Baltimore Metropolitan Council InSITE Model

2019 Validation Documentation Update

prepared for

Baltimore Metropolitan Council

prepared by

Cambridge Systematics, Inc.

with

Gallop Corporation

July 2024

www.camsys.com

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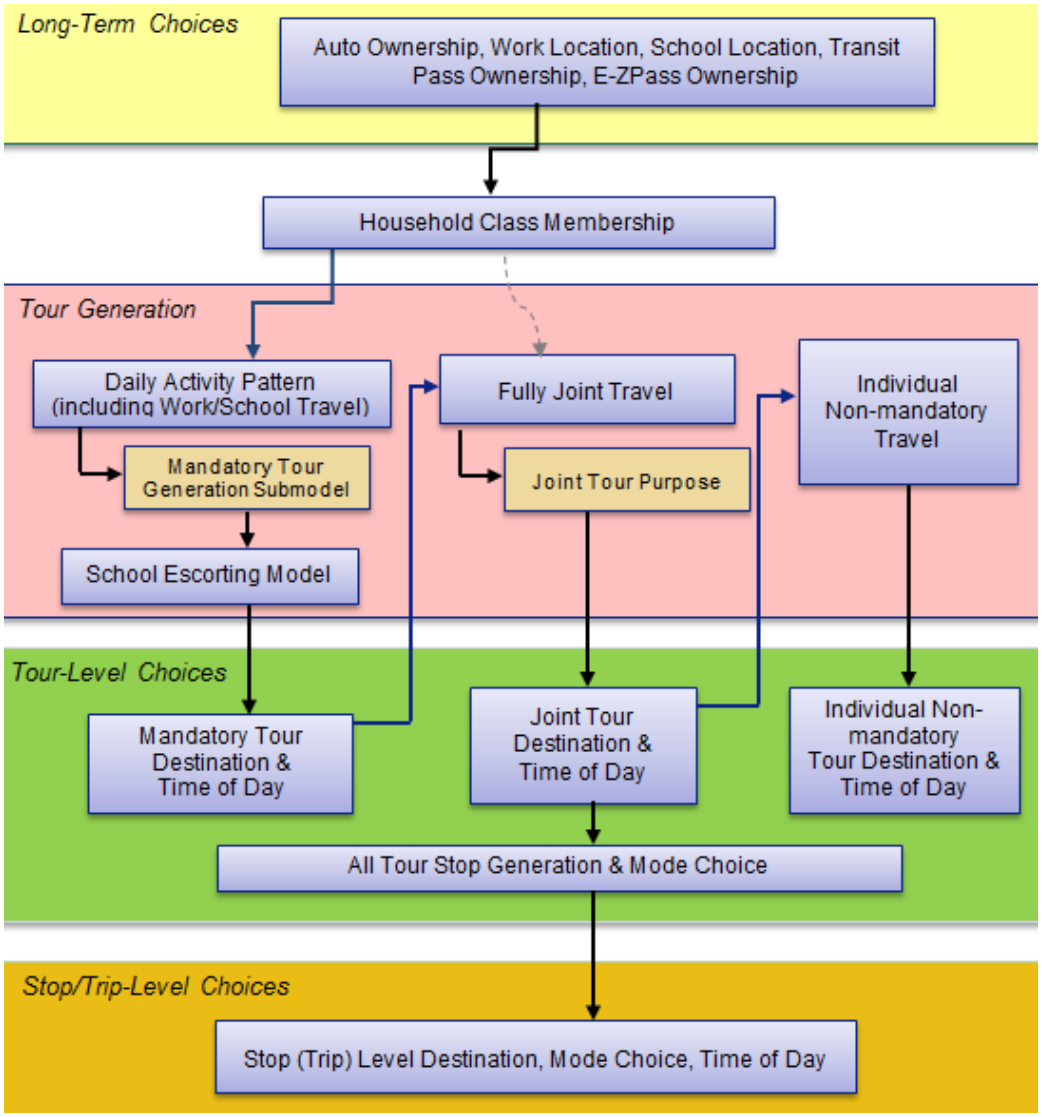
1.0 Introduction

This report summarizes the validation of the updated activity-based model, InSITE, developed for the Baltimore region. This model was originally competed in 2017 for the Baltimore Metropolitan Council (BMC) by a team led by Cambridge Systematics, Inc. (CS). CS, along with Gallop Corporation, and Whitman, Requardt and Associates, LLP (WRA) updated the model in 2022 to represent a base year of 2019 and to incorporate three new counties into the model region. In 2024, CS performed additional validation to incorporate additional changes to the model.

InSITE is applied disaggregately using a synthetic population, generated by the PopGen2 synthetic, representing the population of the model region, which includes the entire BMC region, plus the District of Columbia, the Maryland portion of the region covered by the Metropolitan Washington Council of Governments (MWCOG), and Adams and York Counties in Pennsylvania. The portion of Maryland in the model region consists of Baltimore City and Anne Arundel, Baltimore, Carroll, Harford, Howard, Frederick, Montgomery, Prince George's, and Queen Anne's Counties.

The model structure is shown in Figure 1.1. The activity and travel choices made by each household and person in the synthetic population are realized through Monte Carlo simulation, with the choice probabilities determined by the individual model components.

Figure 1.1. InSITE Activity Based Model Design



A model validation plan (Cambridge Systematics, Inc. et al., 2021) was developed prior to model development. This plan laid out the process that was followed for the model validation and specified the tests that were performed. The tests in the plan included verification of the input highway and transit skim data and the synthetic population data, checks of the results of all model components compared to the 2007-2008 regional household survey data set, and checks of the highway and transit assignment. The remainder of this report focuses on the checks of the activity and travel data from the model components and the assignment results. A listing of references is provided in Chapter 4.0.

1.1 Model Component Validation

Note that some of the smaller boxes in Figure 1.1 include multiple model components. The components that were validated include the following:

- Regular workplace location
- School location
- Vehicle availability
- Daily activity pattern (segmented by person type)
- School escorting
- Fully joint travel (number and purpose of tours)
- Individual non-mandatory tour generation
- Work based subtour generation
- Tour destination choice (segmented by aggregated tour purpose)
- Tour time of day choice (segmented by aggregated tour purpose)
- Tour stop generation (segmented by aggregated tour purpose)
- Tour mode choice (segmented by aggregated tour purpose)
- Stop destination choice
- Stop time of day choice
- Trip mode choice (segmented by aggregated tour purpose)

The tests consisted of comparisons of model results for various market segments to the expanded household survey data. These tests are summarized in Chapter 2.0.

1.2 Highway and Transit Assignment

Tests of the static, aggregate highway and transit assignment processes consist mainly of comparisons of model results to observed data, i.e., traffic and transit ridership counts. Highway assignment checks include:

- Volume/vehicle-miles traveled (VMT) by facility type
- Volume/VMT by area type
- Volume/VMT by county
- Volume/VMT by volume level
- Volume/VMT by time of day
- Volume/count ratio on key routes
- Sum of volumes on screenlines/cutlines

Transit assignment checks include:

- Boardings by service category (Metrobus local, Metrobus park-and-ride, MetroRail)
- Boardings by service category and geographic orientation, defined as follows:
    - Local-Radial
    - Local-Crosstown
    - Local-Circulator
    - Local-Limited
    - Local-Shuttle

    - Park-and-Ride-CBD
    - Park-and-Ride-Secondary
    - MetroRail
- Boardings per linked trip (transfer rate)
- Boardings by route
- Boardings by MetroRail station

The highway and transit assignment testing is summarized in Chapter 3.0.

2.0 Model Component Validation

This chapter summarizes the activity based model component validation. The tests consisted of comparisons of model results for various market segments to the expanded household survey data. These comparisons were done in Excel spreadsheet files. The model application software, TourCast, outputs .dbf files that were imported into a relational database and processed with stored procedures using MySQL. The processed summaries were exported to comma delimited files that can be read directly into the Excel spreadsheets, which were populated in advance with the survey data results. The model results presented in this chapter are based on a model application with three iterations of speed feedback.

The comparisons described in this chapter reflect model calibration adjustments. In some cases, model parameters were adjusted to produce more reasonable results although there was not a universal attempt to match all results from the expanded household survey for all market segments by adjusting model constants or other parameters. This type of adjustment was only made when the uncalibrated model results did not appear reasonable and the survey data results were based on a substantial number of observations. The specific calibration adjustments are documented in the Excel files.

Because of the extensive number of comparisons, the spreadsheet files themselves are incorporated as appendices to this report. The remainder of this chapter summarizes the validation results as presented in these spreadsheet files.

2.1 Long Term Choice Models

2.1.1 Regular Workplace Location

The regular workplace location model simulates for each worker in the synthetic population whether he or she has a regular workplace and the location of that workplace. The Excel file with the results of the regular workplace location model is *1 - Usual_Workplace.xlsm*. Table 2.1 summarizes the regional modeled and observed (from the survey data set) percentages of workers with regular workplaces. The model results show a lower percentage of workers with regular workplaces than the survey data, but the survey results appear to be high.

Table 2.1. Percentage of Workers by Type with Regular Workplaces

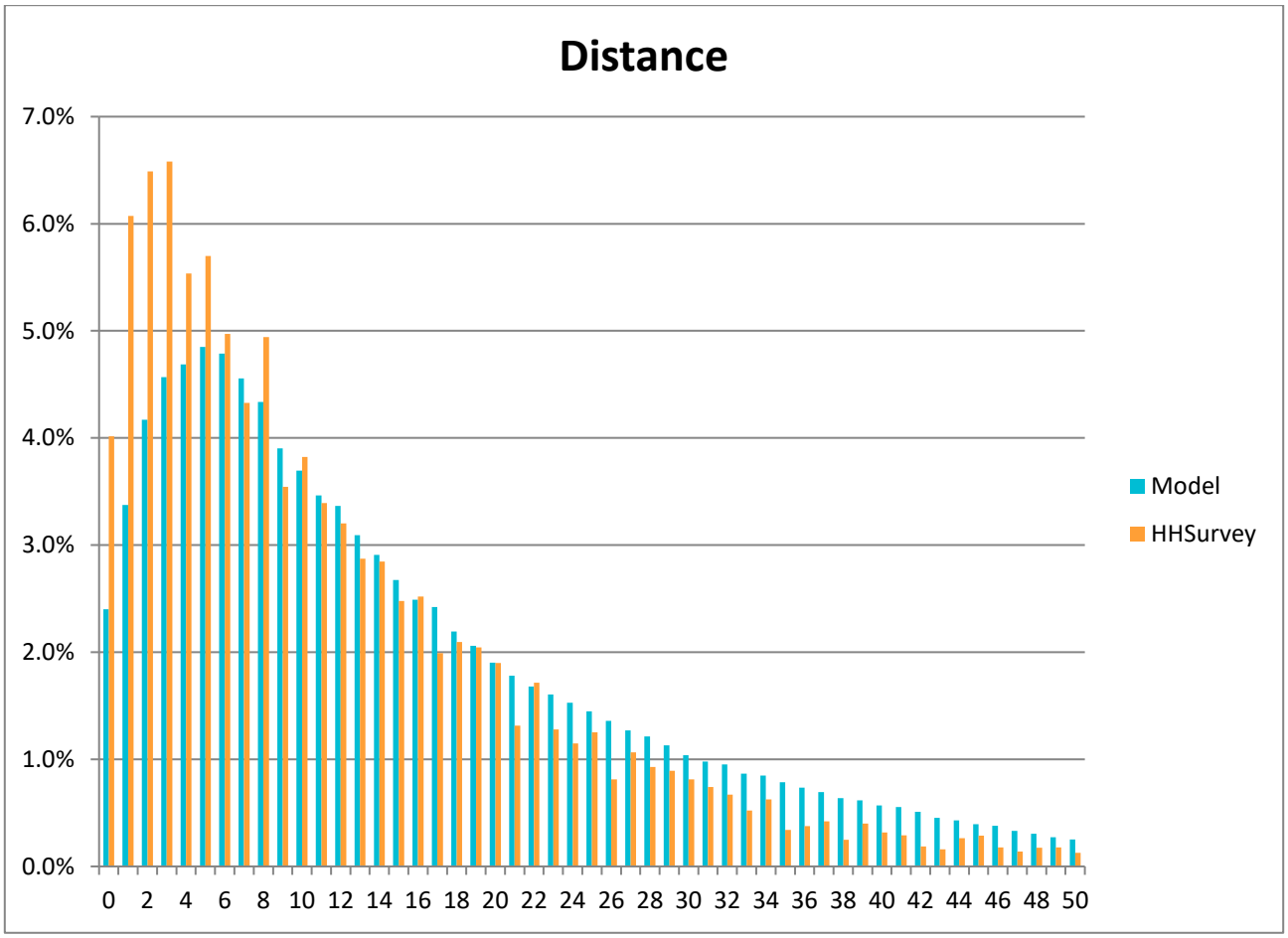
Expanded Survey Data			Model Results			
No Usual Workplace	Total	Percentage	No Usual Workplace	Total	Percentage	**Difference**
601,165	2,762,523	21.8%	69,886	764,949	9.1%	-12.7%

* - Model results represent 25% sample

Figure 2.1 shows the comparisons between the observed (survey) and modeled tour length distance frequency distribution. This figure shows a good fit; the coincidence ratio is 80 percent. The average

tour distances are 12.6 miles (observed) and 16.3 miles (modeled). The higher distance in the model resulted from calibration changes to address low volumes in the highway assignment.

Figure 2.1. Home to Regular Workplace Tour Length Frequency Distribution



The more detailed comparisons in the Excel file shows the following results:

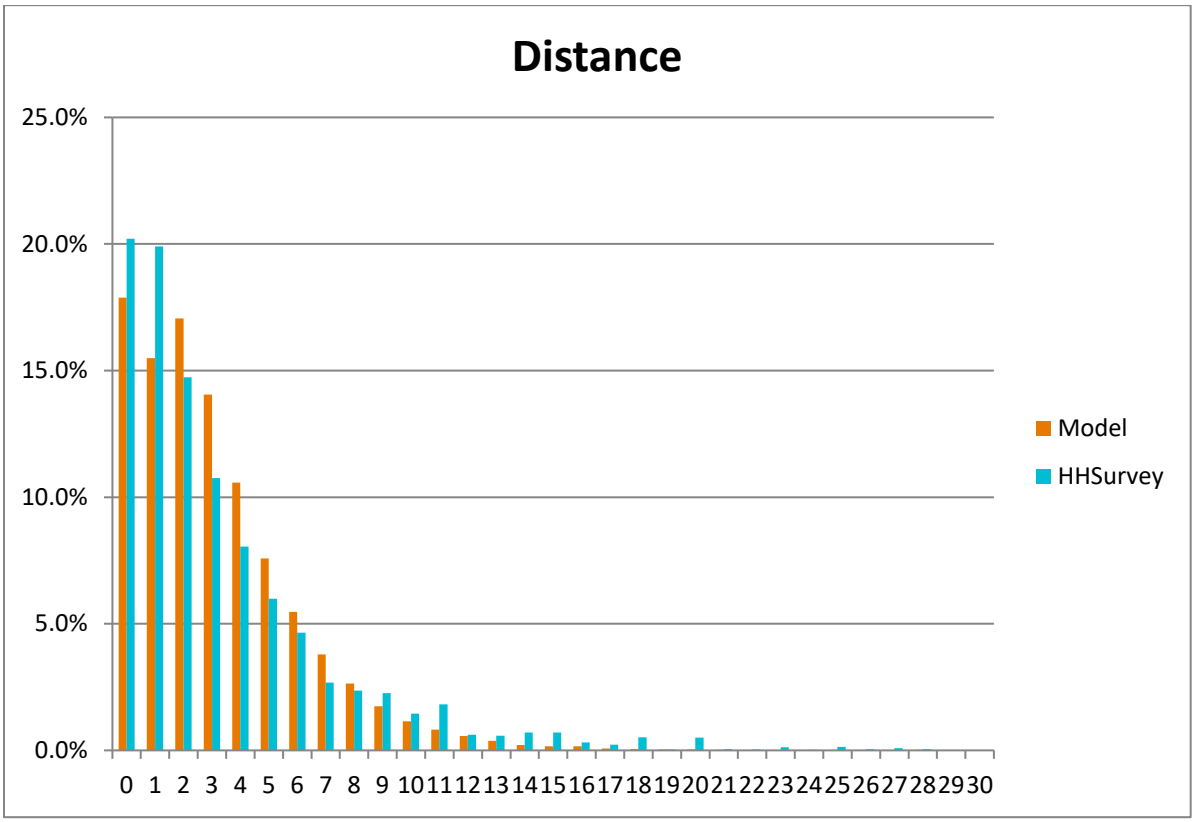
- The distance between home and the regular workplace increases with income, in both the survey data and model results.
- The distance between home and the regular workplace increases as the home location becomes less urban; the survey data trend is well reflected in the model results.
- The modeled percentage of workers whose regular workplaces are in the same zone as their homes is two percent, similar to the survey data.

2.1.2 School Location

The school location model simulates the school location for each child in the synthetic population. The Excel file with the results of the school location model is *SchLocation.xlsm*. Figure 2.2 shows the comparisons between the observed (survey) and modeled school tour length distance frequency

distribution. This figure shows a good fit; the coincidence ratio is 79 percent. The average tour distances are 3.6 miles (modeled) and 4.0 miles (observed).

Figure 2.2. Home to School Tour Length Frequency Distribution



The more detailed comparisons in the Excel files show the following results:

- Both the survey data set and the model results show that children age 16 and older have longer trip lengths than younger children. This reflects that high school students often travel longer distances to school than younger children.
- The model results show a slight increase in trip length to school as income increases. This is generally true in the survey data although the trend is not consistent.
- The overall percentage of students who attend school in their residence zone is 14 percent in the survey data and 13 percent in the model results.

2.1.3 Vehicle Availability

The vehicle availability model simulates the number of vehicles owned by each household in the synthetic population. The Excel file with the results of the vehicle availability model is *Vehicle_Avail.xlsm*. Table 2.2 summarizes the regional results of the calibrated model. On a regional basis, the number of households by number of vehicles owned matches well.

Table 2.2. Vehicle Availability Model – Regional Validation

	Expanded household survey data		Model Results*		Percentage Point
Vehicles	Households	Percentage	Households	Percentage	Difference
0	233,138	9.2%	45,687	8.2%	-1.0%
1	824,477	32.4%	170,795	30.5%	-1.9%
2	974,183	38.3%	222,001	39.6%	1.3%
3+	510,347	20.1%	121,435	21.7%	1.6%
Total	**2,542,146**		**559,918**		

* - Model results represent 25% sample

The more detailed comparisons in the Excel files show the following results:

- The modeled percentage of households owning each number of vehicles matches the survey data well for each county in the model region except the District of Columbia. As indicated in the survey data, the model does simulate the lowest vehicle ownership of any other county, but the vehicle ownership is overestimated.

- Vehicle availability levels were compared for cross-classifications of household size (1, 2, 3, 4+) by income level (<$15,000, $15,000-$29,999, $30,000-$49,999, $50,000-$99,999, >$100,000). The model results show slightly higher vehicle ownership for households with incomes between $15,000 and $50,000, compared to the expanded survey data.

- Vehicle availability levels were compared for cross-classifications of number of workers (0, 1, 2, 3, 4+) by income level (<$15,000, $15,000-$29,999, $30,000-$49,999, $50,000-$99,999, >$100,000). The model results match the expanded survey data well, considering the relatively low number of households surveyed for many of the cells.

2.2 Daily Activity Pattern and Related Models

2.2.1 Daily Activity Pattern Model

The daily activity pattern model simulates whether each person in the synthetic population has mandatory (work, university, or school) activities, has non-mandatory activities only, or makes no travel within the region (i.e., stays at home, is temporarily out of the model region, or has only external travel—travels only between home and locations outside the model region). If a mandatory activity pattern is chosen, the number of mandatory tours (zero, one, or two) is simulated, as well as whether any simulated work tours have stops.

Excel files summarize the results of the daily activity pattern model for each person type:

- Full time and part-time workers - Daily_Activity_Pattern_ft_pt worker.xlsm
- Adult (university) students - Daily_Activity_Pattern_adult student.xlsm
- Seniors - Daily_Activity_Pattern_senior.xlsm

- Non-working adults - Daily_Activity_Pattern_non-working adult.xlsm
- Children age less than 5 - Daily_Activity_Pattern_child0-5.xlsm
- Children age 5-15 - Daily_Activity_Pattern_hild6-15.xlsm
- Children age 16 or older - Daily_Activity_Pattern_child16-17.xlsm

Table 2.3 through Table 2.9 summarize the regional results of the calibrated daily activity pattern model for each person type.

The Excel files show the results segmented by various variables of interest, including county of residence, household size, income level, vehicle availability, and gender. These comparisons show only minor differences between the survey data and the model results (though in many cases, the large number of alternatives in the daily activity pattern model means that the survey data has few observations for several of the alternatives for many of the market segments).

Table 2.3. Regional Comparison of Daily Activity Patterns

Full-Time and Part-Time Workers

Daily Activity Pattern Type	Expanded household survey data		Model Results	
	Count	Percentage	Count	Percentage
1 Work Tour, No Stops	934,164	33.6%	291,934	38.2%
1 Work Tour, With Stops	930,773	33.4%	225,000	29.4%
2 Work Tours, No Stops	28,396	1.0%	9,785	1.3%
2 Work Tours, Stops on One	25,703	0.9%	8,035	1.1%
2 Work Tours, Stops on Both	10,262	0.4%	2,513	0.3%
1 Univ. Tour/1 Work Tour, No Stops	8,941	0.3%	1,857	0.2%
1 Univ. Tour/1 Work Tour, Stops on Work Tour	6,246	0.2%	738	0.1%
1 School Tour/1 Work Tour, No Stops	0	0.0%	0	0.0%
1 School Tour/1 Work Tour, Stops on Work Tour	0	0.0%	0	0.0%
1 Univ. Tour	38,498	1.4%	2,665	0.3%
2 Univ. Tours	2,962	0.1%	0	0.0%
1 School Tour	0	0.0%	0	0.0%
2 School Tours	0	0.0%	0	0.0%
Non-Mandatory Travel Only	496,916	17.9%	139,755	18.3%
Stay at Home/Out of Area/External Travel Only	300,302	10.8%	82,667	10.8%
Total	2,783,164		764,949	

* - Model results represent 25% sample

Table 2.4. Regional Comparison of Daily Activity Patterns - *Adult Students*

Daily Activity Pattern Type	Expanded household survey data		Model Results	
	Count	Percentage	Count	Percentage
1 Work Tour, No Stops	6,542	4.1%	4,166	7.2%
1 Work Tour, With Stops	5,509	3.5%	2,927	5.0%
2 Work Tours, No Stops	127	0.1%	0	0.0%
2 Work Tours, Stops on One	252	0.2%	0	0.0%
2 Work Tours, Stops on Both	47	0.0%	0	0.0%
1 Univ. Tour/1 Work Tour, No Stops	602	0.4%	848	1.5%
1 Univ. Tour/1 Work Tour, Stops on Work Tour	0	0.0%	505	0.9%
1 School Tour/1 Work Tour, No Stops	0	0.0%	0	0.0%
1 School Tour/1 Work Tour, Stops on Work Tour	0	0.0%	0	0.0%
1 Univ. Tour	57,279	36.2%	17,785	30.5%
2 Univ. Tours	1,549	1.0%	815	1.4%
1 School Tour	0	0.0%	0	0.0%
2 School Tours	0	0.0%	0	0.0%
Non-Mandatory Travel Only	36,252	22.9%	16,549	28.4%
Stay at Home/Out of Area/External Travel Only	49,949	31.6%	14,661	25.2%
Total	158,108		58,256	

* - Model results represent 25% sample

Table 2.5. Regional Comparison of Daily Activity Patterns - *Seniors*

Daily Activity Pattern Type	Expanded household survey data		Model Results	
	Count	Percentage	Count	Percentage
1 Work Tour, No Stops	17,788	2.9%	4,209	2.7%
1 Work Tour, With Stops	19,080	3.1%	3,225	2.1%
2 Work Tours, No Stops	1,270	0.2%	0	0.0%
2 Work Tours, Stops on One	2,911	0.5%	0	0.0%
2 Work Tours, Stops on Both	610	0.1%	0	0.0%
1 Univ. Tour/1 Work Tour, No Stops	157	0.0%	0	0.0%
1 Univ. Tour/1 Work Tour, Stops on Work Tour	122	0.0%	0	0.0%
1 School Tour/1 Work Tour, No Stops	0	0.0%	0	0.0%
1 School Tour/1 Work Tour, Stops on Work Tour	0	0.0%	0	0.0%
1 Univ. Tour	4,402	0.7%	383	0.2%
2 Univ. Tours	0	0.0%	0	0.0%
1 School Tour	0	0.0%	0	0.0%
2 School Tours	0	0.0%	0	0.0%
Non-Mandatory Travel Only	389,748	63.0%	99,804	63.6%
Stay at Home/Out of Area/External Travel Only	182,420	29.5%	49,244	31.4%
Total	618,509		156,865	

* - Model results represent 25% sample

Table 2.6. Regional Comparison of Daily Activity Patterns - *Non-Working Adults*

Daily Activity Pattern Type	Expanded household survey data		Model Results	
	Count	Percentage	Count	Percentage
1 Work Tour, No Stops	18,206	4.0%	337	0.2%
1 Work Tour, With Stops	17,411	3.9%	166	0.1%
2 Work Tours, No Stops	426	0.1%	0	0.0%
2 Work Tours, Stops on One	1,057	0.2%	0	0.0%
2 Work Tours, Stops on Both	316	0.1%	0	0.0%
1 Univ. Tour/1 Work Tour, No Stops	300	0.1%	0	0.0%
1 Univ. Tour/1 Work Tour, Stops on Work Tour	0	0.0%	0	0.0%
1 School Tour/1 Work Tour, No Stops	0	0.0%	0	0.0%
1 School Tour/1 Work Tour, Stops on Work Tour	0	0.0%	0	0.0%
1 Univ. Tour	8,245	1.8%	127	0.1%
2 Univ. Tours	0	0.0%	0	0.0%
1 School Tour	0	0.0%	0	0.0%
2 School Tours	0	0.0%	0	0.0%
Non-Mandatory Travel Only	254,359	56.3%	83,408	60.2%
Stay at Home/Out of Area/External Travel Only	151,586	33.5%	54,473	39.3%
Total	451,907		138,511	

* - Model results represent 25% sample

Table 2.7. Regional Comparison of Daily Activity Patterns - *Children Age Less than 5*

Daily Activity Pattern Type	Expanded household survey data		Model Results	
	Count	Percentage	Count	Percentage
1 Work Tour, No Stops	0	0.0%	0	0.0%
1 Work Tour, With Stops	0	0.0%	0	0.0%
2 Work Tours, No Stops	0	0.0%	0	0.0%
2 Work Tours, Stops on One	0	0.0%	0	0.0%
2 Work Tours, Stops on Both	0	0.0%	0	0.0%
1 Univ. Tour/1 Work Tour, No Stops	0	0.0%	0	0.0%
1 Univ. Tour/1 Work Tour, Stops on Work Tour	0	0.0%	0	0.0%
1 School Tour/1 Work Tour, No Stops	0	0.0%	0	0.0%
1 School Tour/1 Work Tour, Stops on Work Tour	0	0.0%	0	0.0%
1 Univ. Tour	0	0.0%	0	0.0%
2 Univ. Tours	0	0.0%	0	0.0%
1 School Tour	130,402	30.7%	25,996	28.8%
2 School Tours	1,033	0.2%	0	0.0%
Non-Mandatory Travel Only	199,734	47.0%	43,348	48.0%
Stay at Home/Out of Area/External Travel Only	93,641	22.0%	20,950	23.2%
Total	618,509		90,294	

* - Model results represent 25% sample

Table 2.8. Regional Comparison of Daily Activity Patterns - *Children Age 5-15*

Daily Activity Pattern Type	Expanded household survey data		Model Results	
	Count	Percentage	Count	Percentage
1 Work Tour, No Stops	2,925	0.4%	0	0.0%
1 Work Tour, With Stops	3,874	0.6%	0	0.0%
2 Work Tours, No Stops	0	0.0%	0	0.0%
2 Work Tours, Stops on One	0	0.0%	0	0.0%
2 Work Tours, Stops on Both	0	0.0%	0	0.0%
1 Univ. Tour/1 Work Tour, No Stops	0	0.0%	0	0.0%
1 Univ. Tour/1 Work Tour, Stops on Work Tour	0	0.0%	0	0.0%
1 School Tour/1 Work Tour, No Stops	1,334	0.2%	0	0.0%
1 School Tour/1 Work Tour, Stops on Work Tour	490	0.1%	0	0.0%
1 Univ. Tour	0	0.0%	0	0.0%
2 Univ. Tours	0	0.0%	0	0.0%
1 School Tour	464,252	70.5%	133,784	73.3%
2 School Tours	9,295	1.4%	1,641	0.9%
Non-Mandatory Travel Only	84,909	12.9%	28,464	15.6%
Stay at Home/Out of Area/External Travel Only	91,430	13.9%	18,552	10.2%
Total	658,509		182,441	

* - Model results represent 25% sample

Table 2.9. Regional Comparison of Daily Activity Patterns - *Children Age 16-17*

Daily Activity Pattern Type	Expanded household survey data		Model Results	
	Count	Percentage	Count	Percentage
1 Work Tour, No Stops	2,719	2.6%	859	3.0%
1 Work Tour, With Stops	3,601	3.4%	182	0.6%
2 Work Tours, No Stops	0	0.0%	0	0.0%
2 Work Tours, Stops on One	0	0.0%	0	0.0%
2 Work Tours, Stops on Both	0	0.0%	0	0.0%
1 Univ. Tour/1 Work Tour, No Stops	0	0.0%	0	0.0%
1 Univ. Tour/1 Work Tour, Stops on Work Tour	0	0.0%	0	0.0%
1 School Tour/1 Work Tour, No Stops	1,809	1.7%	937	3.2%
1 School Tour/1 Work Tour, Stops on Work Tour	484	0.5%	103	0.4%
1 Univ. Tour	0	0.0%	0	0.0%
2 Univ. Tours	0	0.0%	0	0.0%
1 School Tour	61,247	58.2%	16,143	55.6%
2 School Tours	2,299	2.2%	296	1.0%
Non-Mandatory Travel Only	12,440	11.8%	4,666	16.1%
Stay at Home/Out of Area/External Travel Only	20,618	19.6%	5,847	20.1%
Total	105,217		29,033	

* - Model results represent 25% sample

2.2.2 School Escorting Model

For each child traveling to school, the school escorting model determines whether he or she is escorted by another household member to school or from school, and, if so, which household member does the escorting, and whether that household member escorts the student as part of a mandatory tour (for example, on the way to or from work). The Excel file that summarizes the results of the school escorting model is *School_Escort.xlsm*.

Table 2.10 presents a summary of the comparison of the percentage of school escorting alternatives from the survey data set and the model results, by child age group (0-4, 5-15, and 16+). In this table, the five alternatives for each student are:

- Outbound mandatory – Escorting to school as part of a mandatory tour
- Outbound stand alone – Escorting to school as part of a stand alone tour
- Return mandatory – Escorting from school as part of a mandatory tour
- Return stand alone – Escorting from school as part of a stand alone tour
- None – Student is not escorted.

Table 2.11 shows the comparison of escort person types between the survey data set and model results. Both Table 2.10 and Table 2.11 show relatively close agreement between the observed and model results.

The more detailed comparisons in the Excel files show the following results:

- The survey data show that little school escorting occurs in zero car households. The model results reflect this unsurprising result.

- Both the survey data and model results show that most escorts are workers, with non-working adults making up 15 to 20 percent of escorts.

- The household survey data and model results show similar percentages of female escorts (66 percent).

- Generally, fewer children from higher income households are escorted.

Table 2.10. Regional Comparison of School Escorting Alternatives

Escort Type	Child Age	Expanded household survey data		Model Results		Percentage Point Difference
		Count	Percentage	Count	Percentage	
Outbound mandatory	< 5 Years	52,776	19.1%	9,466	18.2%	-0.8%
Outbound standalone	< 5 Years	38,935	14.1%	8,070	15.5%	1.5%
Return mandatory	< 5 Years	44,678	16.1%	9,425	18.1%	2.0%
Return standalone	< 5 Years	38,890	14.0%	8,059	15.5%	1.5%
None	< 5 Years	101,717	36.7%	16,972	32.6%	-4.1%
Total	**< 5 Years**	**276,997**		**51,993**		
Outbound mandatory	5-15 Years	97,828	9.4%	22,536	8.2%	-1.2%
Outbound standalone	5-15 Years	100,988	9.7%	39,926	14.6%	4.8%
Return mandatory	5-15 Years	65,941	6.4%	18,999	6.9%	0.6%
Return standalone	5-15 Years	97,150	9.4%	25,055	9.1%	-0.2%
None	5-15 Years	676,019	65.1%	167,616	61.1%	-4.0%
Total	**5-15 Years**	**1,037,926**		**274,132**		
Outbound mandatory	16+ Years	8,174	5.4%	850	2.4%	-3.0%
Outbound standalone	16+ Years	9,126	6.0%	5,315	15.0%	8.9%
Return mandatory	16+ Years	4,147	2.7%	767	2.2%	-0.6%
Return standalone	16+ Years	6,965	4.6%	1,187	3.3%	-1.3%
None	16+ Years	122,799	81.2%	27,431	77.2%	-4.0%
Total	**16+ Years**	**151,211**		**35,550**		
Outbound mandatory	All	158,778	10.8%	32,852	9.1%	-1.7%
Outbound standalone	All	149,050	10.2%	53,311	14.7%	4.6%
Return mandatory	All	114,767	7.8%	29,191	8.1%	0.2%
Return standalone	All	143,005	9.8%	34,301	9.5%	-0.3%
None	All	900,535	61.4%	212,019	58.6%	-2.8%
Total	**All**	**1,466,134**		**361,674**		

* - Model results represent 25% sample

Table 2.11. Regional Comparison of School Escorting Types – Household Survey vs. Model Results

Escort Person Type	Expanded Household Survey Data		Model Results		Percentage Point Difference
	Count	Percentage	Count	Percentage	
Adult Student	6,913	1.2%	991	0.9%	-0.3%
Worker	453,209	78.0%	95,265	82.2%	4.2%
Non Working Adult	112,286	19.3%	17,793	15.4%	-4.0%
Senior	8,618	1.5%	1,844	1.6%	0.1%
Total	581,026		115,893		

* - Model results represent 25% sample

2.2.3 Joint Travel Model

The fully joint tour models include a generation model, which simulates the number (zero, one, or two) and purposes (meal, shopping, personal business, or social-recreation) of fully joint tours made by each household, and a participation model, which determines which household members participate in each simulated joint tour. The Excel file that summarizes the results of the fully joint tour models is *6 - Tour_Generation_FullyJoint.xlsm*. Both the household survey data set and the model results show an average of 0.25 fully joint tours per household.

The more detailed comparisons in the Excel file show the following results:

- The survey data set shows varying rates of joint tours per household by county, with the lowest rates in Baltimore City and Washington, D.C. This is not surprising since average household size is lower in these cities than in the rest of the model region. These two counties also have the lowest joint tour rates in the model results.

- Among households making joint tours, there is no discernable pattern of the number of joint tours made by income level. The model somewhat overestimates the number of joint tours for the lowest income group.

- Among households making joint tours, zero vehicle households make fewer joint tours though the model somewhat underestimates the joint tour rate for these households.

- The distributions of joint tours by purpose and by party size (2, 3, or 3+) are similar for the survey data set and the model results. The cross-classifications of tour purpose by party size also match well, with the largest differences appearing for the combinations with the lowest incidence in the survey data set (generally, the 3+ person tours).

2.2.4 Individual Non-Mandatory Tour Generation Model

The individual non-mandatory tour generation model simulates the number (zero, one, two, or three) and purposes (meal, shopping, personal business, escorting, or social-recreation) of non-mandatory

tours made by each person in the synthetic population for whom a mandatory or non-mandatory daily activity pattern has been simulated. (At least one non-mandatory tour must be simulated for persons with non-mandatory patterns). The Excel file that summarizes the results of the non-mandatory tour generation model is *6 - Tour_Generation_NonMandatory.xlsx*.

The more detailed comparisons in the Excel file show the following results:

- The modeled percentages of non-mandatory tours by purpose match the percentages from the survey data set well.
- Compared to the survey data set, the model overestimates the percentage of escorting non-mandatory tours made by young children and underestimates the high observed percentage of personal business tours by young children.

2.2.5 Work-Based Subtour Generation Model

The work-based subtour generation model simulates the number (zero, one, or two) and purposes (work, meal, shopping, personal business, escorting, or social-recreation) of work-based subtours made by persons making work tours. The Excel file that summarizes the results of the work-based subtour generation model is *6 - Tour_Generation_WorkBased.xlsx*. The number of modeled work-based subtours per work tour is about the same as the number of such subtours in the expanded household survey data set (0.155 observed versus 0.159 modeled).

The more detailed comparisons in the Excel file show the following results:

- The modeled percentages of work-based subtours by purpose match the percentages from the survey data set well.
- The survey data set shows that males make more work-based subtours than females, and the model results reflect this observation.
- The household survey data show that the rate of making work-based subtours increases with income level though the trend is somewhat inconsistent. The model data show this pattern but at a more consistent rate of increase.

2.3 Tour Level Choice Models

2.3.1 Tour Destination Choice Models

The tour destination choice models simulate the location of the primary activity of each tour. There are Excel files with detailed results for various aggregate activity purposes:

- Work (not to regular workplace) – *9 - Tour_Dest_Choice_Work.xlsm*
- University – *9 - Tour_Dest_Choice_Uni.xlsm*

- Fully joint – *9 - Tour_Dest_Choice_Joint.xlsm*
- Individual non-mandatory (except escort tours) – *9 - Tour_Dest_Choice_NonMandatory.xlsm*
- Work based subtours – *9 - Tour_Dest_Choice_WorkBased.xlsm*

Each spreadsheet file includes histograms comparing the tour length distance frequency distributions for the corresponding activity purpose. Table 2.12 summarizes the coincidence ratios for these comparisons.

Table 2.12. Coincidence Ratios for Tour Length Frequency Distributions

Tour Purpose	Coincidence Ratio
Work (including tours to regular workplace)	85%
University	71%
Joint	74%
Individual non-mandatory	79%
Work based subtours	66%

For each tour purpose, the following comparisons between the observed (expanded household survey) data and model results are included in the Excel files:

- Average tour length (time and distance) by:
  - Tour activity (meal, shop, personal business, or social-recreation) – *for non-mandatory tours only*
  - Income level
  - Area type at home (or workplace for work-based subtours) and at the primary activity location
  - Person type – *except joint tours*
  - Number of household vehicles – *except work-based subtours*
  - Parent tour mode – *work-based subtours only*
- Percentage of intrazonal tours (primary activity location zone is the same as the home zone (or work zone for work based subtours) by:
  - Area type
  - Person type – *work tours only*
  - Number of household vehicles – *except work-based subtours*
  - Parent tour mode – *work-based subtours only*

Generally, the modeled average tour lengths are a bit longer than those in the expanded survey data (see Table 2.13). This reflected a need to calibrate the model to better reflect traffic counts. Intrazonal percentages (see Table 2.14) from the model are slightly lower than shown in the survey data, for the same reason. In the model results, the average tour lengths show a logical progression with tour lengths increasing as income increases; the survey data do not show this pattern for all

tour purposes. Another difference is that the model shows more intrazonal tours for less dense areas while the survey data do not show this pattern.

Table 2.13. Average Trip Length Comparisons by Tour Purpose

Tour Purpose	Observed	Model
Work (including tours to regular workplace)	11.9	12.8
University	7.5	7.9
Joint	6.5	7.1
Individual non-mandatory	5.5	7.7
Work based subtours	3.0	4.2

Table 2.14. Comparison of Intrazonal Percentages

Tour Purpose	Observed	Model
Work (including tours to regular workplace)	5%	3%
University	3%	4%
Joint	8%	7%
Individual non-mandatory	12%	10%
Work based subtours	28%	21%

2.3.2 Tour Time of Day Choice Models

The tour time of day choice models simulate the start and end times, in half hour increments, of the primary activity of each tour. There are Excel files with detailed results for various aggregate activity purposes:

- Mandatory (work, school and university) – *10 - Time_of_Day_Mandatory.xlsm*
- Joint – *10 - Time_of_Day_FullyJoint.xlsm*
- Individual non-mandatory – *10 - Time_of_Day_NonMandatory.xlsm*
- Work based subtours – *10 - Time_of_Day_WorkBased.xlsm*

Each spreadsheet presents histograms comparing the distributions of activity arrival and departures, for the corresponding activity purpose. Table 2.15 summarizes the coincidence ratios for these comparisons.

Table 2.15. Coincidence Ratios for Time of Day Distributions

	Coincidence Ratio	
Tour Purpose	Arrival	Departure
Work	72%	75%
School	68%	67%
University	66%	51%
Joint	76%	71%
Individual non-mandatory	73%	77%
Work based subtours	79%	79%

Table 2.16 presents the activity durations by purpose for the survey data set and the model results. These figures match well.

Table 2.16. Modeled and Observed Activity Durations by Purpose

	Duration (hours)	
Tour Purpose	**Survey**	**Model**
Work	7.1	7.5
School	6.9	6.4
University	4.5	4.7
Joint	1.7	1.8
Meal	1.3	1.5
Shopping	0.8	1.1
Personal Business	2.2	1.4
Social-recreation	2.1	1.7
Escort	0.5	0.3
Work based subtours	0.8	0.8

Each spreadsheet also compares the average activity duration in hours by the following segmentations:

- Income level
- Person type – *except joint tours*
- Gender – *except joint tours*
- Specific activity purpose (e.g., meal, shopping) – *joint, non-mandatory, and work based*

In most cases, the modeled and survey activity durations are within 10 percent or within 10 minutes of one another, when there are sufficient observations in the segment.

2.3.3 Tour Mode Choice Models

The tour mode choice models simulate the main mode of each tour. There are Excel files with detailed validation results for various aggregate activity purposes:

- Work - *8 - Tour_Mode_Choice_Work.xlsm*
- School - *8 - Tour_Mode_Choice_School.xlsm*
- University - *8 - Tour_Mode_Choice_University.xlsm*
- Joint - *8 - Tour_Mode_Choice_Joint.xlsm*
- Individual non-mandatory (except escort tours) - *8 - Tour_Mode_Choice_NonMandatory.xlsm*
- Escort - *8 - Tour_Mode_Choice_Escort.xlsm*
- Work based subtours - *8 - Tour_Mode_Choice_WorkBased.xlsm*

Table 2.17 compares the regional observed and modeled mode shares by tour purpose.

Table 2.17. Regional Modeled and Observed Tour Mode Shares by Purpose

	Work		School		University		Individual Non-Mandatory	
Tour Mode	**Survey**	**Model**	**Survey**	**Model**	**Survey**	**Model**	**Survey**	**Model**
Drive Alone	54.6%	56.6%	0.9%	0.8%	30.8%	31.2%	38.9%	41.3%
Shared Ride 2	16.2%	17.4%	16.4%	38.8%	20.0%	20.6%	26.5%	28.6%
Shared Ride 3+	7.3%	7.8%	30.9%	16.4%	16.0%	16.0%	17.5%	19.1%
Transit-Walk Access	11.5%	5.3%	4.1%	3.6%	11.4%	15.0%	4.9%	1.2%
Transit-Auto Access	5.0%	6.2%	0.3%	0.1%	2.0%	2.6%	0.4%	0.5%
Walk	3.4%	4.4%	6.8%	5.8%	6.6%	9.1%	10.7%	8.4%
Bike	2.0%	2.4%	1.2%	1.5%	4.7%	5.5%	0.9%	1.0%
School Bus			39.4%	33.1%				

	Escort		Joint		Work-Based Subtours		ALL TOURS	
Tour Mode	**Survey**	**Model**	**Survey**	**Model**	**Survey**	**Model**	**Survey**	**Model**
Drive Alone					39.0%	41.2%	34.3%	33.6%
Shared Ride 2	44.3%	44.2%	52.0%	53.6%	11.0%	11.8%	23.9%	23.1%
Shared Ride 3+	43.1%	43.3%	38.9%	39.4%	6.6%	7.2%	18.2%	20.6%
Transit-Walk Access			1.5%	0.9%	2.8%	2.9%	6.5%	6.8%
Transit-Auto Access			0.3%	0.0%	0.0%	0.0%	1.9%	2.1%
Walk	12.6%	12.5%	7.0%	5.9%	39.8%	36.0%	9.2%	9.1%
Bike			0.2%	0.2%	0.7%	0.9%	1.3%	1.2%
School Bus							4.7%	3.6%

For each tour purpose, the spreadsheet files show the following comparisons between the survey and modeled tour mode shares:

- Area type at home (or workplace for work based subtours) and at the primary activity location
- Distance range
- Transit in-vehicle time ranges (walk and auto access)
- Household size and income level
- Vehicles less than, equal to, or greater than number of workers/drivers
- Age and gender

In nearly all cases, the mode shares from the model match those from the survey data well. Some of the key results, which are true for both the observed and model data, include the following:

- In some cases, transit shares are lower in the model than in the survey data. This reflects calibration changes needed to account for transit ridership declining from the time of the household survey through the base year of 2019.
- Not surprisingly, transit and non-motorized mode shares increase as the area becomes more densely developed while auto mode shares decrease. This trend noted in the expanded survey data is also seen in the model although the rate of changes among area types is more

moderate in the model. (It should be noted that except for work and individual non-mandatory tours, the number of survey observations is fairly small for the most urban area types.)

- Transit-walk access mode shares decrease with increased distance; the opposite holds for transit-auto access shares (nearly all transit-auto access tours are for work or university purposes). The model captures these trends better for the walk access tours. Non-motorized trips, naturally, are nearly all short distance, and the model results reflect this.
- Transit mode shares to all counties are low—from zero to two percent—for all tour purposes, with the exception of the three Maryland Counties in the MWCOG region, where the transit shares are a bit higher. Transit shares to the cities of Baltimore and Washington are substantially higher. The model results reflect these trends.
- Transit-walk access shares decrease with increasing income levels for all tour purposes, and the model results accurately reflect this trend. For work tours, transit-auto access shares increase with increasing income levels, and the model results accurate reflect this as well.
- Generally, transit shares decrease with increasing household size, and the model accurately reflects this trend.
- Not surprisingly, transit and non-motorized mode shares are much higher in households with fewer vehicles than workers, or fewer vehicles than drivers, and are even higher in households with zero vehicles. The model reflects these trends accurately.
- Auto shares, especially drive alone, decrease while transit shares decrease with increasing age.
- For work tours, transit and shared ride mode shares are higher for females; drive alone and bike mode shares are higher for males.

2.3.4 Stop Generation Models

The stop generation models simulate the number and purposes of stops made on each tour. Separate models were estimated for each tour purpose. There are Excel files with detailed results for various aggregate activity purposes:

- Mandatory (work, school and university) – *11 - Tour_Stops_Mand.xlsm*
- Joint – *11 - Tour_Stops_FullyJoint.xlsm*
- Individual non-mandatory – *11 - Tour_Stops_NonMandatory.xlsm*
- Work based subtours – *11 - Tour_Stops_WorkBased.xlsm*

Table 2.18 compares the number of observed and modeled shares of half tours by number of stops by tour purpose. Table 2.19 presents the observed and modeled daily stops per half tour in each direction by tour purpose. As these tables show, the model results are close to the observed results from the expanded household survey data set.

Table 2.18. Regional Modeled and Observed Shares of Half Tours by Number of Stops by Purpose

	Work		School/ University		Individual Non-Mandatory	
Stops	**Survey**	**Model**	**Survey**	**Model**	**Survey**	**Model**
0 stops	39%	49%	68%	69%	45%	56%
1 stop	41%	33%	22%	21%	37%	29%
2 stops	12%	10%	7%	7%	12%	9%
3 stops	7%	8%	3%	3%	6%	5%

	Joint		Work-Based Subtours**	
Stops	**Survey**	**Model**	**Survey**	**Model**
0 stops	53%	50%		
1 stop	35%	36%	83%	88%
2 stops	8%	8%	17%	12%
3 stops	4%	5%		

**Note: Model is constrained to produce only 1 or 2 stops per half tour on work based subtours.

Table 2.19. Observed and Modeled Average Number of Stops per Half Tour

	Outbound Half Tour		Return Half Tour	
Tour Purpose	**Survey**	**Model**	**Survey**	**Model**
Work	0.28	0.32	0.59	0.45
School/University	0.11	0.15	0.34	0.28
Individual Mon-Mandatory	0.34	0.27	0.42	0.29
Joint	0.30	0.28	0.34	0.40
Work Based Subtours	0.17	0.17	0.12	0.12

For each tour purpose, the spreadsheet files show the following comparisons between survey and modeled stops:

- Income level
- Person type – *except joint tours*
- Age and gender – *except joint tours*

The more detailed comparisons in the Excel files show some differences between the model results and the expanded survey data (some due to small sample sizes for certain segments), but overall, the model results reflect the observed data fairly well.

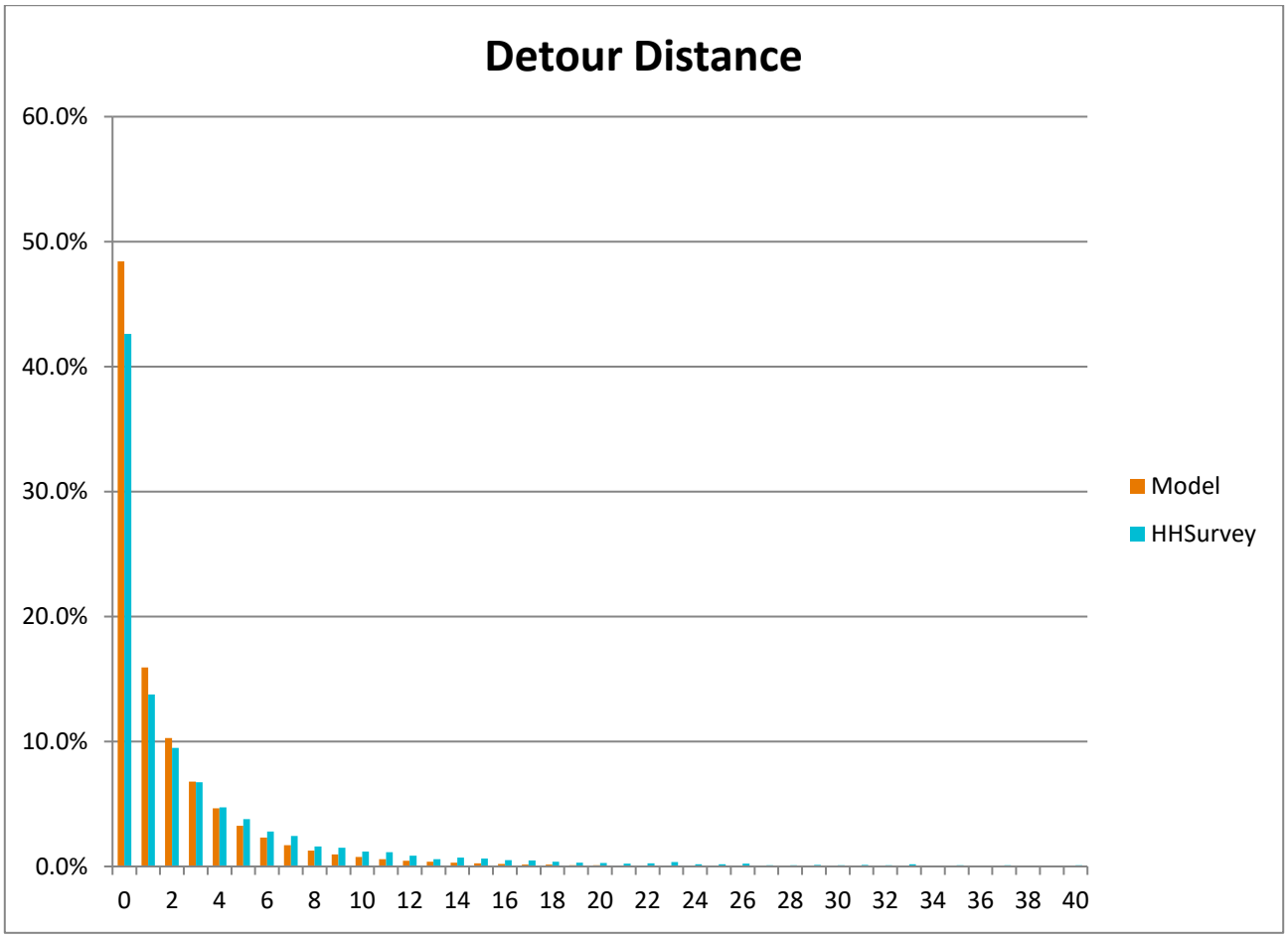
2.4 Stop/Trip Level Choice Models

2.4.1 Stop Destination Choice Models

The stop destination choice model simulates the locations of all intermediate stops between the home (or workplace, for work based subtours) and primary activity location on tours. The Excel file that summarizes the results of this model is *13 - Stop_Dest_Choice.xlsm*.

Figure 2.3 presents a comparison between the observed (survey) and modeled trip length distance distributions. While there are some differences in the distributions, the fits are good; the coincidence ratio is 84 percent. The average trip distances are 4.1 miles (observed) and 5.2 miles (modeled).

Figure 2.3. Trip Length Frequency Distribution for Stops (miles)



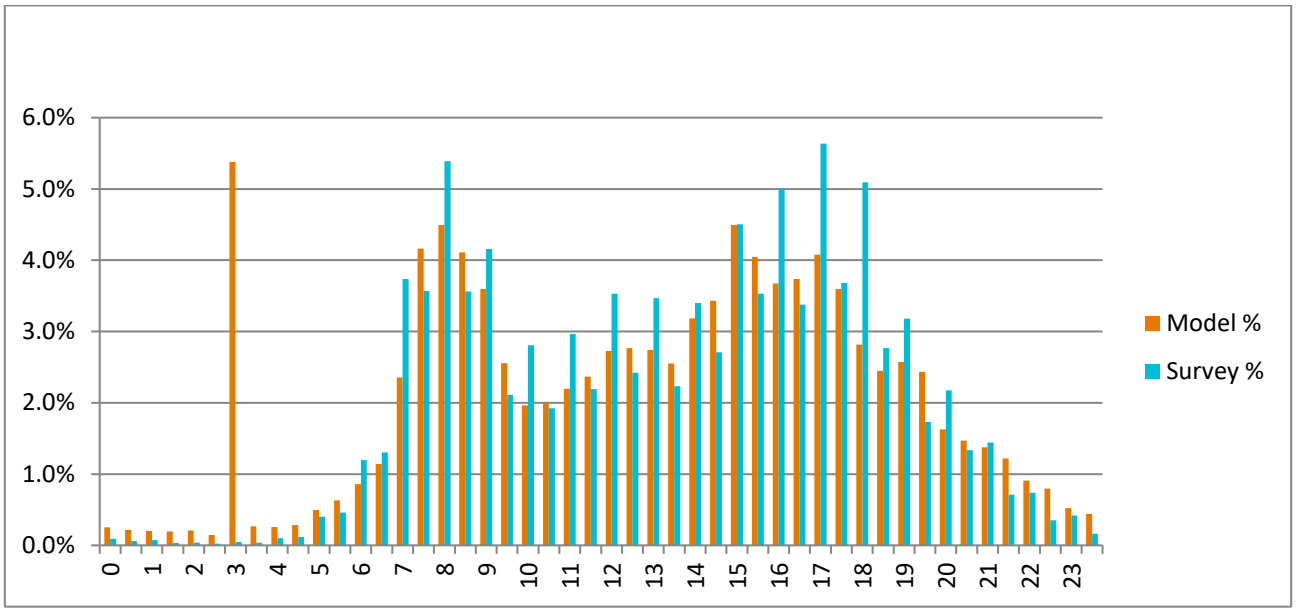
The spreadsheet file also provides comparisons between the observed data from the household survey and the model results for the average trip distances segmented by stop purpose, household income level, tour mode, area type at home and primary destination, and tour purpose. These comparisons show a good match for segments with significant samples in the survey.

2.4.2 Stop Time of Day Choice Models

The stop time of day choice model simulates the times (at the half hour level) of all intermediate stops between the home (or workplace, for work based subtours) and primary activity location on tours. The Excel file that summarizes the results of this model (as well as the trip mode choice model, described in the next section) is *12 – Trip_Mode_Choice.xlsm*.

Figure 2.4 presents a comparison between the observed (survey) and modeled stop time of day distributions. While there are some differences in the distributions, the fit is good.

Figure 2.4. Trip Distribution by Hour of Day



2.4.3 Trip Mode Choice Model

The trip mode choice model simulates the mode for each trip that is part of a tour, conditional on the simulated tour mode. The Excel file *12 – Trip_Mode_Choice.xlsm* also summarizes the results of the trip mode choice model. Following is a summary of trip mode shares by tour mode:

Drive alone:

- Survey: Drive alone – 99%, walk 1.1%
- Model: Drive alone – 100%, walk 0.3%

Tour mode shared ride 2:

- Survey: Drive alone – 24%, shared ride 2 – 74%, walk 2%
- Model: Drive alone – 30%, shared ride 2 – 69%, walk 2%

Tour mode shared ride 3+:

- Survey: Drive alone – 12%, shared ride 2 – 16%, shared ride 3+ – 70%, walk – 2%
- Model: Drive alone – 16%, shared ride 2 – 24%, shared ride 3+ – 60%, walk – 0.2%

Tour mode transit-walk access:

- Survey: Drive alone – 2%, shared ride 2 – 7%, shared ride 3+ – 3%, transit-walk access – 71%, walk – 15%, bike – 0.8%
- Model: Drive alone – 1%, shared ride 2 – 3%, shared ride 3+ – 2%, transit-walk access – 75%, walk – 18%, bike – 0.4%

Tour mode transit-auto access:

- Survey: Drive alone – 10%, shared ride 2 – 8%, shared ride 3+ – 5%, transit-walk access – 8%, transit-auto access – 63%, walk – 5%
- Model: Drive alone – 3%, shared ride 2 – 15%, shared ride 3+ – 8%, transit-walk access – 10%, transit-auto access – 61%, walk – 3%

Tour mode school bus:

- Survey: Shared ride 2 – 9%, shared ride 3+ – 13%, walk – 2%, school bus – 75%
- Model: Shared ride 2 – 8%, shared ride 3+ – 13%, walk – 1%, school bus – 78%

Note that by definition, all trips on walk and bicycle tours have the same trip mode as the tour mode.

The spreadsheet file also shows the following comparisons between survey and modeled trip mode shares:

- Area type at home (or workplace for work based subtours) and at the primary activity location
- Household size and income level
- Vehicles less than, equal to, or greater than number of workers/drivers
- Age and gender

In most cases, the mode shares from the model matched those from the survey data well.

3.0 Highway and Transit Assignment Validation

3.1 Highway Assignment

The highway assignment checks are as follows, with the table where each is summarized shown in parentheses. Generally, the model results compare well with the traffic counts.

- Comparisons of modeled and observed (from traffic counts) vehicle miles traveled (VMT) and volumes summarized by:
  - Roadway facility type (Table 3.1)
  - Area type (Table 3.2)
  - County (Table 3.3)

- Percentage root mean square error between model volumes and traffic counts summarized by:
  - Roadway facility type (Table 3.4)
  - Volume level (Table 3.5)

Table 3.1. Summary of Highway Assignment by Facility Type

Facility Type	Count VMT	Model VMT	% Diff.
Interstate/Freeway	24,389,354	24,679,528	1%
Primary Arterial	9,551,118	9,496,742	-1%
Minor Arterial	6,360,219	5,259,039	-17%
Collector	2,994,695	2,167,292	-28%
Other	1,357,225	1,441,573	6%
All Links	**44,652,611**	**43,044,174**	**-4%**

Table 3.2. Summary of Highway Assignment by Area Type

Area Type	Count VMT	Model VMT	% Diff.
1	16,153,197	16,792,638	4%
2	12,763,159	11,681,685	-8%
3	10,539,570	9,467,712	-10%
4	3,142,752	2,863,857	-9%
5	1,363,931	1,314,340	-4%
6	166,929	226,964	36%
7	382,701	523,025	37%
8	119,183	146,281	23%
9	21,189	27,671	31%
Total	**44,652,611**	**43,044,174**	**-4%**

Table 3.3. Summary of Highway Assignment by County

County	Count VMT	Model VMT	% Diff
Baltimore City	2,429,581	2,440,371	0%
Baltimore County	7,914,812	7,594,391	-4%
Anne Arundel	6,179,557	5,613,361	-9%
Howard	3,569,198	3,314,784	-7%
Carroll	1,069,914	1,038,858	-3%
Harford	2,650,370	2,284,441	-14%
Mont/PG/Frederick	19,423,255	18,904,844	-3%
D.C.	305,085	509,338	67%
Queen Anne	886,380	1,232,869	39%
Adams/York	224,458	110,918	-51%
Total	**44,652,611**	**43,044,174**	**-4%**

Table 3.4. Percentage Root Mean Square Error by Facility Type

Volume Group	% RMSE
Freeway	25.2
Primary Arterial	38.6
Minor Arterial	57.1
Collector	72.2
Other	65.2
All Links	44.0

Table 3.5. Percentage Root Mean Square Error by Volume Group

Volume Group	% RMSE
0-5,000	170.1
5,000-10,000	66.9
10,000-25,000	49.3
25,000-50,000	38.3
50,000-100,000	32.4
>100,000	15.6
All Links	44.0

3.2 Transit Assignment

Table 3.6 shows the comparison of modeled transit boardings and observed boarding counts by service type. Total modeled boardings over all services within the BMC region are reasonably close to observed, with LRT and MARC a bit high. Modeled WMATA ridership is low. This may be partly due to the model's focus on the BMC region, since these services are used in large part by residents of the MWCOG region.

Table 3.6. Comparison of Modeled Boardings to Counts

	Modeled Boardings	Boarding Counts
Total MTA Bus	211,829	211,605
MTA Local Link Routes	104,676	110,901
MTA Express Link Routes	5,975	2,033
MTA City Link Routes	100,463	94,876
Baltimore LRT	30,020	21,693
Baltimore Metro	28,884	27,767
MARC Penn Line	17,904	24,309
MARC Camden Line	4,980	5,034
WMATA	331,076	518,821

Table 3.7 shows the percentage of trips by number of transfers for three transit service types: MTA bus, rail (including light rail and Metro subway), and MARC commuter rail. In this table, the "target" percentages are derived from transit on-board survey data. The comparison shows a reasonably good match for bus and Rail, but the model overestimates the transfers for MARC.

Table 3.8 shows the percentage of linked transit trips and unlinked trips (boardings), and Table 3.9 shows the transfer rates, by access mode and time of day for these same three service types.

Table 3.7. Percentage of Transit Trips by Number of Transfers

% Trips by Number of Transfers	MTA Bus			Rail (LRT & Metro Subway)		
	Target	Model	Diff.	Target	Model	Diff.
0	51%	57%	6%	53%	54%	2%
1	38%	37%	0%	33%	30%	-2%
2	11%	6%	-5%	12%	13%	1%
3+	1%	0%	-1%	2%	2%	0%
Transfer Ratio	1.62	1.50	-0.12	1.64	1.63	-0.01
% Trips by Number of Transfers	**Commuter Rail (MARC)**			**Total**		
	Target	Model	Diff.	Target	Model	Diff.
0	45%	20%	-24%	50%	51%	1%
1	31%	38%	6%	36%	36%	0%
2	20%	22%	2%	12%	9%	-3%
3+	4%	21%	16%	2%	4%	2%
Transfer Ratio	1.84	2.42	0.59	1.65	1.65	0.00

Table 3.8. Percentage of Boardings by Service Type by Time of Day and Access Mode

Time of Day	Access Mode		MTA Bus			Rail (LRT & Metro Subway)		
			Target	Model	Diff	Target	Model	Diff
Peak	Walk	Linked Trips	48%	47%	-1%	33%	36%	2%
		Boardings	47%	50%	3%	37%	38%	1%
	Drive	Linked Trips	2%	9%	7%	25%	29%	4%
		Boardings	2%	8%	6%	18%	26%	9%
	Total	Linked Trips	50%	56%	6%	59%	65%	6%
		Boardings	49%	58%	9%	55%	64%	9%
Off-Peak	Walk	Linked Trips	49%	37%	-11%	30%	21%	-9%
		Boardings	49%	37%	-12%	36%	23%	-13%
	Drive	Linked Trips	2%	7%	5%	11%	14%	3%
		Boardings	2%	5%	3%	9%	13%	4%
	Total	Linked Trips	50%	44%	-6%	41%	35%	-6%
		Boardings	51%	42%	-9%	45%	36%	-9%
Total	Walk	Linked Trips	96%	84%	-12%	63%	57%	-7%
		Boardings	96%	87%	-9%	73%	61%	-12%
	Drive	Linked Trips	4%	16%	12%	37%	43%	7%
		Boardings	4%	13%	9%	27%	39%	12%
	Total	Linked Trips	100%	100%	0%	100%	100%	0%
		Boardings	100%	100%	0%	100%	100%	0%

Time of Day	Access Mode		Commuter Rail (MARC)			Total		
			Target	Model	Diff	Target	Model	Diff
Peak	Walk	Linked Trips	20%	29%	9%	33%	42%	1%
		Boardings	21%	28%	6%	37%	46%	5%
	Drive	Linked Trips	45%	46%	1%	25%	18%	6%
		Boardings	43%	46%	4%	18%	15%	3%
	Total	Linked Trips	65%	75%	10%	59%	60%	7%
		Boardings	64%	74%	10%	55%	61%	8%
Off-Peak	Walk	Linked Trips	12%	13%	1%	30%	30%	-9%
		Boardings	14%	14%	-1%	36%	32%	-9%
	Drive	Linked Trips	23%	12%	-11%	11%	9%	3%
		Boardings	22%	12%	-9%	9%	7%	1%
	Total	Linked Trips	35%	25%	-10%	41%	40%	-7%
		Boardings	36%	26%	-10%	45%	39%	-8%
Total	Walk	Linked Trips	32%	42%	10%	63%	72%	-8%
		Boardings	36%	41%	6%	73%	78%	-4%
	Drive	Linked Trips	68%	58%	-10%	37%	28%	8%
		Boardings	64%	59%	-6%	27%	22%	4%
	Total	Linked Trips	100%	100%	0%	100%	100%	0%
		Boardings	100%	100%	0%	100%	100%	0%

Table 3.9. Transfer Rates by Time of Day and Access Mode

Peak	Walk	1.58	1.65
	Drive	1.43	1.20
	Walk+Drive	1.55	1.51
Off-Peak	Walk	1.63	1.61
	Drive	1.50	1.15
	Walk+Drive	1.61	1.51
Total	Walk	1.60	1.63
	Drive	1.46	1.15
	Walk+Drive	1.58	1.51

4.0 References

Cambridge Systematics, Inc., Gallop Corporation, and Whitman, Requardt & Associates, LLP (2021). BMC InSITE Model Update: Model Validation Plan. Prepared for the Baltimore Metropolitan Council.