Technical Report

FY 2015 SOUTH JERSEY TRAVEL DEMAND MODEL RECALIBRATION AND IMPROVEMENTS

June 2015

AECOM

In association with:

CITILABS

Texas A&M Transportation Institute

Stump/Hausman Partnership

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1 Introduction

As part of the FY2015 South Jersey Travel Demand Model (SJTDM) Recalibration and Improvements project, the South Jersey Transportation Planning Organization (SJTPO) retained the AECOM Team to recalibrate the SJTDM using the latest available data and to streamline the Air Quality Conformity analysis process. The TEAM comprised of AECOM, Citilabs and Stump Hausman Partnership recalibrated the model based on the 2014 Household Travel Survey, traffic counts collected between 2011 and 2013 from various data sources and recent ridership data, and developed an air quality post-processor named AQPP for use by SJTPO staff.

This report describes the model recalibration effort and is organized into 6 chapters. Chapter 2 describes the socioeconomic data and Chapter 3 describes the highway network updates. Chapter 4 describes the Household survey data processing, socioeconomic sub-models, the trip production rates and trip generation validation results. Chapter 5 contains the trip distribution calibration process and results. Chapter 6 describes the mode choice calibration effort and validation results. Chapter 7 presents the highway and transit assignment validation results.

2 Socioeconomic Data

The base year for the model revalidation effort was decided to be 2013 based on discussions with SJTPO staff. The socioeconomic data for the year 2013 was developed by SJTPO staff by linear interpolation of the data for the years 2010 and 2015. Table 2.1 shows a summary of the population, household and employment for 2013. Note that Gloucester and Camden counties are only partially covered by the model.

Table 2-1: 2013 Socioeconomic Data Summary

County	Population	Household	Employment
Atlantic	274,115	104,843	148,032
Cape May	95,302	41,032	36,282
Cumberland	147,133	52,727	63,819
Salem	65,821	25,672	24,732
4-County Total	**582,370**	**224,275**	**272,865**
Gloucester	137,170	47,337	45,560
Camden	63,493	21,339	15,915
Total	**783,033**	**292,950**	**334,340**

Due to the recent closings of several casinos in Atlantic City, it was important to accurately reflect in the socioeconomic data the casinos that were in operation as of 2013. Almost all of the information pertaining to the casinos such as employees, square footage, rooms, etc. was assumed to be the same in 2013 as in the year 2010 with the only change being the addition of the Revel Casino which opened in 2012. Table 2.2 shows the information for the Revel Casino that was included in the model in TAZ 92 and was compiled from various sources. The Saturday peak hour arrival and departure information was derived by SJTPO staff using trip generation equations.

Table 2-2: Revel Casino Characteristics

Rooms	Square Footage	Seats	Employees	Peak Hr Arrivals	Peak Hr Departures
1,400	150,000	1,500	2,750	800	450

Note that several casinos closed in 2014; therefore the socioeconomic data for the future years should reflect these closings.

3 Highway Network

The highway network for the base year 2013 was provided by SJTPO staff and was developed using the 2010 network as a starting point and then coding in the highway improvement projects that were completed between 2010 and 2013. Table 3.1 provides a list of these roadway improvements. Only minor updates were made by AECOM including recoding the facility types of external station links from 13 (centroid connector) to the facility type of the roadway it connects to.

Table 3-1: New Roadway Improvement Projects Coded in 2013 Network

Project Description
Garden State Parkway Interchange 48 to 63 widening (NJTA)
Martin Luther King Blvd widening, Atlantic City (CRDA)
South Inlet Transportation Improvement Project, Atlantic City (CRDA)
Cape May-Lewes Ferry access roads widening (DRBA)

The tolls coded in the toll file for Garden State Parkway, Atlantic City Expressway and New Jersey Turnpike were reviewed against the latest toll rates on these roadways and verified to be accurate as these have not changed recently. The toll on the Atlantic City Expressway off ramp at NJ 50 ($3.00) was missing and was added in the toll file.

4 Trip Generation

One of the impetuses for the SJTDM model update effort was the availability of new Household survey data which was collected in the 4-county region in 2014. Travel data was collected from 1,850 households in the region. This was processed by TTI and AECOM staff and used to update several components of the SJTDM including the trip generation rates. This chapter describes the household survey data processing effort to develop trip production rates used in the trip generation step of the model.

4.1 Household survey data processing

Table 4.1 presents the non-recreational trip purposes in the SJTDM. These purposes were deemed reasonable and carried forward for the model recalibration effort.

Table 4-1: Non-recreational Trip Purposes

#	Purpose	Abbreviation	Description
1	Home-Based Work	HBW	From home to work; work to home
2	Home-Based School	SCH	From home to school; school to home (includes all school trips: primary and secondary)
3	Home-Based College	COLL	From home to college; college to home
4	Home-Based Shop	HBS	From home to shopping; shopping to home (includes eating out and other "quasi-purchasing"-based trips)
5	Home-Based Other	HBO	All other home-based trips not included above (except special recreational trip purposes)
6	Non-Home-Based Work	NHBW	From a non-home location to work; from work to a non-home location (i.e., on the way to or from work)
7	Non-Home-Based Non-Work	NWK	Non-home to non-home segments of a trip chain which both starts and ends at home

The survey responses included trip purposes for the origin and the destination ends of the trip. Table 4.2 shows the survey trip purposes. However, these included several more categories when compared to those included in the model. Model trip purposes were determined for each record in the Household Survey based on the origin and destination trip purposes according to the correspondence in Table 4.3. The 'SCHOL' survey code identified the type of school, in which 3 and 4 refers to K-12 schools and greater than 4 refers to colleges (1 and 2 are daycare/preschool).

Table 4-2: Survey Trip Purposes

Survey Purpose Code	Description
1	Typical home activities
2	Working at home (paid)
3	Work at work location
4	Work- related at non-fixed work location
5	School at home
6	School / School activities
7	Volunteering
8	Everyday shopping
9	Major purchase shopping
10	Drive-thru errands
11	Household & personal errands
12	Vehicle service
13	Health care visit
14	Eat out
15	Socialize with friends/relatives
16	Religious or community event
17	Outdoor exercise or recreation
18	Indoor exercise or recreation
19	Attend major event
20	Casino Visit
21	Drop off/Pick up passenger
22	Change/Transfer trip mode

Table 4-3: Survey to Model Trip Purpose Correspondence

Model Purpose	Survey Purpose Code		Additional Criteria
	Origin	Destination	
HBW	1,2,5	3,4	
SCH	1,2,5	6	SCHOL=3,4
COLL	1,2,5	6	SCHOL >4
HBS	1,2,5	8, 9	
HBO	1,2,5	7, >9	1,2,5 to 1,2,5
NHBW	>5	3, 4	3,4 to 3,4
NWK	>5	>5	

Table 4.4 presents the definitions of the household cross-classification categories for the non-recreational purposes. Note that the five household size categories in the current model have been modified to four categories for the model recalibration effort as only a small number of households have 5+ persons.
The income categories correspond to income quartiles based on the latest census 2010 data (i.e., 25% households comprise each quartile).

Table 4-4: Cross classification Categories for Non-recreational Trip purposes

Variable	Category #	Description
Life-Cycle	1	Any retired people, no children age 18 or older
	2	Any children age 18 or under, no retired people
	3	No children or retired people
Income	1	Less than $30,000
	2	$30,000 - $60,000
	3	$60,000 - $97,500
	4	Greater than $97,500
Household Size	1	1 person/ Household
	2	2 persons/Household
	3	3 persons/Household
	4	4+ persons/Household
Workers	1	1 worker/Household
	2	2 workers/Household
	3	3+ workers/Household

Table 4.5 presents the trips by non-recreational purpose from the 2014 survey.

Table 4-5: Survey Trips by Non-recreational Purpose

Trip Purpose	Trips
Home-Based Work	253,591
Home-Based School	110,537
Home-Based Shopping	140,589
Home-Based Other	549,432
Non-Home-Based Work	150,444
Non-Home-Based Non-Work	366,368
Home-Based College	23,351
Total	**1,594,312**

Table 4.6 presents the recreational trip purposes in the SJTDM. These purposes were deemed reasonable and carried forward for the model recalibration effort.

Table 4-6: Recreational Trip Purposes

#	Purpose	Abbreviation	Description
1	Shore Visit	SHV	One trip end at beach, boardwalk, shopping, dining or other and other trip end at home *
2	Overnight Beach Access	BAC	From home to shore town, shore town to home
3	Daytrip Beach Access	DAC	From home to shore town, shore town to home
4	Seasonal Work	SWK	From home to work, work to home
5	Casino Visit	CVT	Travel between Atlantic City casinos
6	Event Visit	EVT	Travel between events and casinos
7	Casino Access	CAC	Non-work, from home to casino, casino to home
8	Event Access	EAC	Non-work, from home to Atlantic City, Atlantic City to home
9	Casino Bus	CBS	Casino access trips via chartered bus

** relates to location at which person/group is staying while at the shore*

As part of the 2014 Household Survey, a separate Shore Survey was administered to those households that completed the survey online. The following two questions were asked pertaining to recreational trips:

1. Between May and September, about how many times do the people that live in your household travel to the South Jersey shore?
2. Now think about the entire year. How often do the people that live in your household visit the casinos at the Jersey shore?

Additional questions related to the trip to the shore were asked to determine additional information about the trip such as whether they stayed overnight, mode of travel, number of vehicle occupants, distribution of shore location or casino visited, etc. These questions were not applicable to those households that indicated they live at the shore year-round.

Note that the Shore Survey captured trips pertaining to the Overnight Beach Access, Daytrip Beach Access, Casino Access and Event Access trip purposes in the SJTDM via the first question and Casino Access trip purpose via the second question.

It was understood during the design of the Shore Survey questionnaire that the survey responses will not be sufficient to determine recreational trip generation rates, for which a more comprehensive Beach survey would be required as was done in 1996. Instead, the survey data would be used to perform aggregate checks of the recreational trip purposes in the trip distribution, mode choice and vehicle occupancy steps in the SJTDM, which are described in later chapters in this document.

4.2 Socioeconomic Sub-models

The trip rates in the SJTDM for the work-based trip purposes vary by income, lifecycle and workers per household whereas for the non-work based purposes, the rates vary by income, lifecycle and household size. However, the basic input socioeconomic data do not include the number of households for each of these stratifications. The standard variables that are known and can be readily forecasted for each zone include the number of households and population in households.
Therefore, it is necessary to develop a procedure to estimate these values, based on the data items that are available. The SJTDM uses a fairly standard procedure for estimating households by category, which is based on relationships in the Census data as follows:

- Households by size are correlated with the average HH Size per TAZ. As average HH size increases for a TAZ, so does the proportion of larger households.

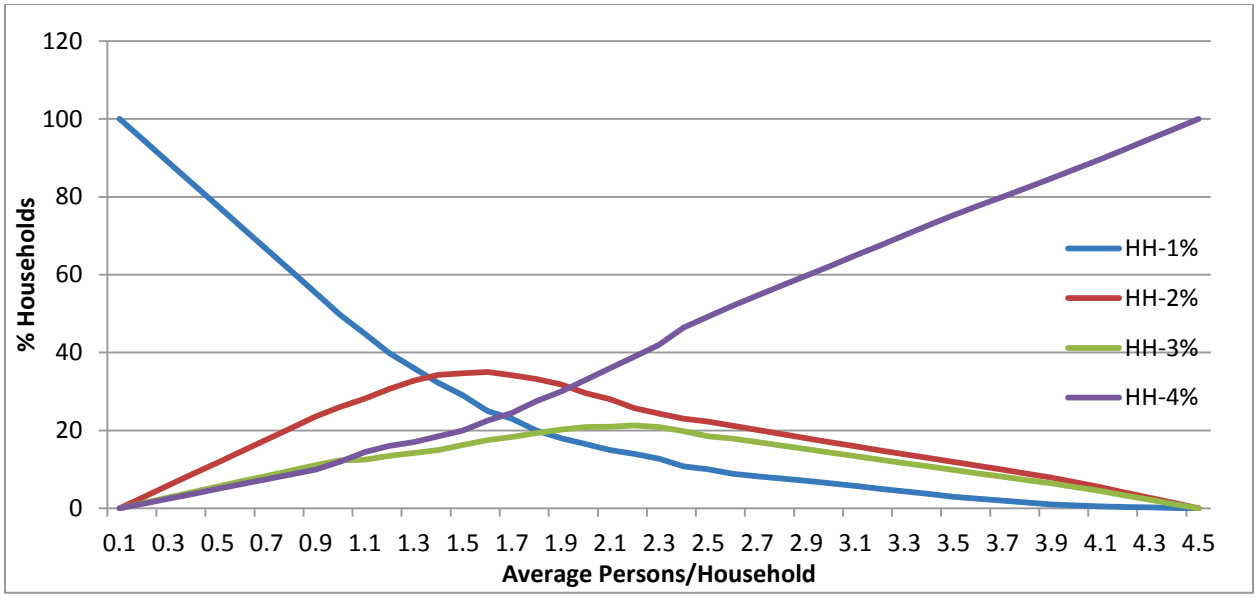
- Household income groups are correlated with the ratio of TAZ median income divided by the regional median income. As a TAZ becomes wealthier on average, compared to the region, the proportion of higher income households increases.
- Percentage of households by the three lifecycle categories were derived by zone from the census 2010 data.
- Workers per household is a function of household size, lifecycle and income, with relationships calibrated from Census data.

These household sub-models were recalibrated using the new Household survey data; this effort is discussed in detail in the following sections.

4.2.1 Household size sub-model

The SJTDM had household size curves which determined for each TAZ the number of households by household size categories (1, 2, 3, 4, 5+) using the average zonal household size (ratio of zonal population and households). These curves were synthesized earlier using Census data. As mentioned earlier, household size 4 and 5+ categories were combined together in this model recalibration effort, which necessitated the combining of the household size curves for these two categories. Moreover, these curves were adjusted to obtain a better match between the model and survey percentage households for each of the 4 household size categories. Figure 4.1 shows the updated curves for the revised size categories (1, 2, 3, 4+). These curves were developed so that at any point, the percentages all sum to 100%. The % distribution in the four size categories was assumed to remain stable over time.

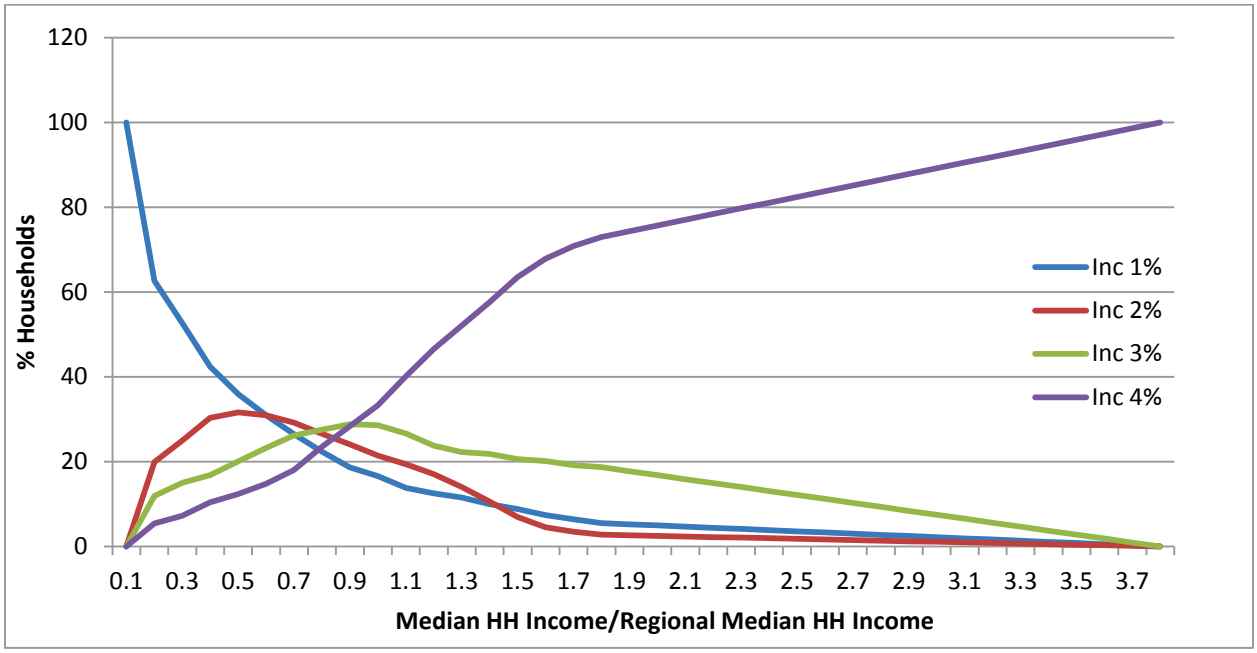
Figure 4-1: Household Size Curves



4.2.2 Household income sub-model

The household income curves in the current model yielded satisfactory results and were therefore not changed. Figure 4.2 shows the household income curve.

Figure 4-2: Household Income Curves



4.2.3 Lifecycle sub-model

The percent distribution of households in each of the three lifecycles developed during the previous model update was adjusted so that the percent marginal at the regional level better match those derived from the 2014 household survey. Note that the definition of 'retired' used earlier in the model referred to those aged 65+ due to limitations of the availability of information about households with retired members from the Census 2010 data. However, in reality those aged 65+ are not necessarily retired. One of the variables included in the new survey was whether the household included retired members; it was therefore deemed appropriate to adjust the zonal percent distribution of households in the model.

4.2.4 Worker sub-model

The SJTDM uses a 4-dimensional joint distribution of households by lifecycle, income, size and workers along with marginal totals of households by lifecycle, income and size to determine the number of households by each of the 3 worker categories at the zonal level. This distribution was adjusted to obtain a better match of the percent marginal at the regional level between the model and the household survey.

4.2.5 Validation Results

The household survey captured the characteristics of households that reside in the 4-county region. However the model boundary extends beyond the 4-county region and includes portions of Camden and Gloucester counties. The validations summaries presented here, which show the percentage of households by household category, therefore are provided separately for the 4-county region and the entire model area. Table 4.7 shows the household size submodel validation summary. A close match has been obtained between the survey and the model at both the 4-county and systemwide levels.

Table 4-7: Household Size Submodel Validation Summary

	Size			
	1	2	3	4+
Survey	28%	32%	16%	24%
Model - 4 County	28%	33%	16%	23%
Entire Model	26%	32%	17%	25%

Table 4.8 shows the household income submodel validation summary. Note that the survey did not capture the exact household incomes but rather income ranges. It was therefore not possible to derive the exact percentage of households in some income categories. Specifically, the income category 3 includes households that have income in the range $60,000-$97,500 and income category 4 includes those households with incomes greater than $97,500. However, the survey income range of $50,000-$99,999 was included in income category 3 and incomes greater than $99,999 included in income category 4. Households that reported incomes less than $25,000 were included in income category 1 and incomes in the range $25,000-$50,000 included in income category 2. This resulted in the income category 3 in the survey to be overstated and categories 1 and 4 to be understated.

Table 4-8: Household Size Submodel Validation Summary

	Income			
	1	2	3	4
Survey	22%	24%	29%	25%
Model - 4 County	25%	22%	25%	28%
Entire Model	25%	22%	25%	28%

Table 4.9 shows the household lifecycle submodel validation summary. A close match has been obtained between the survey and the model at both the 4-county and systemwide levels.

Table 4-9: Household Lifecycle Submodel Validation Summary

	Lifecycle		
	1	2	3
Survey	31%	29%	40%
Model - 4 County	31%	28%	41%
Entire Model	29%	30%	41%

Table 4.10 shows the household worker submodel validation summary. As can be seen, a close match has been obtained between the survey and the model at both the 4-county and systemwide levels.

Table 4-10: Household Worker Submodel Validation Summary

	Worker			
	0	1	2	3+
Survey	30%	37%	26%	7%
Model - 4 County	31%	37%	24%	8%
Entire Model	29%	37%	25%	9%

4.3 Trip Generation Model

4.3.1 Trip Production Rates

Trip production rates by purpose, based on the initial survey data analysis performed by Texas Transportation Institute (TTI) staff, were determined for each of the categories (by size/income/lifecycle for non-work purposes and by worker/income/lifecycle for work purposes) in Table 4.4 using weighted trips and weighted households. We noticed a few anomalies in the initial 'raw' rates that were developed, such as extremely high values or zeroes caused by low sample size. This is typical in most household survey data and a 'smoothing' or adjustment of the rates is often employed to develop rates that are more reasonable. The smoothing is performed by combining rates across the income categories for the same life cycle and household size (or worker) category if there are less than 30 unweighted observations. An inherent assumption here is that household size (or worker) and life cycle dimensions are better predictors of trip activity compared to the income dimension. Our expectation is that within the same lifecycle, trip rates increase with increasing household size (or worker). Note that the adjustment of rates was performed in such a manner as to retain as much as possible the magnitude of the weighted trips observed in the survey across the size (or worker) and lifecycle dimensions. Tables 4.11 to 4.17 show the final smoothed rates that were developed from the household survey.

Table 4-11: HBW Trip Production Rates

Lifecycle	Income	Worker		
		1	2	3+
1	1	0.79	2.08	2.08
	2	0.79	2.08	2.08
	3	1.03	2.08	2.08
	4	1.07	2.08	2.08
2	1	0.84	1.95	3.19
	2	0.84	1.95	3.19
	3	1.16	2.13	3.19
	4	1.16	2.13	3.19
3	1	0.90	1.68	3.54
	2	0.91	1.68	3.54
	3	1.17	2.28	3.54
	4	1.11	2.18	3.54

Table 4-12: NHBW Trip Production Rates

Lifecycle	Income	Worker		
		1	2	3+
1	1	0.57	0.82	0.82
	2	0.57	0.82	0.82
	3	0.57	0.82	0.82
	4	0.57	0.82	0.82
2	1	0.84	1.39	1.36
	2	0.84	1.39	1.36
	3	0.84	1.40	1.36
	4	0.84	1.40	1.36
3	1	0.82	0.74	1.36
	2	0.82	0.74	1.36
	3	0.82	0.95	1.36
	4	0.82	1.18	1.36

Table 4-13: HB School Trip Production Rates

Lifecycle	Income	Size			
		1	2	3	4+
1	1	0.00	0.05	0.15	1.00
	2	0.00	0.05	0.15	1.00
	3	0.00	0.05	0.15	1.00
	4	0.00	0.05	0.15	1.00
2	1	0.00	0.91	1.04	1.91
	2	0.00	0.91	1.04	1.91
	3	0.00	0.91	1.04	1.91
	4	0.00	0.91	1.04	1.91
3	1	0.00	0.00	0.00	0.00
	2	0.00	0.00	0.00	0.00
	3	0.00	0.00	0.00	0.00
	4	0.00	0.00	0.00	0.00

Table 4-14: HB Shopping Trip Production Rates

Lifecycle	Income	Size			
		1	2	3	4+
1	1	0.54	1.02	0.71	0.82
	2	0.54	1.02	0.71	0.82
	3	0.54	1.02	0.71	0.82
	4	0.54	1.02	0.71	0.82
2	1	0.00	0.38	0.80	0.58
	2	0.00	0.38	0.80	0.58
	3	0.00	0.38	0.80	0.58
	4	0.00	0.38	0.80	0.58
3	1	0.35	0.60	0.84	0.41
	2	0.35	0.60	0.84	0.41
	3	0.35	0.60	0.84	0.41
	4	0.35	0.60	0.84	0.41

Table 4-15: HBO Trip Production Rates

Lifecycle	Income	Size			
		1	2	3	4+
1	1	1.81	2.80	2.86	5.00
	2	1.81	2.80	2.86	5.00
	3	1.81	2.80	2.86	5.00
	4	1.81	2.80	2.86	5.00
2	1	0.71	2.92	2.79	3.88
	2	0.71	2.92	2.79	3.88
	3	0.71	2.92	2.79	3.88
	4	0.71	2.92	2.79	3.88
3	1	1.23	1.77	2.33	2.28
	2	1.23	1.77	2.33	2.28
	3	1.23	1.77	2.33	2.28
	4	1.23	1.77	2.33	2.28

Table 4-16: HB College Trip Production Rates

Lifecycle	Income	Size			
		1	2	3	4+
1	1	0.00	0.01	0.03	0.68
	2	0.00	0.01	0.03	0.68
	3	0.00	0.01	0.03	0.68
	4	0.00	0.01	0.03	0.68
2	1	0.00	0.16	0.07	0.20
	2	0.00	0.16	0.07	0.20
	3	0.00	0.16	0.07	0.20
	4	0.00	0.16	0.07	0.20
3	1	0.03	0.07	0.15	0.86
	2	0.03	0.07	0.15	0.86
	3	0.03	0.07	0.15	0.86
	4	0.03	0.07	0.15	0.86

Table 4-17: NHBNW Trip Production Rates

Lifecycle	Income	Size			
		1	2	3	4+
1	1	1.71	2.12	2.06	2.43
	2	1.71	2.12	2.06	2.43
	3	1.71	2.12	2.06	2.43
	4	1.71	2.12	2.06	2.43
2	1	2.12	3.24	1.71	1.88
	2	2.12	3.24	1.71	1.88
	3	2.12	3.24	1.71	1.88
	4	2.12	3.24	1.71	1.88
3	1	1.12	1.13	1.42	2.26
	2	1.12	1.13	1.42	2.26
	3	1.12	1.13	1.42	2.26
	4	1.12	1.13	1.42	2.26

As mentioned earlier, the shore survey component of the household survey did not collect the level of details needed to update the recreational trip rates in the model, which were therefore left unchanged.

4.3.2 Validation Results

The non-recreational trip production rates developed from the new household survey and the recreational trip rates in the model were applied to the model households at the zonal level. Table 4.18 shows the total model-estimated productions and attractions by trip purpose for the entire model area for an average weekday.

Table 4-18: Non-recreational Trip Generation Summary - Entire Model Area

Trip Purpose	Productions	Attractions
Home-Based Work	347,095	347,096
Home-Based School	148,056	148,056
Home-Based Shopping	188,826	188,825
Home-Based Other	739,265	739,265
Non-Home-Based Work	205,240	205,240
Non-Home-Based Non-Work	496,562	496,562
Home-Based College	39,403	39,403
Commercial	237,821	237,821
Trucks	74,014	74,014
Total - All Purposes	**2,476,282**	**2,476,282**
Person Trips /HH - Model	**7.4**	

Table 4.19 shows a comparison of the total trips by purpose from the model for an average weekday at the 4-county level with those from the household survey. Note that the model also estimates trips from group quarters separately, the rates of which were left unchanged. These trips are shown separately in the table. As can be seen, the total model estimated trips at the 4-county level (excluding those from group quarters) matches the total survey trips closely. The total person trips estimated per household of 7.1 also matches that from the survey well.

Table 4-19: Non-recreational Trip Generation Summary Comparison – 4-county level

Trip Purpose	Model - Total	Model - GQ	Model w/o GQ	Survey
Home-Based Work	256,784	0	256,784	253,591
Home-Based School	107,394	0	107,394	110,537
Home-Based Shopping	144,674	3,550	141,124	140,589
Home-Based Other	559,996	11,900	548,096	549,432
Non-Home-Based Work	152,602	0	152,602	150,444
Non-Home-Based Non-Work	380,217	11,242	368,975	366,368
Home-Based College	29,036	5,260	23,776	23,351
Commercial	191,118	0	191,118	
Trucks	59,620	0	59,620	
Total - All Purposes	**1,881,439**	**31,952**	**1,849,487**	
Person Trips /HH - Model			**7.1**	
Person Trips /HH - NJ HH Survey			**7.1**	
Total - excluding Comm/Truck	**1,630,701**	**31,952**	**1,598,749**	**1,594,312**

Table 4.20 shows the trip generation summary for the recreational trip purposes, for the entire model area for a full activity day.

Table 4-20: Recreational Trip Generation Summary Comparison

Trip Purpose	Productions	Attractions
Overnight Beach Access	53,046	52,961
Daytime Beach Access	20,538	20,489
Seasonal Work	17,418	17,418
Shore Visit	610,382	571,944
Casino Access	151,548	153,937
Event Access	6,345	6,345
Casino Bus	2,907	2,907
Casino Visit	14,620	14,620
Event Visit	6,813	6,812
Total - All Purposes	**883,616**	**847,433**

5 Trip Distribution

5.1 Model Calibration

The Household survey data captured trips that have both ends of their trip within the SJTDM area (I-I) and as well as external trips which have at least one end outside the model area (E-I, I-E and E-E trips). For the purposes of generating comparisons of average trip lengths and trip length frequency distributions from the model vs the survey for the internal trip purposes, the records corresponding to the external trips were excluded.

Each survey record was tagged with the origin and destination TAZ from the SJTDM. Distance skims from the model were also appended to the data.

The friction factors in the model for some trip purposes were calibrated to obtain a better match between the observed and modeled average trip lengths and trip length frequency distributions (TLFDs). Figures 5.1 to 5.4 show the final friction factors for the trip purposes that were calibrated. The friction factors for the remaining purposes produced satisfactory results.

Figure 5-1: HBW Friction Factors

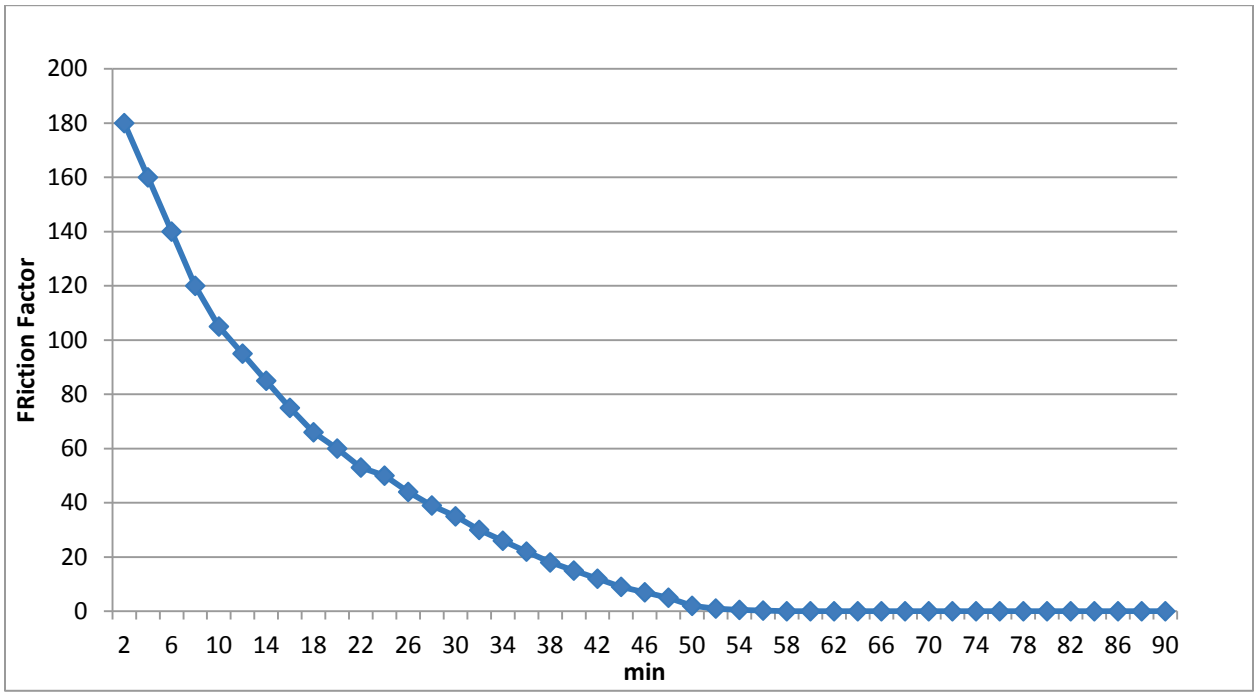


Figure 5-2: HB School Friction Factors

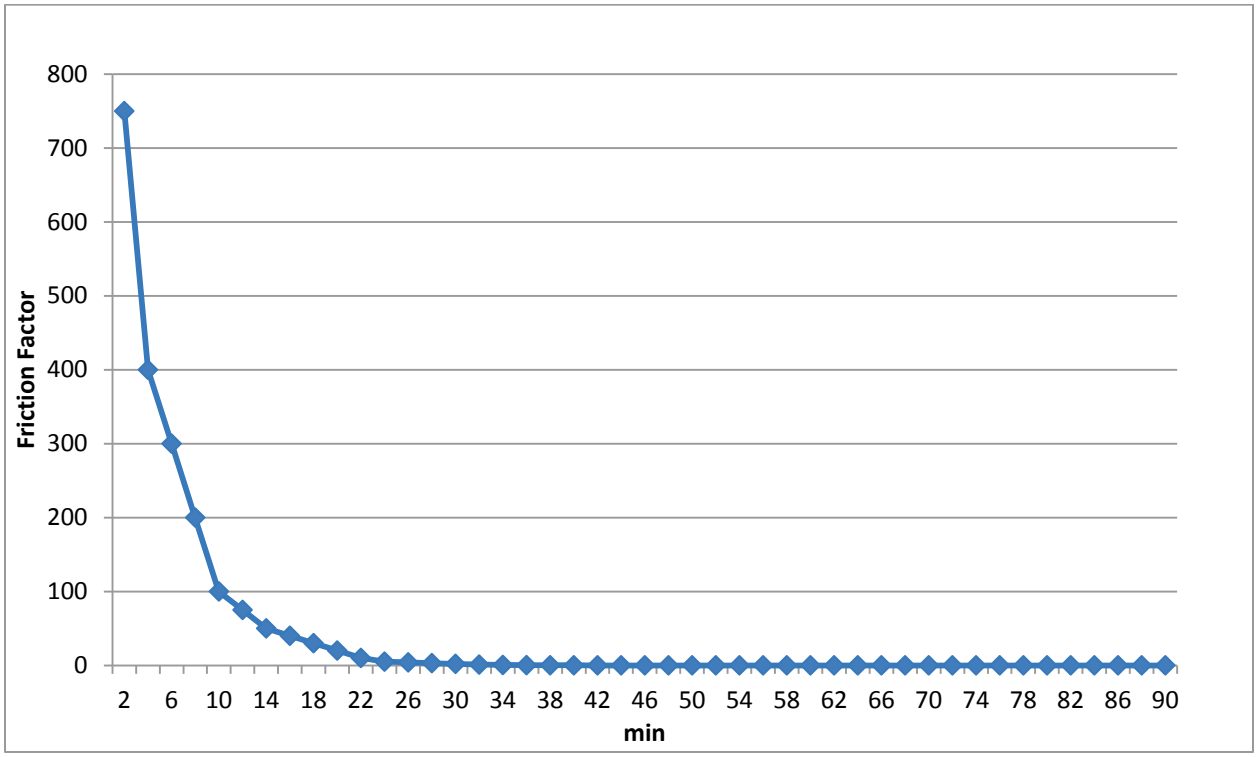


Figure 5-3: NHBNW Friction Factors

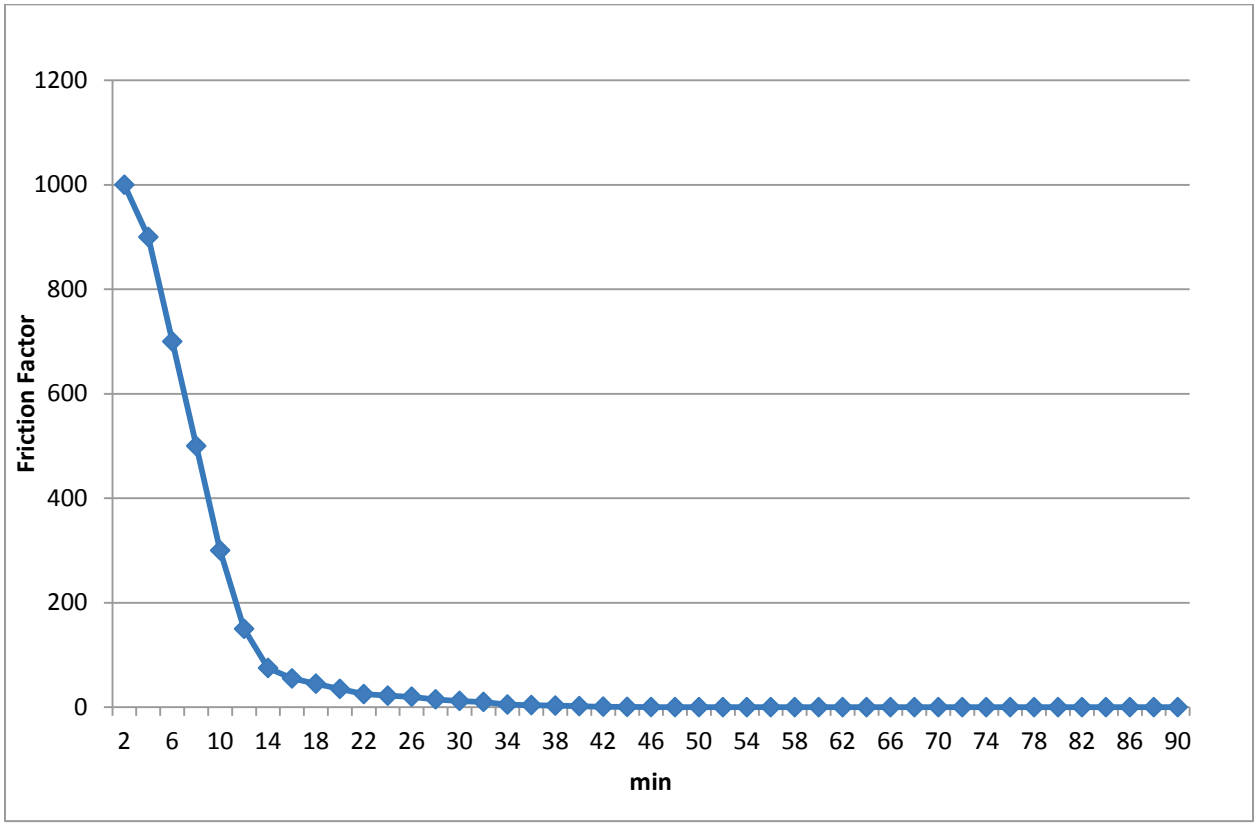
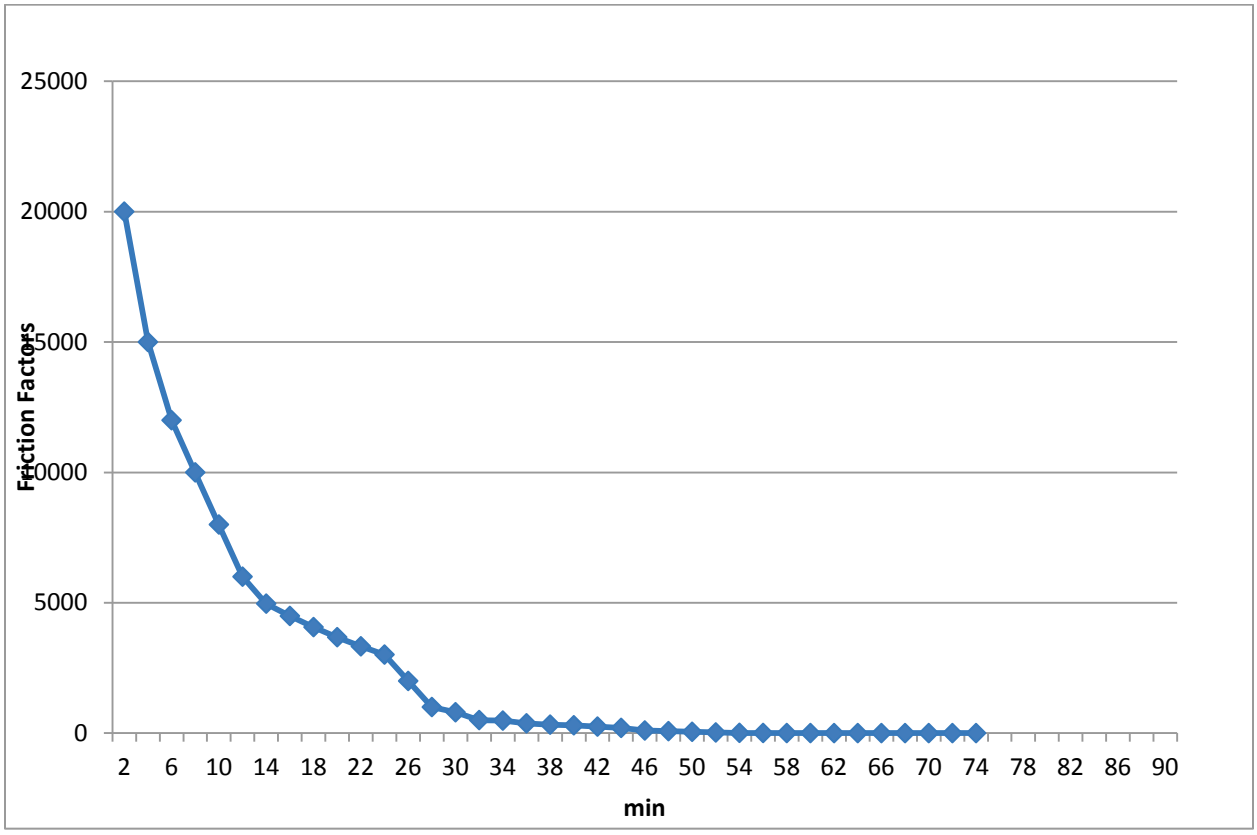


Figure 5-4: HB College Friction Factors



5.2 Validation Results

Table 5.1 presents a comparison of the average trip lengths (in minutes) by purpose between the 2014 survey and the 2013 base year model. A close match between the model and survey has been obtained for the most part. Table 5.2 presents a similar comparison on the basis of travel distance (miles). Note that the observed trip distance of 12.1 miles for the Home-Based College derived from the household survey did not seem reasonable relative to the observed travel times. College trips in the model were estimated using a process developed during the previous model update and calibrated using zip code data of college students. The resulting trip length from the model for this purpose was therefore not expected to be comparable to those from the household survey. Based on discussions with SJTPO staff, the zip code data was deemed to better reflect the college trip making characteristics.

Table 5-1: Comparison of Average Trip Lengths (minutes)

Trip Purpose	Model	Observed
Home-Based Work	24.6	23.6
Home-Based School	14.4	13.8
Home-Based Shopping	15.5	17.0
Home-Based Other	16.0	16.1
Non-Home-Based Work	19.1	18.7
Non-Home-Based Non-Work	17.9	16.8
Home-Based College	28.9	27.0

Table 5-2: Comparison of Average Trip Lengths (miles)

Trip Purpose	Model	Observed
Home-Based Work	13.2	11.1
Home-Based School	6.1	4.6
Home-Based Shopping	6.0	5.5
Home-Based Other	6.3	5.6
Non-Home-Based Work	9.5	7.3
Non-Home-Based Non-Work	7.7	5.4
Home-Based College	17.4	12.1

For the purposes of developing trip length frequency distributions (TLFDs) from the survey, the trips by purposes were grouped into 5 minute bins. Note that grouping of the survey data in bins smaller than 5 minutes revealed a very irregular pattern caused by the reporting of most trip travel times rounded to the nearest 5 minutes. Therefore, the model TLFD was also grouped in 5 minute intervals for comparison purposes. Figure 5.5 shows a comparison of the TLFD for the HBW purpose. Comparisons for the other purposes are shown in Figures 5.6 to 5.11. Overall, trip patterns between the survey and the recalibrated model are similar. A measure commonly used to quantify the fit between two distributions is the 'coincidence ratio', shown in Table 5.3. A ratio above 0.8 is generally indicative of a good fit. As can be seen, the coincidence ratios for almost all trip purposes are above 0.8 with the exception of the Home-Based College purpose which for reasons mentioned earlier cannot be expected to obtain a better fit.

Figure 5-5: Trip Length Frequency Distribution for HBW

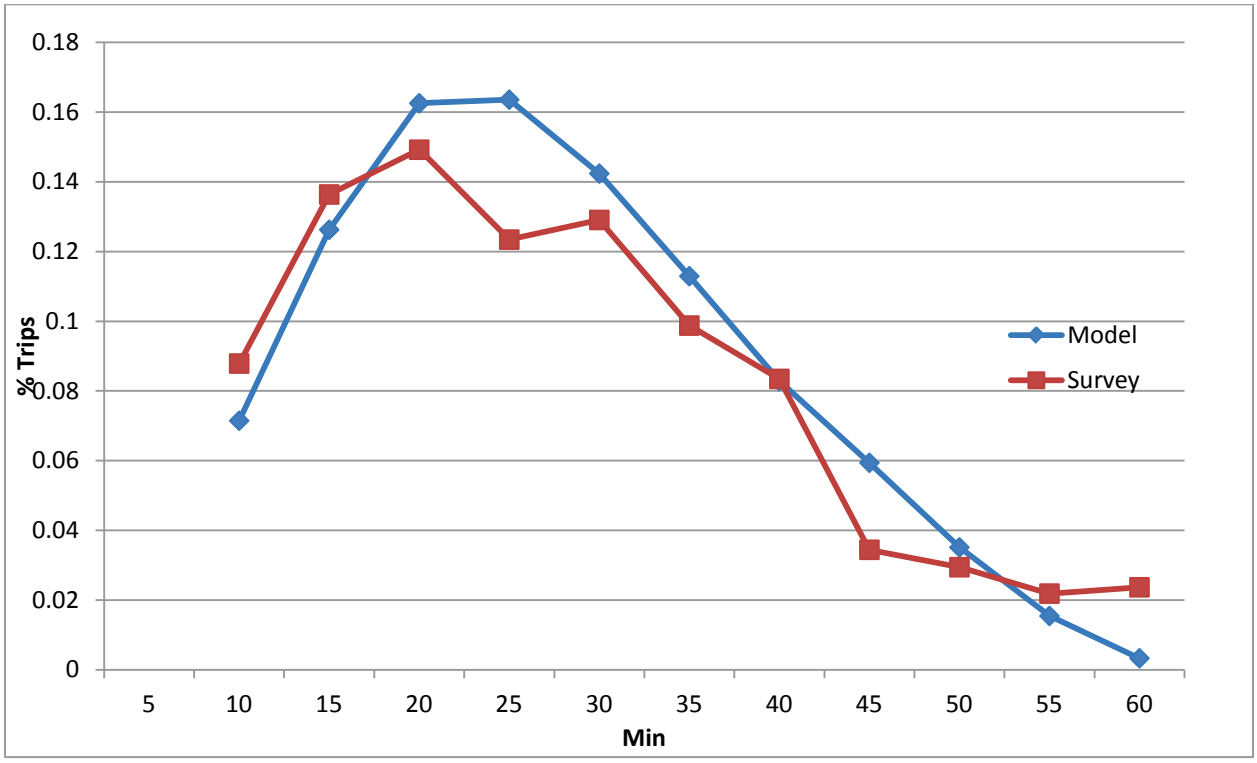


Figure 5-6: Trip Length Frequency Distribution for HBSchool

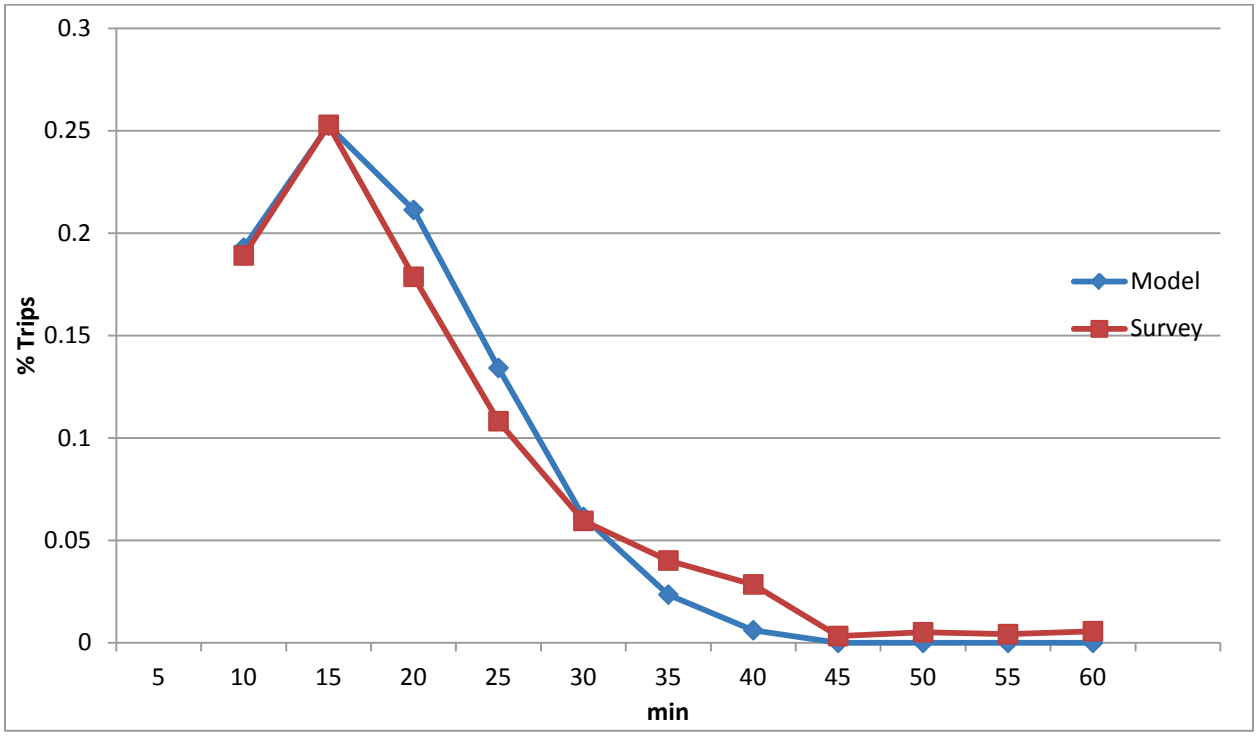


Figure 5-7: Trip Length Frequency Distribution for HBShop

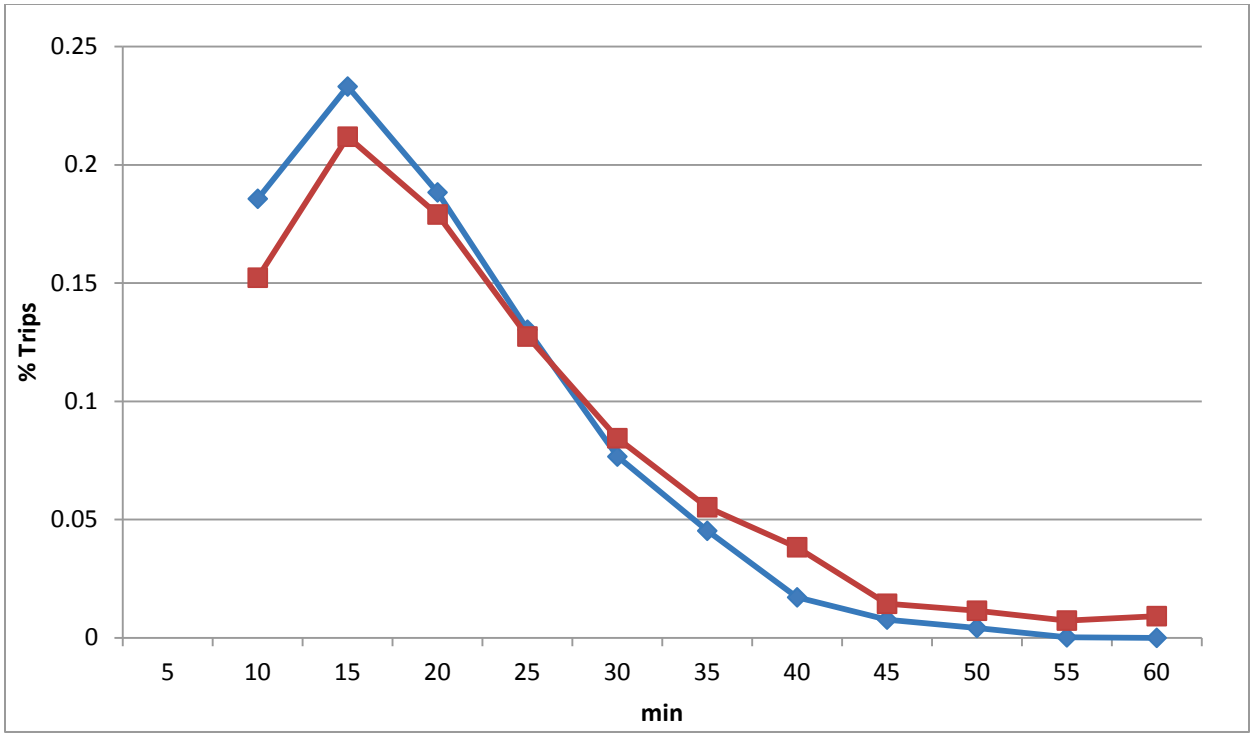


Figure 5-8: Trip Length Frequency Distribution for HBO

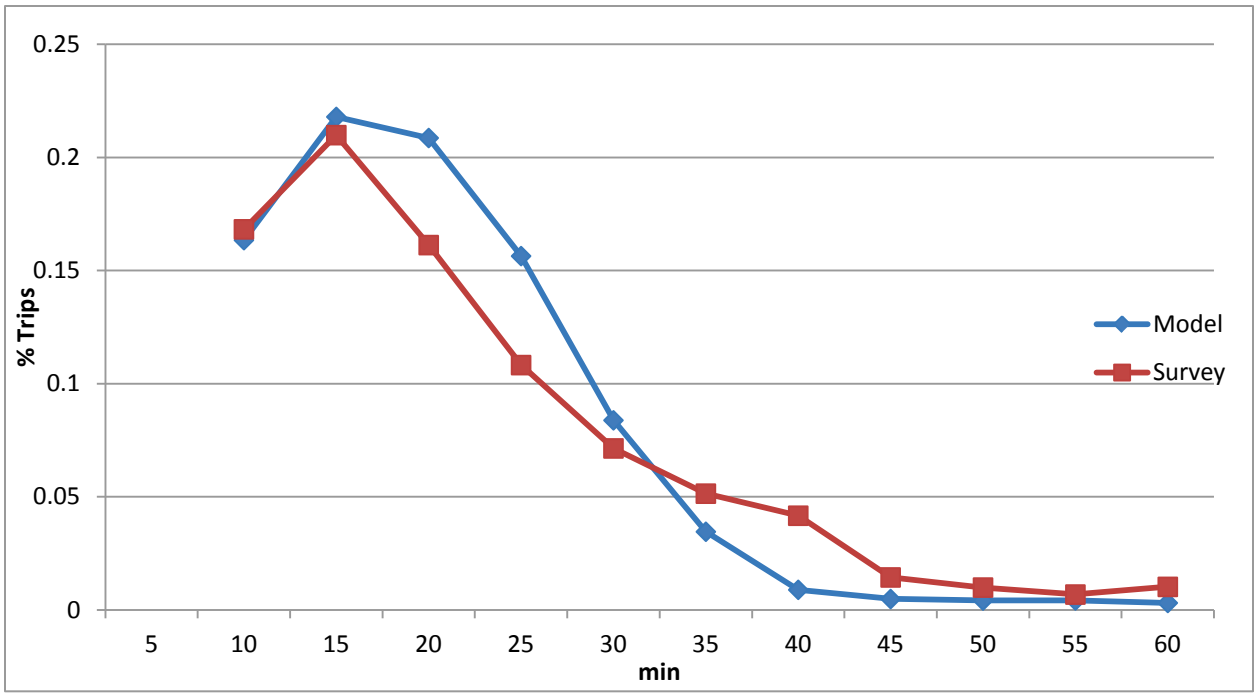


Figure 5-9: Trip Length Frequency Distribution for NHBW

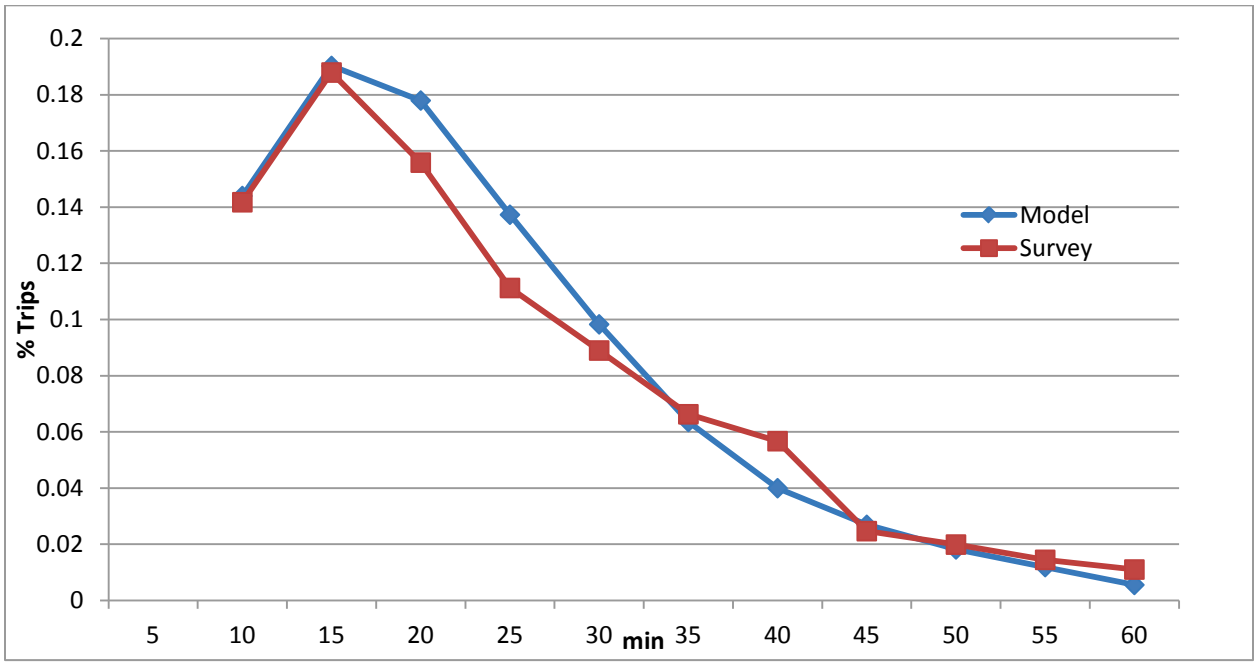


Figure 5-10: Trip Length Frequency Distribution for NHBNW

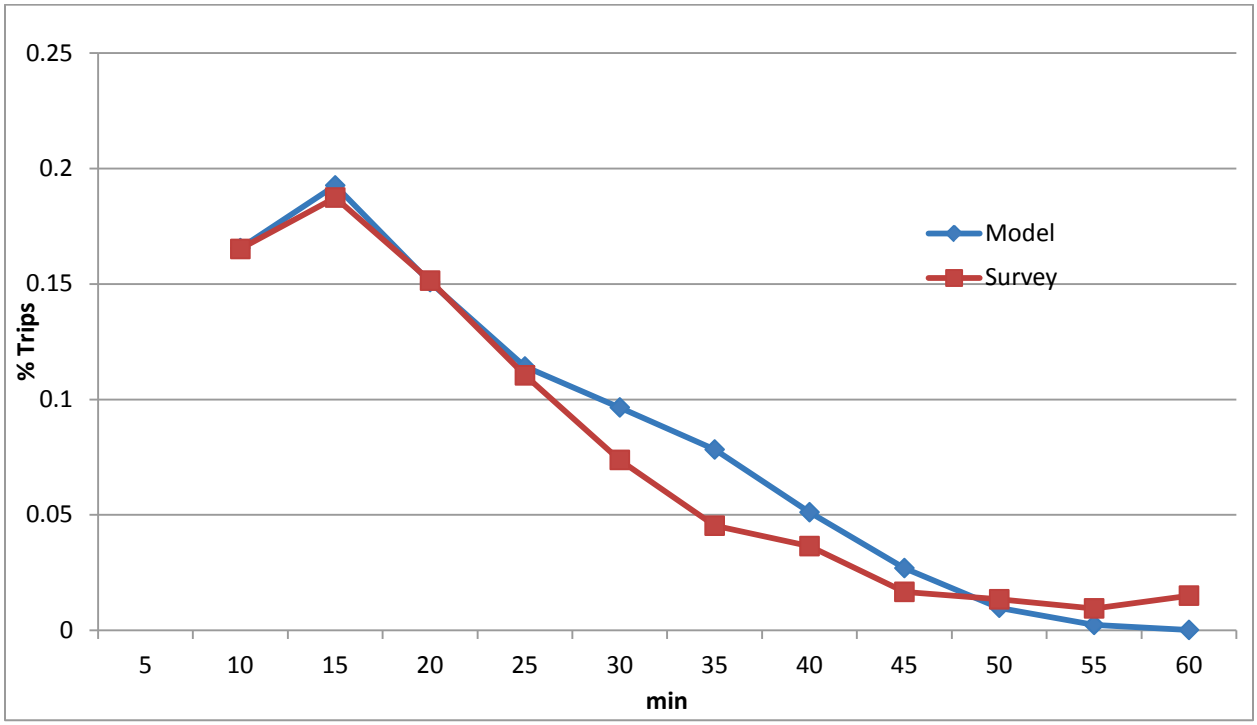
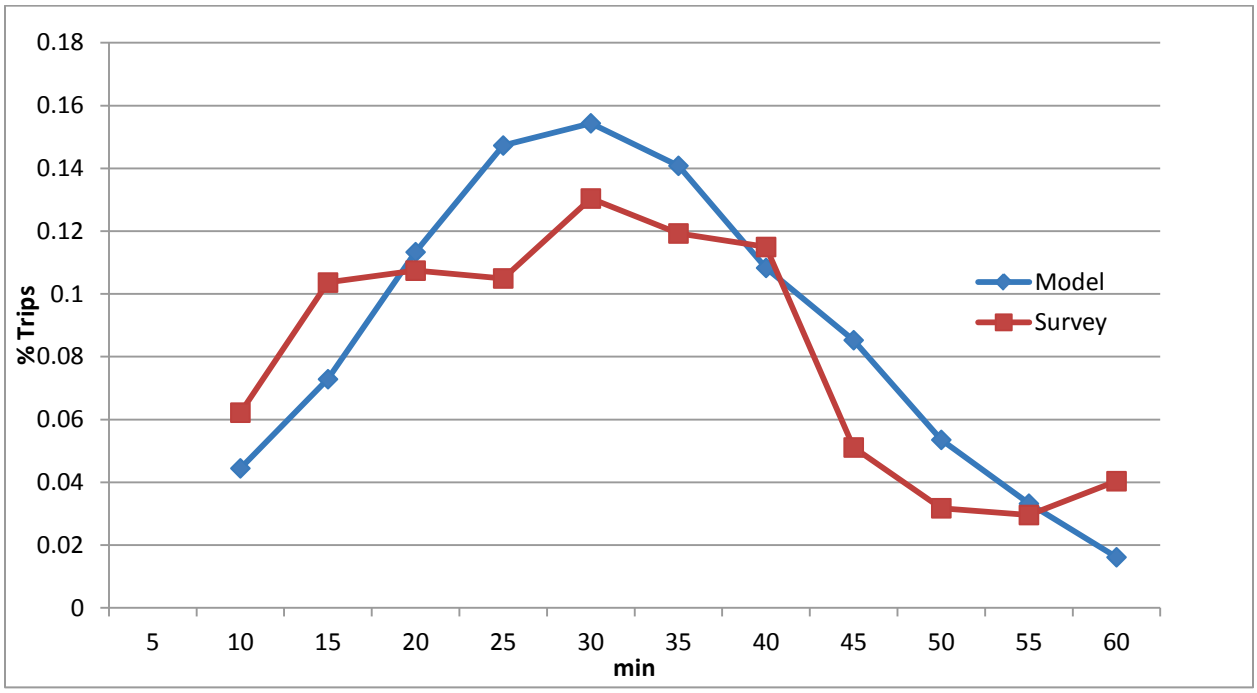


Figure 5-11: Trip Length Frequency Distribution for HBCollege



Another way to compare the model vs survey TLFD is to look at cumulative trips within a specified time band, i.e. how many trips have trip lengths of less than 15 minutes or 30 minutes. This method is not common, but provides an interesting way to analyze model vs survey trip length patterns. Figures 5.12 to 18 show comparisons of the TLFD on a cumulative basis. All purposes except HBSchool depict a reasonable match between model and survey.

Figure 5-12: Trip Length Frequency Distribution (Cumulative) for HBW

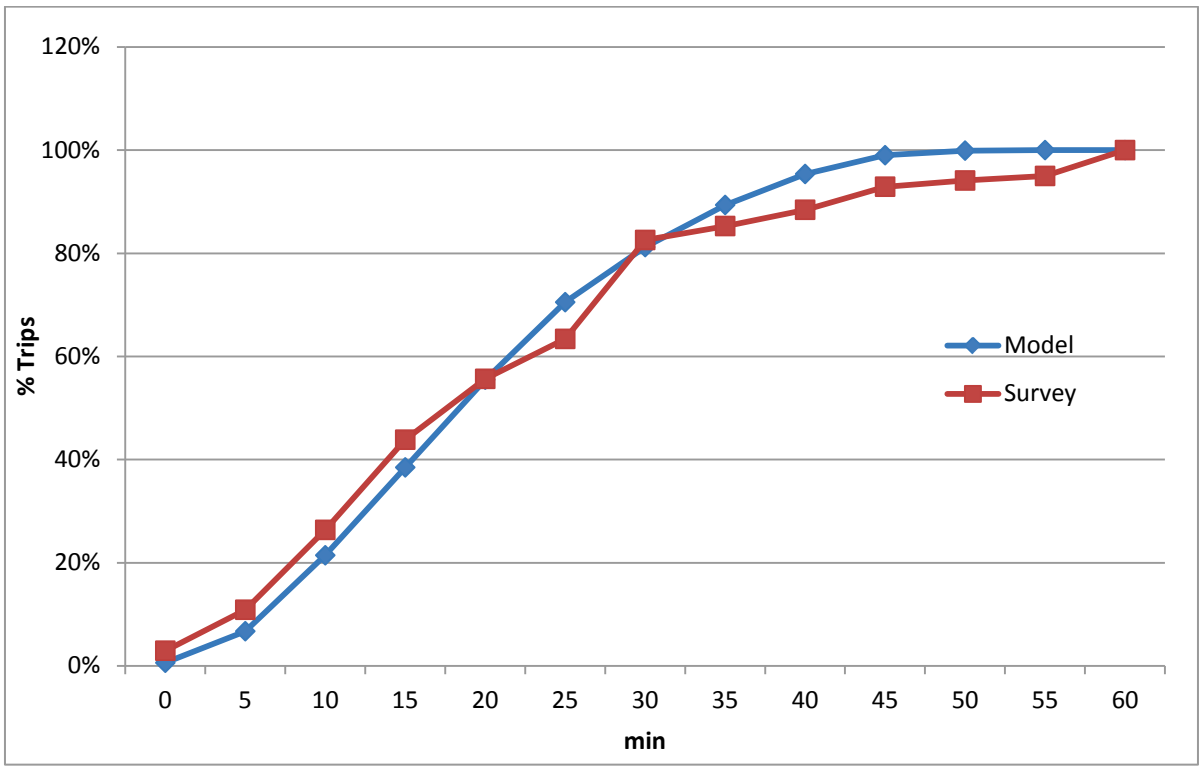


Figure 5-13: Trip Length Frequency Distribution (Cumulative) for HBSchool

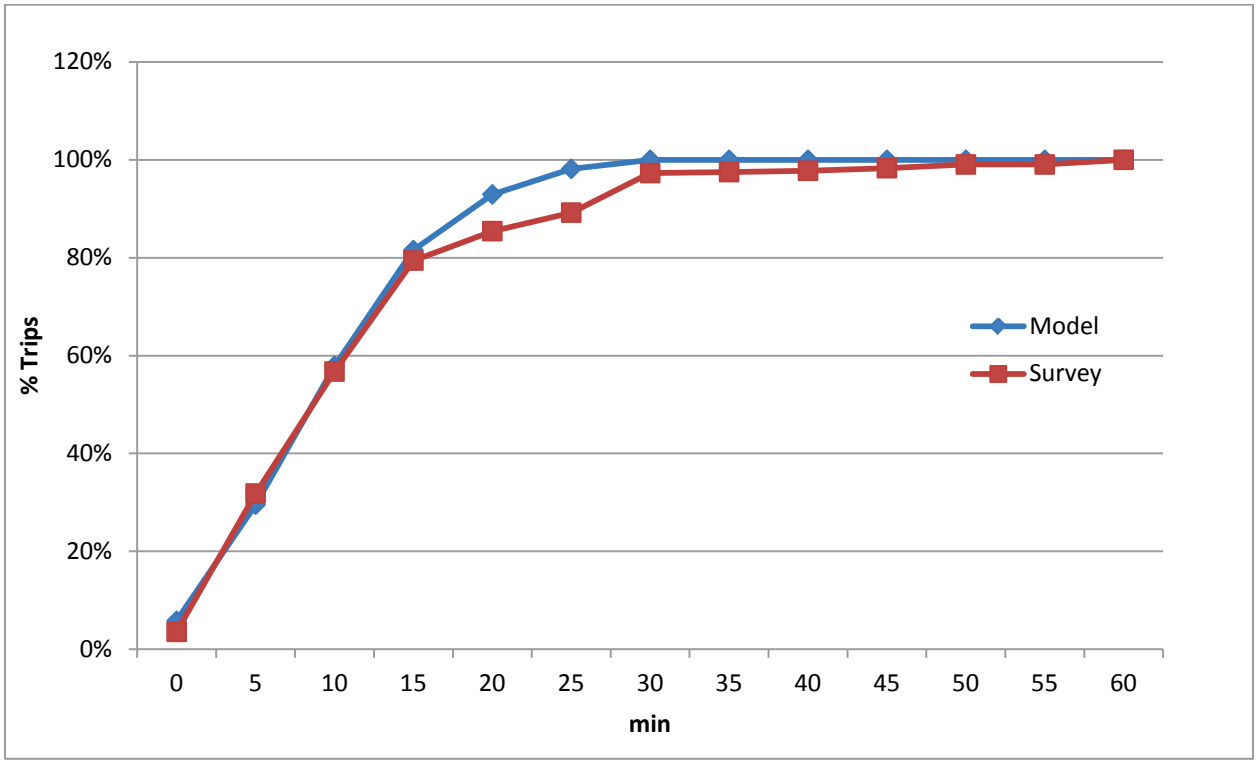


Figure 5-14: Trip Length Frequency Distribution (Cumulative) for HBShop

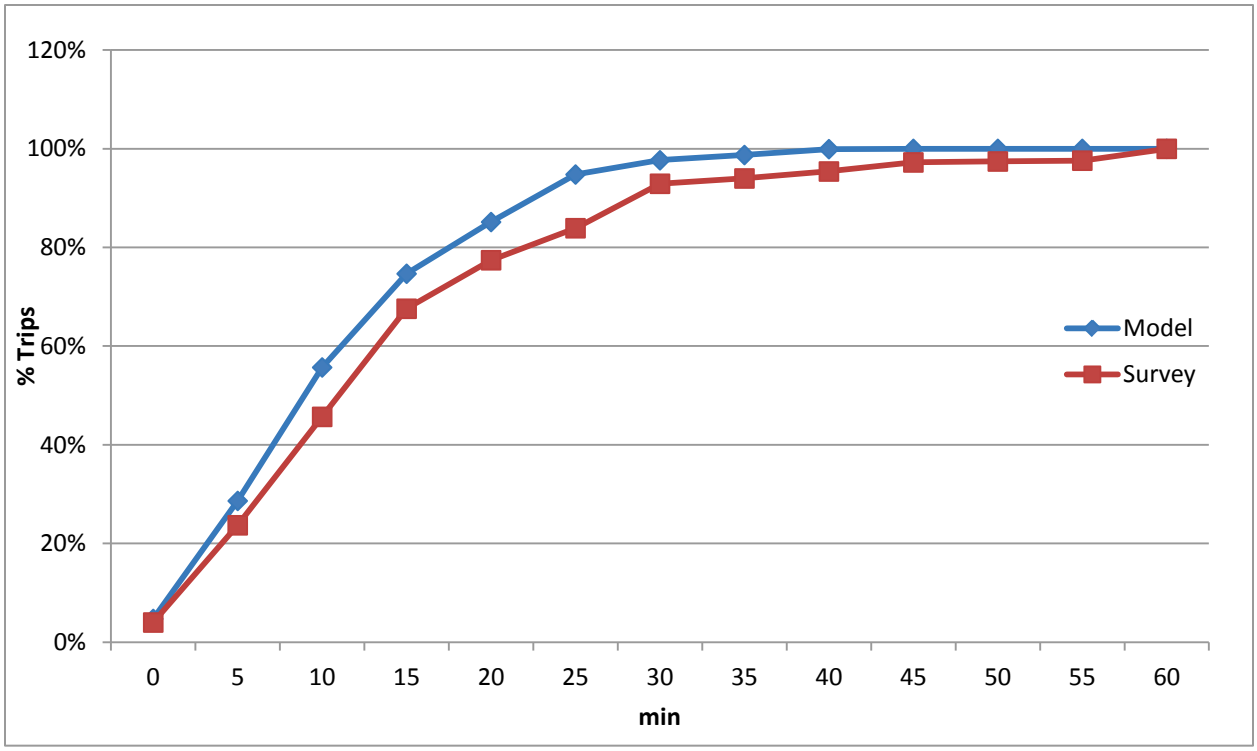


Figure 5-15: Trip Length Frequency Distribution (Cumulative) for HBO

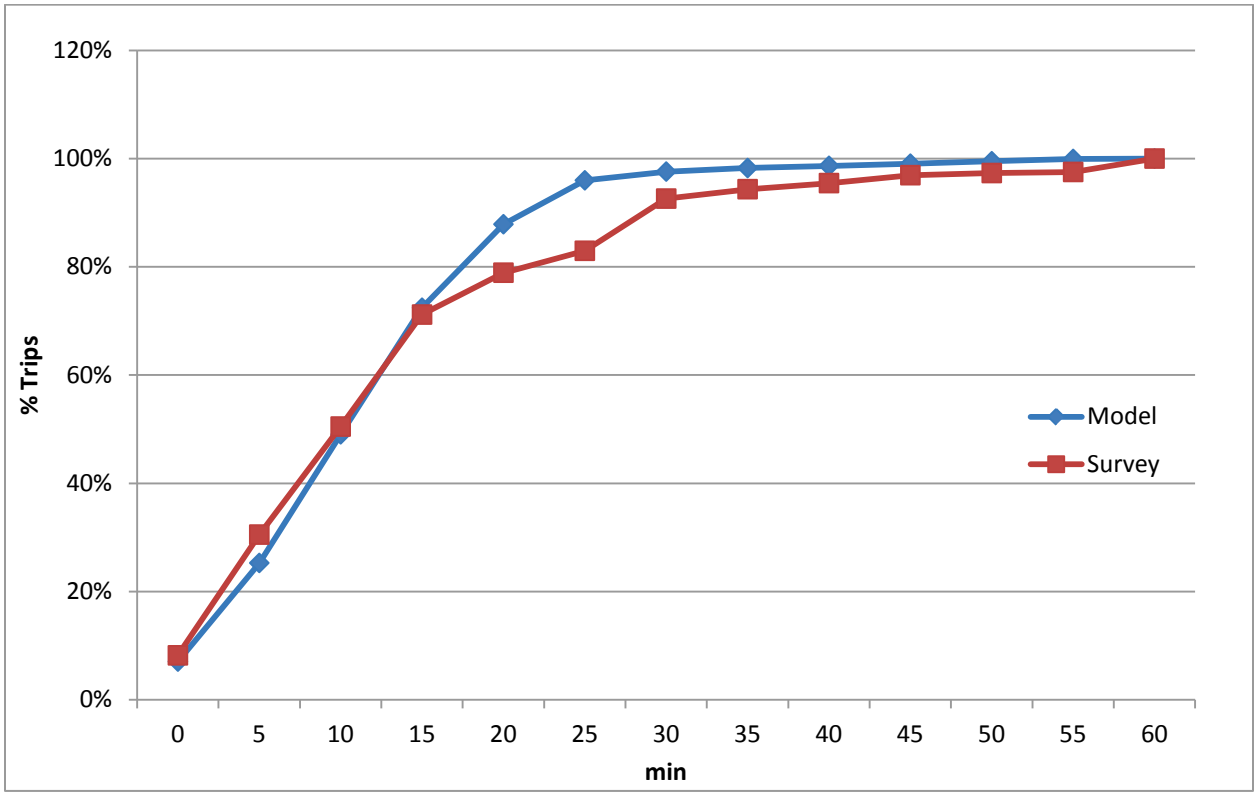


Figure 5-16: Trip Length Frequency Distribution (Cumulative) for NHBW

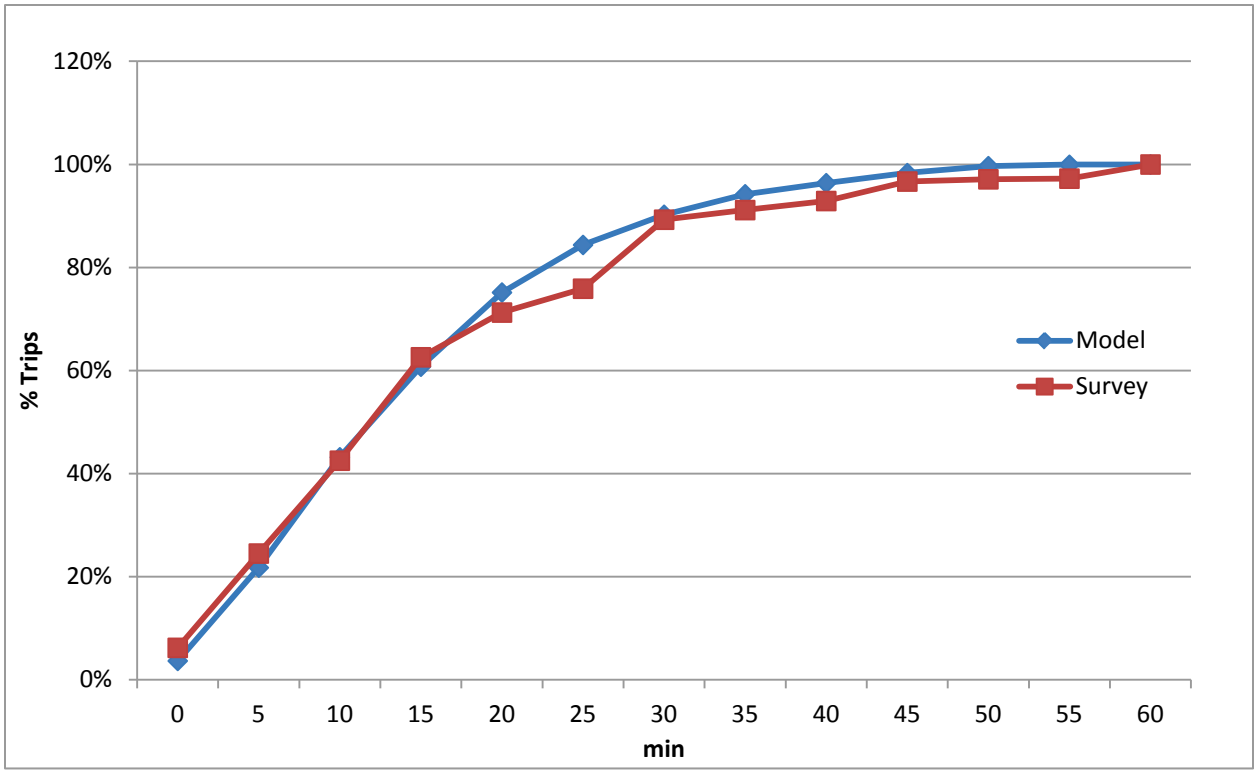


Figure 5-17: Trip Length Frequency Distribution (Cumulative) for NHBNW

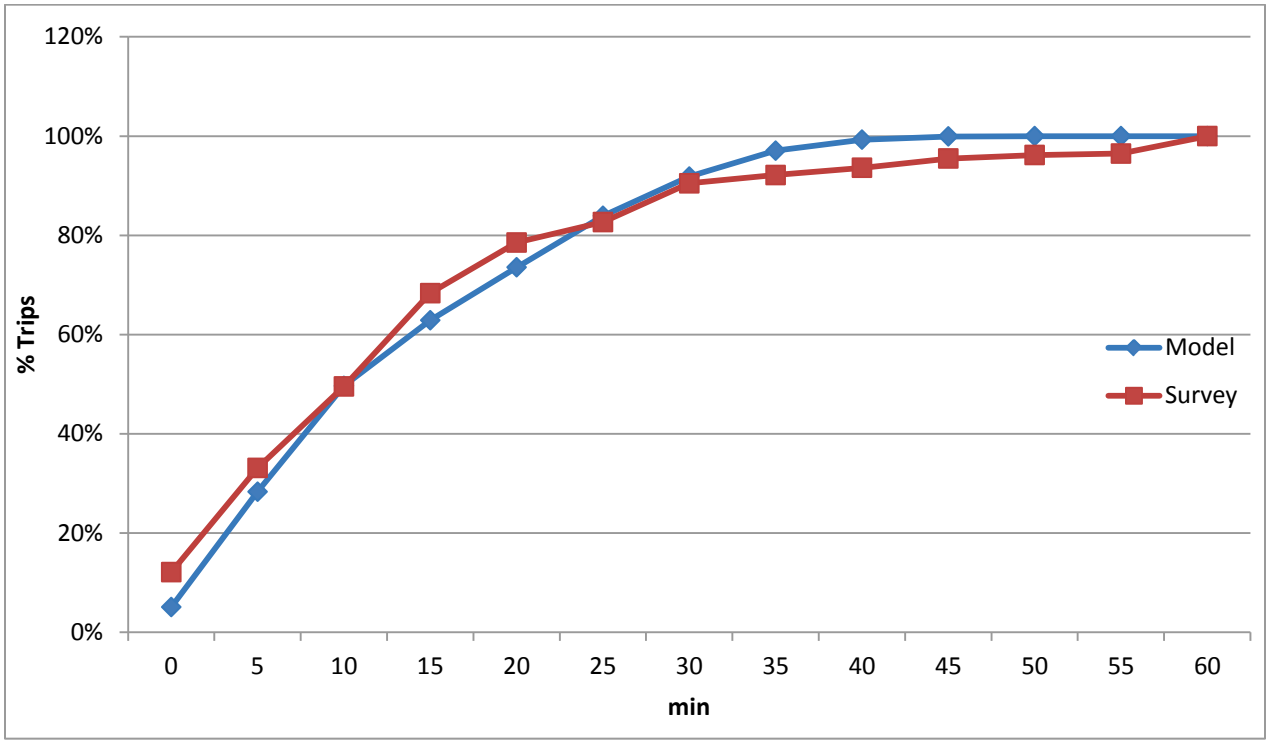


Figure 5-18: Trip Length Frequency Distribution (Cumulative) for HB College

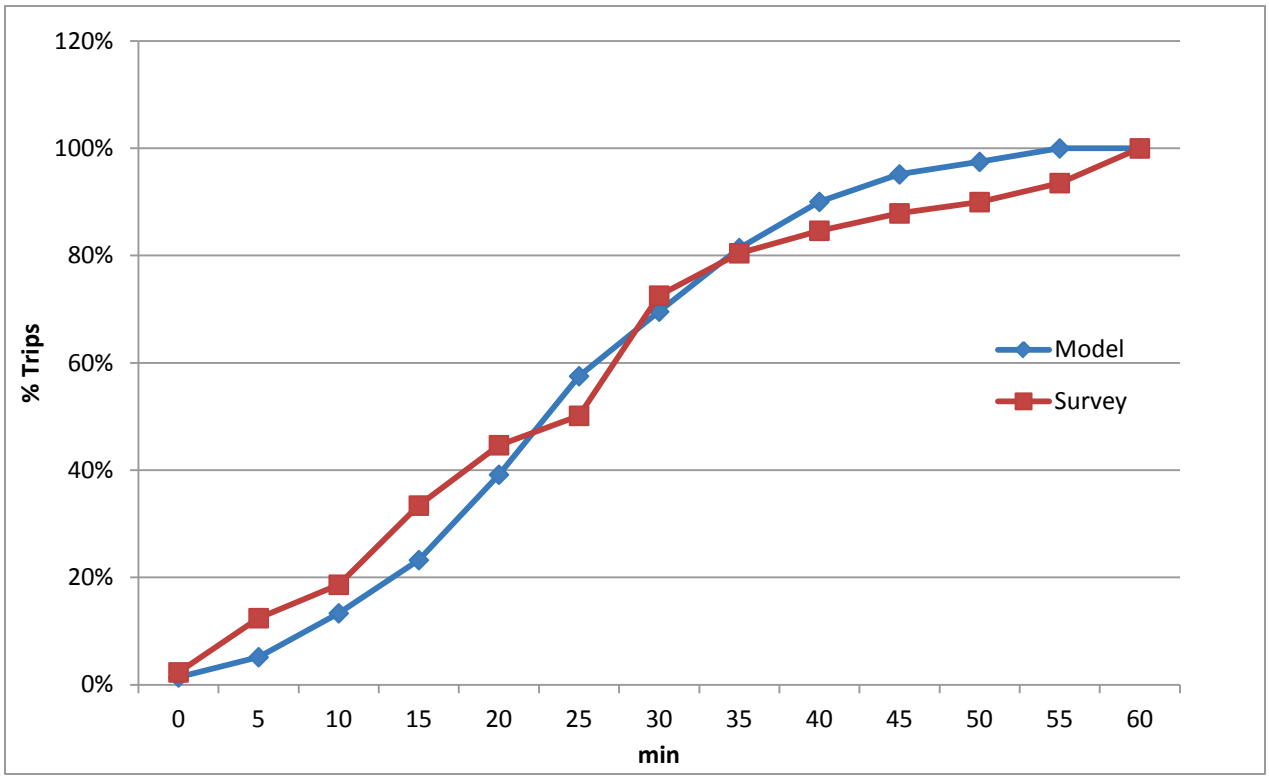


Table 5-3: Coincidence Ratios of Trip Length Frequency Distributions

Trip Purpose	Coincidence Ratio
Home-Based Work	0.84
Home-Based School	0.87
Home-Based Shopping	0.85
Home-Based Other	0.80
Non-Home-Based Work	0.90
Non-Home-Based Non-Work	0.87
Home-Based College	0.78

Table 5.4 shows a comparison of trip distribution from the four counties to major casino destinations, grouped by marina, uptown, midtown, and downtown.

Table 5-4: Comparison of Casino Access Trip Distribution

Survey

County of Residence	Casino District				Total
	Marina	Uptown	Midtown	Downtown	
Atlantic County	33.0%	26.1%	26.2%	14.5%	**100%**
Cape May County	32.7%	26.1%	26.3%	14.8%	**100%**
Cumberland County	30.4%	23.0%	31.0%	15.6%	**100%**
Salem County	34.8%	35.4%	21.0%	8.8%	**100%**
Total	**32.5%**	**26.0%**	**26.8%**	**14.5%**	**100%**

Model

County of Residence	Casino District				Total
	Marina	Uptown	Midtown	Downtown	
Cape May County	36.2%	25.7%	28.5%	9.6%	**100%**
Cumberland County	31.2%	24.9%	36.4%	7.5%	**100%**
Salem County	3.0%	11.2%	81.8%	4.0%	**100%**
Total	24.7%	22.6%	45.2%	7.5%	**100%**
Total	**29.4%**	**22.9%**	**39.4%**	**8.3%**	**100%**

6 Mode Choice

6.1 Model Calibration

The Household survey data captured trips that have both ends of their trip within the SJTDM area (I-I) and as well as external trips which have at least one end outside the model area (E-I, I-E and E-E trips). For the purposes of generating comparisons of mode shares from the model vs the survey for the internal trip purposes, the survey records corresponding to the external trips were excluded.

The mode shares observed from the household survey are shown in Table 6.1. Note that the mode categories in the survey data are different from that in the SJTDM. In order to determine Drive-Alone and Carpool mode shares in the survey for comparison with the model, additional data processing steps were needed. The trips reported as Auto/Van/Truck as the driver also included those involving carpools (vehicles with 2 or more occupants). Those trips were considered as carpool trips if the 'partysize' (which refers to total vehicle occupants) variable is greater than 1. The taxi/limo mode in the survey was also included as part of the carpool mode. The jitney and paratransit modes were combined with the public bus mode. Modes indicated as 'something else' was assumed to be drive-alone. Note that there were no survey responses in which the rail mode was utilized. The rail mode share was therefore derived using information from the transit onboard survey data.

Table 6-1: Mode Shares from Household Survey

Mode #	Mode	HBW	NHBW	NHBNW	HBO	HBShop	HBSch	HBCollege
1	Walk	5%	8%	10%	11%	6%	9%	9%
2	Bike	1%	1%	1%	2%	2%	0%	3%
3	Auto/Van/Truck (as the driver)	88%	84%	57%	62%	69%	7%	69%
4	Auto/Van/Truck (as a passenger)	5%	4%	21%	22%	21%	32%	11%
5	Public Bus/Local Bus	1%	3%	6%	1%	1%	2%	0%
6	Dial- a- ride/Paratransit	0%	0%	0%	0%	1%	0%	0%
7	Taxi/Limo	0%	0%	0%	0%	0%	0%	0%
8	School bus	0%	0%	3%	1%	0%	50%	8%
9	Moped	0%	0%	0%	0%	0%	0%	0%
10	JITNEY	0%	0%	1%	1%	0%	0%	0%
11	Don't travel to school	0%	0%	0%	0%	0%	0%	0%
97	Something else	0%	0%	0%	0%	0%	1%	0%
-7	Refused	0%	0%	0%	0%	0%	0%	0%
-8	Don't know	0%	0%	0%	0%	0%	0%	0%
Total		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

AECOM also reviewed the various transit on-board survey data provided by NJ Transit pertaining to buses in the South Jersey region as well as for the Atlantic City Rail line (ACRL). Mode shares were derived for each route for the duration of the time period that the survey was performed. Table 6.2 shows a summary of the average mode shares by access mode obtained from the various surveys. An average transit mode split by access mode was derived from these surveys for comparison with the model. For the bus mode, only the 2011 South Jersey Bus Study, 2008 Atlantic City Survey and 2008 South Jersey Bus Study were used to derive the average observed mode splits as the rest of the surveys are seasonal in

nature. For the rail mode, the Friday mode split from the ACRL survey is used to compare with the model which is also based on a weekday.

Table 6-2: Transit Access Mode Splits from Transit On-Board Surveys

Survey Source	Routes	Season/Month	Walk	Drive (Drove, Carpool, Dropped Off)	Transfer from Transit (Bus, Train, Jitney)	Other (Bike, Taxi, Other, Missing))
2011 South Jersey Bus Study	313, 315, 316, 468, 501, 502, 504, 505,	Spring and Summer	83%	5%	8%	4%
2008 Atlantic City Survey	552 ,554	Spring and Summer	70%	6%	18%	6%
2008 South Jersey Bus Study	400, 401, 402, 408, 410, 412	Fall (October)	83%	8%	6%	2%
2014 Intercity Bus Study	313, 315, 317, 319	Winter	51%	11%	19%	19%
2010 Route 319 Survey	319	Spring	13%	56%	21%	11%
2011 Recreational Transit Study	316	Summer Weekend	52%	29%	5%	14%
2012 Atlantic City Rail Survey	ACRL	Fall (September) Friday	17%	46%	31%	6%
		Fall (September) Saturday	12%	52%	29%	7%

The bus mode shares derived from the household survey were also adjusted slightly based on information obtained from the on-board survey data. Table 6.3 shows a summary of the observed mode shares for the SJTDM modes. Note that in the model, the College trips are combined with the NHBNW trips prior to the mode choice step.

Table 6-3: Observed Mode Shares (SJTDM modes)

Mode	HBW	NHBW	NHBNW	HBO	HBShop	HBSch
Drive-Alone	75.9%	69.2%	35.3%	38.8%	51.0%	2.8%
Carpool	14.8%	18.8%	50.6%	46.4%	40.6%	37.1%
School Bus	0.0%	0.0%	0.0%	0.0%	0.0%	49.8%
Bike-Walk	5.4%	8.2%	11.7%	13.1%	7.6%	9.3%
Bus	3.8%	3.9%	2.3%	1.8%	0.8%	0.9%
Rail	0.1%	0.0%	0.1%	0.0%	0.0%	0.0%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

The transit bias constants in the model for the non-recreational purposes were adjusted slightly to obtain a better match of mode shares between the model and the observed data. Table 6.4 shows the constants and the values that were modified highlighted in yellow.

Table 6-4: Transit Bias Constants – Non-Recreational Purposes

Mode	HBW Inc1	HBW Inc2	HBW Inc3	HBW Inc4	SCH Inc1	SCH Inc2	SCH Inc3	SCH Inc4
Carpool	-1.0000	-1.5000	-2.0000	-2.5000	4.0000	2.5000	2.5000	3.0000
Transit	0.7500	0.7500	0.7500	0.7500	-0.5000	-0.5000	-0.5000	-0.5000
Walk/Bike	6.0000	5.0000	4.0000	3.0000	6.0000	5.0000	4.0000	3.0000
Transit-Rail	0.2500	0.2500	0.2500	0.2500	0.6000	0.6000	0.6000	0.6000
Transit-Drive-Rail	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Transit-Drive-Bus	-0.2000	-0.2000	-0.2000	-0.2000	-0.5000	-0.5000	-0.5000	-0.5000
Walk/Bike - Bike	-7.6000	-7.9000	-8.7000	-2.8000	-2.3000	-2.4000	-1.8000	-1.5000

Mode	HBS Inc1	HBS Inc2	HBS Inc3	HBS Inc4	HBO Inc1	HBO Inc2	HBO Inc3	HBO Inc4
Carpool	-0.5000	-0.3000	-0.3000	-0.3000	0.2000	0.1000	0.1000	0.1000
Transit	-0.5000	-0.5000	-0.5000	-0.5000	-0.5000	-0.5000	-0.5000	-0.5000
Walk/Bike	-0.5000	-1.5000	-2.5000	-3.5000	3.5000	2.5000	1.0000	0.5000
Transit-Rail	0.6000	0.6000	0.6000	0.6000	0.6000	0.6000	0.6000	0.6000
Transit-Drive-Rail	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Transit-Drive-Bus	-0.5000	-0.5000	-0.5000	-0.5000	-0.5000	-0.5000	-0.5000	-0.5000
Walk/Bike - Bike					-1.9000	-2.2000	-2.2000	-2.2000

Mode	NHBW	NHBNW
Carpool	-1.7500	0.2500
Transit	0.2500	0.2500
Walk/Bike	-1.2500	3.2500
Transit-Rail	0.2500	0.2500
Transit-Drive-Rail	-0.5000	-0.5000
Transit-Drive-Bus	-0.2500	-0.2500
Walk/Bike - Bike		-4.0000

The mode share information for the recreational purposes derived from the shore survey did not seem reasonable. It was therefore assumed that the mode shares in the model that were previously calibrated using the comprehensive Beach Survey done in 1996 was valid. The transit bias constants for the recreational purposes were left unaltered.

6.2 Validation Results

Table 6.5 shows a comparison of the base year 2013 mode shares from the recalibrated model along with those from the survey for the non-recreational purposes.

Table 6-5: Mode Share Validation Results – Non-recreational purposes

Purpose	Mode	Model	Observed
HBW	Drive-Alone	79.0%	75.9%
	CarPool	13.2%	14.8%
	School Bus	0.0%	0.0%
	Bike-Walk	4.3%	5.4%
	Bus	3.1%	3.8%
	Rail	0.4%	0.1%
	Total	**100%**	**100%**
SCH	Drive-Alone	2.4%	2.8%
	CarPool	38.5%	37.1%
	School Bus	51.2%	49.8%
	Bike-Walk	8.0%	9.3%
	Bus	0.0%	0.9%
	Rail	0.0%	0.0%
	Total	**100%**	**100%**
HBS	Drive-Alone	53.5%	51.0%
	CarPool	38.1%	40.6%
	School Bus	0.0%	0.0%
	Bike-Walk	6.3%	7.6%
	Bus	2.0%	0.8%
	Rail	0.2%	0.0%
	Total	**100%**	**100%**

Purpose	Mode	Model	Observed
HBO	Drive-Alone	38.0%	38.8%
	CarPool	47.2%	46.4%
	School Bus	0.0%	0.0%
	Bike-Walk	13.7%	13.1%
	Bus	1.1%	1.8%
	Rail	0.0%	0.0%
	Total	**100%**	**100%**
NHBW	Drive-Alone	74.3%	69.2%
	CarPool	15.4%	18.8%
	School Bus	0.0%	0.0%
	Bike-Walk	6.3%	8.2%
	Bus	3.7%	3.9%
	Rail	0.3%	0.0%
	Total	**100%**	**100%**
NHBNW	Drive-Alone	35.3%	35.3%
	CarPool	52.7%	50.6%
	School Bus	0.0%	0.0%
	Bike-Walk	9.6%	11.7%
	Bus	2.3%	2.3%
	Rail	0.1%	0.1%
	Total	**100%**	**100%**

Table 6.6 shows the model-estimated mode shares for the recreational purposes.

Table 6-6: Model-Estimated mode shares – Recreational purposes

Purpose	Mode	Mode Share
BAC	Drive-Alone	0.3%
	CarPool	99.6%
	Bike-Walk	0.0%
	Bus	0.0%
	Rail	0.0%
	Total	**100%**
DAC	Drive-Alone	2.7%
	CarPool	97.1%
	Bike-Walk	0.1%
	Bus	0.1%
	Rail	0.0%
	Total	**100%**
SWK	Drive-Alone	76.9%
	CarPool	17.3%
	Bike-Walk	0.4%
	Bus	5.1%
	Rail	0.2%
	Total	**100%**
SHV	Drive-Alone	1.3%
	CarPool	43.0%
	Bike-Walk	55.7%
	Bus	0.1%
	Rail	0.0%
	Total	**100%**

Purpose	Mode	Mode Share
CAC	Drive-Alone	6.4%
	CarPool	92.6%
	Bike-Walk	0.0%
	Bus	0.2%
	Rail	0.8%
	Total	**100%**
EAC	Drive-Alone	6.4%
	CarPool	92.0%
	Bike-Walk	0.0%
	Bus	0.2%
	Rail	1.4%
	Total	**100%**
CVT	Drive-Alone	29.2%
	CarPool	46.3%
	Bike-Walk	22.9%
	Bus	1.6%
	Rail	0.0%
	Total	**100%**
EVT	Drive-Alone	25.9%
	CarPool	38.7%
	Bike-Walk	26.3%
	Bus	9.1%
	Rail	0.0%
	Total	**100%**

Table 6.7 shows a comparison of the average mode split between the walk and drive access modes based on the surveys listed in Table 6.2 with those from the base year 2013 model.

Table 6-7: Comparison of Transit Access Mode Split

Source	Bus		Rail	
	Walk-Access	Drive Access	Walk-Access	Drive Access
On-Board Surveys	92%	8%	27%	73%
Model	93%	7%	28%	72%

7 Assignment

7.1 Data Sources

Traffic counts were compiled by SJTPO staff for the years 2011 to 2013 from NJDOT. These counts were supplemented by AECOM for Garden State Parkway.

Transit ridership data was obtained from NJ Transit for Bus and Atlantic City Rail routes, as shown earlier in Table 6.2

7.2 Validation Results

7.2.1 Systemwide Validation

A comparison of model-estimated volumes by volume groups is shown in Table 7.1. It can be seen that an acceptable level of match has been obtained between the model and the observed traffic counts.

Table 7-1: Highway Assignment Validation by Volume Groups

Volume Group	Count Range	Model RMSE (%)	Max. Recommended RMSE Range*	Volume	Count	Volume/Count	No. of Links
1	1- 5,000	41%	45 - 55%	1,231,743	1,184,455	1.04	501
2	5,000- 10,000	38%	35 - 45%	1,608,821	1,703,416	0.94	247
3	10,000- 20,000	29%	27 - 35%	1,176,135	1,136,129	1.04	80
4	20,000- 30,000	20%	24 - 27%	801,030	797,650	1.00	34
5	30,000- 40,000	14%	22 - 24%	84,088	93,978	0.89	3
6	40,000- 50,000	7%	20 - 22%	87,591	92,424	0.95	2
ALL	**1-500,000**	**38%**	**32 - 39%**	**4,989,408**	**5,008,052**	**1.00**	**867**

*Source: Travel Model Validation and Reasonableness Checking Manual, 2nd Edition (FHWA – Sep 2010)

Table 7.2 shows a comparison of the volumes and counts by facility type and area type. Table 7.3 shows the ratios of volume and count and number of links with counts, by facility type and area type.

Table 7-2: Highway Assignment Validation by Facility Type and Area Type

Volume

FT\AT	1	2	3	4	Total
1	0	54,832	222,501	1,175,759	**1,453,092**
2	0	0	0	71,149	**71,149**
3	108,188	210,132	175,895	1,288,317	**1,782,532**
4	0	0	0	24,096	**24,096**
5	58,460	50,067	162,169	643,656	**914,352**
6	31,935	69,200	52,415	153,114	**306,664**
7	0	5,055	12,638	59,777	**77,470**
8	0	16,449	33,089	106,067	**155,605**
9	5,786	7,543	5,791	27,702	**46,822**
10	2,165	3,637	0	2,200	**8,002**
11	0	2,657	68,919	78,022	**149,598**
Total	**206,534**	**419,572**	**733,418**	**3,629,860**	**4,989,384**

Count

FT\AT	1	2	3	4	Total
1	0	53,447	191,523	1,115,802	**1,360,772**
2	0	0	0	80,876	**80,876**
3	110,910	216,448	176,682	1,243,601	**1,747,641**
4	0	0	0	18,650	**18,650**
5	66,374	57,671	187,934	685,637	**997,616**
6	35,416	44,801	50,322	175,356	**305,895**
7	0	7,218	12,080	58,647	**77,945**
8	0	18,398	43,208	116,787	**178,393**
9	10,108	18,810	7,390	26,040	**62,348**
10	3,864	4,890	0	1,150	**9,904**
11	0	3,283	69,228	95,501	**168,012**
Total	**226,672**	**424,966**	**738,367**	**3,618,047**	**5,008,052**

Table 7-3: Volume/Count Ratio and number of links with counts by Facility Type and Area Type

Volume/Count

FT\AT	1	2	3	4	Total
1	0.00	1.03	1.16	1.05	**1.07**
2	0.00	0.00	0.00	0.88	**0.88**
3	0.98	0.97	1.00	1.04	**1.02**
4	0.00	0.00	0.00	1.29	**1.29**
5	0.88	0.87	0.86	0.94	**0.92**
6	0.90	1.54	1.04	0.87	**1.00**
7	0.00	0.70	1.05	1.02	**0.99**
8	0.00	0.89	0.77	0.91	**0.87**
9	0.57	0.40	0.78	1.06	**0.75**
10	0.56	0.74	0.00	1.91	**0.81**
11	0.00	0.81	1.00	0.82	**0.89**
Total	**0.91**	**0.99**	**0.99**	**1.00**	**1.00**

 # Links

FT\AT	1	2	3	4	Total
1	0	3	11	54	**68**
2	0	0	0	4	**4**
3	14	30	20	185	**249**
4	0	0	0	4	**4**
5	10	16	36	198	**260**
6	6	11	14	54	**85**
7	0	2	2	16	**20**
8	0	4	12	79	**95**
9	4	4	4	18	**30**
10	3	4	0	4	**11**
11	0	1	15	25	**41**
Total	**37**	**75**	**114**	**641**	**867**

7.2.2 Screenline Validation

Figure 7.1 shows the nine screenlines included in the SJTDM. Table 7.4 shows a comparison of model volumes and counts along these screenlines. Overall, the screenline volumes are within 4% of the counts.

Figure 7-1: Screenline Locations

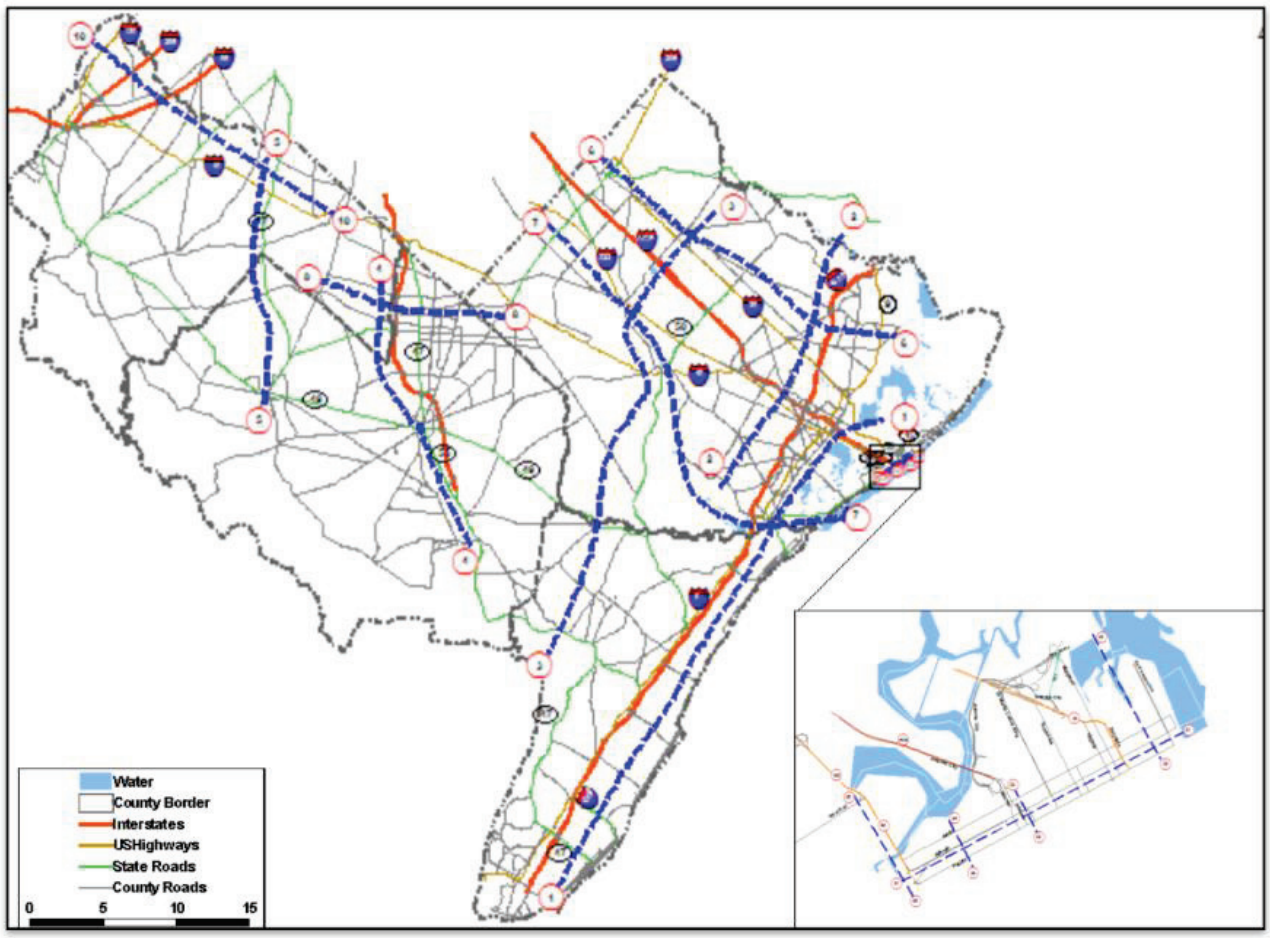


Table 7-4: Highway Validation Summary by Screenline

Screenline	# Links	Volume	Count	Volume/Count
1	20	203,664	197,393	1.03
2	16	136,277	114,919	1.19
3	16	63,883	47,958	1.33
4	12	58,856	67,013	0.88
5	8	28,530	40,044	0.71
6	16	52,829	56,102	0.94
7	4	18,300	16,080	1.14
8	11	64,435	59,221	1.09
9	12	62,612	64,675	0.97
Total	**115**	**689,386**	**663,405**	**1.04**

7.2.3 Transit Assignment Validation

Table 7.5 shows a comparison of model-estimated ridership with observed data by mode.

Table 7-5: Transit Validation Summary

Mode	Ridership	
	Model	Observed
Bus	31,836	32,226
Rail	3,622	3,280
Jitneys	11,379	21,920
Total	**46,837**	**57,426**
Excluding Jitneys	**35,458**	**35,506**