are under-estimated by 23%, while trolley route 530 matches well (-1%). The estimated boardings on premium express routes (800 series) are matching observed well (13%). The estimated boardings on regular express bus routes are not matching well (157%). Perhaps, introducing a higher transfer weight penalty for these buses is warranted since there are a lot of local bus boardings for express bus modes. If the transfer weight is higher it may make the path less attractive and thus reduce the boardings for 'regular express' routes.

Table 215: Transit Boardings by Mode

Route Name	observed	estimated	difference	% Difference
Local	**176,553**	**167,497**	**(9,055)**	**-5%**
1	17,828	14,573	(3,255)	-18%
2	16,213	19,272	3,059	19%
3	13,114	13,290	176	1%
4	8,745	4,864	(3,882)	-44%
5	1,408	143	(1,266)	-90%
6	5,899	3,229	(2,670)	-45%
7	3,453	944	(2,509)	-73%
8	4,717	3,031	(1,686)	-36%
9	7,463	6,980	(484)	-6%
10	573	35	(538)	-94%
11	1,217	256	(961)	-79%
13	12,001	15,619	3,618	30%
14	1,248	547	(701)	-56%
15	623	108	(516)	-83%
16	73	16	(57)	-78%
17	1,406	105	(1,302)	-93%
18	861	241	(620)	-72%
19	4,497	3,149	(1,348)	-30%
20	3,248	1,818	(1,430)	-44%
22	1,155	522	(634)	-55%
23	3,338	1,531	(1,807)	-54%
24	716	221	(495)	-69%
31	745	55	(690)	-93%
32	1,458	162	(1,296)	-89%
40	11,050	13,404	2,354	21%
41	1,614	1,326	(288)	-18%
42	10,223	11,848	1,625	16%
43	2,572	1,094	(1,478)	-57%
52	4,342	7,218	2,876	66%
53	2,736	2,519	(217)	-8%
54	3,118	4,185	1,067	34%
55	4,021	4,502	482	12%
56	3,013	5,319	2,305	76%

Route Name	observed	estimated	difference	% Difference
57	4,302	4,783	481	11%
62	6,028	12,186	6,158	102%
65	1,787	4,037	2,250	126%
70	240	118	(122)	-51%
71	81	165	84	103%
72	552	867	314	57%
73	484	254	(229)	-47%
74	61	25	(36)	-59%
76	377	182	(195)	-52%
77	410	383	(27)	-7%
234	13	6	(7)	-53%
235	40	-	(40)	-100%
401	421	110	(311)	-74%
402	368	62	(306)	-83%
403	551	34	(518)	-94%
411	520	510	(10)	-2%
412	431	85	(345)	-80%
413	212	158	(54)	-26%
414	232	151	(81)	-35%
415	88	17	(71)	-81%
432	1,504	386	(1,118)	-74%
433	1,468	513	(955)	-65%
434	1,200	185	(1,015)	-85%
503	235	22	(213)	-91%
501	121	72	(49)	-41%
504	138	61	(76)	-55%
Express	**10,680**	**6,953**	**(3,727)**	**-35%**
80	516	591	75	15%
81	1,259	488	(771)	-61%
82	257	289	32	12%
83	631	522	(109)	-17%
84	639	431	(208)	-33%
85	830	753	(77)	-9%
88	388	703	315	81%
89	138	99	(39)	-28%

Route Name	observed	estimated	difference	% Difference
90	157	83	(75)	-48%
91	1,020	914	(106)	-10%
92	226	112	(114)	-51%
93	1,247	503	(744)	-60%
94	166	58	(108)	-65%
96	155	126	(29)	-19%
97	342	123	(219)	-64%
98	448	330	(118)	-26%
101	488	110	(378)	-77%
102	212	102	(110)	-52%
103	126	111	(14)	-11%
PH1	84	10	(74)	-88%
PH2	57	10	(47)	-83%
PH3	76	15	(61)	-81%
PH5	60	39	(21)	-35%
PH4	31	25	(6)	-18%
PH6	138	83	(55)	-40%
W1	544	210	(334)	-61%
W2	256	85	(171)	-67%
W3	190	29	(160)	-84%
Limited Stop	**36,638**	**31,720**	**(4,918)**	**-13%**
1L	3,063	2,423	(640)	-21%
A	21,684	21,111	(572)	-3%
C	6,847	5,036	(1,811)	-26%
E	5,044	3,150	(1,894)	-38%
Total	**223,871**	**206,170**	**(17,701)**	**-8%**