

# BROOME-TIOGA TRANSPORTATION STUDY

Analysis Report | June 5, 2018







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# EXECUTIVE SUMMARY

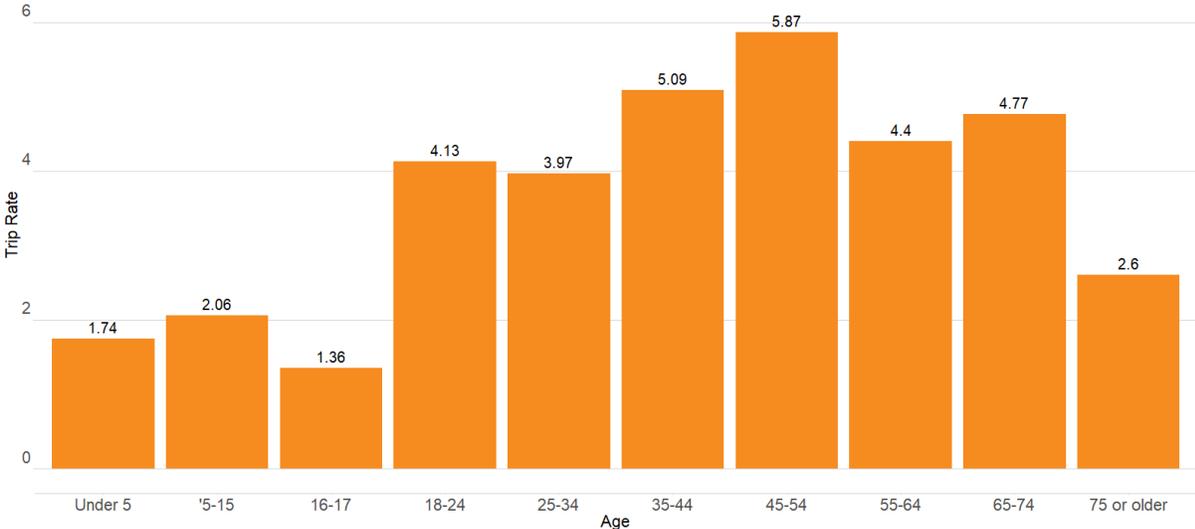
The Binghamton Metropolitan Transportation Study (BMTS) commissioned the Broome-Tioga Transportation Study to support travel forecasting, which will improve outcomes for BMTS' planning and program development work. The study collected demographic and travel information from 919 households throughout Broome and Tioga county ("the study region"), exceeding the original target of 750. The sample rate was 0.92% of households in the region, nearly double the standard sample rate of 0.5% for household travel surveys. This memo provides a "summary of response," outlining what was collected and describing key findings.

These households reported 3,392 complete travel days, with 12,846 trips taking place on those days. Due to the use of smartphones in collecting most of this travel data, the study also collected nearly 500,000 GPS points for all trips, with accurate origins, destinations, and trip paths. Travel data was collected on Tuesdays to Thursdays from February 20 to March 8, 2018.

To support a higher quality and more useful dataset, BMTS requested that the study region be stratified into three segments: general population, higher education, low income. All three segments responded above expectations. The sample plan was successful in attracting a representative sample (even before the data weighting process) and at increasing participation among those enrolled in higher education. A comprehensive data weighting process further ensures that the dataset accurately represents the region across a number of important socio-economic variables.

Three of the most important results from this project include trip rates, travel mode shares, and the geographic coverage of the trip data. Figure 1 shows the results of weekday trip rates by age group, with the 35-54 age range averaging over five trips per day, while those above 75 and under 18 average fewer than three trips per day. The overall weighted trip rate was 4.0.

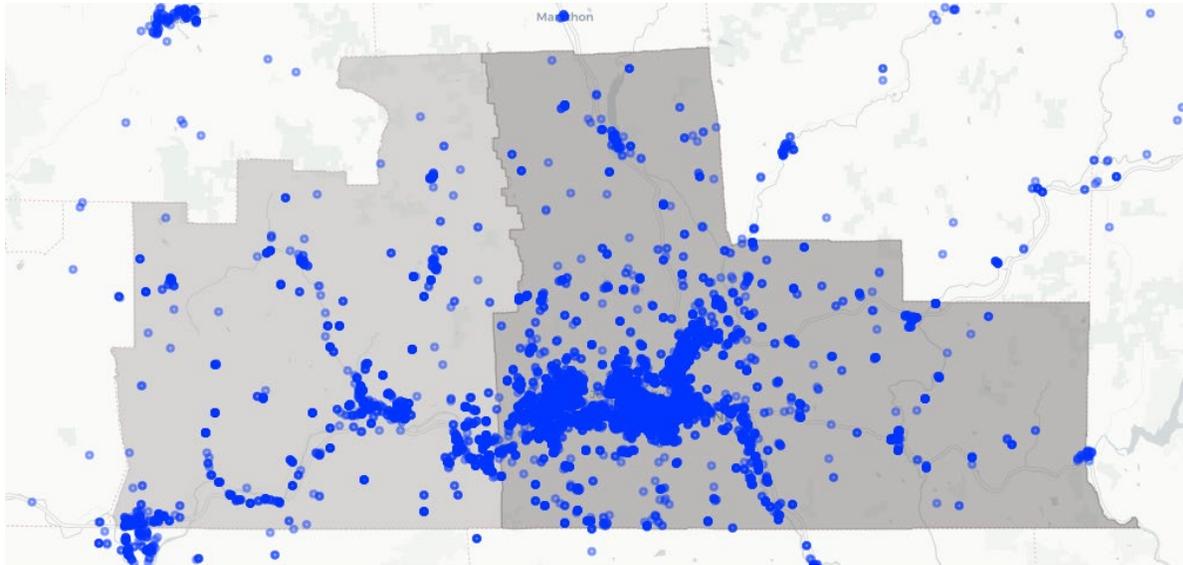
**FIGURE 1: PERSON TRIP RATE BY AGE (WEIGHTED)**



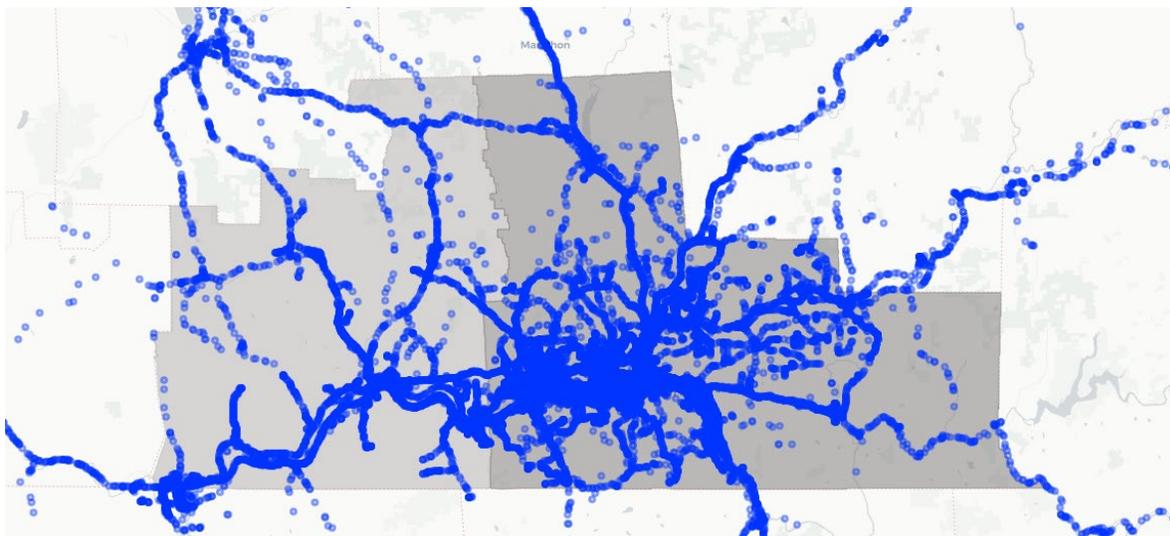
Looking at the trips by travel mode, car trips represented 83% of all trips, with walking second at 11.5%, and transit third with a 2.1% mode share. All other modes combine for a 3.6% share (see also Table 2).

Finally, looking at the geographic coverage of the dataset, Figure 2 and Figure 3 show, at a high-level, the geographic coverage of the travel data. Figure 2 plots trip destinations in and around the study region, showing approximately 12,000 trip destinations (many are overlapping). Figure 3 plots a 15% sample of rMove trip path location data for trips starting or ending in the study region (75,000 location points).

**FIGURE 2 TRIP DESTINATIONS IN AND AROUND THE STUDY REGION (SHADED)**



**FIGURE 3 A 15% SAMPLE OF TRIP LOCATIONS FROM RMOVE (STUDY REGION IS SHADED)**



The remainder of this memo contains two sections. The first describes key demographics, while the second reviews some key travel behaviors. The dataset is extremely rich and there are many important and interesting findings that are not covered in this memo, but which should help sustain and improve BMTS in executing their mission.

# 1.0 SAMPLING AND DEMOGRAPHICS

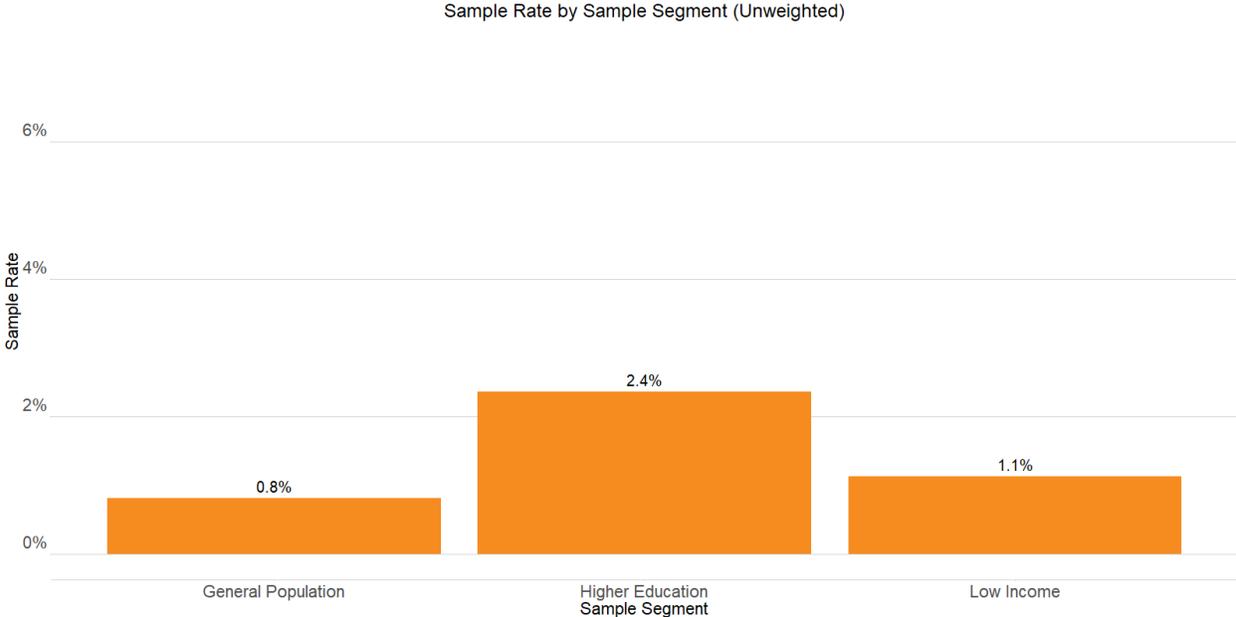
This study used a region-specific study plan that was designed to achieve a final sample size of at least 750 households. The address-based sample plan used compensatory oversampling to compensate for low response among certain groups (low income households, in this case) and targeted oversampling to gather a higher volume of data among groups of particular interest (higher education students). The sections below analyses the overall effectiveness of the study sample plan, both in overall response and spread of demographics.

## 1.1 SAMPLE SEGMENT ANALYSIS

### ***Sample Rate by Sample Segment (Complete Households / Total Households in the Region)***

The estimated total sample rate for this region was .76% (750 complete households / 99,004 households in the region), with the higher education segment predicted to have a higher sample rates due to targeted oversampling. In practice, all segments exceeded the estimated sample rates, with the higher education segment reaching 2.4% (double the expected rate). The final sample size overall was 919 complete households, which corresponds to a .92% sample rate. Additionally, low-income households were proportionally represented in the sample (even before data weighting), which is a very rare result among travel surveys. The targeted and compensatory oversampling in this study were effective in generating participation from low-income households and those enrolled in higher education (see also Figure 4, Figure 5, and page 7 of the weighting memo).

**FIGURE 4: SAMPLE RATE BY SAMPLE SEGMENT (UNWEIGHTED)**

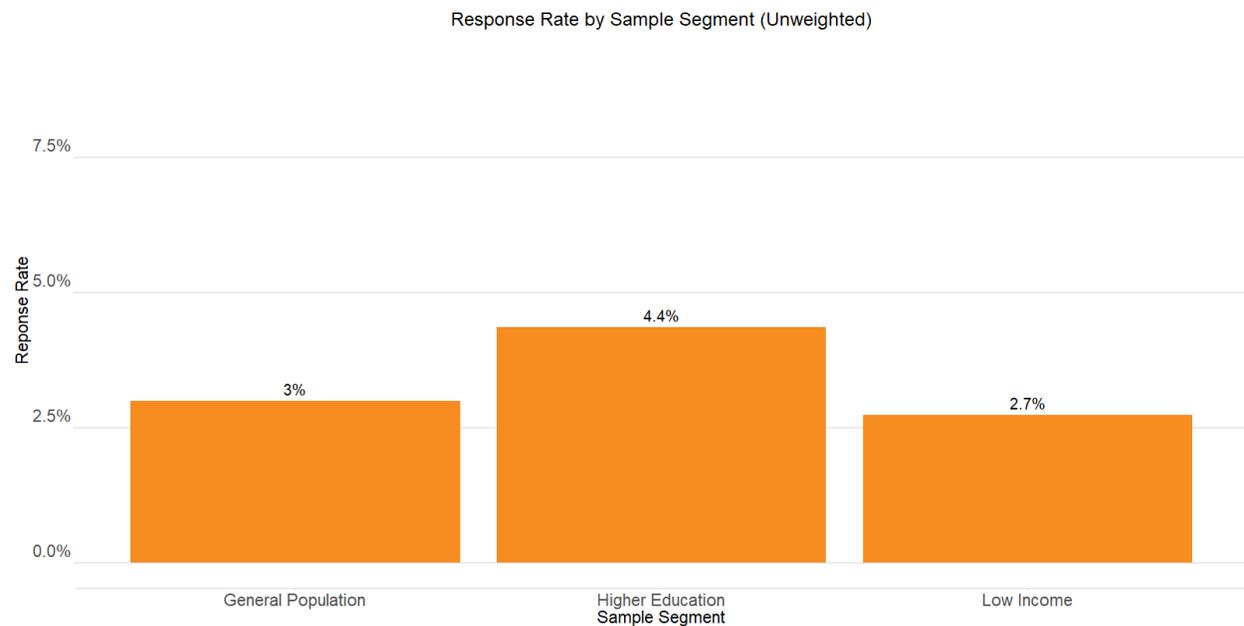


## ***Response Rate by Sample Segment (Complete Households / Invited Households)***

The sample plan for this study estimated a response rate of roughly 2.6% for the entire region, with the higher education and low-income segments responding slightly lower and the general population slightly higher. In practice, all segments exceeded the estimates, with the higher education segment (used for targeted oversampling) responding at the highest rate overall.

The high response rate was mostly due to a very strong recruitment rate and overall interest in the study among the region. A portion of the high response rate in the higher education segment may be attributed to the fact that those households were not able to complete Part 2 of the study using rMove (rMove households generally have a slightly lower rate of completion than online diary households). As expected, the low-income segment responded at the lowest rate, although still above estimates in the sample plan.

**FIGURE 5: RESPONSE RATE BY SAMPLE SEGMENT (UNWEIGHTED)**



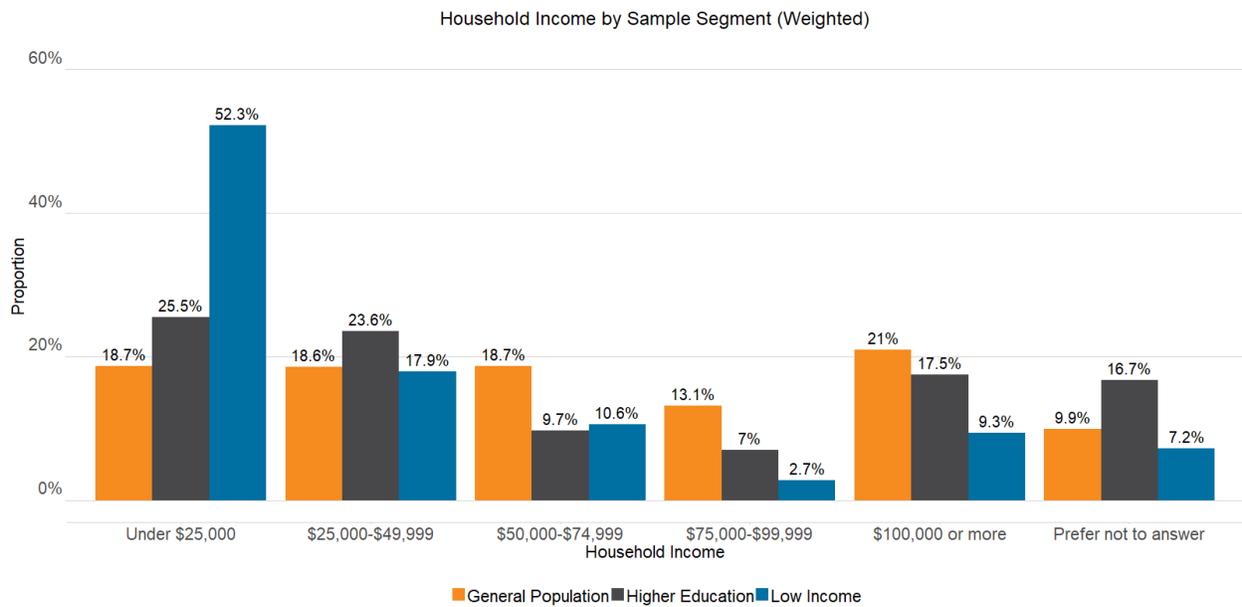
## ***Household Income by Sample Segment***

In addition to targeted oversampling for university students, the sample plan also included compensatory oversampling for low-income households, which typically respond at a lower rate. The low-income segment was comprised of 11 census tracts, all of which contained at least 50% of households with annual incomes below \$30,000. The low-income sample segment contained the largest percentage of households with reported annual incomes below \$25,000 (see figure below). The low-income sample segment had the most skewed income distribution, whereas the general population segment (and the higher education segment, to some degree) are much more evenly distributed. The final household counts in each segment are listed below in Table 1, and the income distribution within sample segments are shown in Figure 6.

**TABLE 1: FINAL SAMPLE SIZE BY SAMPLE SEGMENT**

SAMPLE SEGMENT	COMPLETED HOUSEHOLDS
General Population	676
Higher Education	109
Low Income	134

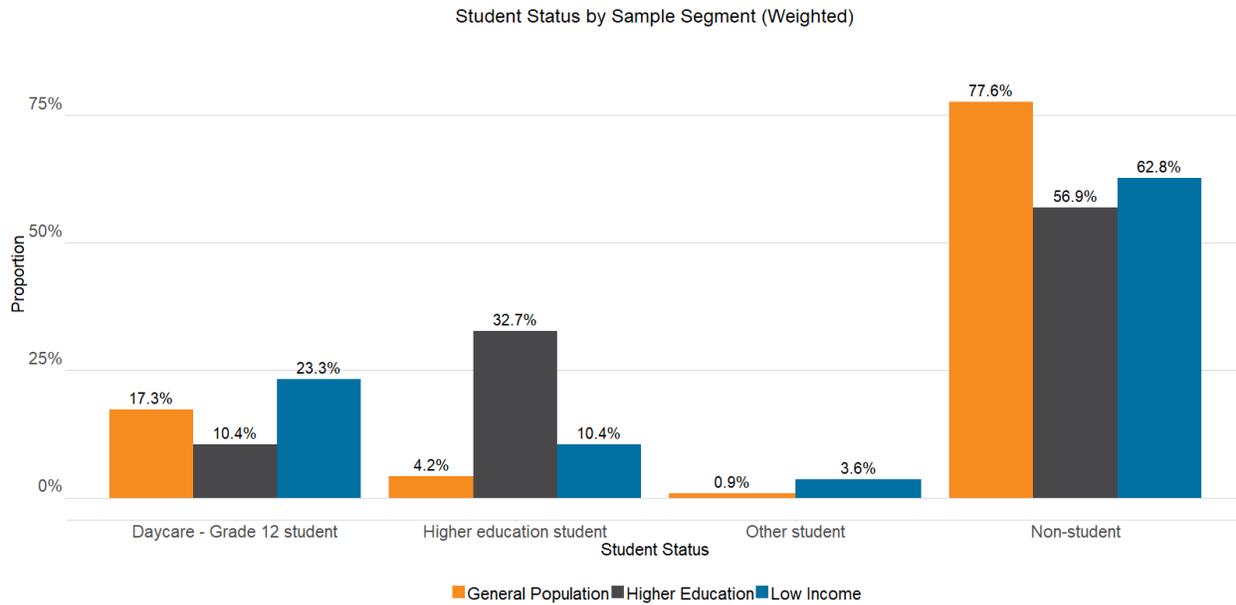
**FIGURE 6: HOUSEHOLD INCOME BY SAMPLE SEGMENT (WEIGHTED)**



***Person Student Status by Sample Segment***

Although only 22% of the general population segment reported themselves as students, the low-income and higher education segments reported much higher shares of students (33% and 10%, respectively). The higher education segment stands out particularly well in its proportion of higher education students, with nearly eight-times the rate of the general population segment (32% vs 4%). The total distributions are shown below in Figure 7.

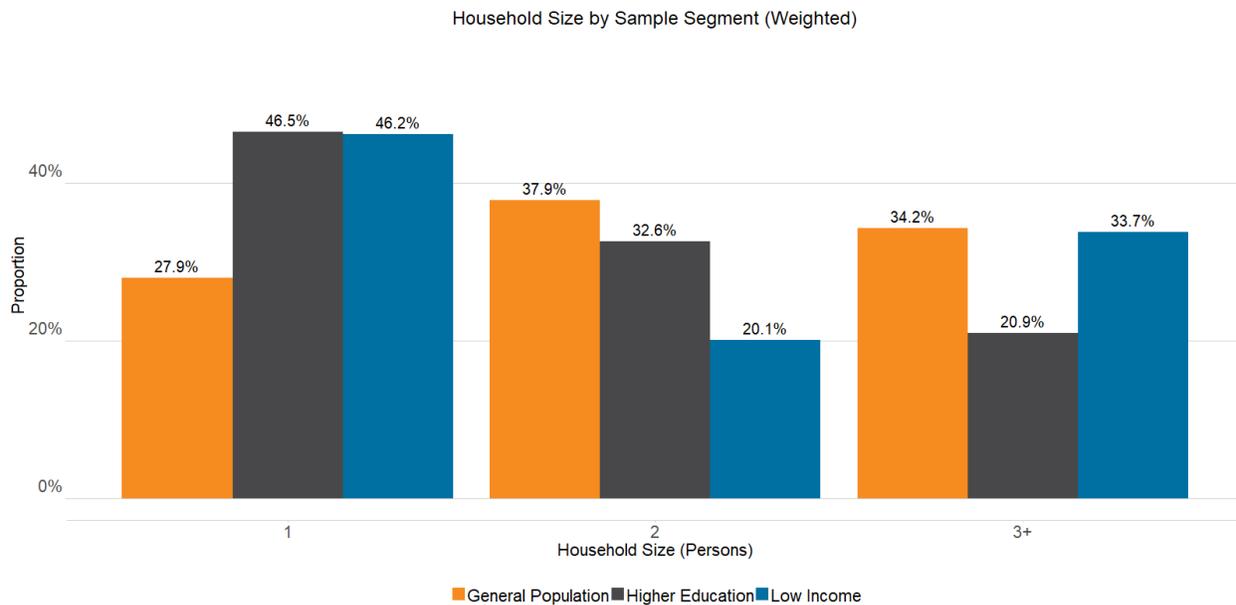
**FIGURE 7: STUDENT STATUS BY SAMPLE SEGMENT (WEIGHTED)**



### ***Household Size by Sample Segment***

Looking at household size by sample segment, two trends emerge. First, nearly half of the higher education and low-income households were single person households. It's possible that this is a result of students living alone or in single dorms for the higher education segment, or due to the positive correlation between household size and household income for the low-income segment. Second, the general population and low-income segment have one-third of households with larger (3+ person) households. Figure 8 below uses weighted data, so these relationships essentially mirrors the American Community Survey data for the region.

**FIGURE 8: HOUSEHOLD SIZE BY SAMPLE SEGMENT (WEIGHTED)**

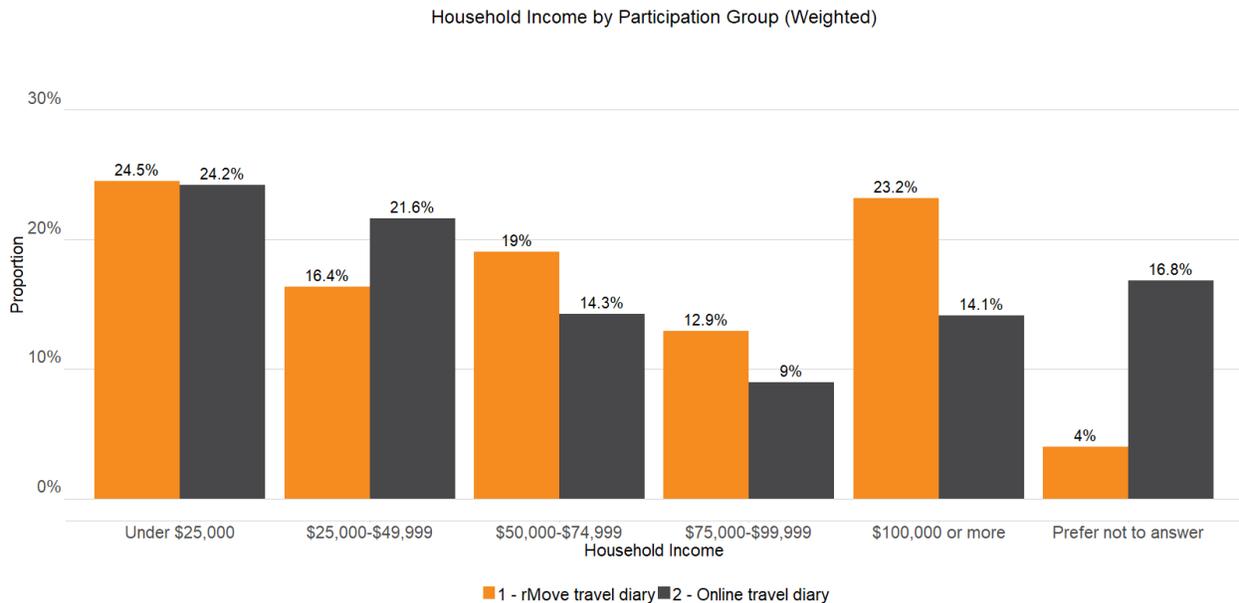


## 1.2 PARTICIPATION GROUP AND DEMOGRAPHIC ANALYSIS

### Household Income by Participation Group

In general, higher income households had higher rates of rMove participation because these households are slightly more likely to own smartphones. A significantly lower rate of rMove households responded “Prefer not to answer” than online diary households (4% vs 17%).

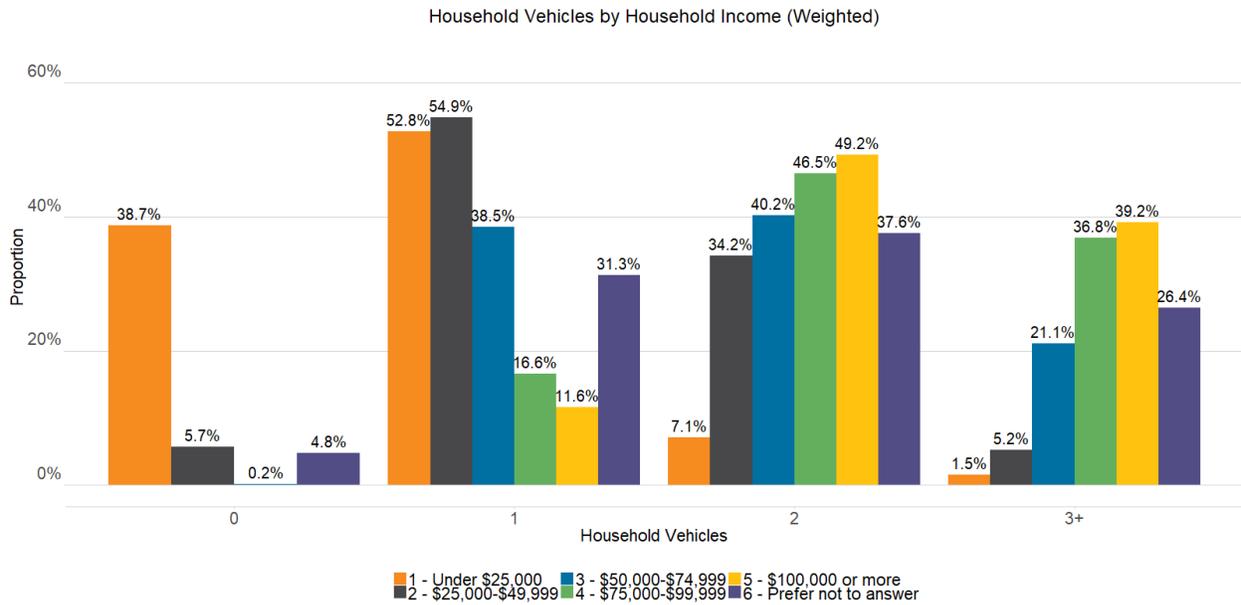
FIGURE 9: HOUSEHOLD INCOME BY PARTICIPATION GROUP (WEIGHTED)



### Household Vehicles by Household Income

In general, the lower income brackets have fewer cars and *significantly* higher rates of zero-vehicle households. As incomes increase, vehicles increase as well. (This trend is also evident in the trip mode analysis as low-income households have lower car-mode trip rates.) Overall, 11% of households had 0-vehicles. The full distribution of vehicles by income is shown in Figure 10.

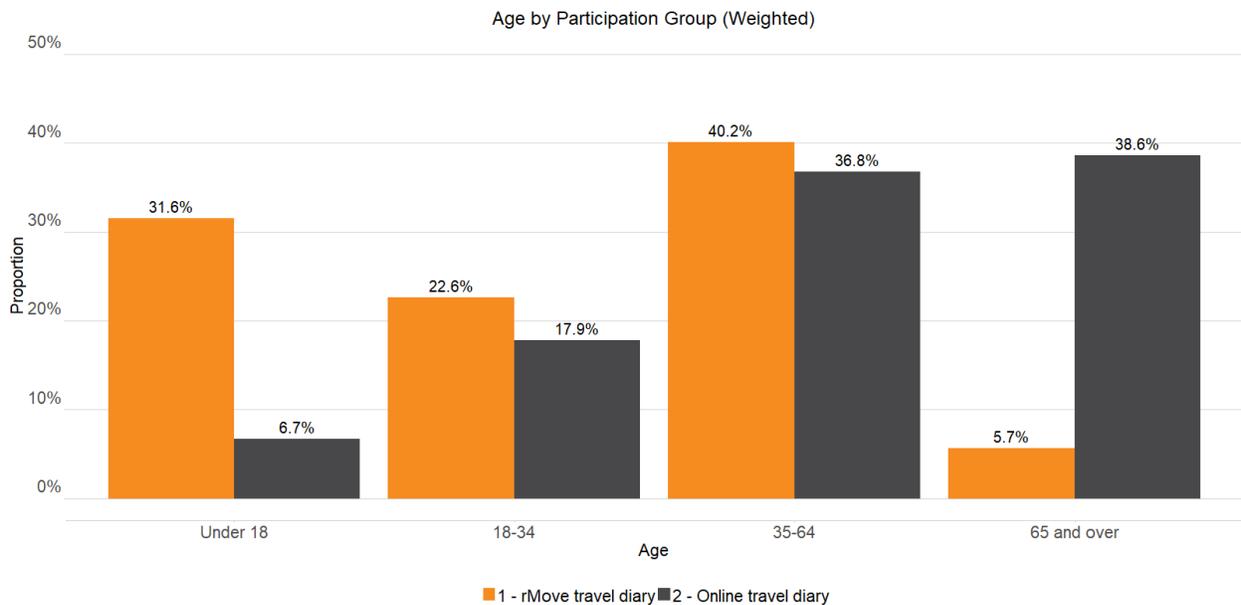
**FIGURE 10: HOUSEHOLD VEHICLES BY HOUSEHOLD INCOME (WEIGHTED)**



**Age by Participation Group**

Age by participation group also reveals a clear trend as younger participants tend to use rMove more frequently than older participants (particularly those over 65 years old). Since younger participants often respond to surveys at lower rates, it is especially beneficial that these households trend toward rMove because the travel data they report is often greater in quantity and detail than the travel data rSurvey households report. (Note that persons under 18 years old didn't participate in rMove directly but had trips reported by proxy from their parents.)

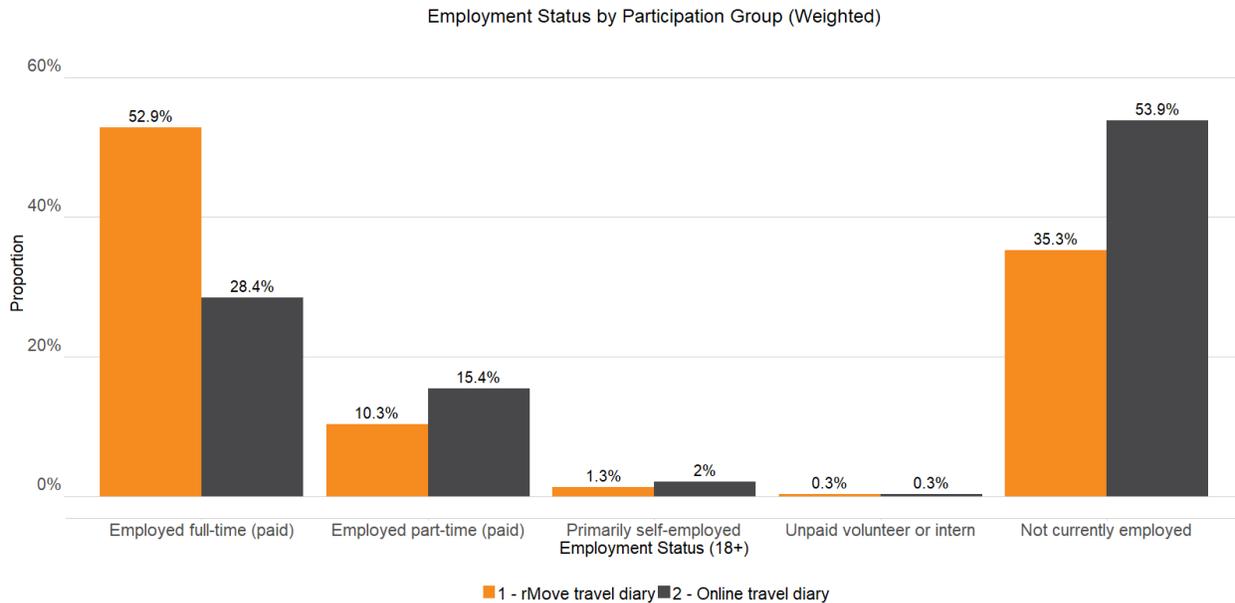
**FIGURE 11: AGE BY PARTICIPATION GROUP (WEIGHTED)**



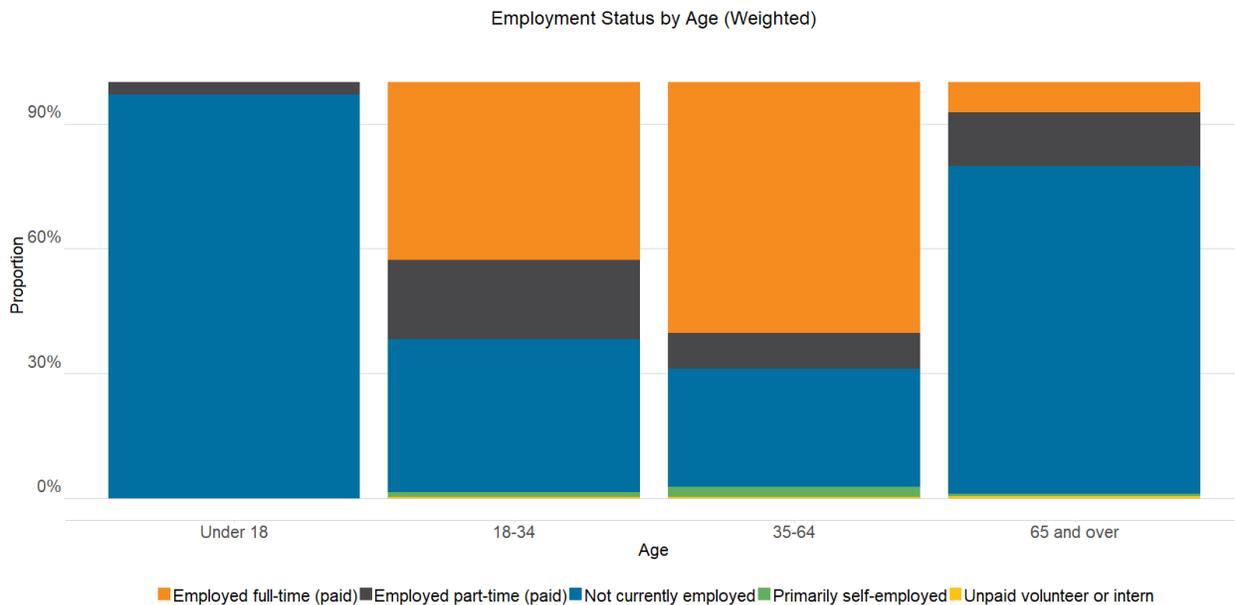
## Employment Status by Participation Group

Employment status by participation group (Figure 12) becomes more logical when paired with the age by participation group analysis above. For example – the online diary group had a significantly higher rate of unemployed participants, but that group also had a much higher rate of participants age 65 and over. Likewise, the rMove group has a much higher rate of full-time employed individuals because that group also has a much higher rate of working-age participants. The relationship between age and employment status overall is shown in Figure 13.

**FIGURE 12: EMPLOYMENT STATUS BY PARTICIPATION GROUP (WEIGHTED)**



**FIGURE 13: EMPLOYMENT STATUS BY AGE (WEIGHTED)**



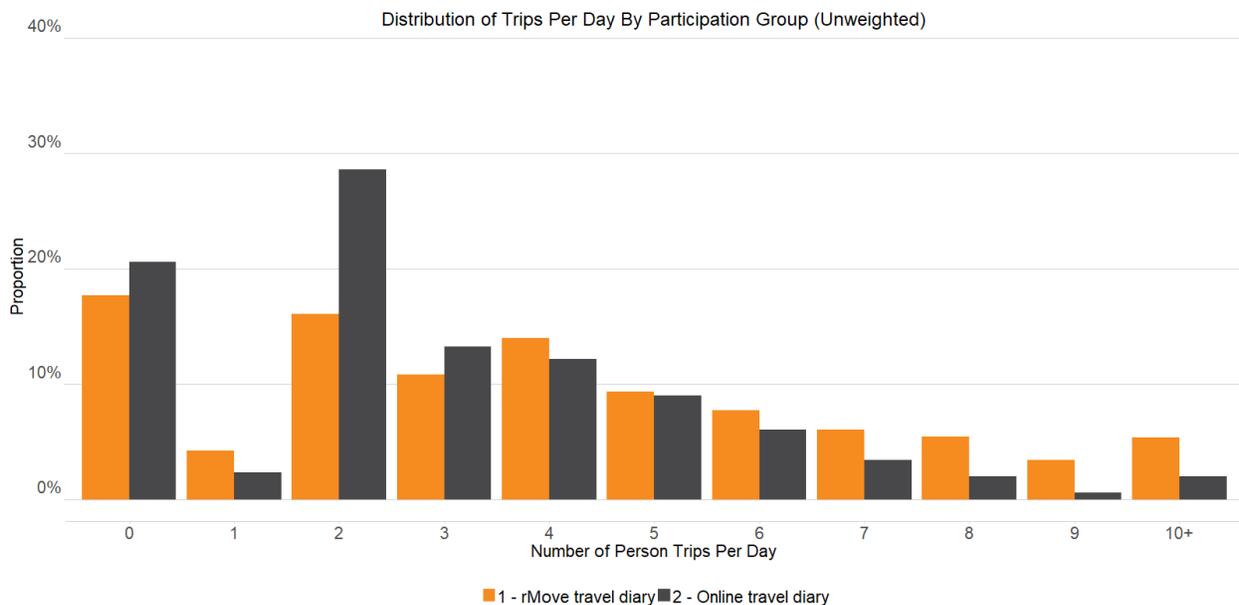
## 2.0 TRIP AND TRAVEL ANALYSIS

This study collected trip data by smartphone and through an online travel diary. As described earlier, households and people differ by their methods of participation. Smartphone-owning households represent the general population fairly well, while households using the online diary are much older and smaller (e.g., retired without children at home). The sections below demonstrate how the demographic and participation group differences reflect in travel data collected.

### 2.1 OVERALL TRIP RATES

One of the most notable differences between groups is the difference in volume of trips collected. Figure 14 shows the unweighted distribution of travel days by the number of trips taken per day. rMove households average about 4.1 trips per person-day, while the online diary averages about 3.0 trips per day (once again, this is partly due to demographics, but partly due to rMove’s ability to more accurately capture travel behavior). Participants using rMove had 2.5 times as many days with 7 or more trips (20% vs 8% of days).

**FIGURE 14: DISTRIBUTION OF TRIPS PER DAY BY PARTICIPATION GROUP (UNWEIGHTED)**

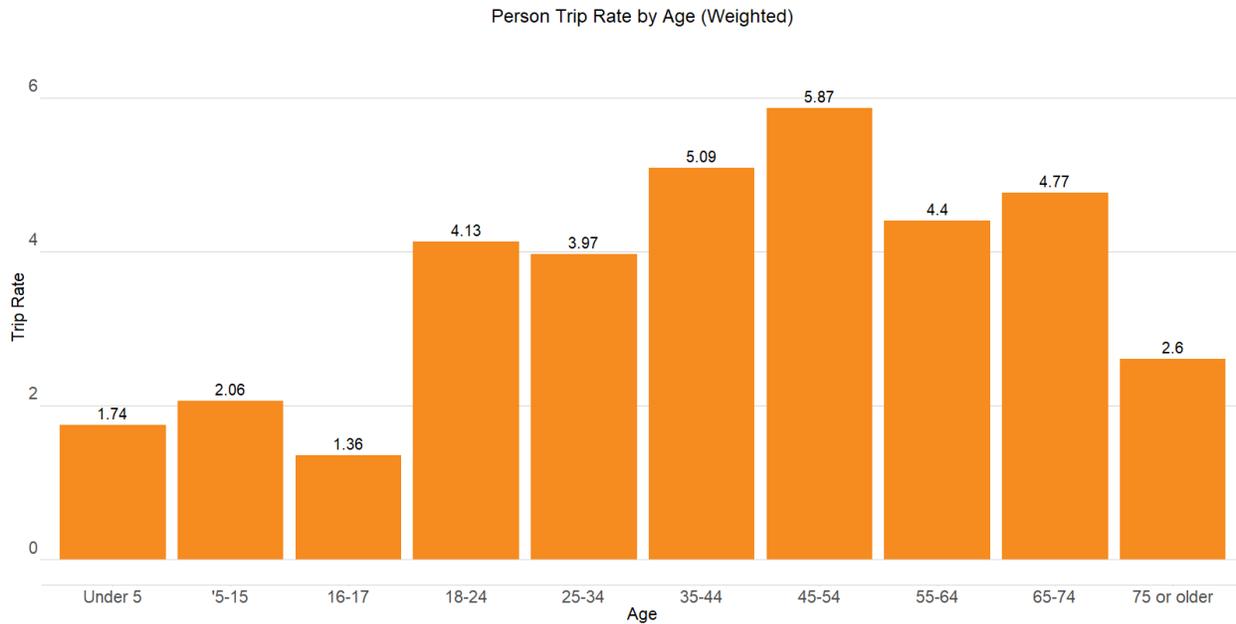


In the figures that follow, any weighted trip analyses include a set of adjustments to help make the online travel diary data more apples-to-apples comparable to rMove travel data. In essence, these adjustments to the trip weights help to reduce any biases that exist in how people reported their travel online. (A full description of these adjustments is in the weighting memo). The results below should be considered current, reliable descriptions of several high-level travel patterns in the Broome-Tioga region.

## Person Trip Rate by Age

Overall, younger individuals make fewer trips each day than older individuals, apart from those over age 65. A portion of the individuals over age 65 likely make fewer trips because they have fewer obligations and/or because traveling in general is a somewhat strenuous activity. While younger individuals may truly make fewer trips each day on average, it's likely that the lower trip rate is partially due to proxy-reporting. This study required adults to report travel for the children in the household, which often leads to trips getting unintentionally dropped. This is a known, consistent issue among household travel surveys in general.

**FIGURE 15: PERSON TRIP RATE BY AGE (WEIGHTED)**

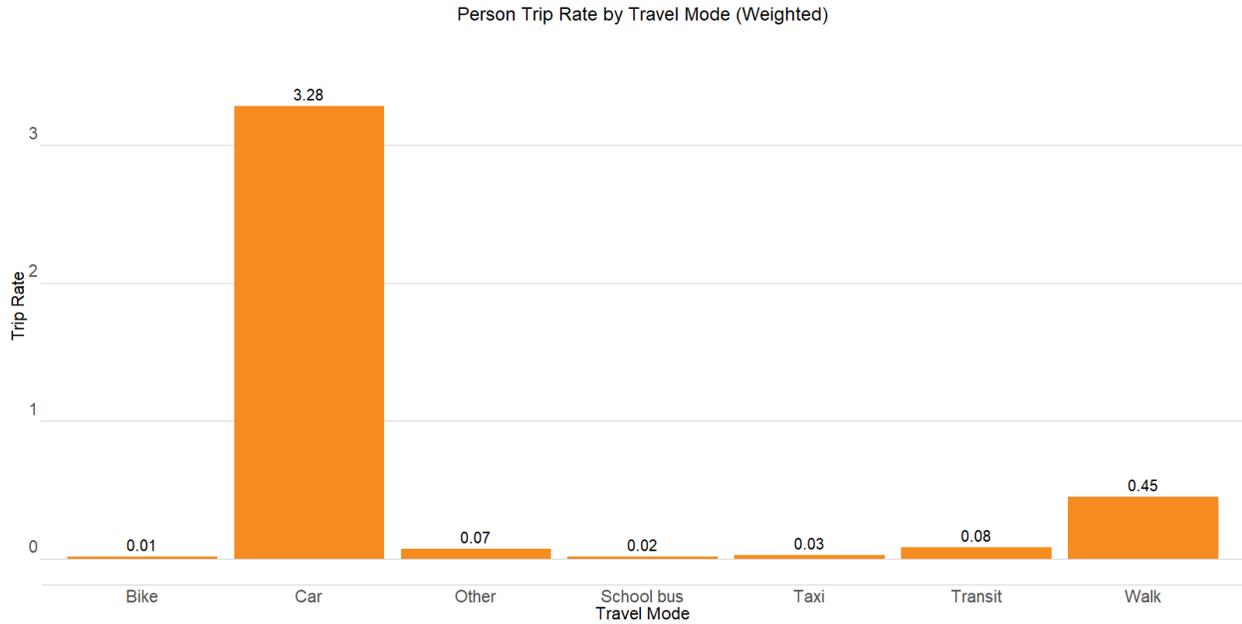


## 2.2 TRAVEL MODE ANALYSIS

### Person Trip Rate by Travel Mode

As expected, the clear majority of trips are made by car, with 3.28 car trips per weekday. The next most frequent mode is walking, with a rate of 0.45 walking trips per day. On average, this means individuals take one walking trip about every two days, which may be logical given the typical trip distance in the region as well as the cooler weather during the study period of February and March 2018. (Walking trip rates may be very slightly higher in the summer than they are in the winter, for example.) The total trip rates by travel mode are shown in Figure 16.

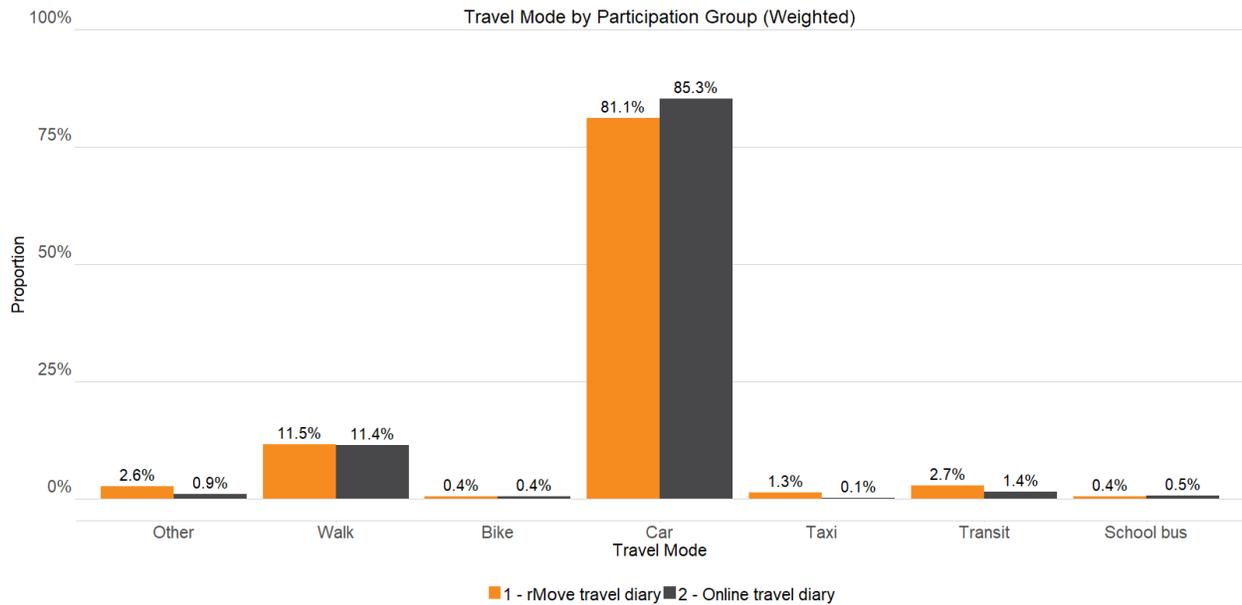
**FIGURE 16: PERSON TRIP RATE BY TRAVEL MODE (WEIGHTED)**



***Travel Mode by Participation Group***

This study showed similar mode rates between the participation groups, although rMove captured a slightly higher share of non-car trips. This is likely tied to the higher rate of short trips rMove captured, but there may be other factors that slightly influence mode choice (e.g., participant age). The total mode rates are also shown below in Table 2.

**FIGURE 17: TRAVEL MODE BY PARTICIPATION GROUP (WEIGHTED)**



**TABLE 2: DISTRIBUTION OF TRIPS BY TRAVEL MODE (WEIGHTED)**

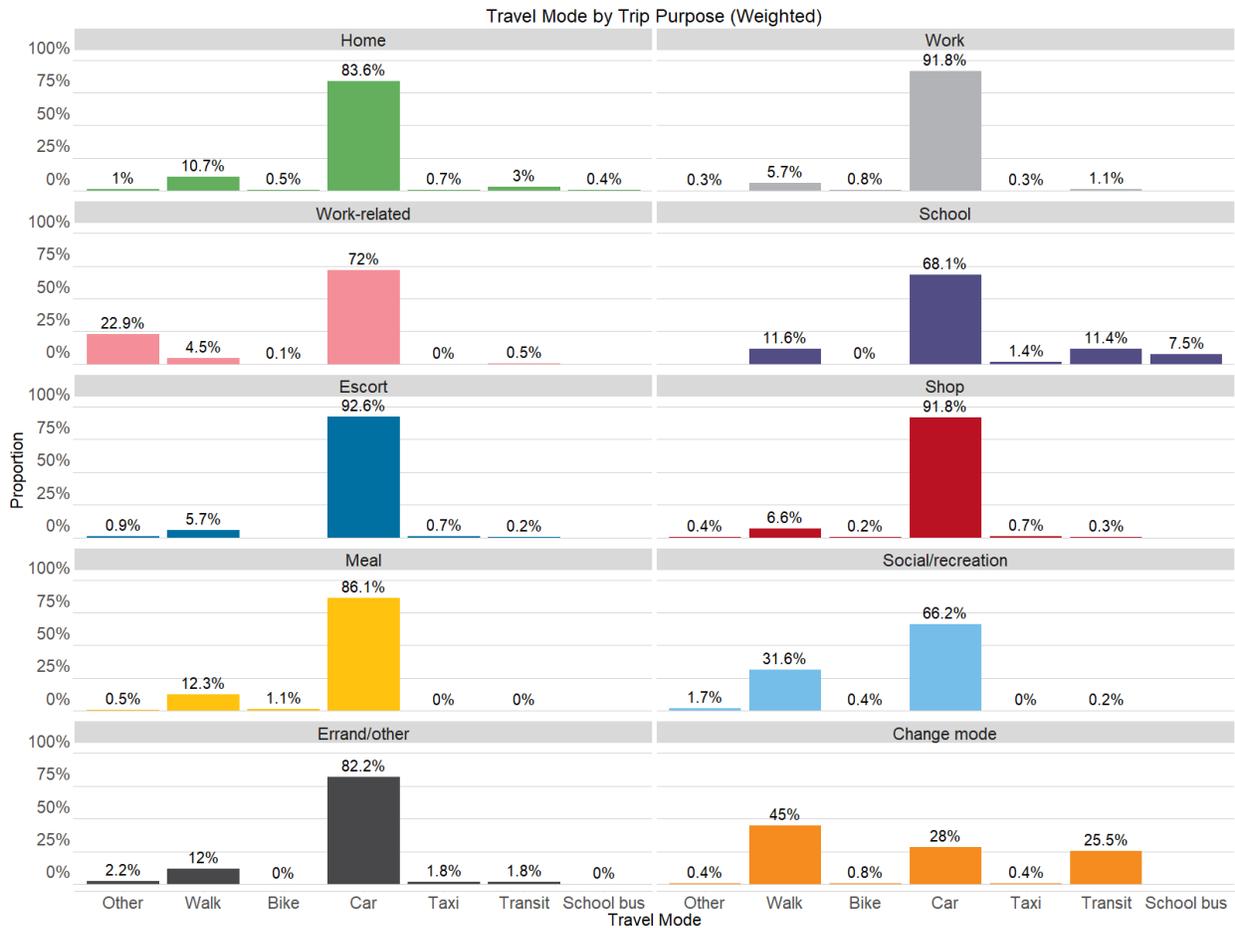
NUMBER OF PERSON TRIPS	% OF TRIPS
Other	1.9%
Walk	11.5%
Bike	0.4%
Car	83.0%
Taxi	0.8%
Transit	2.1%
School bus	0.5%

### ***Travel Mode by Trip Purpose***

This project collected detailed information about the purpose of each trip. The detailed purpose categories are consolidated into ten core categories: Home, Work, Work-related (e.g., traveling for work), School, Escort (e.g., child drop-off), Shopping, Meal, Social/Recreation, Errand/Other, and Change Mode (implying they had not reached their final destination).

Although car trips dominate regional travel overall (83% mode share), there are noticeable difference when mode is broken out by purpose. Walk trips make up a comparatively large portion of recreational and change mode trips. Many transit trips are only one leg of multi-leg trips, given that a higher rate of the change mode trips are by transit .

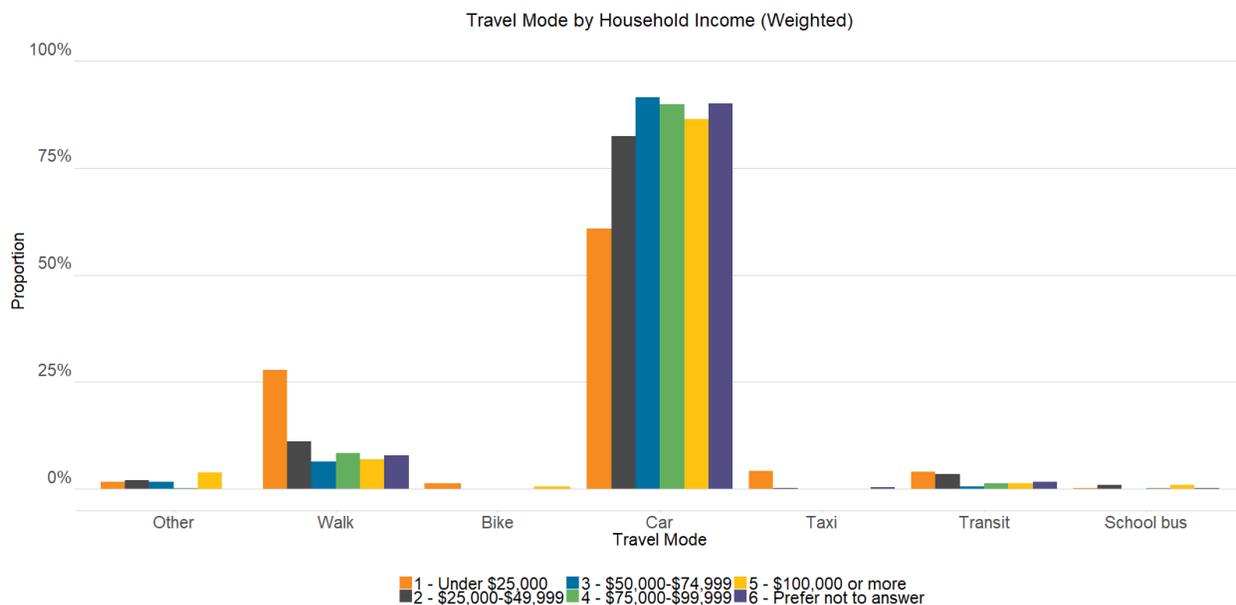
**FIGURE 18: TRAVEL MODE BY TRIP PURPOSE**



***Travel Mode by Household Income***

As expected, one of the most noticeable patterns when analyzing mode by income is the comparatively high share of walk trips among low-income households. As mentioned earlier (and shown in Figure 10), these households also have fewer vehicles on average, so it is consistent that they also have fewer car trips. These households also have much higher rates of transit trips compared to higher income brackets (see Table 3 below).

**FIGURE 19: TRAVEL MODE BY HOUSEHOLD INCOME (WEIGHTED)**



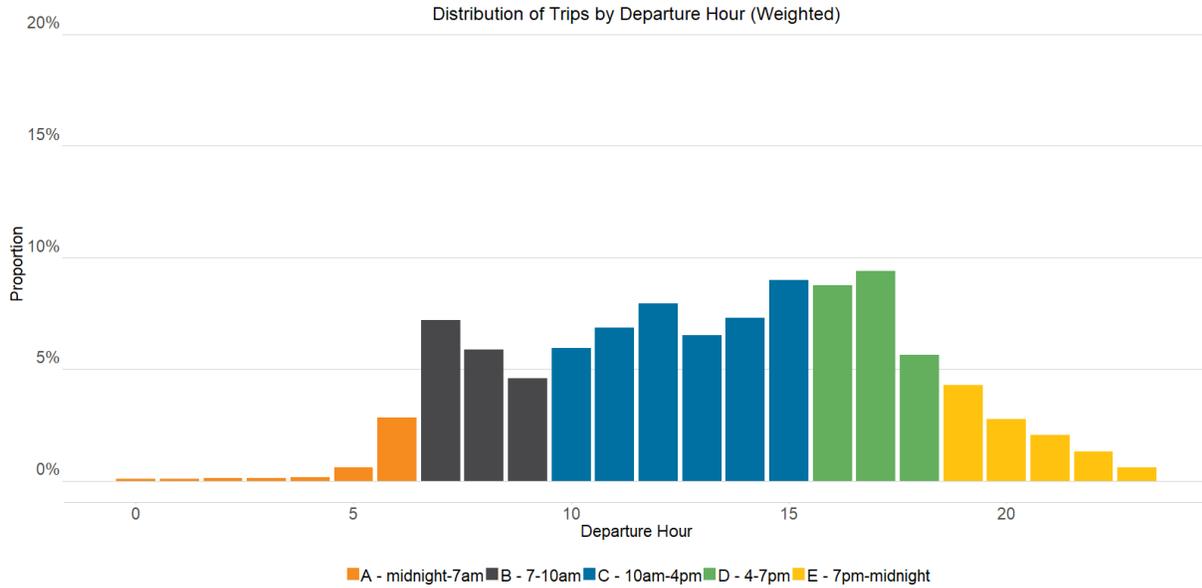
**TABLE 3: TRAVEL MODE BY HOUSEHOLD INCOME (WEIGHTED)**

	UNDER \$25,000	\$25,000 - \$49,999	\$50,000 - \$74,999	\$75,000 - \$99,999	\$100,000 OR MORE	PREFER NOT TO ANSWER
Other	1.6%	1.9%	1.6%	0.2%	3.8%	0.0%
Walk	27.8%	11.1%	6.3%	8.3%	7.0%	7.8%
Bike	1.3%	0.1%	0.1%	0.6%	0.0%	0.0%
Car	60.9%	82.4%	91.6%	89.9%	86.4%	90.0%
Taxi	4.2%	0.2%	0.0%	0.0%	0.0%	0.4%
Transit	4.1%	3.4%	0.5%	1.3%	1.3%	1.7%
School bus	0.2%	1.0%	0.0%	0.1%	0.9%	0.2%

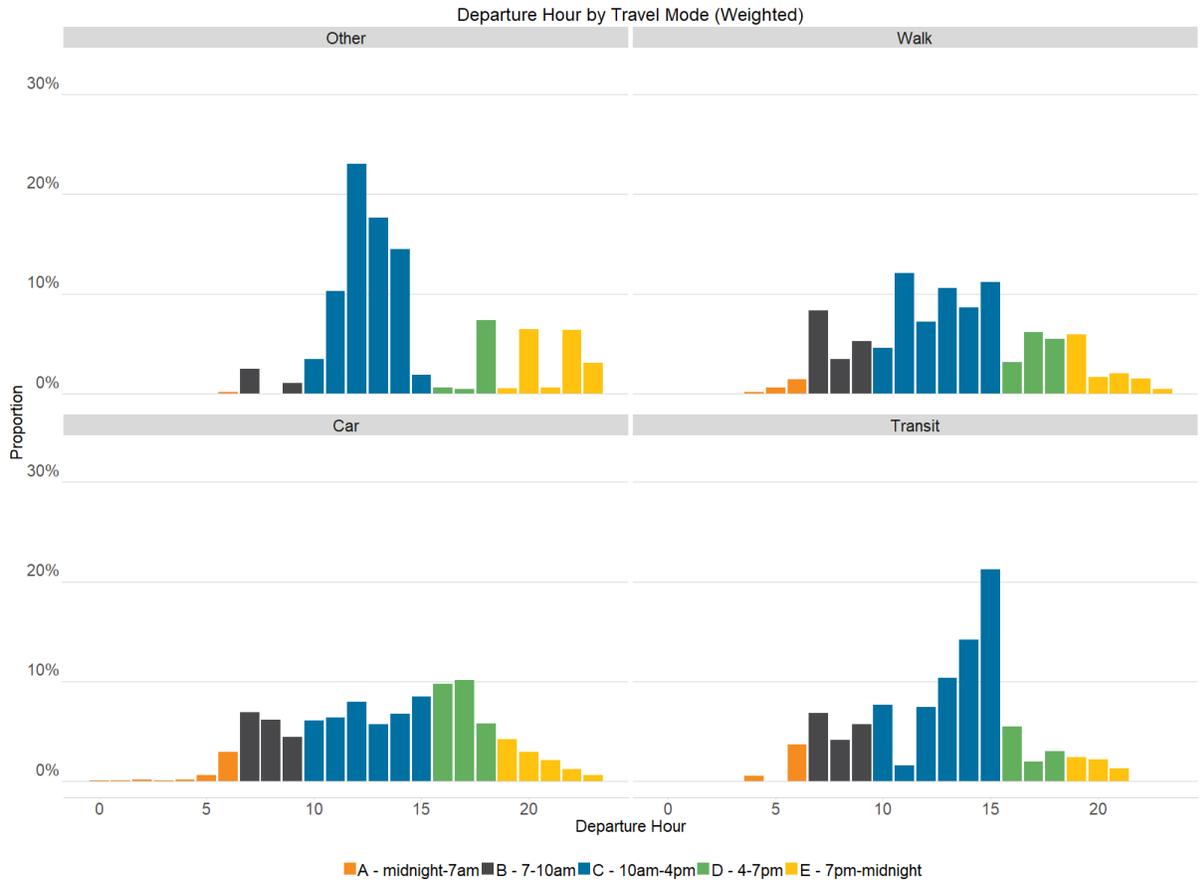
***Departure Hour by Travel Mode***

When looking at travel mode by time of day (Figure 21), there are several patterns among the modes. Car trips are relatively constant throughout the day but do rise slightly during work/school commute hours. Given that car trips make up the vast majority of total trips, it may not be surprising that the distribution of total trips mirrors the distribution of car trips very closely. Walk trips are more frequent in the middle of the day, possibly because participants take more short trips during the work day (e.g., walk to lunch, walk to corner store). Transit trips are more frequent in the afternoon when people are returning home from work or school. (Figure 26 shows a breakdown of mode by purpose, and homebound trips are among the most frequent transit trips.)

**FIGURE 20: DISTRIBUTION OF TRIPS BY DEPARTURE HOUR (WEIGHTED)**



**FIGURE 21: DEPARTURE HOUR BY TRAVEL MODE (WEIGHTED; SHOWING MODES WITH MORE THAN 100 UNWEIGHTED TRIPS; TRIPS THAT EITHER START OR STOP IN THE STUDY REGION)**

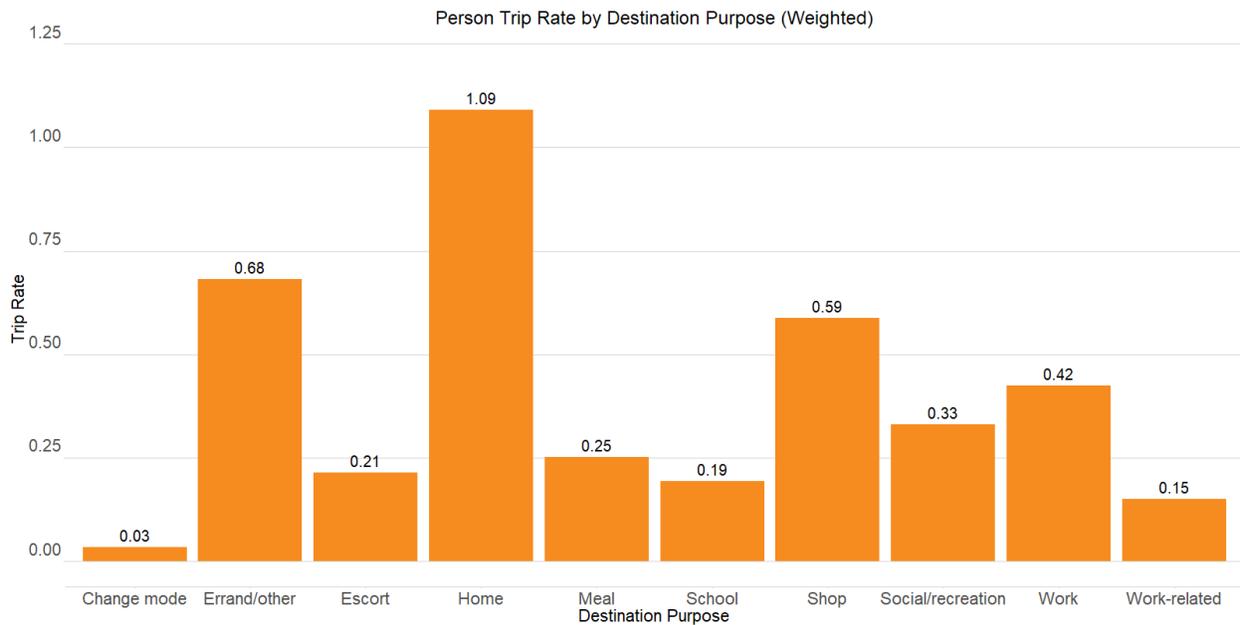


## 2.1 TRIP PURPOSE ANALYSIS

### *Person Trip Rate by Travel Purpose*

Given that most individuals end their days at home (and may go home more than once during the day), it is logical that trips to home have a trip rate above 1 – also the highest trip rate of all purposes. Errand and shopping trips have the next highest trip rates, with individuals going on errand/shop trips slightly more than once every two days. Trips to the grocery store, bank, convenience store, or post office all fall into these categories. The work and school trip rates are slightly lower, but not surprising given the student/employment rates in the region.

**FIGURE 22: PERSON TRIP RATE BY TRAVEL PURPOSE (WEIGHTED)**

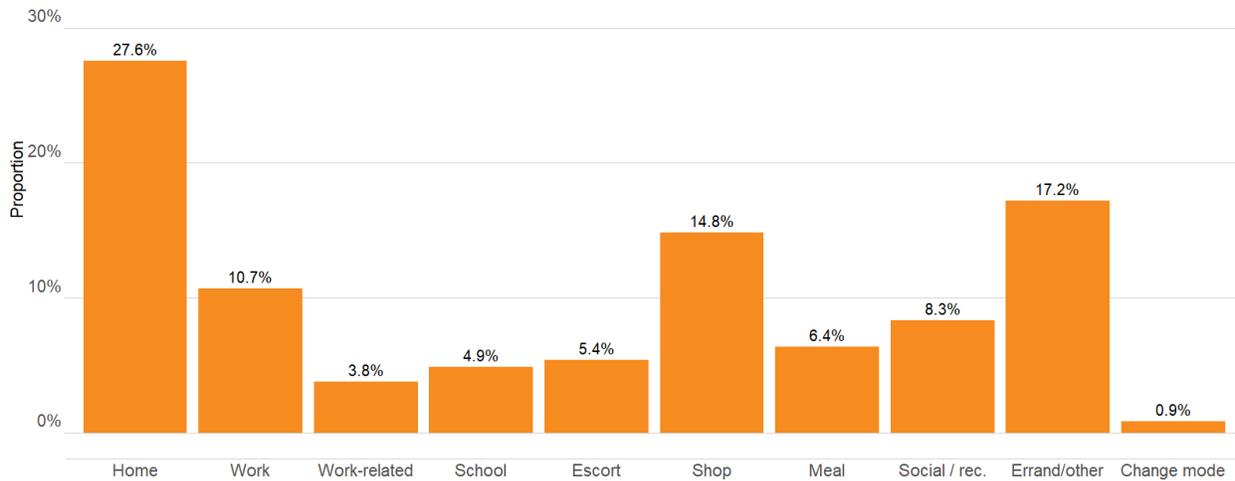


### *Distribution of Destination Purpose*

As is typical, the highest share of trip purposes is trips to home. The rate of work and work-related trips is somewhat low, but less so when considering the percentage of employed participants overall. While it may be surprising that shop and errand trips have such high percentages, it's worth noting that individuals may only go to home or to work once a day, but they may run several errands in between, resulting in a higher rate of those trips.

**FIGURE 23: TRIPS BY DESTINATION PURPOSE (WEIGHTED)**

Distribution of Trips by Destination Purpose (Weighted)

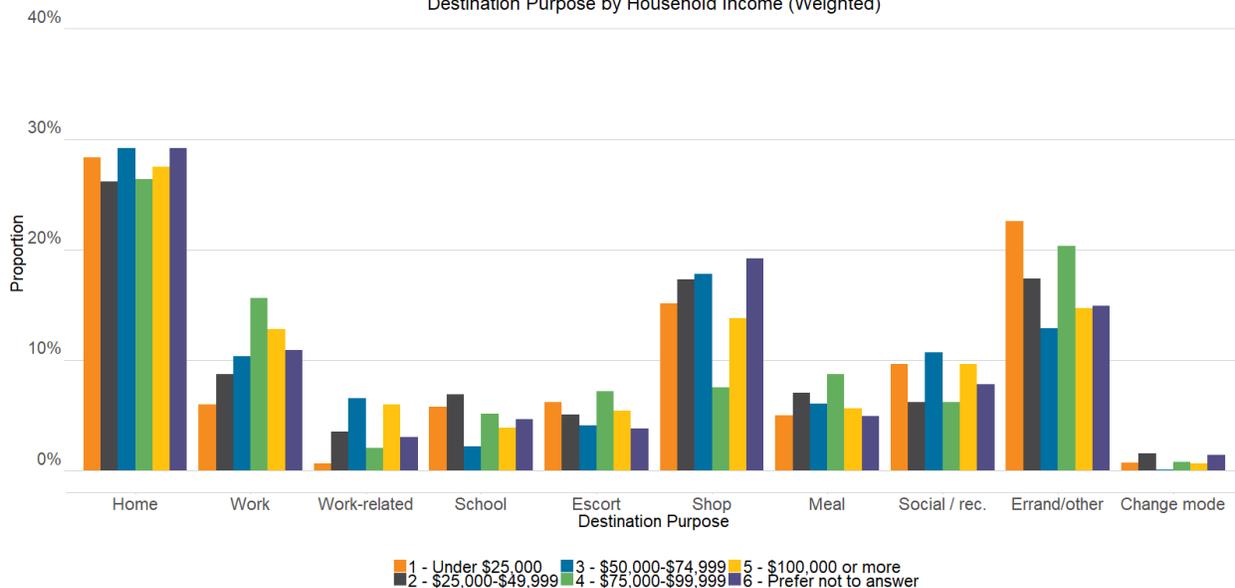


***Destination Purpose by Household Income***

One of the most noticeable patterns when looking at purpose by income is the pattern in work trips. In general, the higher income households tend to take more trips to work. This is logical given that retired, unemployed, or student households likely have lower annual incomes, on average. As shown in Figure 24, low income households also had more than double the rate of change mode purpose trips, which is likely tied to the high share of transit trips shown in Table 3.

**FIGURE 24: DESTINATION PURPOSE BY HOUSEHOLD INCOME (WEIGHTED)**

Destination Purpose by Household Income (Weighted)



## Departure Hour by Destination Purpose

When trip purposes are analyzed by time of day, there are several noticeable and expected peaks. For example – there are clear work and school peaks between 6-9am and clear meal peaks around logical meal times, especially lunch and dinner. Home trips have an inverse pattern with peaks later in the day, around 4-6pm, likely when many people are leaving work or school for the day. There is an unusually high peak in change mode trips between 3-4pm, which is likely tied to the high rate of transit trips at the same time (see Figure 21).

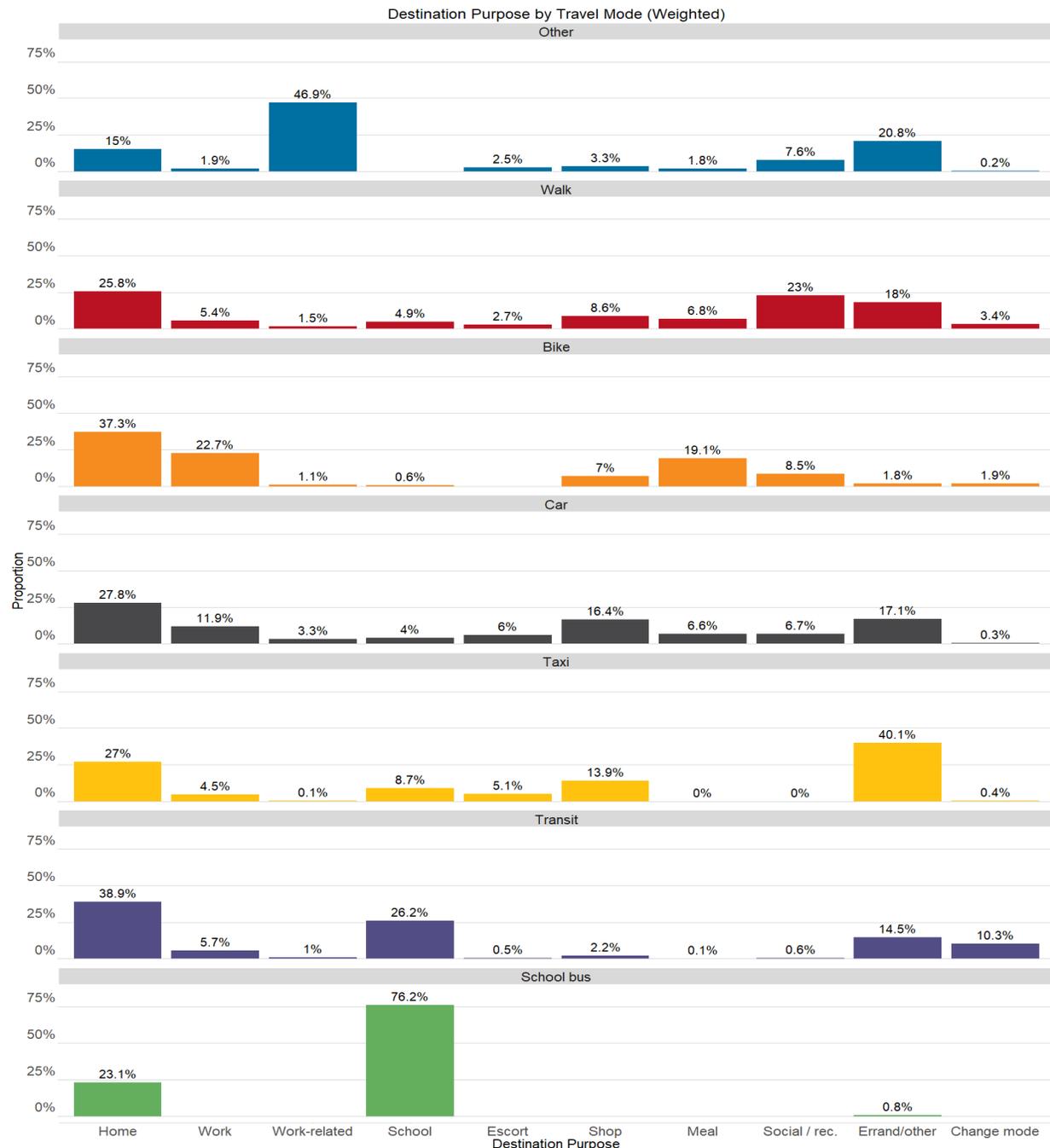
**FIGURE 25: DEPARTURE HOUR BY DESTINATION PURPOSE (WEIGHTED)**



## Destination Purpose by Travel Mode

The analysis of purpose by mode emphasizes several patterns but may also reveal an oddity in the dataset. One logical pattern is the high share of school bus trips going to school and back home. The chart below shows a similar pattern among transit trips, although with slightly more variety among the other purposes. One of the unexpected patterns is the high spike in work-related “other” mode trips. The final dataset includes 63 of these trips, 41 of which were reported by the same person. Because there are (relatively) so few trips that fall into the “other” mode category, the individual with 41 trips likely had a much larger impact.

**FIGURE 26: DESTINATION PURPOSE BY TRAVEL MODE (WEIGHTED)**



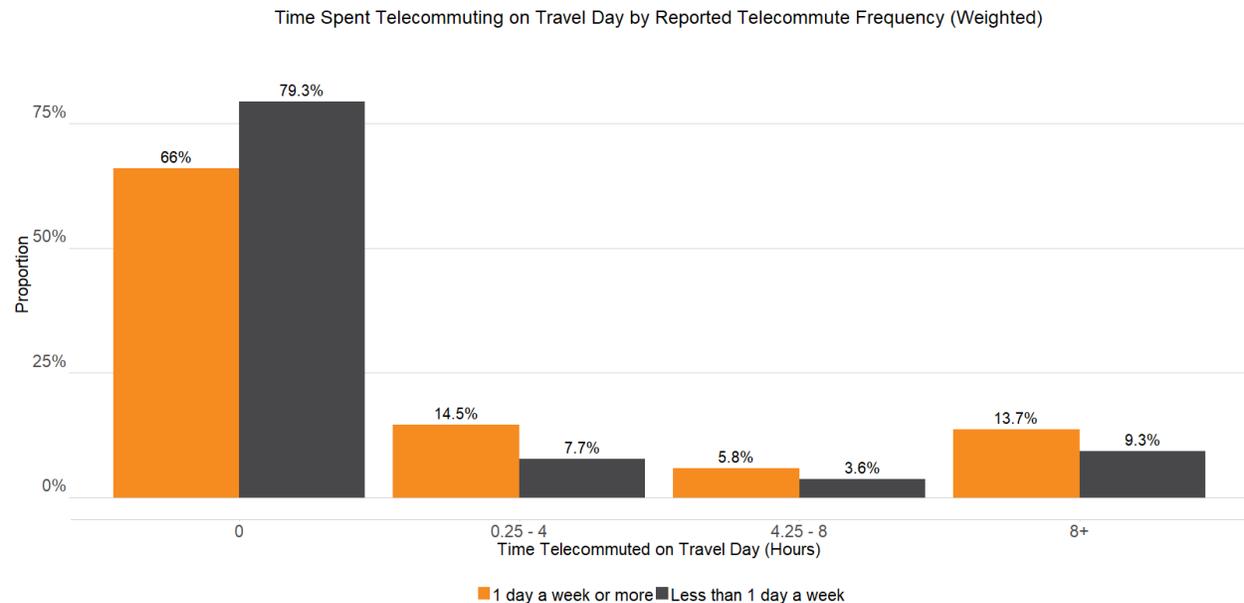
## 2.2 TRAVEL DAY ANALYSIS

Study participants were asked to provide details about their day as a whole in addition to their travel information on their travel days. These details included online shopping time, telecommute time, deliveries, and why participants made no trips (if they did not travel on their travel days). The most notable analyses from these questions are explained in the sections below.

### ***Telecommute Time by Reported Telecommute Frequency***

This study asked employed participants to report in Part 1 how frequently they work from home. Part 2 (the travel diary) also asked participants each day how much time they spent working at home that day. The results of the two responses are shown below. As expected, individuals who reported working from home at least 1 day per week reported higher rates of working at home on their travel days. However, it's also important to note that this data is weighted to include only Tuesday/Wednesday/Thursday, and it's possible that many people work from home on Fridays (among those who work from home at least one day per week).

**FIGURE 27: TELECOMMUTE TIME BY REPORTED TELECOMMUTE FREQUENCY (WEIGHTED)**



### ***Person Trip Rates by Day of Week and Participation Group***

As expected, the trip rates by day of week are very similar between the two participation groups when using weighted data (as shown below in Figure 28). Given that Tuesdays, Wednesdays, and Thursdays all have similar travel behavior, it is also not surprising that the three days are fairly uniform within participation groups. The only slight exception is the lower trip rate on Thursday among rMove households, which may indicate missing trips on their final day of travel.

**FIGURE 28: PERSON TRIP RATES BY DAY OF WEEK AND GROUP (WEIGHTED)**

