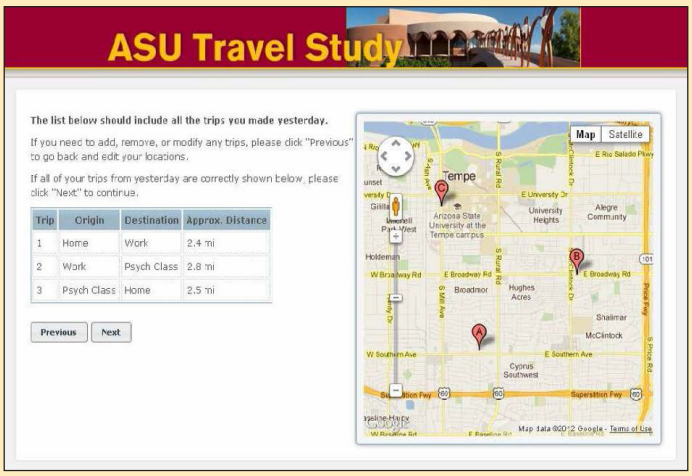
Arizona State University

Arizona State University Travel Survey and Model Update

Final Report



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1. Introduction

Arizona State University (ASU) is a major generator of travel demand in the Greater Phoenix Region area. Over the past several years, ASU has experienced considerable growth in enrollment and this growth has contributed to substantial increases in travel demand. These increases in travel demand are occurring throughout the valley due to the spatially dispersed nature of ASU population and due to the disproportionate growth of branch campuses of ASU. Arizona State University operates four campuses. The original home campus is the Tempe campus, and this campus continues to serve as the flagship campus of ASU. This campus had the duplicated enrollment[1] of 58,371 students in Fall 2010, up from 44,126 in the year 2000. Arizona State University also has three branch campuses, all of which are experiencing impressive growth in enrollment contributing to increases in travel demand. The Downtown Phoenix campus opened in 2006 and its duplicated enrollment has gone from 6,229 in Fall 2006 to 13,567 in Fall 2010. The Polytechnic campus in the East Valley has also posted impressive gains in enrollment over the past five years. In the Fall of 2006, the Polytechnic campus reported the duplicated enrollment of 6,545 students; in Fall 2010, enrollment stood at 9,752 students. The fourth campus is the West campus; duplicated enrollment at this campus has gone up from 8,211 in Fall 2006 to 11,813 in Fall 2010. The total unduplicated enrollment[2] of ASU in Fall 2010 stood at 70,440 which made it the largest public university in the nation in terms of enrollment.

While the growth of ASU in recent years has certainly contributed to changes in travel demand characteristics, there are other factors that have also changed the dynamic of ASU environment. ASU continues to grow its online offerings, thus making it possible for students to attend classes "anytime from anywhere". In other words, students do not necessarily have to be physically present at campus at the time that the class is taught in the classroom. ASU continues to attract an increasing number of traditional students (typical college-age students) and has greatly expanded its dormitory capacity – particularly at the Downtown and Tempe campus locations – to accommodate these students in residential villages. Barrett, The Honors College at ASU, has established itself as a preeminent Honors Program in the nation and ASU has built considerable infrastructure to accommodate the growth in Barrett. This includes exclusive dormitories for Honors College students, as well as special academic villages that cater to the unique experiences of these students. While the numbers of traditional students are going up, so are the numbers of non-traditional students. With the economy experiencing a downturn, many mature individuals (with families and other responsibilities) have returned to ASU to enhance their educational credentials and pick up skills that would make them more competitive in the job market. These transformations in the student demographic are likely to have important implications for travel demand associated with ASU.

Perhaps the most important change that has taken place in the transportation context is the start of light rail service in December 2008. Light rail service has provided students an economical and efficient way to travel to and from campus. ASU continues to operate free shuttle service between the main campus and its branch campuses, but the highly subsidized transit pass program has made it possible for students to take advantage of light rail service in an economical fashion. Light rail stops are located around the edge of Phoenix and Tempe campuses, thus making it a very convenient option for travel to and from campus. Many students ride

[1] It counts students enrolling at multiple ASU campuses.
[2] It counts students enrolling at the primary campus.

the train and it is time to take stock of the travel demand characteristics of ASU in light of the presence of the light rail system. No study of ASU travel demand had been undertaken following the opening of light rail service. The previous survey of ASU travel demand characteristics was undertaken in Fall 2007, a full year before the opening of the light rail line. As such, it has been extremely valuable to undertake this ASU travel data collection and model update effort so that the MAG regional travel demand model accurately reflects current and emerging activity-travel patterns that may be attributed to Arizona State University.

ASU travel data collection effort was designed in such a way that it was possible to collect detailed information about activity engagement, time use, and trip chaining patterns. The motivation behind this approach to ASU travel data collection is that MAG is currently undertaking the development of an activity-based travel demand model system. In order to eventually develop and estimate an ASU travel demand model that is compatible with and may be seamlessly integrated with the MAG activity-based travel demand model, the data collection effort was deliberately geared towards collecting travel information in the activity-based behavioral context.

2. Arizona State University Travel Survey Design and Administration

2.1. Determination of Sample Size and Margin of Error in Travel Characteristics for the Arizona State University Travel Survey

This section describes calculations to determine the sample size and the margin of error in travel characteristics for the Arizona State University travel survey. In the previous ASU travel survey conducted in 2007, response rates were generally found to be about 4-5% of the respective market segments, namely, undergraduate students, graduate students, faculty, and staff. With the enhanced web-based survey implementation and the New Apple IPAD raffle draw for the 2012 survey, it was expecting that response rates can be potentially doubled to about 8-10%. While it may be useful to determine sample sizes required for various levels of desired precision on different travel characteristics, it is also of value to identify the degree of precision that can be expected if the survey achieves the envisioned 8-10% response rate.

In order to make sample size calculations, two travel characteristics are considered. They are the basic travel characteristics that one would like to achieve a high degree of precision. The first is overall average daily trip rate per person, which is an appropriate measure of total travel demand. The second is percent of individuals driving alone, which is a good measure of mode usage. All sample size calculations furnished in this memo are based on a desired confidence level of 95%, the standard value that is used for statistical purposes. If d is the degree of precision, then it can be said that the true population value of the characteristic of interest lies within $\pm d$ of the sample estimate. For example, suppose the estimated average trip rate is 4.2 trips per person. For the sample size obtained, and assuming a 95% confidence level, let 0.2 be the value of d. Then, it can be said that the true average trip rate for the population of interest lies between 4.0 and 4.4.

For purposes of this survey, four demographic segments are considered. They are as follows:

1) Undergraduate students
2) Graduate students
3) Faculty
4) Staff

Additional segmentation is possible, but it is sufficient to view the sample size and precision estimates for these four demographic segments to understand the implications for any other type of demographic segment that may be of interest (such as students living on-campus, students who attend classes Downtown ASU campus, and so on). The sample size calculation formulas require that one specify a degree of precision and a standard deviation (or variance) for the travel characteristic (variable) of interest. The tables furnished in this report provide sample size estimates for a range of precision levels – showing how the sample size requirement increases with increasing level of precision – and documents the assumptions made in the context of developing each table. Before proceeding to sample size calculations, it may be of value to quickly review the population sizes for each market segment – but recognizing that the population size itself does not have a direct bearing on sample size requirements, except that smaller samples may be sufficient for populations that are small in size.

ASU student population in Fall 2010 has the following overall profile:

- ASU Total Students 70,440
  - Undergraduate Students 56,562
    - Freshman 10,373
    - Sophomore 11,619
    - Junior 15,729
    - Senior 18,511
    - Non-degree 330
  - Graduate Students 13,878
    - Masters 8,424
    - Doctoral 4,603
    - Non-degree 851

Preliminary numbers from Fall 2011 suggest that the total undergraduate student enrolment at ASU has grown to 58,404. In Fall 2010, students were split between full-time and part-time status as follows:

- ASU Total Students 70,440
  - Undergraduate Students 56,562
    - Full-Time 46,994
    - Part-Time 9,568
  - Graduate Students 13,878
    - Full-Time 9,451
    - Part-Time 4,427

The academic definition of part-time includes undergraduate students registered for less than 12 credit hours, graduate students with active assistantships registered for less than 6 credit hours, and graduate students without assistantships registered for less than 9 credit hours. In terms of students attending classes on the various ASU campuses, it should be noted that the students attending different campuses are not mutually exclusive. Many students attend classes on multiple campuses and it is therefore difficult to determine numbers of students that are exclusively dedicated to each campus. ASU does have statistics on the number of students in Fall 2010 who attended at least one class on the various campuses of the institution. The numbers for Fall 2010 are as follows:

- ASU Total Students (Unduplicated) 70,440
  - Tempe 58,371
  - West 11,813
  - Polytechnic 9,752
  - Downtown 13,567

It should be noted that the number of students attending different campuses add up to a value substantially larger than 70,440 because of the double- and triple-counting of students who attend classes on multiple campuses.

The numbers of faculty and staff on ASU campuses are available as of Fall 2009. Since then, ASU has hired new faculty and staff, but there has also been an approximately equal amount of reduction. As such, the total faculty and staff numbers are unlikely to be much different from figures available for Fall 2009. The faculty and staff composition, as of Fall 2009, is as follows:

- Total ASU Faculty and Staff 12,142
  - Faculty 2,991
  - Staff and Non-Faculty 9,151
    - Administrators 93
    - Professionals 2,858
    - Classified Staff 3,249
    - Graduate Assistants 2,951

For purposes of calculating sample sizes, the person trip rate may be considered a continuous variable while the mode usage may be considered a proportion (discrete) variable. For the continuous variable, the sample size needed to achieve a degree of precision of $\pm d$ with a confidence of (1-α)100% is given by:

$$n' = \left[\frac{z_{\alpha/2}\, s}{d} \right]^2$$

where n' = required sample size

d = degree of precision

s = standard deviation of travel characteristic of interest

$z_{\alpha/2}$ = standard normal distribution value corresponding to a (1-α)100% confidence level

For small populations, a finite population correction may be applied to obtain the true sample size required to achieve desired precision and confidence levels:

$$n = \frac{n'}{1 + \frac{n'}{N}}$$

where n = final sample size

N = population size

When $N >>>>> n'$, then n is very nearly equal to n'.

In addition to providing values for the desired precision and confidence levels, the analyst must also provide a standard deviation for the travel characteristic of interest (person daily trip rate in this case) to compute the sample size. An appropriate assumption for this value may be made in the absence of prior information regarding the value of this standard deviation.

In the case of a travel characteristic that is discrete and the variable of interest is a proportion, the formula for calculating sample size is as follows:

$$n' = \frac{z_{\alpha/2}^2 p(1-p)}{d^2}$$

where p is the proportion of individuals in the population exhibiting the trait of interest (say, using single occupant vehicle as the mode of transportation for traveling to and from ASU). In the absence of prior information regarding the value of p, the analyst must make assumptions regarding its possible value – but noting that the use of p=0.5 would serve the most conservative calculation of sample size requirements (maximum sample size requirement is at an assumption of p=0.5). In addition, d is provided in terms of percentage points converted to a decimal value. For example, if it is desired to determine modal split within ±1 percentage point of the true population value, then the value of d is 0.01.

Table 2.1 shows the calculations for undergraduate student population. In this tabulation, all undergraduate students are considered a single population regardless of their level and on- or off-campus living arrangement. As the population size does not impact sample size calculations, except at low population sizes, it is sufficient to view sample size and precision calculations for the undergraduate student body as a whole. The same values are going to apply to market segments within the undergraduate student body, except for the finite sample correction that may be warranted at small population sizes. As the survey is capturing on-campus (within campus) movements, the average trip rate is assumed to be 10 trips per person (as opposed to the usual 4 trips per person) and the standard deviation is assumed to be 4, a value that is reasonably conservative from a sample size calculation perspective. If one were to assume that trip frequency is approximately normally distributed in large samples, then an assumption that the standard deviation is 4 and the mean trip rate is 10 implies that about 95 percent of the undergraduate student body has a daily trip frequency between 2 and 18 (i.e., within ±2 standard deviations of the mean). The project team believes that this is a reasonable assumption as it is very unlikely that students are going to report more than 18 trips in the survey, even if they made more trips in reality. The accompanying spreadsheet provides the ability to re-compute sample sizes on the fly by just changing the value of the standard deviation in the corresponding cell.

The sample size calculations suggest that it should be possible to obtain average daily person trip rate estimates from the survey within ±0.1 trips at a 95% confidence level, even with a response rate that is less than 10 percent. For a precision level of ±0.2 trips, and assuming the same confidence level of 95%, it is found that the sample size that is required is just about 1,500 persons suggesting that ASU travel survey will inevitably provide high levels of precision in terms of overall person trip rate, which is a key indicator of travel demand. For the sample size calculations related to the modal split (single occupant vehicle proportion), a

very conservative assumption that p=0.5 is used. This assumption is reasonable as it is possible that just about one-half of the students drive alone with the other half relying on transit, walk, bicycle, and ride-share. However, regardless of the proportion of interest, the sample size required is maximized when an assumption is made that p=0.5. As such, the sample size calculations in this table are quite conservative. If it is desired that the proportion be estimated within $\pm$ 0.1 percentage points of the true value (i.e., d = 0.001), then the sample size requirement is extremely large. Even with a finite sample correction, the entire undergraduate student body population needs to be surveyed.

Table 2.1 Sample Size Calculations for Undergraduate Student Population

Undergraduate Students			Population 58404				
Person Trip Rate		Average	10	***Modal Split***		SOV	0.5
		Std Dev	4			Non-SOV	0.5
Margin of Error	Conf Level (z-value)	Sample Size	Finite Pop Correction	Margin of Error	Conf Level (z-value)	Sample Size	Finite Pop Correction
0.1	1.96	6147	5561	0.001	1.96	960400	55056
0.2	1.96	1537	1497	0.002	1.96	240100	46977
0.3	1.96	683	675	0.003	1.96	106711	37746
0.4	1.96	384	382	0.004	1.96	60025	29602
0.5	1.96	246	245	0.005	1.96	38416	23173
0.6	1.96	171	170	0.006	1.96	26678	18313
0.7	1.96	125	125	0.007	1.96	19600	14675
0.8	1.96	96	96	0.008	1.96	15006	11939
0.9	1.96	76	76	0.009	1.96	11857	9856
1.0	1.96	61	61	0.010	1.96	9604	8248
1.1	1.96	51	51	0.011	1.96	7937	6988
1.2	1.96	43	43	0.012	1.96	6669	5986
1.3	1.96	36	36	0.013	1.96	5683	5179
1.4	1.96	31	31	0.014	1.96	4900	4521
1.5	1.96	27	27	0.015	1.96	4268	3978
1.6	1.96	24	24	0.016	1.96	3752	3525
1.7	1.96	21	21	0.017	1.96	3323	3144
1.8	1.96	19	19	0.018	1.96	2964	2821
1.9	1.96	17	17	0.019	1.96	2660	2544
2.0	1.96	15	15	0.020	1.96	2401	2306

Assuming a response rate of between 8 and 10 percent, it is likely that about 5000+ undergraduate student responses were obtained for the Spring 2012 survey. For that number of responses, the degree of precision that can be achieved is $\pm$ 1.2-1.4 percentage points. In other words, one can be 95 percent confident that the sample proportion of those using SOV is within $\pm$1.2 to 1.4 percentage points of the true value. If the sample estimate is 50 percent using SOV, then the true population value is between 48.7 and 51.3 percent, which is a reasonably narrow bandwidth for drawing inferences regarding modal split.

The remainder of this section presents similar tables for graduate students, faculty, and staff/non-faculty. Table 2.2 presents the sample size calculations for the graduate student body. The same assumptions regarding mean and standard deviation of person daily trip rate are made for the calculations furnished in Table 2.2. For this population, assuming a 10 percent response rate, it appears that the average trip rate can be estimated within ±0.2 of the true population value. This constitutes a high degree of precision. Even if the response rate is only about 5 percent, the degree of precision is ±0.3 trips per person.

Table 2.2 Sample Size Calculations for Graduate Student Population

Graduate Students			Population 13878				
Person Trip Rate		Average	10	***Modal Split***		SOV	0.5
		Std Dev	4			Non-SOV	0.5
Margin of Error	Conf Level (z-value)	Sample Size	Finite Pop Correction	Margin of Error	Conf Level (z-value)	Sample Size	Finite Pop Correction
0.10	1.96	6147	4257	0.010	1.96	9604	5671
0.15	1.96	2732	2282	0.011	1.96	7937	5046
0.2	1.96	1537	1383	0.012	1.96	6669	4502
0.3	1.96	683	651	0.013	1.96	5683	4029
0.4	1.96	384	374	0.014	1.96	4900	3619
0.5	1.96	246	242	0.015	1.96	4268	3263
0.6	1.96	171	169	0.016	1.96	3752	2952
0.7	1.96	125	124	0.017	1.96	3323	2680
0.8	1.96	96	95	0.018	1.96	2964	2442
0.9	1.96	76	75	0.019	1.96	2660	2232
1.0	1.96	61	61	0.020	1.96	2401	2046
1.1	1.96	51	51	0.021	1.96	2178	1882
1.2	1.96	43	43	0.022	1.96	1984	1736
1.3	1.96	36	36	0.023	1.96	1816	1605
1.4	1.96	31	31	0.024	1.96	1667	1488
1.5	1.96	27	27	0.025	1.96	1537	1383
1.6	1.96	24	24	0.026	1.96	1421	1289
1.7	1.96	21	21	0.027	1.96	1317	1203
1.8	1.96	19	19	0.028	1.96	1225	1125
1.9	1.96	17	17	0.029	1.96	1142	1055
2.0	1.96	15	15	0.030	1.96	1067	991

With respect to modal split, the calculations are made assuming a value of p=0.5. This is an extremely conservative estimate and it is unlikely that one-half of graduate student trips are made by drive alone. However, assuming that p=0.5, then a response rate of about 10 percent would yield a precision of ±2.5 percentage points. In other words, if the sample estimate of SOV proportion is 50 percent, then the true population value lies between 47.5 and 52.5 percent at a 95 percent confidence level. This is once again a reasonably narrow band within which modal split is being estimated. However, in view of the importance of estimating modal split accurately (particularly for transit analysis), efforts should be made to maximize response rate for graduate students. The 2007 survey of ASU students generally showed that graduate

students are more likely to respond to the survey than undergraduate students; as such, achieving a 10 percent response rate should be very much within reach.

Table 2.3 Sample Size Calculations for Faculty Population

Faculty			Population 3000				
Person Trip Rate		Average	7	***Modal Split***		SOV	0.5
		Std Dev	3			Non-SOV	0.5
Margin of Error	Conf Level (z-value)	Sample Size	Finite Pop Correction	Margin of Error	Conf Level (z-value)	Sample Size	Finite Pop Correction
0.1	1.96	3457	1606	0.010	1.96	9604	2286
0.15	1.96	1537	1016	0.015	1.96	4268	1762
0.2	1.96	864	671	0.020	1.96	2401	1334
0.3	1.96	384	341	0.025	1.96	1537	1016
0.35	1.96	282	258	0.030	1.96	1067	787
0.4	1.96	216	202	0.035	1.96	784	622
0.5	1.96	138	132	0.040	1.96	600	500
0.6	1.96	96	93	0.045	1.96	474	410
0.7	1.96	71	69	0.050	1.96	384	341
0.8	1.96	54	53	0.055	1.96	317	287
0.9	1.96	43	42	0.060	1.96	267	245
1.0	1.96	35	34	0.065	1.96	227	211
1.1	1.96	29	28	0.070	1.96	196	184
1.2	1.96	24	24	0.075	1.96	171	162
1.3	1.96	20	20	0.080	1.96	150	143
1.4	1.96	18	18	0.085	1.96	133	127
1.5	1.96	15	15	0.090	1.96	119	114
1.6	1.96	14	13	0.095	1.96	106	103
1.7	1.96	12	12	0.100	1.96	96	93
1.8	1.96	11	11	0.105	1.96	87	85

Table 2.3 presents sample size calculations for the faculty segment. For faculty and staff, different assumptions have been made regarding the mean and standard deviation of person daily trip rate, as it is likely that faculty and staff do not undertake the same number of trips (particularly within campus trips) that students undertake. The average person daily trip rate is assumed to be 7 trips per person and the standard deviation is assumed to be 3. These assumptions imply that, in large samples and assuming an approximately normal distribution for trip frequency, 95 percent of the population makes between 1 and 13 trips per day (±2 standard deviations of the mean). It is reasonable to expect that the vast majority of faculty fall within this range of trip frequencies; even if some faculty members make more than 13 trips, it is unlikely that they

will actually report them in the survey. For purposes of calculating sample size and precision in the context of a proportion variable, a value of p=0.5 is used thus providing for conservative estimates.

To estimate average trip rate within ±0.1 trips, a sample size of more than 1,500 would be needed. It is unlikely and virtually impossible to get a 50 percent response rate for a survey of this nature. If it is assumed that a 10 percent response rate can be achieved, then about 250 to 300 responses would be obtained. With the finite sample correction, this sample size would provide a precision level of ±0.3 trips, thus suggesting that the true population value for mean daily trip rate would lie within ±0.3 trips of the sample estimate. If the sample estimate of the average is 7 trips per day, then there is 95 percent probability that the true value lies between 6.7 and 7.3 trips per day. This is somewhat less than ideal, but it is likely the best that can be achieved. Every attempt was made to obtain a sample size where the precision level is closer to ±0.2 trips per person.

With respect to modal split, trying to obtain high precision levels would necessitate achieving impossibly high response rates. More than 2,000 responses would need to be obtained to estimate modal split within ±1 percentage point. It should be noted that the calculations are very conservative as they correspond to a value of p=0.5. It is therefore likely that, in reality, higher precision levels than those shown in the table can be achieved. However, assuming p=0.5 and a response rate of just under 10 percent, it appears that the precision level that would be achieved is 6 percentage points. If the sample estimate of SOV proportion is 50 percent, then the true population value will lie (at a 95 percent confidence level) between 44 and 56 percent. This is a rather wide band, but it should be noted that the band is considerably narrower for other modes of transportation (such as rideshare, bus, rail, walk, and bike) whose shares are likely to be each considerably smaller than 0.5.

Finally, Table 2.4 shows sample size calculations for non-faculty (staff and administrators). Similar to faculty, the average trip rate is assumed to be 7 trips per day (including intra-campus movements) and the standard deviation is assumed to be 3. If a response rate just under 10 percent is achieved, then the average trip rate would be estimated within a margin of error of ±0.2 trips at a 95 percent confidence level.

In the case of modal split, assuming a value for p=0.5, a response rate greater than 50 percent would be needed to estimate modal share within a margin of error of ±1 percentage point. With a response rate of under 10 percent, it is found that the modal split can be estimated within a margin of error of about ±3 percentage points at a 95 percent confidence level. If the proportion of SOV trips is estimated from the survey to be 50 percent, then it means that the true value lies between 47 and 53 percent at a 95 percent confidence level. This is a reasonably acceptable band, especially considering that the sample size calculations are quite conservative under a scenario where it is assumed that p=0.5.

In summary, it may be concluded that the sample sizes that would be realized with response rates between 8 and 10 percent would provide adequate precision in estimates of important travel characteristics for various key population market segments of ASU. The tables can be used to determine sample sizes needed for any market segment at different levels of precision or calculate precision levels that can be achieved for different sample sizes.

Table 2.4 Sample Size Calculations for Staff and Administrator Population

Administrators & Staff			Population 9500				
Person Trip Rate		Average	7	***Modal Split***		SOV	0.5
		Std Dev	3			Non-SOV	0.5
Margin of Error	Conf Level (z-value)	Sample Size	Finite Pop Correction	Margin of Error	Conf Level (z-value)	Sample Size	Finite Pop Correction
0.1	1.96	3457	2535	0.010	1.96	9604	4776
0.15	1.96	1537	1323	0.015	1.96	4268	2945
0.2	1.96	864	792	0.020	1.96	2401	1917
0.3	1.96	384	369	0.021	1.96	2178	1772
0.4	1.96	216	211	0.022	1.96	1984	1641
0.5	1.96	138	136	0.023	1.96	1816	1524
0.6	1.96	96	95	0.024	1.96	1667	1418
0.7	1.96	71	70	0.025	1.96	1537	1323
0.8	1.96	54	54	0.026	1.96	1421	1236
0.9	1.96	43	42	0.027	1.96	1317	1157
1.0	1.96	35	34	0.028	1.96	1225	1085
1.1	1.96	29	28	0.029	1.96	1142	1019
1.2	1.96	24	24	0.030	1.96	1067	959
1.3	1.96	20	20	0.031	1.96	999	904
1.4	1.96	18	18	0.032	1.96	938	854
1.5	1.96	15	15	0.033	1.96	882	807
1.6	1.96	14	13	0.034	1.96	831	764
1.7	1.96	12	12	0.035	1.96	784	724
1.8	1.96	11	11	0.036	1.96	741	687
1.9	1.96	10	10	0.037	1.96	702	653

2.2. Design of a Robust Survey Process

The overall survey process is depicted in Figure 2.1. It should be recognized that this figure represents a substantial simplification of the survey process; trying to capture all of the process mechanisms and feedback loops within the constraints of a single figure is difficult. Nonetheless, the figure embodies the essential elements of the process and reflects the level of coordination and care that must be exercised in designing and implementing a ASU population travel survey.

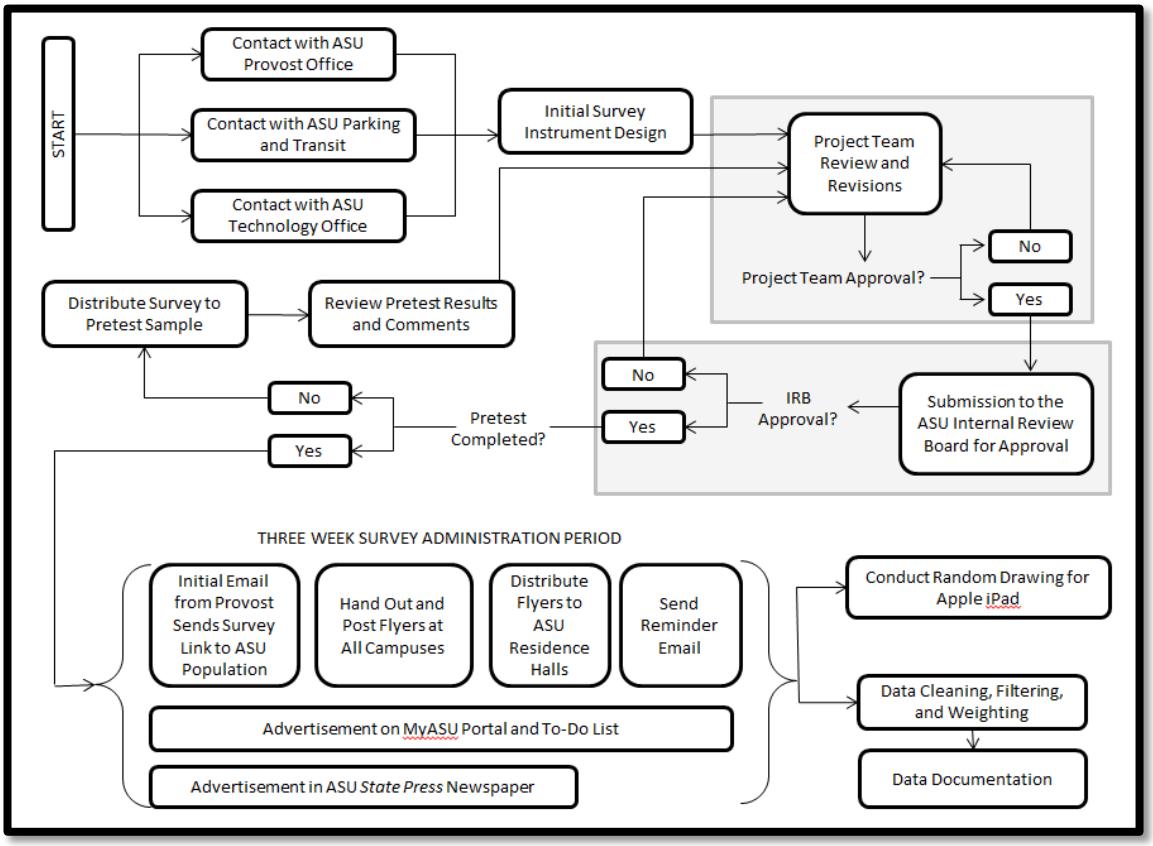


Figure 2.1 Overall Survey Design Process

At the outset, the project team contacted three major entities of ASU survey administration to facilitate coordination of the survey effort and the Arizona State University Office of the Provost, which is in charge of all academic and student affairs at ASU. The Office of the University Registrar, which houses all student records, is a unit of the Office of the Provost. The administration of a survey to the entire student population (as well as faculty and staff) can be accomplished only with the cooperation and consent of the Office of the Provost which has access to the universal e-mail address databases and is the only entity on campus authorized to send out mass e-mail messages requesting participation in the survey. The project team also contacted ASU Parking and Transit Services Office (PTS) to coordinate survey administration. PTS conducts its own surveys on a periodic basis to gather data and obtain feedback about transportation needs and options for ASU population (they do not conduct the equivalent of travel diary surveys). This office has a plethora of secondary data including parking capacity and price levels (parking supply), number of parking permits sold by pricing level and facility (parking demand), number of subsidized transit passes sold by semester and population market segment, amount of utilization of the transit passes, and ridership on inter-campus shuttles. This office also provided valuable input on the design of the survey and the questions to be included in the survey. PTS sends out news and announcements to the entire ASU population on a frequent and regular cycle; the office agreed to include information and reminders about this survey in all of its electronic transmissions during the survey administration period. Finally, the project team coordinated with the University Technology Office (UTO) to facilitate the deployment of the web-based online travel survey. The survey was hosted on a third party server, but all announcements and reminders about the

survey were sent through mass e-mail communications facilitated by UTO in connection with the Office of the Provost.

Moreover, UTO is the custodian of MyASU, the portal through which all students and employees access their accounts, records, and information. Within the MyASU portal, UTO included a link to the survey with a "To-Do" item in the task list that could not be dismissed by the individual MyASU user. Coordination with these institutional entities proved critical to the success of the survey.

With input and buy-in from these three entities, the survey team was proceeded with the design of the survey itself. The survey instrument design went through much iteration of review and refinement. After the project team, in consultation with the three ASU entities, was satisfied with the survey design, content, and administration protocol, the entire survey was submitted to ASU Internal Review Board (IRB) to satisfy requirements related to experiments involving human subjects. Feedback received from the Internal Review Board was incorporated into the survey and an iterative process of survey refinement was followed to finalize the survey and obtain IRB approval. The IRB feedback consisted almost entirely of comments related to subject privacy. After IRB approval was obtained, the survey was subjected to a pre-test that closely mimicked the real survey administration protocol. A convenient sample of faculty, staff, and students (in the School of Sustainable Engineering and the Built Environment) was recruited to participate in the pre-test. A pre-test invitation was sent to 75 students (50 undergraduate students and 25 graduate students), 30 faculty members, and 20 staff members. A total of 78 responses were received in the pre-test (36 undergraduate students, 14 graduate students, 15 faculty members, and 13 staff members). The rather high response rate is not surprising, given that this pretest was administered to a convenience sample of individuals within the home department of the project's principal investigator. Pre-test subjects were asked to provide open-ended feedback on the survey content and administration. Those who responded identified a handful of logical skips of certain questions that could be incorporated based on previous questions. The respondents also requested the administration team include an estimate of survey completion time at the outset of the survey. Based on the open-ended feedback received from the pretest respondents, and a thorough analysis of the pretest data, the survey instrument was revised and refined through an iterative process, and subjected to a final IRB approval prior to deployment in the field.

The survey was administered through an online web-based interface and collected detailed socio-economic and demographic information, allowing for various strategies to be employed during the survey administration process to maximize response rates and enhance the quality of data collected through the survey. The survey was deployed in the field for a period of three weeks; the three week period was selected such that it would represent typical or normal working days at ASU, and would be well clear of spring break and the final exams. The response rates for different demographic segments were monitored twice a week and special reminders were targeted towards segments whose representation in the dataset was lagging.

2.3. Design of the Online Survey Instrument

A careful and collaborative process was adopted in the development of the survey instrument. The entire survey instrument was first prepared on paper before being programmed online for web-based deployment. This section offers a brief description of the information content of the survey and highlights some of the key

features that were built into the online survey that made it possible to collect high fidelity spatial detail about trip making patterns.

One of the key decision elements in the survey design involved determination of whether to collect all trips made by individuals over the course of a travel survey day or limit the data collection effort to only those trips which had at least one end at an ASU campus. While it was appealing to limit the data collection to ASU-based trips (to reduce survey burden) because the special generator travel demand model is only concerned with trips to and from the special generator, the project team decided against doing so with a view to obtain comprehensive information about the activity-travel patterns of ASU population. It was felt that the data collected in this survey would be useful to develop specific models for ASU population that could be integrated into the activity-based travel demand microsimulation model that is adopted by MAG. Also, it was felt that a continuous time approach to travel survey data collection where individuals have to report all trips undertaken in the day in a sequential fashion would aid in jogging respondents' memories about the trips they made in the day. In addition, the project team made a decision to collect data on intra-campus trips where both trip ends are located on the same ASU campus. While it was recognized that asking respondents to report such trips would add burden, it was felt that collecting intra-campus travel information is critical to modeling circulator bus and non-motorized mode use, and fully measuring all travel demand that occurs in and around ASU campuses. As the spatial resolution of models become increasingly fine-grained, the explicit representation and accounting of (short) intra-campus trips becomes possible. As such, the intra-campus trips are included within the scope of the travel data collection effort with an eye towards the future of travel demand model development.

Figure 2.2 presents a schematic of the information requested of respondents through the online survey. The schematic is presented in a very simplified fashion to depict the types of information collected in the survey and some of the conditional logic that was built into the survey. The deployment of the survey through a web-based interface made it possible to implement complex skip patterns and logic flows without unduly burdening the respondent. In the opening page of the survey, the study was introduced with a short welcome screen and link to more detailed information for the interested reader. Every survey screen had a footnote with contact information for the study so that respondents could e-mail or call if they had any questions at any time as they responded to the survey. The survey was designed such that no single screen included too many questions; the screens were purposefully kept very simple to facilitate the skip patterns and avoid visual clutter.

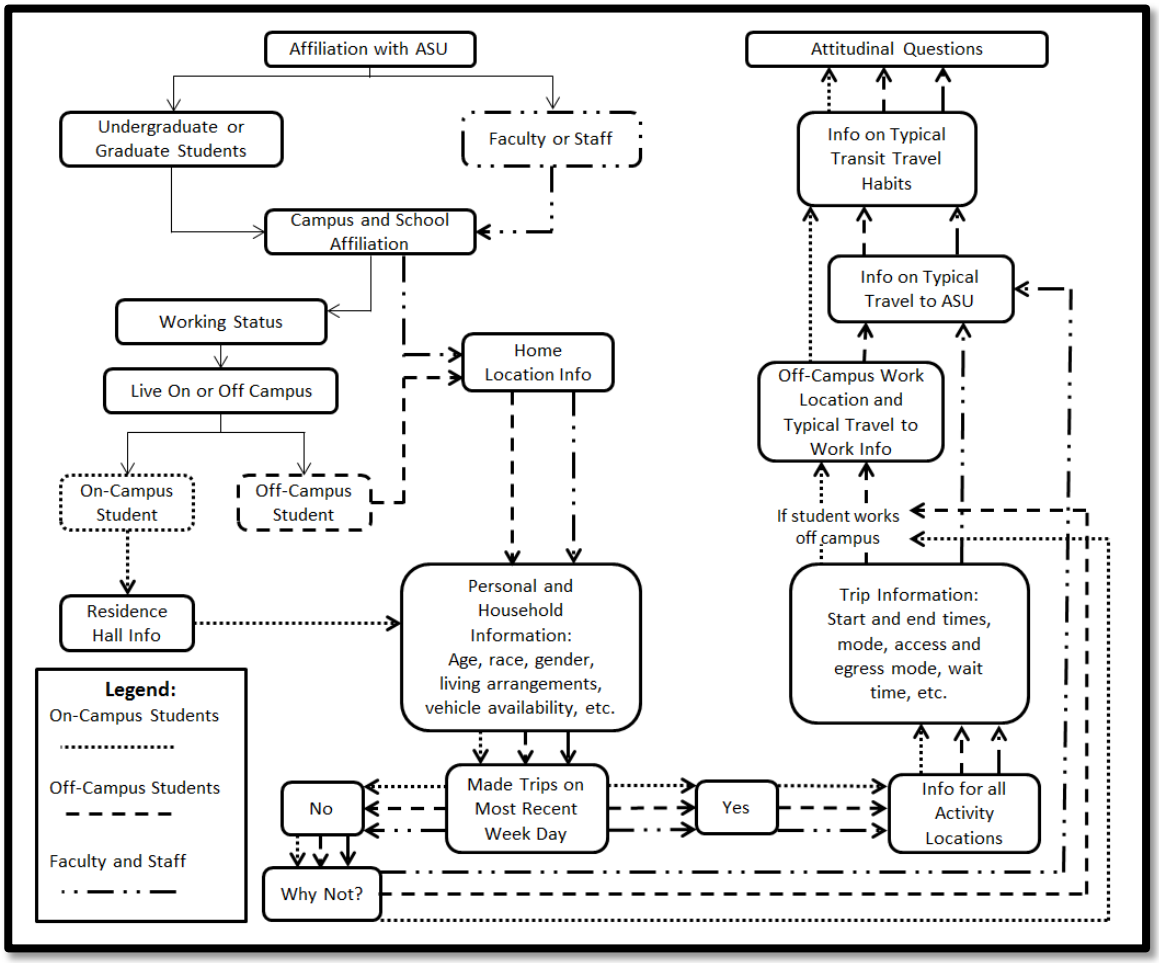


Figure 2.2 Flow of Survey Design Content

The survey instrument then proceeded into the travel diary portion of the survey. In this portion of the survey, a set of instructions and a complete example were furnished upfront so that the respondent could see how trips had to be reported for the travel day. Respondents were asked to provide travel information for the previous day; if respondents were taking the survey on a Sunday or Monday, then the online survey automatically requested the respondent to provide trip information for the prior Friday. An explicit question was included to identify zero trip-makers. If respondents indicated that they did not travel at all on the previous weekday, then they were asked to identify one or more reasons for not making any trips at all. After they identified a legitimate reason for not making or reporting any trips for the previous weekday, the survey instrument skipped the diary portion and routed them directly to the subsequent stage of the survey. For those who reported making at least one trip, they were asked to report all trips including those that are not ASU-based and including all intra-campus trips.

The travel diary portion of the survey collected detailed information about all trips made by the respondent. The respondent was prompted to identify all of the activity locations visited through the course of the travel survey day and then asked to provide detailed information for each trip between locations. Information collected included start and end times of the trip (using a user-friendly slider bar that prevented errors – for example, if a trip end time was designated as being prior to a trip start time), mode of transportation

(including specific vehicle make, model, and year if a vehicle was used), trip purpose, access and egress modes for transit and personal vehicle trips, specific mode if transit was used, wait and transfer times, parking location and search time (if a vehicle was used), out of pocket cost for transit fare or parking, and locations of trip origin and destination. Respondents were presented with a user-friendly map-based interface that could be used to identify locations using point-and-click features. Locations could also be identified by typing an address, cross streets, or landmark in a search textbox.

Respondents were allowed to identify the nearest cross streets of the location they visited if they were not comfortable identifying the exact address of the location. It was not possible to implement error trapping in the context of this element of the survey. If respondents chose to randomly identify locations that were not accurate, there was no way to trap the error and prompt respondents to locate the correct place. Given the ease of use of the interface and the flexibility afforded the respondents in providing approximate locations, the respondents would not randomly assign incorrect locations to places they visited during the day. A similar interface was used to obtain data on respondent residential and work locations. A screenshot of the interface is presented in Figure 2.3.

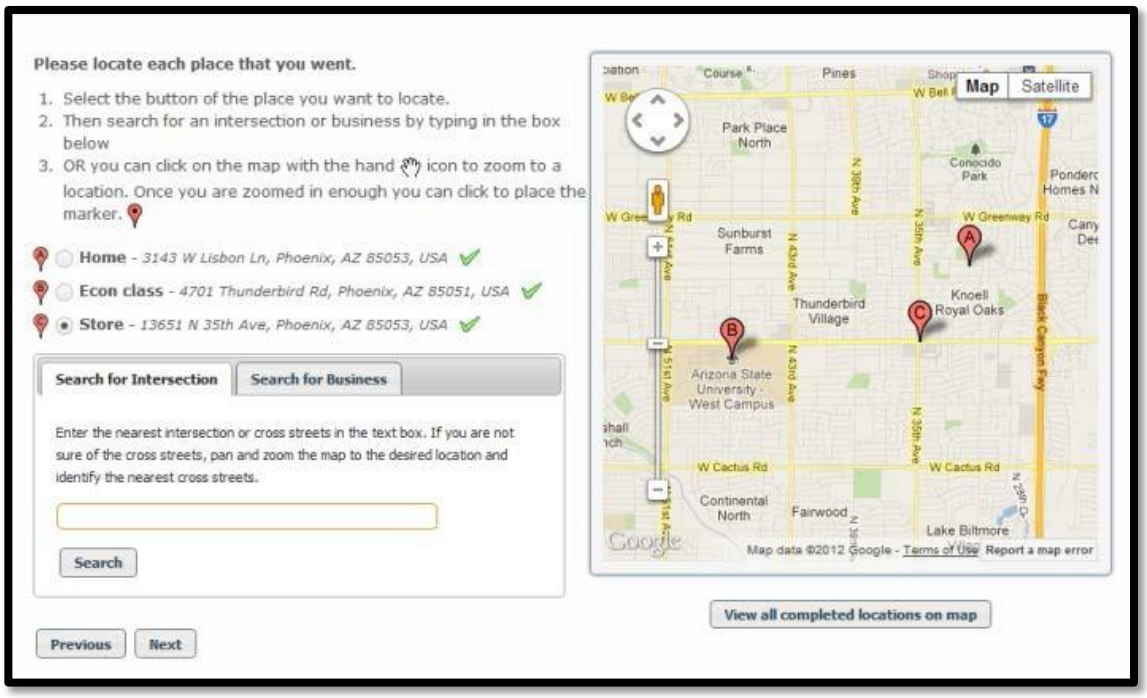


Figure 2.3 Survey Screen: Map Interface for Identifying Locations

In addition to collecting specific trip information for a travel survey day (previous weekday), the survey also collected "typical" travel to and from ASU undertaken by the individual. As some respondents indicated that they did not travel at all on the previous weekday or may have had an unusual travel day, it was considered prudent to obtain some basic information about usual travel to and from ASU. Respondents were asked to provide the usual mode of travel, travel time, departure and arrival times, parking location, and access and egress modes for their regular daily travel to and from ASU. The information provided on the usual or typical

mode used to travel to and from ASU is used to estimate mode choice models. Students who worked off-campus were asked to provide information on the work location, work schedule, and usual travel mode to and from the work place. The survey then asked respondents a series of questions about their transit mode use patterns. Respondents were asked to provide the frequency with which they used transit, the alternative modes of transport that are available to them for their travel to and from ASU, and other considerations related to the use of transit modes in particular. In order to obtain more in-depth qualitative information about traveler attitudes towards various modes of transport, a series of statements were presented at the end of the survey and respondents had to indicate the extent to which they agree or disagree with the statement on a five point scale. These attitudinal statements were intended to offer insights about perceptions and feelings towards the automobile and transit modes. Examples of such statements include "I am not afraid to ride transit", and "My personal vehicle reflects who I am". The survey ended with a thank you screen and an open text box in which respondents could share comments and thoughts about the survey or transportation options serving ASU.

In order to encourage participation in the survey, an incentive was introduced. All respondents were informed that they would have the opportunity to be entered into a drawing to win the latest iPad, one each for a student and a faculty/staff respondent.

Respondents were informed that they could be entered into the drawing for the iPad only if they provided a valid e-mail address at which they could be contacted. Nearly 90 percent of the respondents furnished identification and contact information so that they could be entered into the iPad drawing. Given the large number of respondents who entered the iPad drawing, the incentive may have played a positive role in enhancing participation and response rates. It should be noted that respondents were reminded that all information had to be complete and accurate for entry into the drawing. This was done to encourage complete and accurate reporting of information on the part of respondents, though it was not strictly enforced.

2.4. Survey Administration and Response Tracking

The survey was administered in close coordination with the various administrative units on campus. The survey was hosted on a third party server to facilitate ease of access and retain greater control of the online survey system by the project team. In order to make it easy for ASU population to remember the online survey, two simple web addresses were registered and directed such that typing in either address in the URL address bar would redirect a user to the actual survey hosted on the third party server.

The simple addresses registered through a domain registry are www.asutravelsurvey.com and www.asutravelsurvey.org (these addresses are now expired and no longer functional).

Although the survey was hosted on a reliable and high power server, there was some concern that the server may crash or get overloaded (and therefore respond slowly) if thousands of individuals clicked on the survey link at once. In order to stagger the demand on the server, the Office of the Provost sent out the announcement about the survey to the entire ASU population of students, faculty, and staff at 3:30 AM on Wednesday, April 4, 2012 when a vast majority of ASU population are likely to be offline. As individuals are likely to access their accounts in a somewhat staggered fashion as the day progresses, it was felt that sending out the announcement in the middle of the night would prevent server overload. The email message provided

a brief description of the survey and the ways in which the data would be used by planning agencies and the university administration for transportation planning and analysis. The message included a link to the survey instrument, requested participation from ASU community, assured respondents of the safety and privacy of all information provided, and furnished contact information for the principal investigator of the study should anyone have comments or concerns about the survey. The email message also included details about the iPad drawing that would take place at the end of the three-week survey period.

This e-mail message was bundled with a series of accompanying strategies and elements to enhance response rates. First, the University Technology Office introduced a "To-Do" task in the MyASU portal account of all students, faculty, and staff reminding the community to participate in and respond to the survey. This "To-Do" task could not be dismissed by users and was locked in place for the entire three-week deployment period. The MyASU portal also included a graphical running banner highlighting ASU travel survey and encouraging the community to respond. Second, 10,000 flyers were printed, distributed and posted throughout the four ASU campuses. Student workers employed on the project fanned out on all four campuses and distributed flyers to students, faculty, and staff as they went about their daily business on campus. Flyers, measuring one-half the size of a 8.5x11 inch paper and printed on brightly colored paper, were posted in all departments, schools, colleges, centers, administrative units, libraries, student union buildings, recreational centers, dining hall, and residential dormitories to which the student workers could gain access. Of the 15 working days for which the survey was open online, flyers were distributed on campus on seven days (about every other day). Third, a slightly simplified version of the flyer was published as an advertisement in ASU daily campus newspaper. The ad, placed at prominent locations in the online and print editions of the newspaper, was run for two weeks, further enhancing the publicity of the survey. The flyer and the advertisement included logos of the sponsoring agencies (Maricopa Association of Governments and Valley Metro), thus lending credibility to the survey and appealing to the civic consciousness of ASU community. Figure 2.4 presents screenshots of the MyASU portal screen with the "To-Do" task and running banner, as well as a version of the flyer and advertisement used for publicity purposes.

Figure 2.4 Select Survey Advertisement Strategies

ASU Parking and Transit Services office included a link and reminder to ASU travel survey in its periodic electronic newsletters that were sent to the entire survey community. In the three-week period covered by the survey, only one ASU Parking and Transit Services newsletter was sent out to the community. The office also advertised the survey prominently on its website. Finally, ASU State Press (campus newspaper) ran a full length feature article on the research study including quotes from the principal investigator as well as the MAG project manager. All of these efforts helped raise awareness of the project and generate a sense of goodwill among the community. The Office of the Provost preferred not to generate and send out reminder e-mail messages to the entire ASU population as several other mechanisms were in place to remind ASU population about the survey, it was felt that email reminder messages were not necessarily critical to achieving desirable sample sizes. Given the size of ASU population, even very low response rates would yield sample sizes sufficient to infer travel characteristics about ASU population segments at desired levels of precision and confidence.

The choice of a pure online web-based travel survey administration method was one that was made after careful consideration and review of the literature. Some consideration was given to the possibility of administering the survey through a variety of methods (mail and online, for example) to enhance response rates. However, in the context of a ASU population setting, it was felt that such a mixed mode administration approach was not warranted as the value added would be modest at best.

Over the past decade, web-based surveys have become increasingly popular in the travel data collection domain. Despite raising some new challenges and issues, including a web-based survey in a travel diary data collection effort had a positive impact on response rates. A number of studies have shown that, although response rates for online surveys are typically lower than for traditional mail-in travel surveys, the return times are much shorter and completeness is much greater (see, for example, Truell, et al, 2002; Sheehan, 2001; Kaplowitz, et al, 2004). It is well known that college students spend substantial amounts of time online, more so than the average internet user. ASU students, faculty, and staff are all expected to use the internet on a regular basis to interact with colleagues and students, access and update course materials, manage human resource functions, and utilize ASU resources such as library reference materials and online databases. Every student, faculty and staff member is expected to check his or her school email address and MyASU portal account on a regular basis. This makes the most common concern of web-based surveys – bias due to a lack of web access – a non-issue (Solomon, 2001).

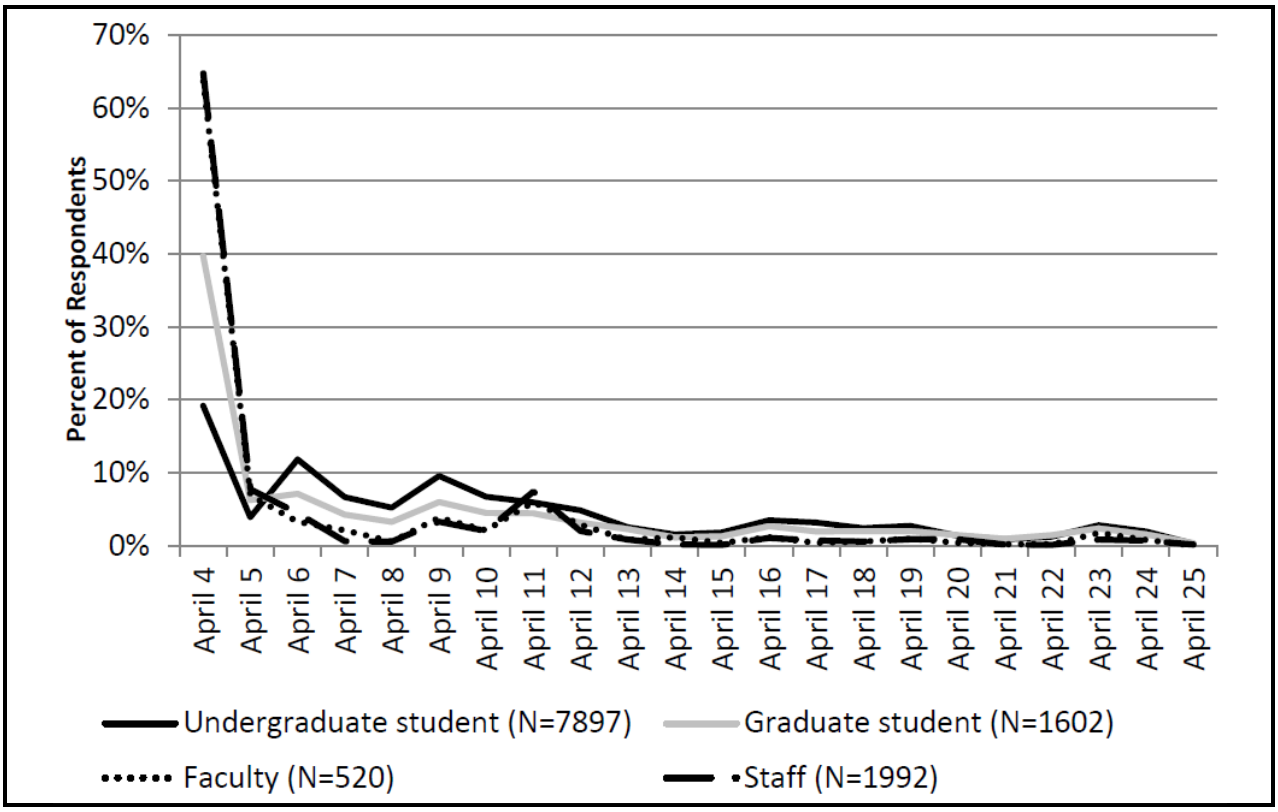


Figure 2.5 Date and Day of Week Profile of Responses to ASU Travel Survey

ASU travel and mode usage survey was closed on April 26, 2012. Figure 2.5 shows the progression of responses by survey date with an inset graph summarizing the number of responses by day of the week (travel diary day for which trips were reported). Overall, it can be seen that respondents took the survey within the first week of its deployment. In the case of faculty and staff, an impressive 65 percent of the respondents took the survey on the very first day that the survey was deployed. As the survey was deployed on a Wednesday, a larger percent of responses were obtained for Tuesday with the pattern much more pronounced for faculty and staff members. About 40 percent of graduate student respondents participated on the very first day. Undergraduate students tended to exhibit the most staggered response profile of all groups, with just under 20 percent participating on the opening day of the survey. From the inset graph, it can be seen that undergraduate students (and to a lesser degree, graduate students) completed the survey at the end of the week and on a weekend day, resulting in a higher response profile for these groups on Thursday and Friday (the previous weekday). The response profile by calendar date shows that participation was rather modest after the first week with only a small percent of respondents taking the survey after that point. The small bumps in the profile coincide with the timing of publicity and reminder messages; for example, the bump seen on April 23rd coincides with the final reminder message and appeal sent through ASU Parking and Transit Services newsletter, and the vast distribution of flyers 48 hours before close of the survey. It can be seen from the graphs that a majority of respondents provided data for Tuesday, Wednesday, and Thursday (as the travel diary days). As Mondays and Fridays are sometimes considered unusual travel days, having a healthy proportion of the data on Tuesdays through Thursdays is beneficial from a travel model development perspective.

In the last week of May, 2012, drawings were held at the offices of MAG to identify the winners of the iPad raffle. All respondents were assigned a random identification number, shuffled randomly, and then one student and one faculty/staff member were drawn from the random lists to identify the winners of the raffle. This entire drawing process was conducted in front of MAG staff and recorded on video camera as proof of the objectivity of the prize drawing process. The winners were notified via email and asked to report in person to sign a form (acknowledging receipt of the iPad and releasing ASU and MAG of all liability) and receive the iPad.

2.5. Data Preparation and Quality Analysis

One of the challenges associated with a web-based online survey is that the survey administration team has no direct contact with the survey respondents. In a computer-assisted telephone interview, on the other hand, survey administrators make direct contact with respondents and have the opportunity to clarify responses, ensure that respondents are answering accurately and correctly, and ask follow-up questions to prevent under-reporting of trips. In a web-based survey, respondents may provide erroneous information because they genuinely misunderstand or misinterpret the question being asked; or simply because they, as one user put it, "just want the iPad." Despite the many error traps and safeguards incorporated in the survey, it is still very much possible to receive frivolous and erroneous/invalid responses that should not be included in any analysis or model development effort.

A very thorough and systematic coding and analysis of the raw data has been conducted. An intensive quality control and assurance process was implemented wherein all records were subjected to a number of consistency checks to see if the records would pass through the quality filters. Because respondents were generally not allowed to skip questions, it is difficult to identify areas where the quality of provided data is questionable, except in the area of reported trip characteristics. For example, if a reported trip is 5 miles long, made using the walk mode, and has duration of 5 minutes, an error is clearly present. In the example provided, however, it is difficult to ascertain whether the reporting error is in the origin/destination combination (from which distance is calculated), in the trip duration, or in the mode of travel. Therefore, a series of logical checks were applied to the trip data, allowing the trips with possibly erroneous information to be "flagged" as possibly erroneous data. The series of "flags" or filters applied at the trip level is described below, and the percentages of flagged trips for many segments of students are displayed in Figure 2.6.

1. Respondents were asked to provide on a map the locations of their origins and destinations for each trip, as well as to describe each origin and destination in their own words. A trip was flagged if the respondent-provided origin description was different from the destination description, but the recorded latitude and longitude were identical. This flag would most likely indicate a respondent who did not diligently record the trip end locations on the map feature.
2. Students were asked whether they lived on or off campus. Trip ends were identified that were likely located at home using a combination of the trip purpose and the user-provided description of the destination. If the trip end was on an ASU campus, but the student replied they lived off campus, the trip was flagged. This error could be caused by misreporting the trip purpose, a misunderstanding of what is considered on-campus housing, or a lack of diligence in using the map feature.

3. If both trip ends were recorded on the same ASU campus – an intra-campus trip – and the trip duration was longer than 30 minutes, the trip was flagged. These flags could result from a misreporting of the trip duration or, again, a lack of diligence in using the map feature.
4. The four different ASU campuses are widely spread across the Phoenix area, with the two closest campuses measuring about 8.5 miles apart. If a trip had one end at one ASU campus and the other end at another campus – an inter-campus trip – and the mode of travel was walking, the trip was flagged. These flags are likely caused by either a misreporting of the travel mode or a lack of diligence using the map feature.
5. If an inter-campus trip reportedly took 15 minutes or less, it was flagged. Though it is possible to drive from the parking lot on Tempe campus to the parking lot on Downtown campus in 15 minutes if no traffic exists, it is not possible to go from your Tempe campus location to your car, drive to the Downtown campus, find a parking space, and then move to your Downtown campus location in 15 minutes. These flags are likely caused by misreporting trip duration or simply by a misunderstanding of what constitutes a trip.
6. Finally, after all of the above trip filters were applied, the origin and destination descriptions of all remaining trips were manually checked. Any trip with an origin or destination description that could be identified as frivolous or intentionally misleading was flagged.

Figure 2.6 reveals that flag #1 was the most commonly applied. This flag was applied to those trips in which the origin and destination had identical latitude and longitude, even though the respondent indicated that the two trip ends were different activity locations. This flag can only really arise from a lack of diligence in using the map feature. As seen in Figure 2.3, survey respondents were allowed to pinpoint their own trip end locations on the map feature. There was little to no motivation for students to carefully select their trip end locations, leading to some erroneous trip characteristic information that could not be reliably imputed. In general, undergraduates have a greater percent of their trips flagged as erroneous than graduate students.

Figure 2.6 displays the flags applied at the trip level. Still more records were excluded from the final filtered data based on person-level indicators.

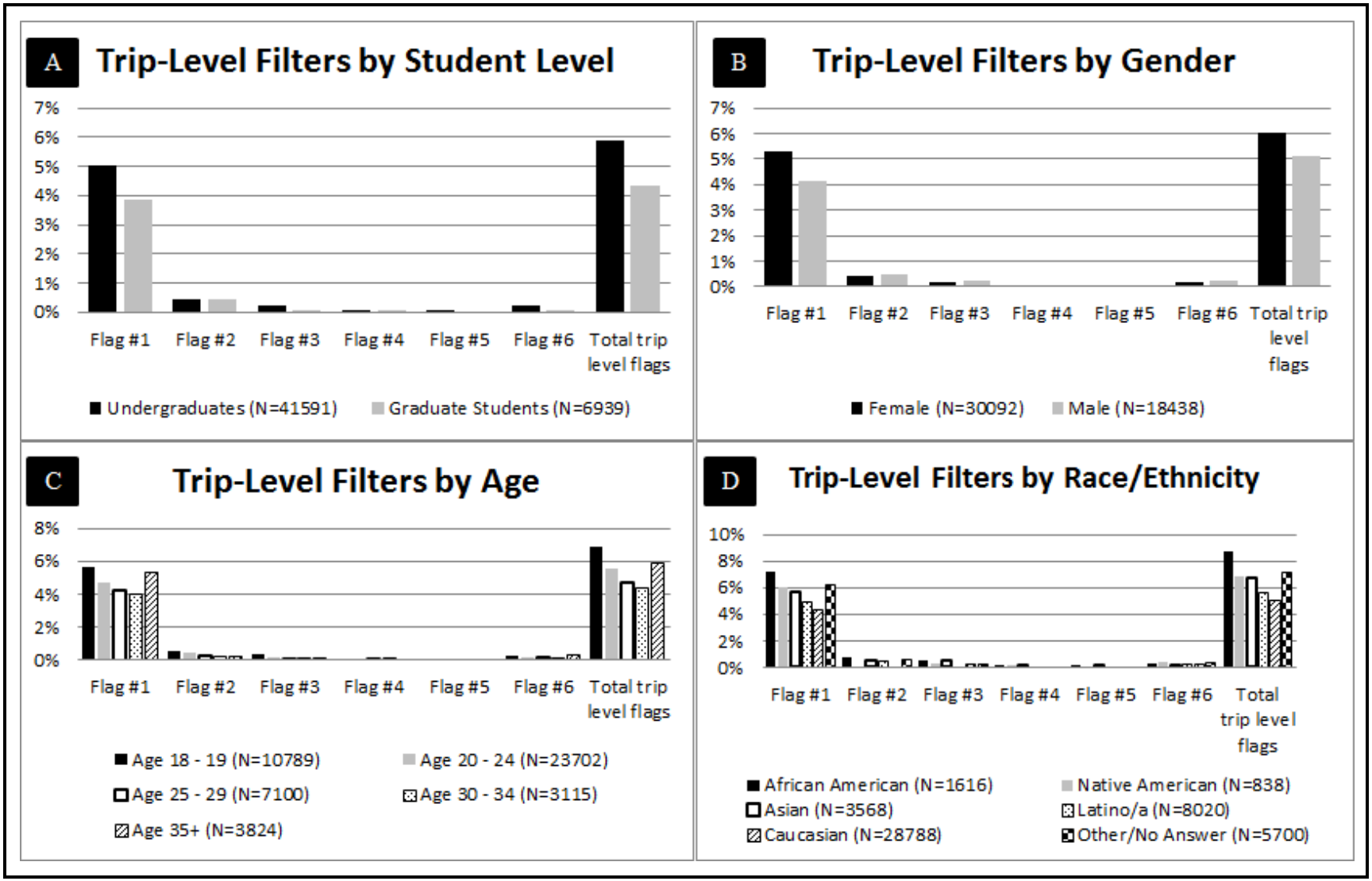


Figure 2.6 Percent of Total Trips Flagged

Figure 2.7 displays similar information for the person-level filters applied. Those person-level filters are described below.

Records were excluded if the person reported making only one trip – that is one direction with no return trip – and the trip record was deemed illegitimate. The legitimacy of the single trip was determined by the researchers based on the provided description of origin and destination. For example, if a student traveled simply from their dormitory to their parents' house, the single trip was legitimate, owing to the fact that it is perfectly reasonable to spend the night at one's parents' home. However, if the student traveled from home to economics class without a return trip, it was assumed that the respondent likely did not spend the night in the classroom, and the person was excluded from the filtered database.

1. Records were excluded if the person reported making zero trips for an illegitimate reason. At the start of the travel diary, students were asked whether they made any trips at all on the travel day. If they responded no, they were asked to provide a reason, either choosing from a list of provided reasons, or choosing "other" and writing in their own reason. If the student chose to write in his or her own reason, the researchers were able to determine whether this was a legitimate reason or not. In many cases, students reported making no trips simply because they did not understand the meaning of a "trip" in the context of the survey.
2. Finally, if 30% or more of the trips a student reported were flagged as possibly erroneous using the list of trip-level filters provided above, then that student was excluded from the filtered database.
3. The charts below show that, in general, illegitimate zero-trip makers were more common than illegitimate 1-trip makers. Undergraduate students were more likely to be filtered out than graduate students.

In a number of instances, it was able to apply logical imputation techniques and fix obvious errors, thus minimizing the loss of data due to incorrect entries. However, such imputation must be done with extreme care, and it was decided not to perform imputation where ambiguity remained. Trip records that had missing or erroneous data, and person records corresponding to these problematic trips, were filtered and removed from the analysis-ready datasets.

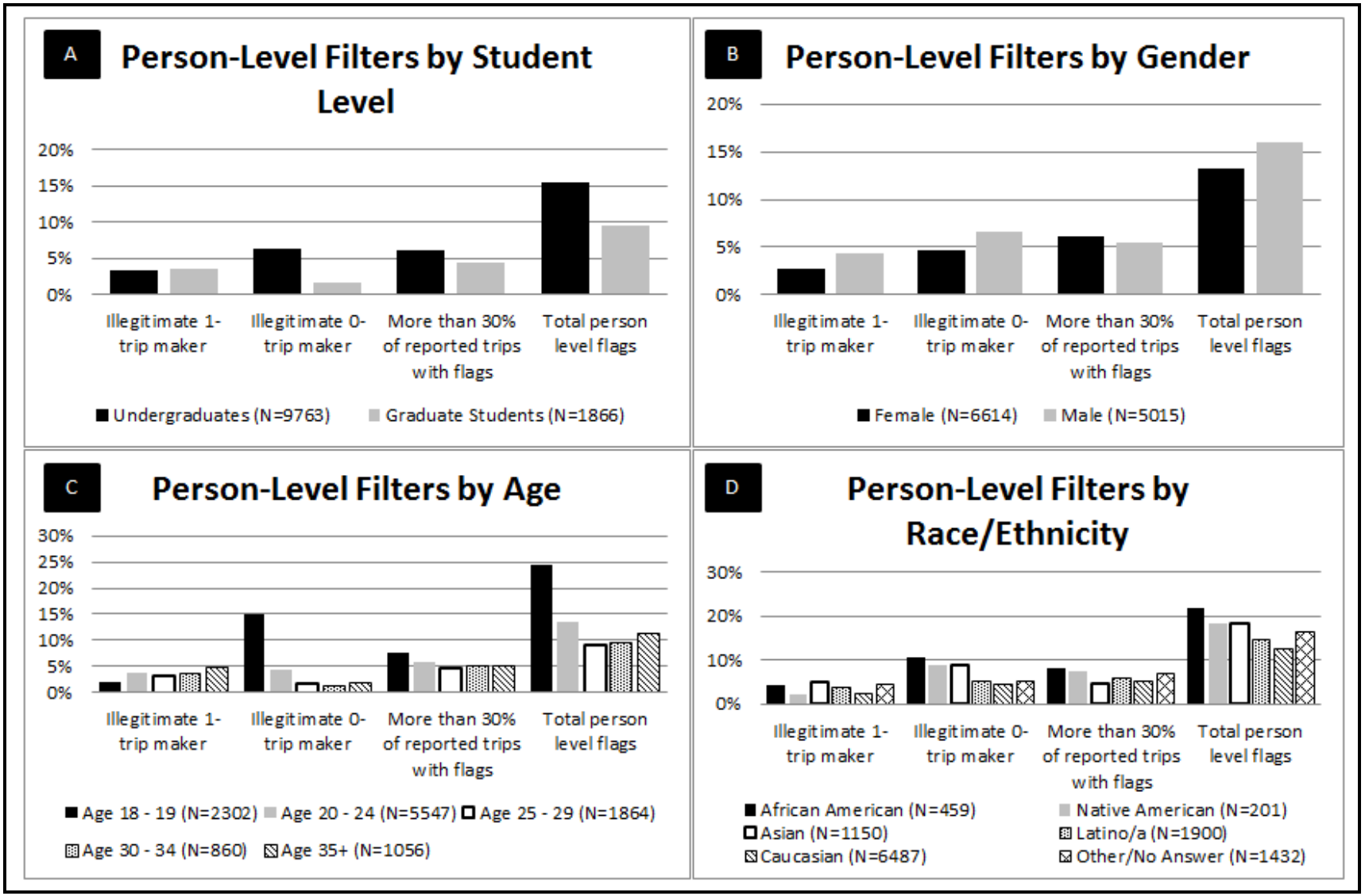


Figure 2.7 Percent of Total Persons Filtered

Table 2.5 offers a summary of the final survey dataset compiled after the extensive filtering and cleaning process was performed. The final cleaned dataset includes a total of 12,011 respondents of which 7,897 are undergraduate students, 1,602 are graduate students, 1,977 are staff members, and 535 are faculty members. The overall response rate is 14.7 percent for ASU population as a whole, a number that is generally consistent with response rates from other travel surveys (Miller, 2012). In an ASU setting, where the population is hard to reach and the project team does not have direct access to the sampling frame, it is reasonable to expect response rates to be rather modest. The response rates for the student segments are the lowest; this finding is consistent with the notion that students are likely to be less inclined, engaged, and interested in participating in a survey about an issue that is going to affect them only for the duration that they go to school at ASU. Staff members record the highest response rate at nearly 32 percent, while faculty members record a substantially lower response rate at 17 percent.

Table 2.5 also shows the number of trips reported by each market segment and the average trip rate that results from dividing the total number of trips reported by the number of respondents in each category. Trip rates are all-inclusive, and account for legitimate zero trip makers as well as intra-campus and inter-campus trips. The trip rates constitute daily total trip rate per capita and includes all trips regardless of whether they are ASU-based. The trip rates appear to be reasonable and in line with daily trip rates reported from other travel surveys, although it is not clear if respondents accounted for all intra-campus trips (many of which may be very short in distance and duration) in their reporting of trips. Freshmen and sophomores tend to have higher trip rates, presumably because a higher proportion of them live in on-campus dorms. As living on-campus affords a greater level of flexibility and accessibility for returning “home” to the dorm for short periods between classes, or visiting various locations on campus, it would be reasonable to expect these students to have higher trip rates.

Table 2.5 Summary of ASU Travel Survey Sample Profile

Affiliation	# Respondents (Response Rate)	% of Total Respondents	% of Total Segment	# Trips	Average Trip Rate	% of Total Trips	% of Total Segment
Freshman	1304	10.9%	16.5%	6857	5.26	12.8%	18.9%
Sophomore	1470	12.2%	18.6%	7145	4.86	13.4%	19.7%
Junior	2703	22.5%	34.2%	12079	4.47	22.6%	33.4%
Senior	2420	20.1%	30.6%	10130	4.19	18.9%	28.0%
Total Undergraduate Student Segment	7897 (13.5%)	65.7%	100.0%	36211	4.59	67.7%	100.0%
Graduate Student Segment	1602 (11.6%)	13.3%	100.0%	6139	3.83	11.5%	100.0%
Academic Professional	163	1.4%	8.2%	677	4.15	1.3%	7.6%
Academic Professional w/ Admin Appointment	23	0.2%	1.2%	99	4.30	0.2%	1.1%
Administrative Staff	169	1.4%	8.5%	738	4.37	1.4%	8.3%
Admin Executive	30	0.2%	1.5%	120	4.00	0.2%	1.3%
Classified Staff	661	5.5%	33.4%	2999	4.54	5.6%	33.7%
Service Professional	885	7.4%	44.8%	4110	4.64	7.7%	46.1%
Other	46	0.4%	2.3%	169	3.67	0.3%	1.9%
Total Staff Segment	1977 (31.9%)	16.5%	100.0%	8912	4.51	16.7%	100.0%
Faculty	472	3.9%	88.2%	1980	4.19	3.7%	87.7%
Faculty w/ Admin Appointment	48	0.4%	9.0%	216	4.50	0.4%	9.6%
Post-Doctoral Fellow	15	0.1%	2.8%	62	4.13	0.1%	2.7%
Total Faculty Segment	535 (17.9%)	4.5%	100.0%	2258	4.22	4.2%	100.0%
Total Respondents	12011 (14.7%)	100.%		53520	4.46	100.0%	

2.6. Survey Data Expansion

The survey data was weighted and expanded to ensure that non-response biases were corrected and the weighted survey sample could be used to draw inferences regarding ASU population travel characteristics. Due to the differential response rates across market segments, staff members were over-represented in the dataset while students were slightly under-represented in the dataset relative to the true ASU population. The synthetic population generation method embedded in a software tool called PopGen was adopted to weight and expand the survey sample. PopGen is a synthetic population generation algorithm which is able to weight and expand any survey sample dataset such that the weighted and expanded survey sample dataset exhibits traits that closely mirror those of the true population (Ye, et al, 2009). In the PopGen algorithm, weights are computed in an iterative manner to simultaneously match multiple attributes of interest between the weighted survey sample and the true population.

In order to apply the weighting procedure using PopGen, marginal distributions had to be compiled for a number of socio-economic and demographic variables of interest. Using data available from the Office of the Provost and the Office of Institutional Analysis (ASU, 2012), it was able to compile univariate marginal distributions for a number of attributes. The weighting and expansion procedure embedded in PopGen was then applied to the survey sample to compute weights for each person in the respondent sample of ASU travel survey. All trips reported by a respondent were assigned the same person-level weight. Attributes used to control the weighting process for undergraduate students included gender, race, age, college/school affiliation, and level (freshman, sophomore, junior, and senior). Graduate student respondent weights were computed based on controls for gender, race, age, and college/school affiliation. Weights for faculty members were computed based on controls for gender, race, and school/college affiliation, while those for staff members were computed using controls on gender, race, and job category/class. In general, the control variables for the survey sample weighting and expansion process are used. The weighting and expansion process executed through the use of PopGen yielded a weighted and expanded sample that was virtually identical to the general population with respect to distributions of known control variables. Figure 2.8 offers an illustrative example of the comparison of selected marginal controls against unweighted and weighted sample distributions for a few demographic categories. In the interest of brevity and because the weighting procedure is not the focus of this research, graphs for other attributes and population market segments are not presented here. The graph shown in the figure depicts the comparison for undergraduate students, the largest segment in the survey sample. It is found that the weighted survey sample closely matches the population control distributions. It is also noteworthy that the unweighted sample does not depict any substantial non-response biases, suggesting that the survey design and response process did not induce any skew in the response profile.

This section presents a detailed report of the process followed and results obtained in administering a comprehensive activity-travel survey to ASU population. Universities are recognized as special generators in transportation planning processes; however, ASU populations remain under-studied in the travel behavior analysis arena due in part to their hard-to-reach nature. The information reported here is based on a comprehensive survey of ASU population of staff, students, and faculty. ASU, located in the Greater Phoenix metropolitan region in Arizona, is one of the largest universities in North America with more than 70,000 students attending classes on its four campuses, and 12,000 faculty and staff members. An online web-based

travel survey was administered to the entire ASU population with a view to collecting comprehensive socio-economic, demographic, and travel activity data. Some information concerning the built environment (locations of trip-ends) and respondents' attitudes were also gathered. Respondents were asked to provide detailed trip information for all travel undertaken on the previous weekday and the online survey incorporated user-friendly features that allowed respondents to identify locations visited using map-based interfaces. The survey was conducted over a three-week period in the Spring 2012 semester. The preceding includes detailed information about the survey administration process, survey instrument design and questionnaire content, and survey sample profile in terms of response rates and trip rates. A synthetic population generation procedure was deployed to weight the survey sample and correct for non-response biases. The data that was obtained in the administration of this survey was used to complete the research reported herein.

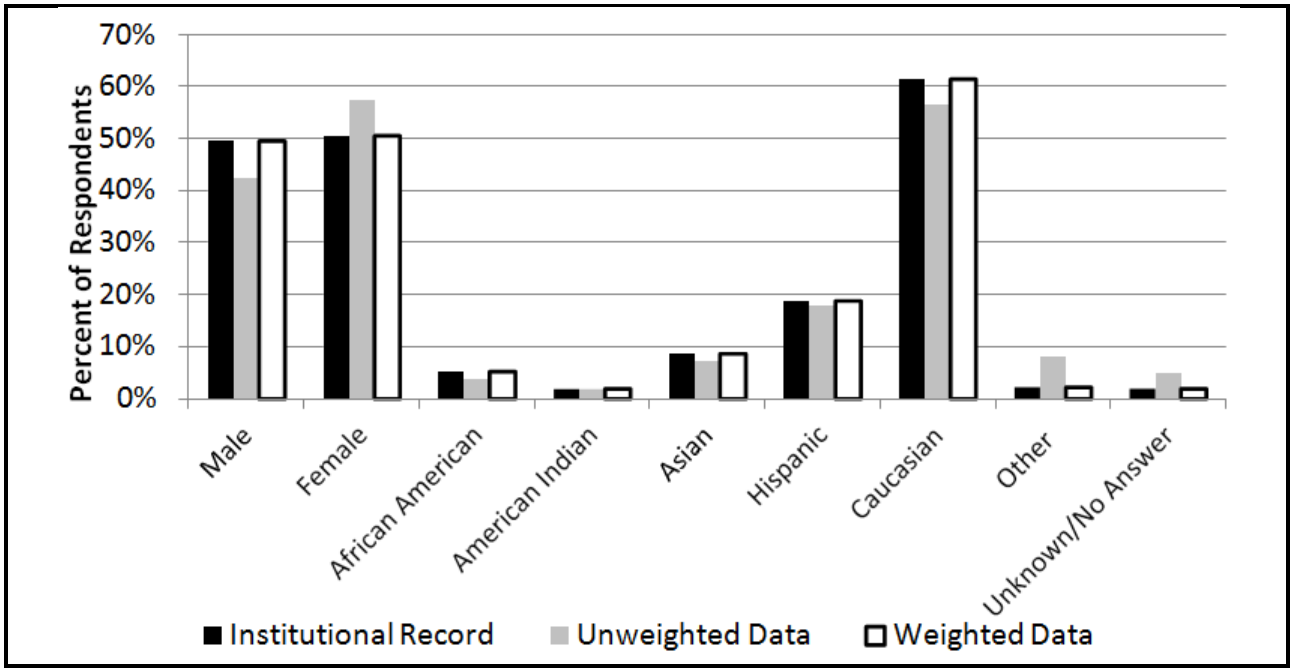


Figure 2.8 Unweighted versus Weighted Data for Undergraduate Student Sample

3. Analysis of Observed ASU Student Travel Characteristics

3.1 Demographic Analysis of Students

Table 3.1 provides a description of student demographics, including gender, ethnicity, income, living arrangements, and other relevant characteristics. The table shows demographic characteristics weighted or scaled to meet the population of students during the Spring 2012 semester: 58,404 undergraduate students and 13,850 graduate students. One can see from Table 3.1 that genders are split very close to evenly, with only a slight skew toward female students. The majority of both undergraduate and graduate students identify themselves as Caucasian. In the undergraduate community, the second most popular ethnicity identification is Hispanic or Latino(a) at 18.8%, or approximately 10,980 students. In the graduate student community, only 10.4% of respondents identified as Hispanic or Latino(a) while 19.9% – roughly 2,760 graduate students – identify as Asian. More than one third of undergraduate students (36.5%) report having an annual income of less than $5,000. This roughly coincides with the 35.0% of undergraduate students who do not work. The majority of the remaining undergraduate students report an annual income less than $40,000. The majority of graduate students (60.4%), on the other hand, report an annual income somewhere between $10,000 and $70,000. Again within the graduate student demographic, the 13.2% of students who report an annual income less than $5,000 roughly coincides with the 18.6% of students who do not work.

Living arrangements, working arrangements, and the number of household vehicles are demographics that play a major role in determining travel decisions such as time of day, trip purpose, location choice, and mode choice. A majority of undergraduates (81.2%) and nearly all graduate students (99.4%) live off campus. Of the approximately 10,980 students who live on campus, 79.9% (about 8,770) live at the Tempe campus. The downtown campus houses 10.2% of on-campus undergraduates, the polytechnic campus houses 8.2%, and the west campus houses only 1.7%. Of the remaining approximate 47,420 undergraduate students, 57.5% live with family members – likely parents and siblings – while 30.4% live with roommates. Only 8.6% live alone, and the remaining 3.5% live with both roommates and family members. Only about 80 graduate students live on campus, and the majority of those (69.0%) live on the polytechnic campus. This is likely because the polytechnic campus boasts a family housing option, where students can live in a rental community of single-family detached houses with their spouses, children, or partners. The remaining 31.0% of on-campus graduate students live at the Tempe campus.

As mentioned above, 35.0% of undergraduate students and 18.6% of graduate students claim that they do not work. These students could be receiving support from family members, scholarships, grants, etc. and therefore not need to work. This, however, is not the norm, especially for graduate students. 9.1% of graduate students say that they work both on campus and off campus. The remaining 72.3% of graduate students are split nearly evenly between working on campus and off campus. One can speculate that those grad students working on campus are likely working as teaching assistants or research assistants while earning their degrees. Of undergraduate students who work, a large majority is the work off campus students. Only 11.4% of undergraduate students report working on campus while the remaining 5.3% report working both on campus and off campus.

Table 3.1 Student Demographic Characteristics

Demographics		Undergraduates (N = 58,404)	Graduate Students (N = 13,850)
Gender	Male	49.5%	49.2%
	Female	50.5%	50.8%
Race / Ethnicity	African American	5.2%	3.9%
	Native American	1.9%	1.6%
	Asian	8.6%	19.9%
	Hispanic / Latino(a)	18.8%	10.4%
	White/Caucasian	61.4%	60.8%
	Other	2.2%	1.6%
	Prefer Not to Answer	1.9%	1.9%
Annual Household Income	Less than $5,000	36.5%	13.2%
	$5,000 - $9,999	17.3%	7.5%
	$10,000 - $19,999	17.5%	21.2%
	$20,000 - $39,999	11.5%	25.7%
	$40,000 - $69,999	3.4%	13.5%
	$70,000 - $99,999	0.8%	6.0%
	$100,000 or more	1.0%	5.0%
	Prefer Not to Answer	12.0%	8.0%
Age	18 – 24	81.9%	22.2%
	24 – 34	13.5%	51.2%
	35 – 44	3.2%	15.7%
	45 or older	1.4%	10.9%
Mobility Limitations Due to Disability	Yes	2.3%	2.2%
	No	95.8%	95.5%
	Prefer Not to Answer	1.9%	2.3%
Living Arrangements	Lives on Campus	18.8%	0.6%
	Downtown Campus	10.2%	0.0%
	Polytechnic Campus	8.2%	69.0%
	Tempe Campus	79.9%	31.0%
	West Campus	1.7%	0.0%
	Lives Off Campus	81.2%	99.4%
	With Family Members	57.5%	52.3%
	With Roommates	30.4%	26.8%
	With Both Family and Roommates	3.5%	2.1%
	Lives Alone	8.6%	18.8%
Working Arrangements	Works Off Campus	48.3%	36.4%
	Works On Campus	11.4%	35.9%
	Works Both On and Off Campus	5.3%	9.1%
	Does Not Work	35.0%	18.6%
Total Vehicles in the Household	0	16.6%	12.7%
	1	26.2%	33.5%
	2	26.7%	36.9%
	3 or more	30.5%	16.9%

Undergraduate students, as discussed, tend to live off campus with family, roommates, or both. 30.5% of all undergraduates report having 3 or more vehicles in their households. The question that gathered this information in the survey asked respondents to include all vehicles in working order to which they personally had regular access. The wording attempted to make a clear distinction between the number of vehicles to which a person has access and the number of vehicles owned by adults in the household. Only 16.6% of

undergraduates, however, report having zero vehicles in the household. This means that approximately 9,700 undergraduate students are transit captive. Somewhat surprisingly in a car-oriented city like Phoenix, 12.7% of graduate students live in zero-car households, making approximately 1,760 graduate students transit captive as well. Only 16.9% of graduate students – compared to 30.5% of undergraduates – report having 3 or more vehicles available in the household. Given that graduate students tend to have a higher income and can therefore be responsible for a higher portion of rent, it is reasonable to believe that graduate students tend to live with fewer other adults, reducing the need for many household vehicles.

3.2 Students' versus Other Adults' Travel Characteristics

The travel behavior research community is aware that certain personal characteristics – household size, working status, gender, etc. – affect the decisions that are made concerning travel behavior. Because students have very different personal characteristics, including household and work obligations, generally lower incomes, often unusual living arrangements, etc., it is reasonable to assume that students will have very different travel characteristics. This section describes the differences in student travel characteristics at ASU compared to the typical working adult, represented by ASU Staff members. Faculty members are not used as comparison because an initial analysis showed that faculty members tend to work outside the time range of the typical working adult, often working early mornings, working late into the evening, working from home, etc. Figures 3.1 - 3.3 and Table 3.2 provide evidence of these differences in travel behavior.

Figure 3.1 presents the travel time of day for student trips as well as staff trips. This chart shows the percentage of each segment's total trips – not just ASU-based trips –that takes place within each one-hour time bin. Smaller time bins were tested for this chart, but a smaller time bin results in time of day curves that are much too "choppy" to read. This figure shows that staff trips resemble what would be considered normal for the average working adult. There is a high peak at 7:00 AM representing travel to work, a moderate peak at 12:00 PM representing lunch trips, and another high peak at 5:00 PM representing the journey away from work. A negligible number of trips occur between 12:00 AM and 4:00 AM. Students have a much different time of day distribution than staff members. For students, there are two mid-day peaks occurring at 11:00 AM and 1:00 PM, coinciding with the times between classes. These two mid-day peaks are higher than the AM and PM peaks, which are both very moderate peaks and occur at 8:00 AM and 4:00 PM, respectively. The slope of decreasing trip percentages between the PM peak and the end of the day is much shallower than that of staff members, indicating that students are much more likely to make their trips at the end of the day than staff members. Finally, unlike the staff distribution, the percent of student trips occurring between 12:00 AM and 3:00 AM is not negligible, indicating that students often make trips very late at night.

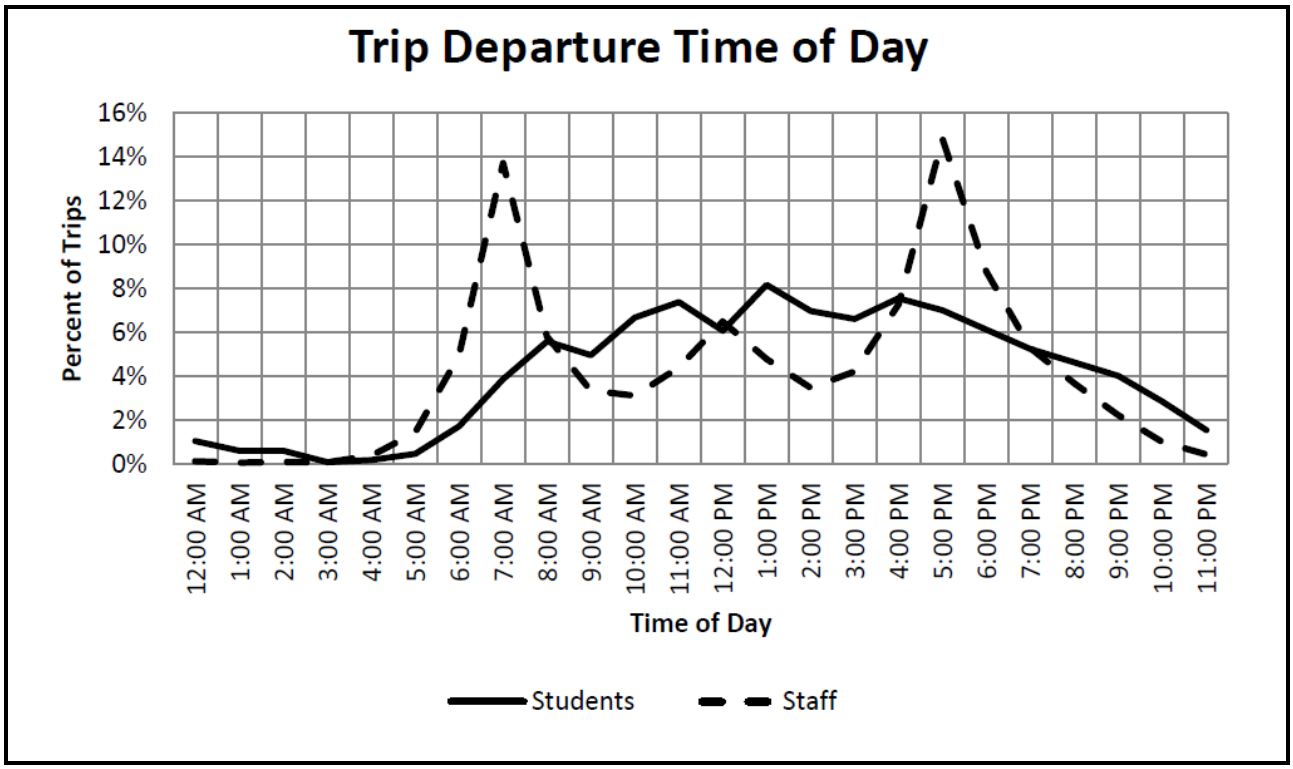


Figure 3.1 Student and Staff Time of Day Distributions

One interesting characteristic to compare is the time of day at which students and staff make their longer trips or their shorter trips. Overall, the average trip length for students was 6.4 miles, and the average trip duration for students was 10.9 minutes. The average overall trip length for staff members was 7.6 miles and the duration was 12.8 minutes. Students, therefore, make on average overall shorter trips than staff members. Figure 3.2 shows the average distance of trips beginning in each hour of the day. As one would expect, the average duration curves match the distance curves shown here. Figure 3.1 shows that neither students nor staff make a great deal of trips in the early hours of the morning. Figure 3.2, however, shows that these very rare trips have quite long distances. It is quite possible that the longer distance trips observed during the early morning hours could reflect the capture of staff members who work the "night shift" at ASU (janitors, security guards, etc.) This could also be true to a lesser extent of students who work night shifts at various jobs across the metropolitan area. The AM peak for staff trips occurs at 7:00 AM, during which time the average staff trip length is 10 miles. The average distance one hour earlier at 6:00 AM is 14 miles. This suggests that many staff members who live farther from work leave at an earlier time. The average staff trip length during the PM peak hour is about 9 miles, while the average distance one hour earlier is about 10 miles. This suggests that staff members are likely not to travel directly from work to home, but are rather likely to make a stop along the way. The average trip length during the lunch-time peak is only about 4 miles, revealing the short-distance lunch trips. The longest average student trip is about 13 miles and occurs at 4:00 in the morning, again perhaps reflecting night shift jobs. The average trip length during the students' AM peak hour is about 8 miles while it is about 11 miles in the hour before, displaying the same behavior as staff. After 8:00 AM the average student trip length does not reach any higher than 8 miles. This reveals that, in

general, though students may make more trips than staff members, their trips are shorter distance and therefore duration.

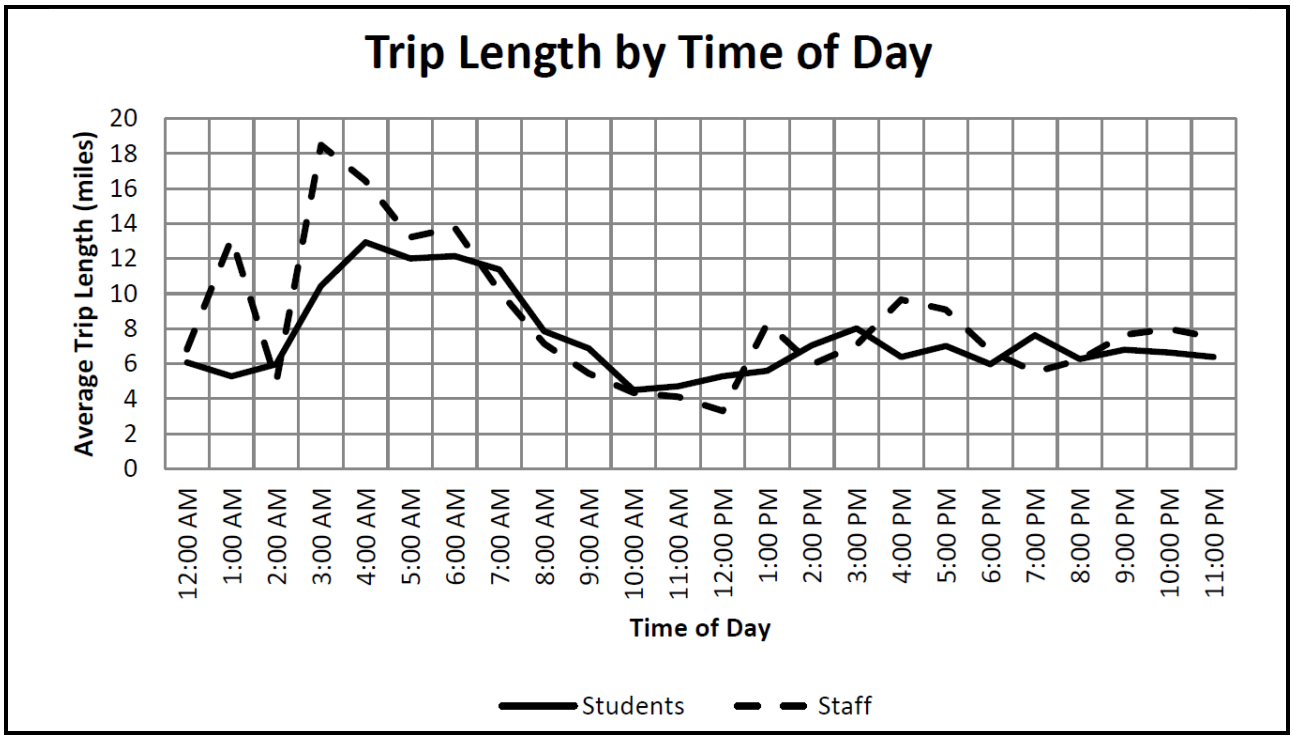


Figure 3.2 Student and Staff Average Trip Length by Time of Departure

Figure 3.3 shows the mode share of trips within each purpose. In other words, for all trips being made for a specific purpose, what portion uses the SOV mode, what purpose uses bus, etc? The vast majority – more than 60% – of student work and work-related trips are made using single-occupancy vehicle (SOV). Staff also use SOV for work trips about 48% of the time, but they also use walk mode about 28% of the time. Staff likely use the walk mode more because nearly all staff work on campus while, as seen in Table 3.1, only about half of students work on campus. For the small number of staff trips that are made for school or school-related trips (these could include either taking or teaching class), the walk mode holds the greatest share, while the SOV and, to a lesser degree, the HOV modes are also substantial. Student school trips are also most likely to use the walk mode, but students are less likely to use the HOV mode than staff for these trips. Bike and light rail also each hold a larger portion of school trips for students than staff members. Trips in the "maintenance" category include eating meals, shopping, and personal business. For these trips, students are more likely than staff to use the HOV, bike, and walk modes, where staff make the majority of these trips using SOV. Interestingly, the mode share of social recreation trips looks very similar between students and staff.

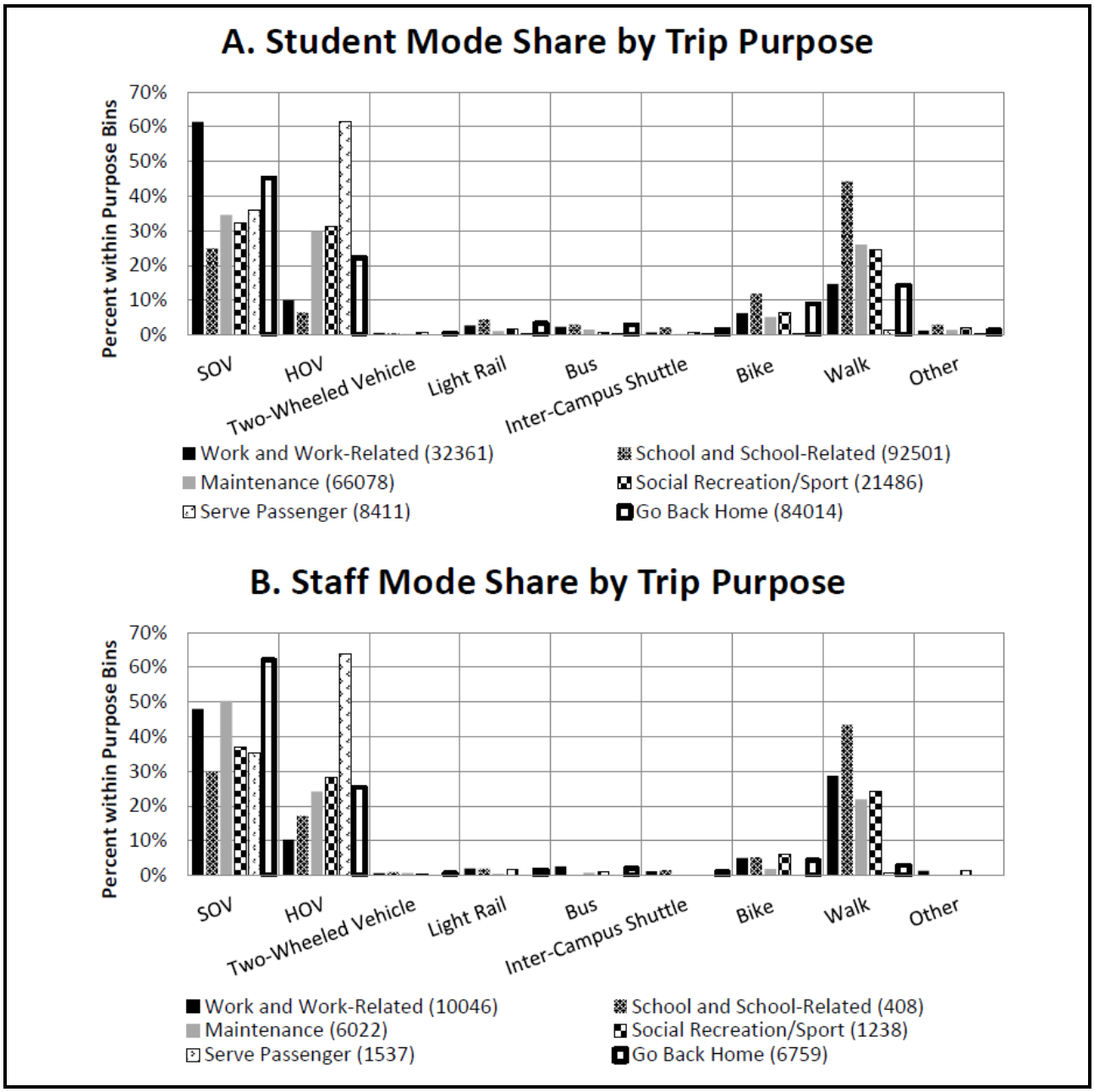


Figure 3.3 Mode Share Within Each Trip Purpose by Student Level

As would be expected, the serve passenger purpose is almost entirely SOV (the journey to pick up the passenger) and HOV (the journey to drop the passenger off) for both students and staff. Staff trips made for the purpose of returning home are made almost exclusively using SOV and, to a lesser degree, HOV. Walk and Bike do capture a small amount of staff return-home trips. Students are much less likely than staff to use SOV for the return-home trips and much more likely to use walk and bike. Students are also slightly more likely to use light rail to return home. This indicates that students are probably more likely to live near their mandatory (work and school) trip generator (in this case, ASU) than staff members.

The trip rates presented in Table 3.2 are calculated using only those staff and students who made trips during the travel day. The calculation excludes zero-trip respondents and is therefore slightly higher than they would be if all students and staff were considered. These trip rates, however, are simply being used for comparison. The percent difference between student trip rates and staff trip rates is calculated as the absolute value of the difference between the two rates divided by the average of the two rates. As might be expected, staff members have a much higher work trip rate and students have a much higher school trip rate.

Staff members also have a higher trip rate for serving passengers than students, indicating that staff members generally have more household responsibilities. Students have a higher trip rate for returning home than staff members, likely because students tend to live closer to where they work and/or go to school. This implication is supported by Figure 3.3. Students also have a slightly higher trip rate for social recreation trips. Interestingly, the trip rate for maintenance trips is nearly the same for students as it is for staff. It is reasonable to infer from this comparison that adults in general will have approximately the same number of maintenance trips per day.

Table 3.2 Trip Rates by Purpose for Staff and Students

Purpose	Students: N = 62,142		Staff: N = 5,827		% Diff.
	Total Trips	Trip Rate	Total Trips	Trip Rate	Trip Rates
Work or Work-Related	32,363	0.52	10,046	1.72	107%
School or School- Related	92,501	1.49	408	0.07	182%
Maintenance Activities	66,081	1.06	6,023	1.03	3%
Social Recreation / Sport	21,486	0.35	1,237	0.21	48%
Serve Passenger	8,412	0.14	1,538	0.26	64%
Go Back Home	84,014	1.35	6,759	1.16	15%
Other	22,992	0.37	2,342	0.40	8%
All Purposes	327,849	5.28	28,353	4.87	8%

The above comparisons show a marked difference between student trips and staff trips. As staff can be taken to represent the typical working adult, the comparison highlights the ways in which students are not adequately represented in many policies related to transportation planning. For example, it is currently common practice that consulting firms that are evaluating the effects of potential transportation investments investigate traffic during the AM and PM peak times. The time of day distributions presented here, however, show that this policy overlooks the peak travel times of students. The sections that follow will further analyze student trips and examine the variations in travel behavior choices between different market segments of student.

3.3 Undergraduate versus Graduate Student Travel

Not all student travel is the same. In fact, travel patterns and statistics can be quite widely varied across different types of students. The analysis that follows compares the travel behaviors of undergraduate students to those of graduate students at ASU. Graduate students are, in general, older than undergraduates. They tend to have different priorities, households responsibilities, and working responsibilities compared to undergraduates. Where undergraduates tend to take more classes during the day than graduate students,

graduates often work full time while attending school, either on campus in a research setting or off campus in an internship setting.

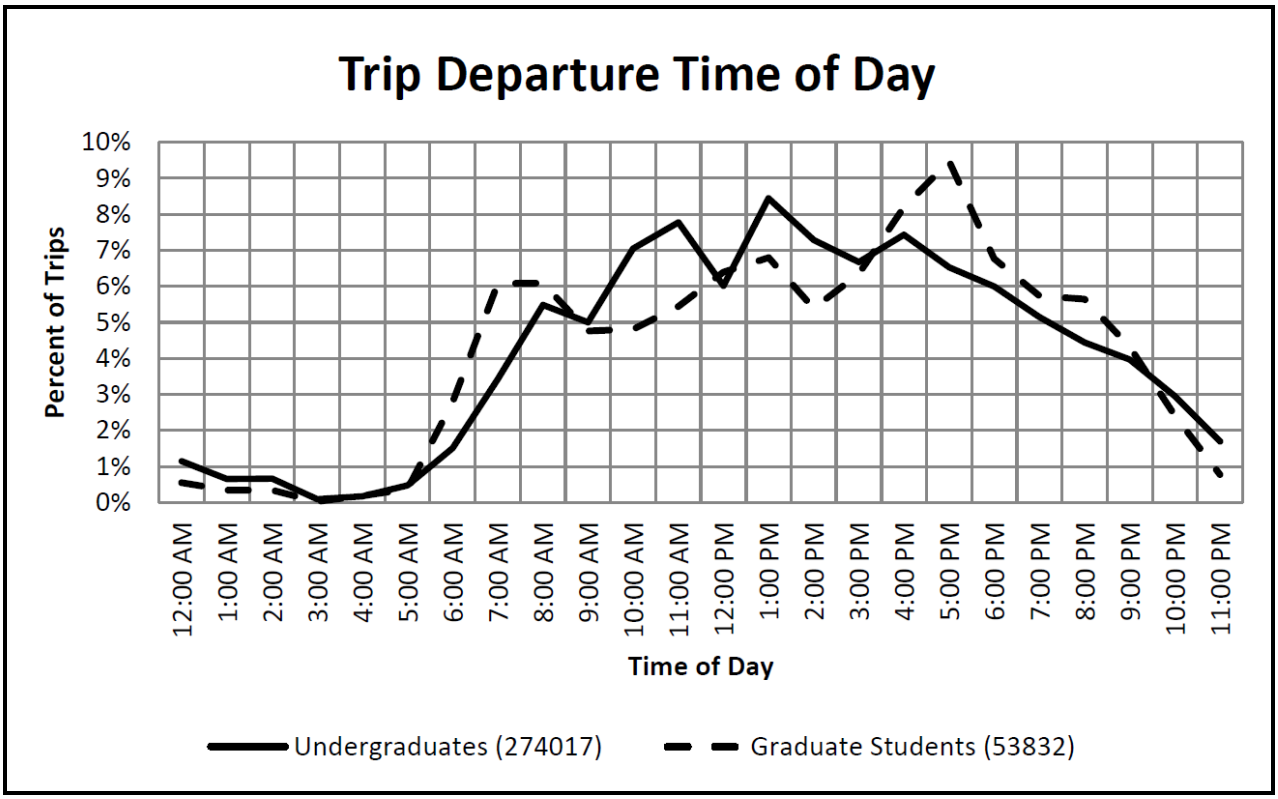


Figure 3.4 Undergraduate and Graduate Student Time of Day Distributions

Figure 3.4 displays the differences in travel time choices between the two groups. Undergraduate student behavior does not conform to the traditional AM peak and PM peak hours that are generally expected. The peak time for undergraduate students is during the mid-day, with a very sharp slope in the morning and a very gradual slope in the evening. There are several small peaks in the mid-day that generally coincide with class start times. Graduate students do come closer to the AM and PM peak model that is expected, but the graduate student AM peak is much smaller – closer to a mid-day lunch time peak – than what would be expected for a typical working adult sample. The mid-day peak occurs around 1:00 PM – later than would be expected for the lunch-time journey – and is actually higher than the AM peak. Finally, the graduate students' PM peak is quite high, with more than 9% of their daily trips taking place between 5:00 and 5:59 PM. These graduate student patterns appear to indicate somewhat of a middle ground between student and working adult. It's likely that graduate students are split between those who work during the regular business day, attending class or doing research in the evenings, and those who spend their days on campus, often making their commute trips later in the day. Undergraduate and graduate students alike make a non-negligible portion of their daily trips in the early hours of the morning, pointing to the often late-night studying and/or social recreation that is known to occur on college campuses.

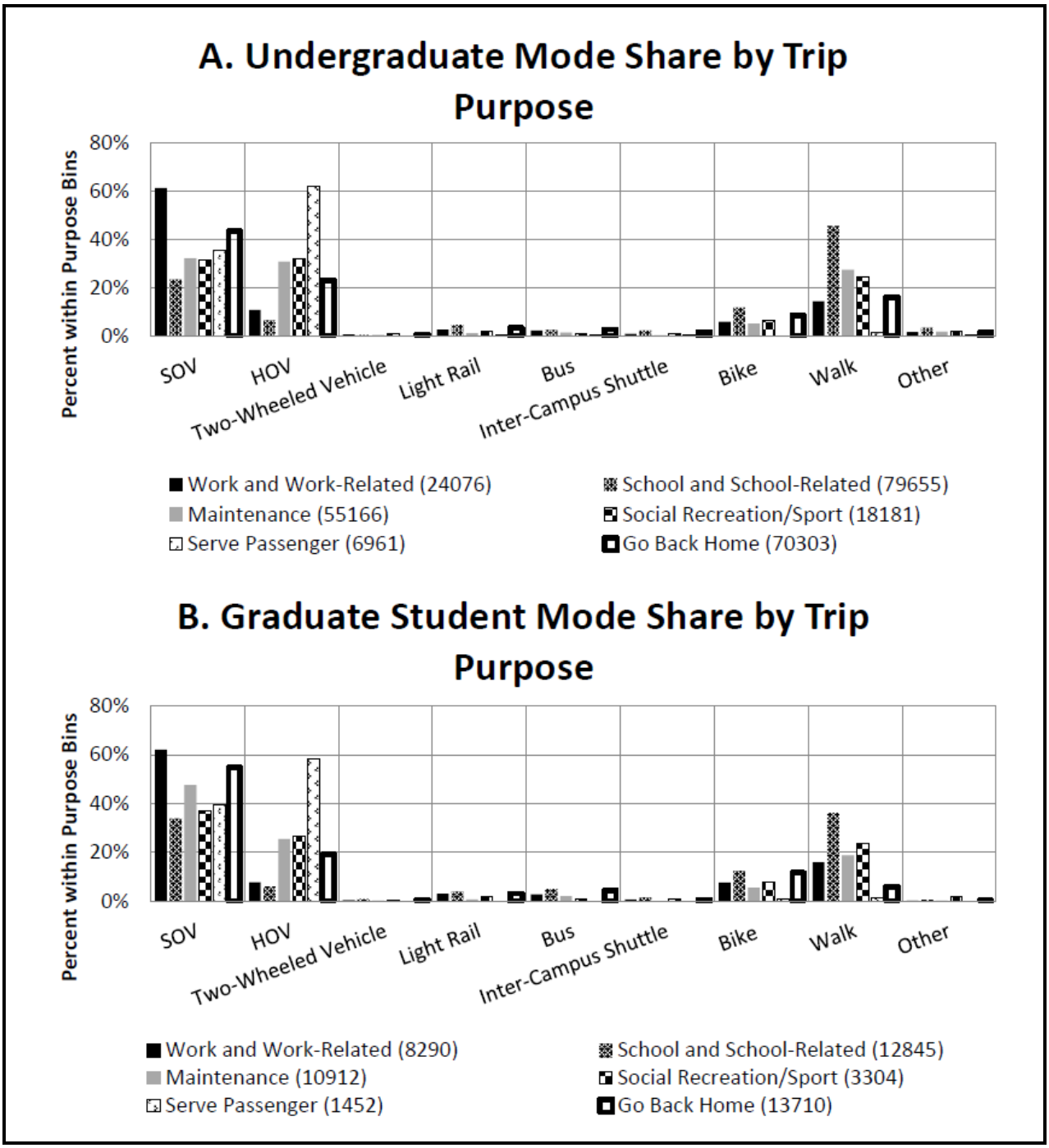


Figure 3.5 Mode Share Within Each Trip Purpose by Student Level

The undergraduate and graduate student mode share values for each trip purpose are compared in Figure 3.5. One can see that the mode distribution for work-related trips is very similar between graduate and undergraduate students, though a noticeably higher percent of undergraduate work trips than graduate student work trips are made using HOV or a shared ride. Compared to undergraduates, graduate students make more school-related trips using the SOV mode or the Valley Metro bus and less school-related trips using the walk mode. The greater mode share for SOV could mean that graduate students live farther from

school, or it could indicate that graduate students make more complex trip chains to and from school. Maintenance trips, which include those trips made for personal business, shopping, and eating meals, have a much higher SOV mode share from graduate students than undergraduates. This could indicate that undergraduate students tend to travel shorter distances than graduate students for their maintenance activities. Social recreation activities for undergraduates has approximately the same mode share for SOV and HOV modes, with a substantial share granted to walk and a significant share to bike. Graduate student mode share is very similar, besides a higher SOV and lower HOV mode share, consistent with the general graduate student trend toward more SOV use. The return home trips for undergraduate students have a higher mode share for walk than bike, but the opposite is true for graduate students. This could support the claim that undergraduates are much more likely to live on campus, but that graduate students still tend to live close to campus. In addition, graduate students are more likely to use the bus for return home trips.

Table 3.3 Trip Selected Travel Characteristics by Student Level

Activity Type	Duration (min)		Distance (mi)		Trip Rate	
	UGs*	Grads**	UGs*	Grads**	UGs*	Grads**
Work/ Work Related	22.45	23.37	7.8	9.0	0.41	0.60
School/ School Related	18.99	19.58	4.7	5.7	1.36	0.93
Eat Meal	13.74	14.32	3.5	3.8	0.52	0.38
Social/ Recreational	21.18	19.89	7.8	6.4	0.31	0.24
Shopping	16.21	14.54	4.5	4.1	0.22	0.23
Personal Business	18.00	20.34	8.2	7.8	0.20	0.18
Serve Passenger	20.61	19.06	8.1	7.8	0.12	0.10
Go Home	22.01	22.08	7.3	9.2	1.20	0.99
Other	22.18	22.04	9.0	6.6	0.34	0.24
Intra-Campus	8.92	7.49	0.6	0.5	1.21	0.52
Inter-Campus	53.10	50.35	18.3	20.8	0.04	0.03
To/From Campus	26.54	22.82	7.6	5.9	1.35	1.12
Non-Campus Based	20.96	21.41	8.4	9.0	2.09	2.22
All Trips	19.73	20.18	6.2	7.1	4.69	3.89

** Undergraduate Students; ** Graduate Students*

The distances and travel times presented in Table 3.3 have not been filtered to illuminate outliers. The trip rates have been calculated based solely on the number of trips made and the number of respondents represented. There are therefore several non-trip makers factored into the trip rate calculation. One can see that in general graduate students travel farther and spend more time traveling than undergraduates. With the exception of social recreation and shopping, grad students' average trip length is greater than or nearly the same as undergrads' for every trip purpose. However, when graduate students travel to and from campus they travel shorter distances and spend less time than when undergraduates travel to and from campus. Undergraduates make overall more trips per day than grad students, but grad students make more non-campus based trips. This disparity in trip rates is especially noticeable in intra-campus trips, with undergrads making more than twice as many intra-campus trips as grad students. Graduate students do make more work-based trips per day than undergraduate students. The two segments make approximately the same number of daily personal business and shopping trips: two purposes that could be considered maintenance

activities. However, undergraduates make quite a bit more trips per day for social recreation than graduate students.

Table 3.4 Daily Activity Participation by Student Level

Activity	Average Daily Time Spent (min)		Average Portion of the Day Spent		Percent of Segment that Participated	
	UGs*	Grads**	UGs*	Grads**	UGs*	Grads**
All In-Home	826.6	806.0	57%	56%	100%	100%
Travel	133.8	107.1	9%	7%	100%	100%
Work/Work-Related	130.1	193.7	9%	13%	37%	47%
School/School-Related	195.9	211.8	14%	15%	74%	63%
Eat Meal (Out of Home)	36.3	30.3	3%	2%	43%	37%
Social Recreation/Sport	45.6	36.9	3%	3%	24%	22%
Shopping	14.6	16.1	1%	1%	19%	21%
Personal Business	18.7	13.2	1%	1%	15%	15%
Serve Passengers	6.5	3.2	0%	0%	8%	6%
Other Activities	31.9	21.7	2%	2%	21%	14%
Total Discretionary	81.9	67.3	6%	5%	55%	49%
Total Maintenance	33.3	29.2	2%	2%	31%	32%
Total Mandatory	326.0	405.5	23%	28%	89%	90%

** Undergraduate Students; ** Graduate Students*

Table 3.4 examines the activity participation of undergraduate and graduate students. In this table, and in the figure that follows, travel is taken as one of the activity choices. In-home activities are grouped together, as the travel survey did not ask students to specify between in-home activity types. Only those students who reported making at least one trip were considered for calculating the expansion factor, and everyone was assumed to have started the day at home. These activity-based analyses do not use weighted data. The table reveals that graduate students spend a greater portion of the day at work than undergraduates and that graduate students are more likely to work on a given day. Undergraduates are more likely than graduate students to attend school or a school-related activity in a given day, but graduate students that do participate spend slightly more time on school-related activities. A larger portion of undergraduates participated in social recreation and in eating meals outside the home on the travel day. However, for those that did participate, graduate and undergraduate students spent about the same portion of their day on these activities. Consistent with the results from the trip rates in Table 3.3, maintenance activity time and participation were very close between the two student levels.

Figure 3.6 displays time of day profiles for undergraduate and graduate students while Figure 3.7 shows similar profiles for faculty and staff, for the sake of comparison. These profiles show at any given time point in the day, what percentage of the specific segment is participating in each of the activities available. One must note that these profiles begin at 3:00 AM and go to 3:00 AM the following day. This reflects the way in which the survey was structured. The figure shows that compared to undergraduates, a much larger portion of graduate students are participating in work activities during typical business hours. Undergraduate work participation is more evenly spread across the day, with many undergraduates still working after 7:00 at night.

In comparison, staff have a very obvious peak in the time of day during which work is performed. A larger percentage of graduate students are completing their school activities in the evening, between 5:00 and 9:00 PM. The evening hours for undergrads seems to be heavily filled with social recreation activities. One can see that there are a larger percentage of undergraduates participating in at-home activities during the middle of the day and larger percentage that are not back at home by 2:00 AM. Faculty and staff tend to have only a very small portion of their population at home in the middle of the day and a comparatively small portion who have not returned home by 11:00 PM.

Table 3.5 compares undergraduate and graduate student travel patterns concerns trip chaining behavior. The data is not weighted. For the purpose of this analysis, only home-based trip chains are considered. A home-based trip chain is one in which the students leaves his or her home and makes several stops before returning to the home. Any time a person leaves the home a trip chain occurs. For example, a student may leave home, stop at a coffee shop, go to work for several hours, go to a restaurant for lunch, make a stop at ASU for a class, and then finally return home. This would be a trip chain with 4 stops. On the other hand, a person who simply goes from home to the grocery store and back home has made a trip chain with just 1 stop. The table shows that undergraduates make more home-based trip chains per person, but that graduate students' trip chains last on average about 90 minutes longer. Undergraduate trip chains are more likely to include an ASU stop.

There is little difference between the activity purpose of the first stop on the chain for undergraduates versus graduates. Generally, the first stop on any students' trip chain is either work or school related. The first place students stop after leaving ASU is usually home, but those who do not go from ASU straight home tend to go to eating a meal or shopping. 17% of the trip chains made my undergraduates and 15% made by graduate students in the travel day is simply to go from home to ASU and back to home again.

The tables and figures that have been presented in this section demonstrate the differences between travel characteristics of undergraduate and graduate students. Graduate students tend to spend their days at work and come to ASU in the evenings while undergraduates are often at ASU during the middle of the day. Graduate students tend to use the SOV and bus modes of travel more often than undergraduates. Undergraduates also participate more heavily in social recreation and in eating meals outside of the home. It's possible that these differences in travel characteristics can stem from differences in age, working status, household responsibilities, vehicle ownership, or any of a number of socio-demographic variables between undergraduate and graduate students.

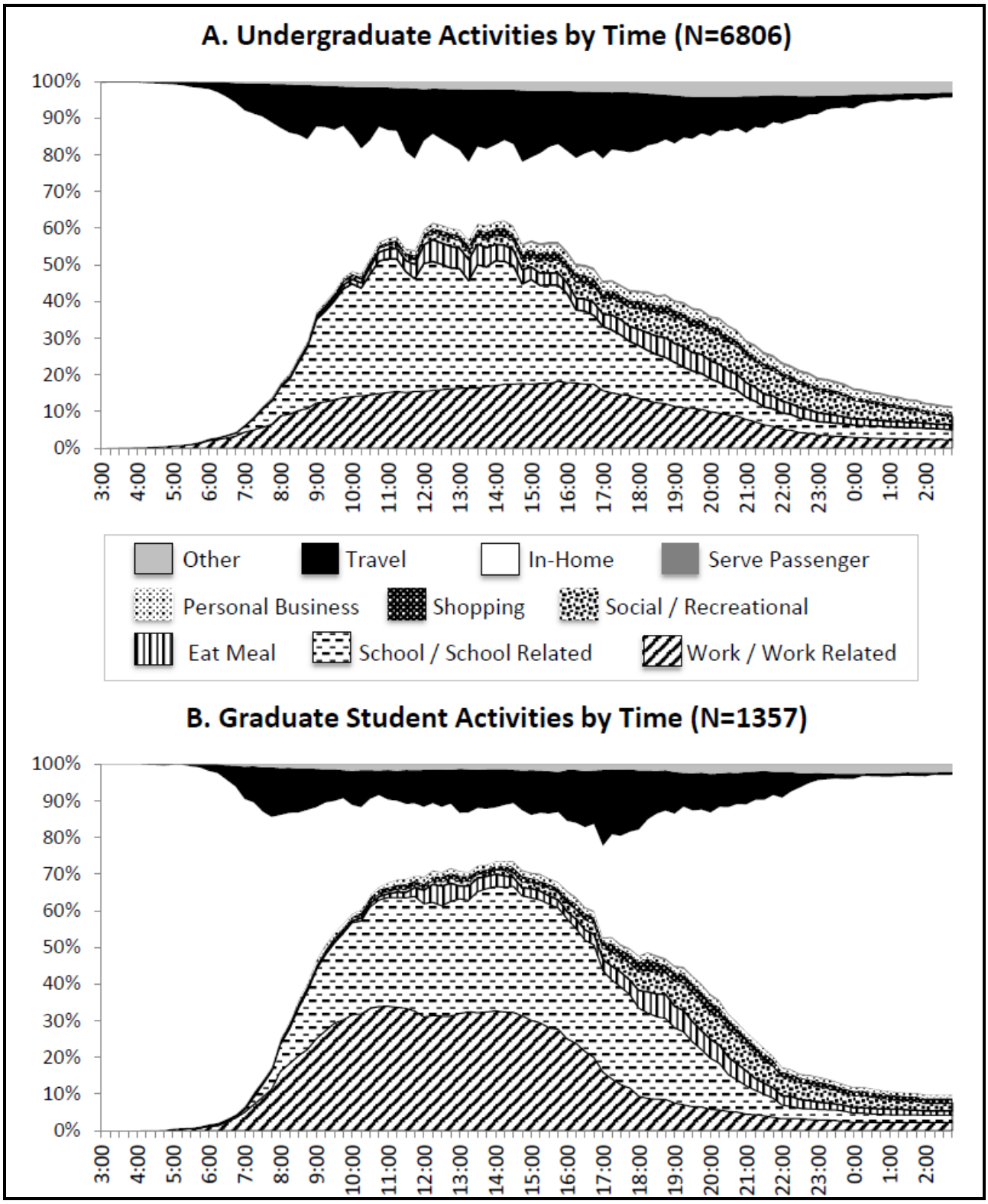


Figure 3.6 Time Of Day Profiles for Students

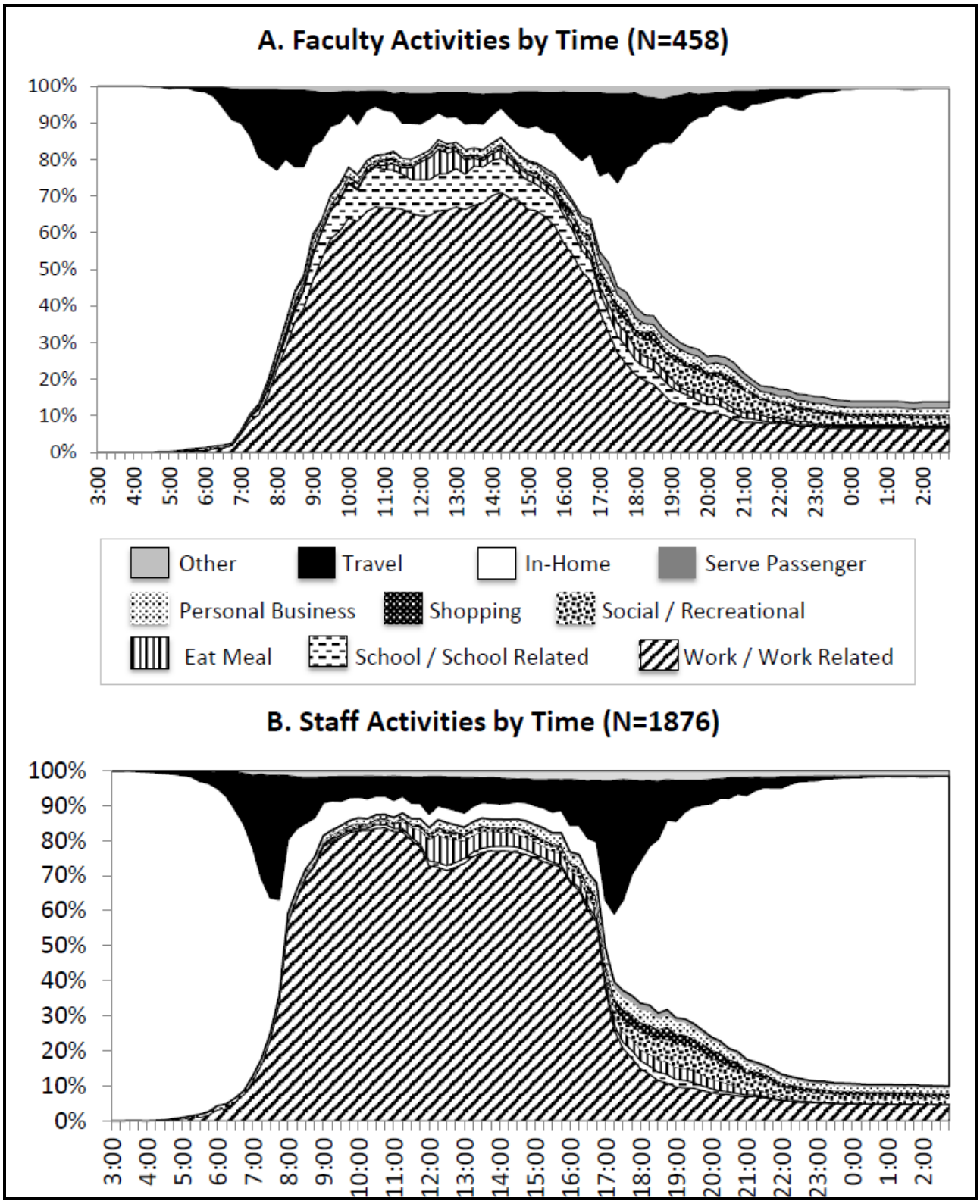


Figure 3.7 Time Of Day Profiles for Faculty and Staff

Table 3.5 Analysis of Trip Chaining Behavior

	Undergraduates	Graduate Students
Number of Home-based (HB) Trip Chains	9486	1606
Avg HB Chains per Person	1.20	1.00
Avg HB Chains per Trip Makers	1.39	1.18
Avg HB Chain Duration (min)	353.9	444.8
Avg Stops/HB Chain	2.59	2.59
% HB Chains with ASU Stop	62%	58%
Work / Work Related (not ASU)	12%	18%
School / School Related / Campus	52%	47%
Eat Meal	7%	6%
Social / Recreational	6%	8%
Shopping	5%	6%
Personal Business	4%	5%
Serve Passenger	4%	3%
In-Home	4%	2%
Other	7%	6%
Work / Work Related (not ASU)	5%	3%
School / School Related / Campus	1%	2%
Eat Meal	7%	9%
Social / Recreational	3%	4%
Shopping	4%	6%
Personal Business	3%	3%
Serve Passenger	2%	2%
In-Home	67%	67%
Other	6%	4%
% of Tours that are Home-ASU-Home	17%	15%

3.4 Travel Characteristics by Living Arrangement

The analysis that follows compares students travel characteristics by student living arrangements. One of the factors that is known to affect the way people make travel choices is household interactions. A student who lives with a child, for example, will likely have responsibilities to escort that child to activities, necessitating the need for using a personal vehicle on a trip that would normally be made using, for example, bike. A person who lives with a roommate that also attends ASU may carpool with that roommate, requiring him or her to change their schedule to accommodate the roommate's. The categories that have been identified for this analysis are students who live on campus, who live off campus with family (either parents and siblings, or spouses and their own children), who live off campus with roommates, who live off campus with both family members and roommates, and who live off campus alone. Figure 3.8 shows the time of day distribution based on living arrangements.

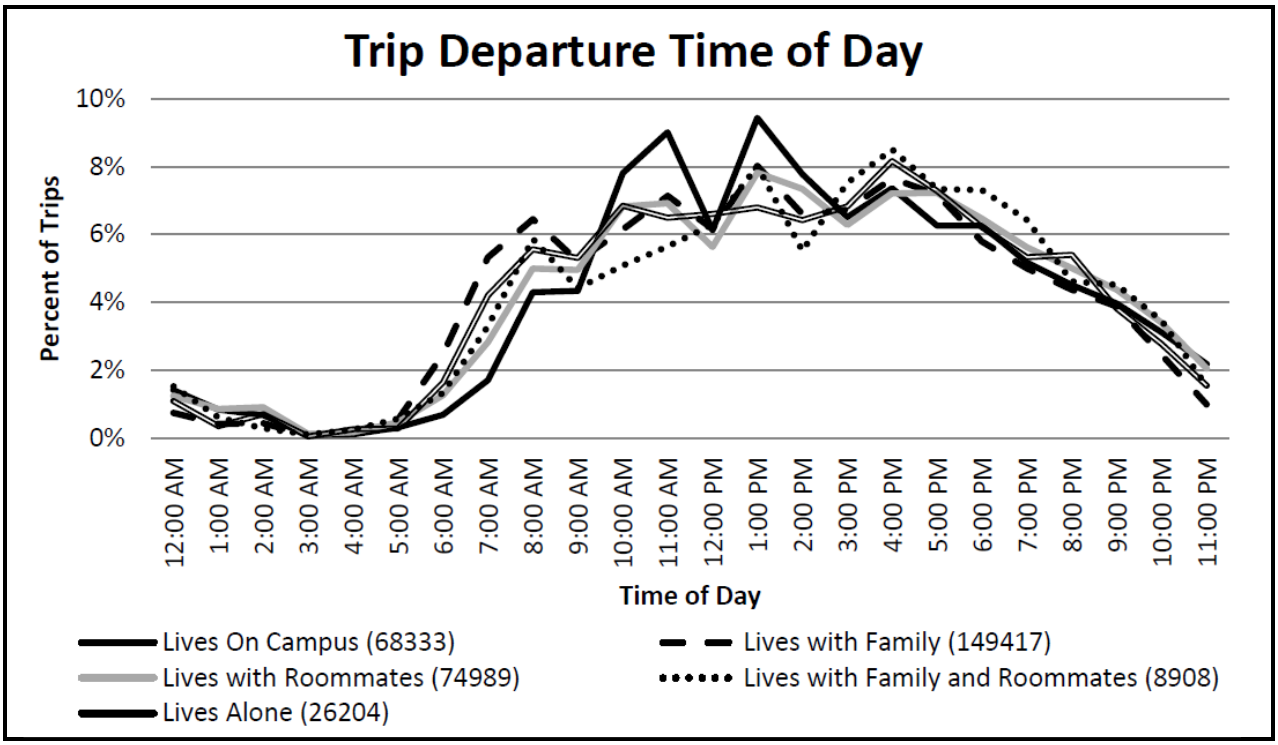


Figure 3.8 Time of Day Distributions by Student Living Arrangement

There is little difference between trip departure times based on living arrangement in Figure 3.8. All students tend to travel more during the middle of the day and typically lack that classic AM and PM peak seen in ASU staff and other working adults. The time between 6:00 AM and 8:00 AM is somewhat revealing, however. Students who live with family members have the greatest portion of their trips take place during this AM time period, followed by students who live alone. On-campus residents have the smallest portion of their trips taking place during this AM peak. This could be indicative of the time that a student needs to leave the house in the morning in order to reach his or her mandatory activities on time. If this is true, it would support the idea that students who live with family members and who live alone live father from campus than those who live with roommates or with both family and roommates.

Figures 3.9 A through E show the mode split by trip purpose for students with different living arrangements. The mode split for on-campus students for all purposes leans heavily toward non-motorized modes. This appears to be the most significant difference between different living arrangements in terms of mode share. With the exception of serving passengers (which, as would be expected, has the highest mode share with HOV). All trip purposes for on-campus students have more than 35% of trips made by the walk mode. On-campus students also use the HOV mode share quite a bit for maintenance and discretionary trips. In comparison, all off-campus students use personal auto modes (SOV and HOV) most often.

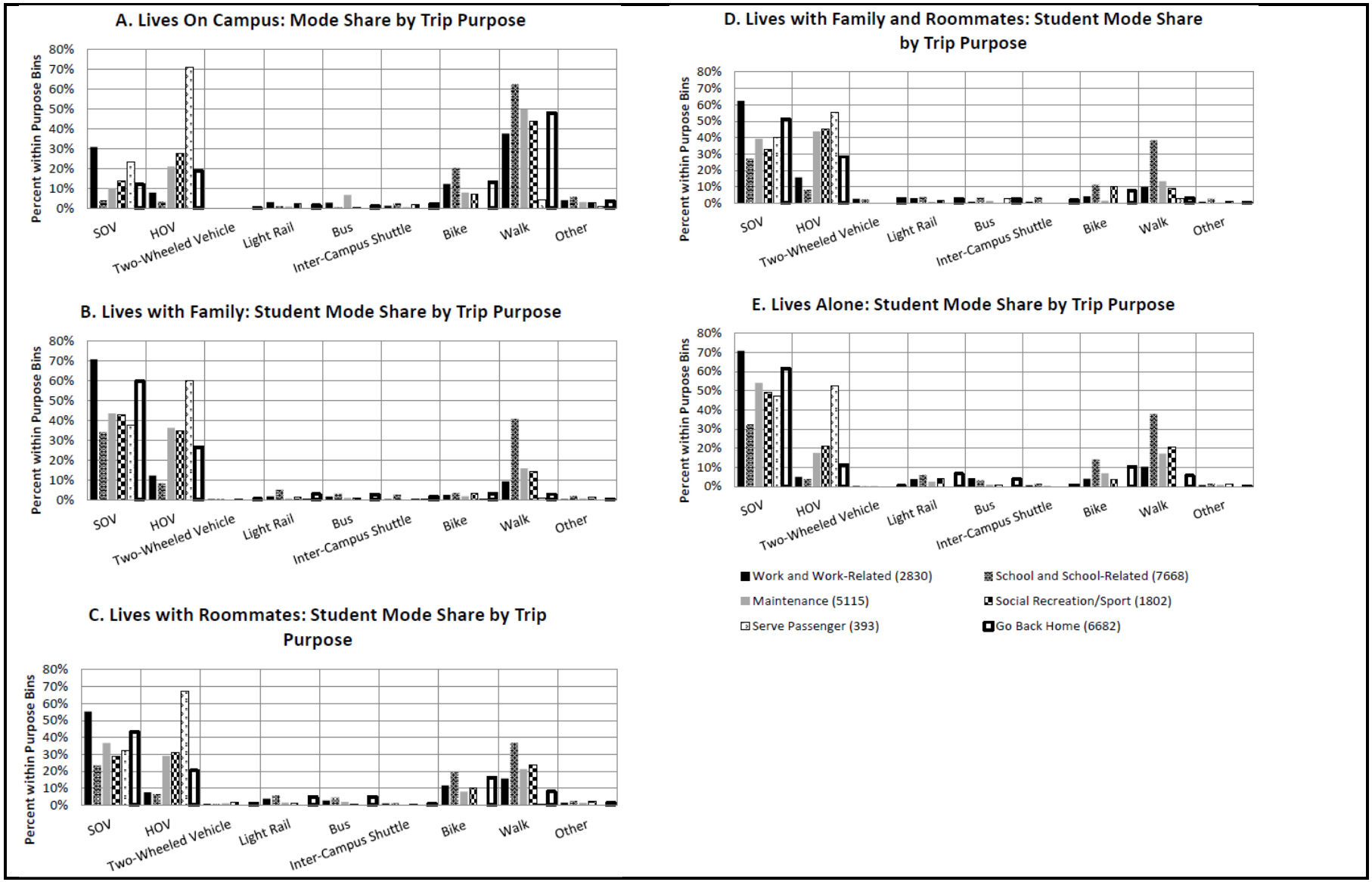


Figure 3.9 Mode Share Within Each Trip Purpose by Living Arrangement

Off-campus students do, however, still tend to make a large percentage of school trips using the walk mode. Students who live with roommates are more likely than students who live with family members to use non-motorized (walking or biking) or transit modes (bus and light rail) for their return home trips. This could indicate that students who live off campus with roommates still live close to their ASU campuses.

Based on the different household interaction between these students, it is reasonable to believe that students living in varying arrangements will have varying trip times, distances, and rates for varying trip purposes. For example, someone who lives alone has nothing stopping them from traveling to the other side of town to pick up a pair of shoes. Someone who has to pick up his or her roommate from class at a certain time, however, must only consider those shoe stores that are within the space-time available while still meeting the roommate obligation. Table 3.6 shows the average trip length, travel time, and trip rate made for each purpose.

Table 3.6 Selected Travel Characteristics by Living Arrangements

		Living Arrangements				
		On-Campus	**With Family**	**With Roommates**	**With Both**	**Alone**
Trip Length (miles)	Work/Work-Related	4.3	9.5	6.4	8.7	8.1
	School/School-Related	1.9	6.9	3.4	5.0	4.3
	Eat Meal (Out of Home)	1.8	4.6	3.0	4.0	3.4
	Social Recreation/Sport	3.3	5.0	3.7	3.5	4.8
	Shopping	4.4	7.2	4.5	5.0	5.5
	Personal Business	4.2	5.9	6.0	3.7	5.8
	Serve Passengers	7.1	7.5	6.7	5.9	6.5
	Go Home	3.5	9.2	5.1	7.4	6.4
Travel Time (minutes)	Work/Work-Related	8.13	15.65	11.42	14.25	13.58
	School/School-Related	4.06	11.54	6.74	9.08	8.10
	Eat Meal (Out of Home)	4.11	8.61	6.37	7.88	6.73
	Social Recreation/Sport	7.05	9.57	7.56	6.99	9.40
	Shopping	8.17	12.39	8.69	10.23	10.18
	Personal Business	8.23	10.80	10.72	8.17	10.70
	Serve Passengers	12.96	13.44	11.83	11.80	12.66
	Go Home	6.73	15.37	9.59	13.12	11.52
Trip Rate	Work/Work-Related	0.37	0.47	0.46	0.54	0.42
	School/School-Related	1.80	1.20	1.17	1.25	1.15
	Eat Meal (Out of Home)	0.97	0.39	0.45	0.42	0.38
	Social Recreation/Sport	0.47	0.23	0.33	0.27	0.27
	Shopping	0.24	0.23	0.21	0.32	0.20
	Personal Business	0.25	0.19	0.17	0.24	0.18
	Serve Passengers	0.07	0.17	0.06	0.12	0.06
	Go Home	1.69	1.08	1.06	1.19	1.00

The table shows that students who live off campus with family members almost universally travel longer distances. This is true for every trip purpose besides personal business, in which students who live with families or roommates tend to travel the same distances and with the same travel time. The distance that those who live alone have to make for social recreation trips is the second longest for that trip purpose. On-

campus students travel extremely short distance except to serve passengers. This table again confirms that those who live off campus with roommates are likely to live close to campus. Students who live off campus with roommates are undercut in travel time and distance only by those who live directly on campus. As would be expected, students who live on campus have the highest trip rate to school and school-related activities. Students who live with family have the highest trip rate for serving passengers, likely picking up their own children or younger family members. On-campus students have the highest trip rate for eating meals outside of the home, but it is rather surprisingly students who live with both family members and roommates that have the highest trip rate to social recreation activities. It is also these students who have the highest trip rates to work and work-related activities. On-campus students have the lowest work related trip rate.

Table 3.7 Daily Activity Participation by Living Arrangements

		Living Arrangements				
		On-Campus	**With Family**	**With Roommates**	**With Both**	**Alone**
Average Time Spent Daily (min)	In Home	868.3	817.1	807.4	801.5	816.1
	Travel	133.0	133.0	122.6	126.1	120.8
	Work/Work Related	72.1	155.4	151.6	185.8	152.0
	School/School-Related	174.7	204.5	198.2	199.4	213.8
	Eat Meal	52.9	27.0	40.7	36.5	32.0
	Shopping	13.3	14.0	17.2	19.6	14.6
	Social Recreation/Sport	61.7	34.0	52.5	35.7	46.1
	Personal Business	21.6	17.1	17.6	9.2	17.2
	Serve Passengers	3.3	8.3	4.4	4.5	2.4
	Other Activities	39.2	29.7	27.8	21.6	25.0
Average Portion of the Day Spent	In Home	60%	57%	56%	56%	57%
	Travel	9%	9%	9%	9%	8%
	Work/Work Related	5%	11%	11%	13%	11%
	School/School-Related	12%	14%	14%	14%	15%
	Eat Meal	4%	2%	3%	3%	2%
	Shopping	1%	1%	1%	1%	1%
	Social Recreation/Sport	4%	2%	4%	2%	3%
	Personal Business	1%	1%	1%	1%	1%
	Serve Passengers	0%	1%	0%	0%	0%
	Other Activities	3%	2%	2%	1%	2%
Percent of the Segment that Participated	In Home	100%	100%	100%	100%	100%
	Travel	100%	100%	100%	100%	100%
	Work/Work Related	27%	40%	42%	47%	38%
	School/School-Related	77%	71%	73%	68%	72%
	Eat Meal	64%	36%	43%	35%	36%
	Shopping	18%	20%	19%	24%	20%
	Social Recreation/Sport	32%	20%	26%	23%	24%
	Personal Business	17%	15%	14%	15%	16%
	Serve Passengers	4%	11%	5%	9%	4%
	Other Activities	19%	23%	17%	13%	16%

Table 3.7 describes the activity participation metrics of students with different living arrangements. Average time spent in various activities is presented in terms of absolute minutes as well as in a percent of the day. The data in the table is not weighted and is computed only for those that reported making at least one trip in the travel day. Every person was assumed to begin the day at home. One can see that the greatest portion of the day is spent on in-home activities, no matter the living arrangements. Interestingly, every group spends approximately the same amount of time traveling and participating in maintenance activities (shopping and personal business). On-campus students spend the least amount of time in both work activities and school activities. Students who live with family are the only group that spends any noticeable portion of their day serving passengers. Students who live on campus and students who live with roommates spend the greatest portion of their day in social recreation activities. This is understandable, since these two groups have the greatest access to people their own age, making social activities easier to access. On-campus students had the greatest participation rate in school and school-related activities but the least participation in work activities. People who live with both family and roommates are the opposite, with the greatest participation rate in work and least in school on the travel day. Though on-campus students do not spend the greatest amount of time in social recreation, they do have the greatest participation rate, with 32% of on-campus students participating in some social recreation on the travel day. In general, it seems that students who live off-campus with roommates have more school participation, less work participation, and more social recreation than other students who live off campus. This analysis shows that students who have varying living arrangements also have varying travel and activity behavior patterns that can be considered when contemplating policies that affect ASU students.

3.5 Travel Characteristics by Working Status

Just as a student's living arrangements will have an effect on their daily responsibilities, and therefore their travel behavior, a student's working status will weigh heavily on his or her travel patterns. As shown in Table 3.1, graduate students work almost equally on and off campus. Nearly half of all undergraduates work off campus while another third does not work at all. This is compared to only 18.6% of graduate students who do not work. Only 5% of undergraduates, compared to 10% of graduate students, have jobs both on and off campus.

Figure 3.10 shows the time of day distribution for trips made by students of varying working status. The figure shows that students who don't work tend to travel more during the middle of the day. The higher number of mid-day trips is also seen in those students who work on campus. Surprisingly, students who don't work tend to make fewer trips late in the evening that those students who work on campus, off campus, or both. In general, though, no student sub-groups display the typical morning and evening peak that is expected from the typical working adult.

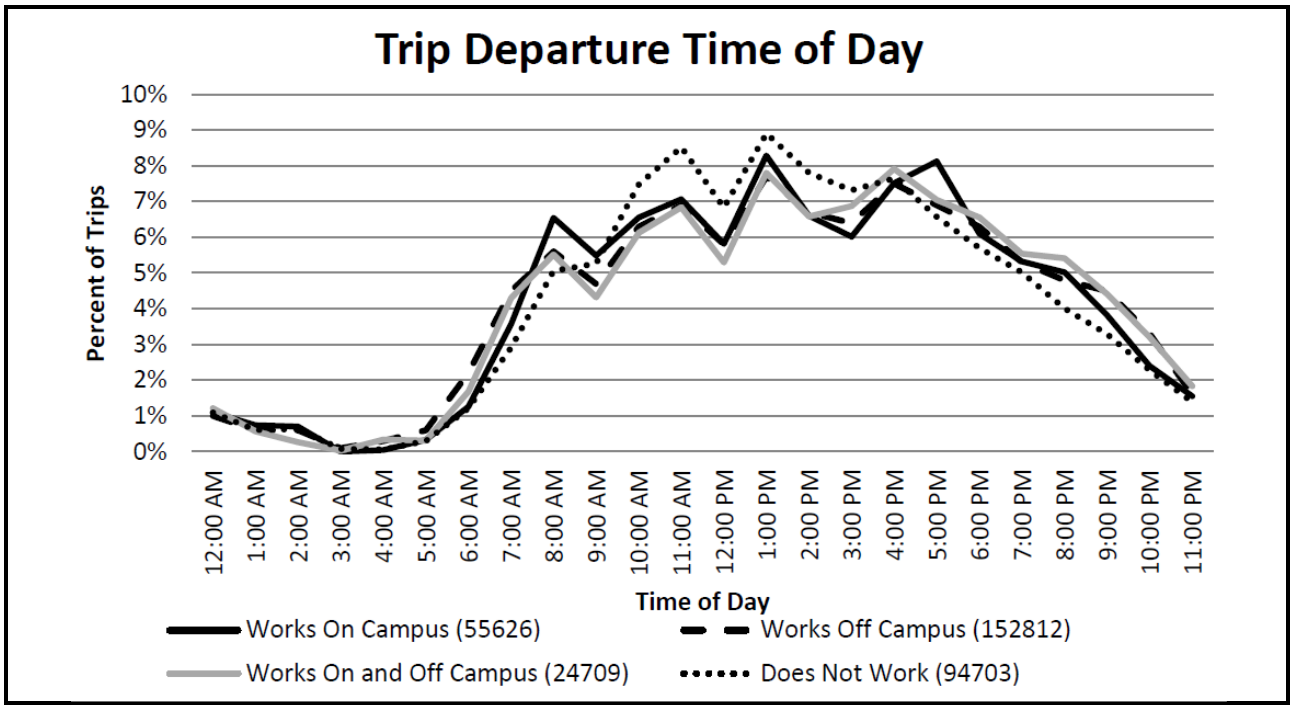


Figure 3.10 Time of Day Distributions by Student Working Status

The differences in working status also have an effect on the mode of travel that is chosen for each different trip purpose in the travel survey. One can see from Figure 3.11 that students who work on campus prefer the walk mode for work-related trips. This is in contrast to those who work off campus, who overwhelmingly prefer the SOV mode for the same trip type.

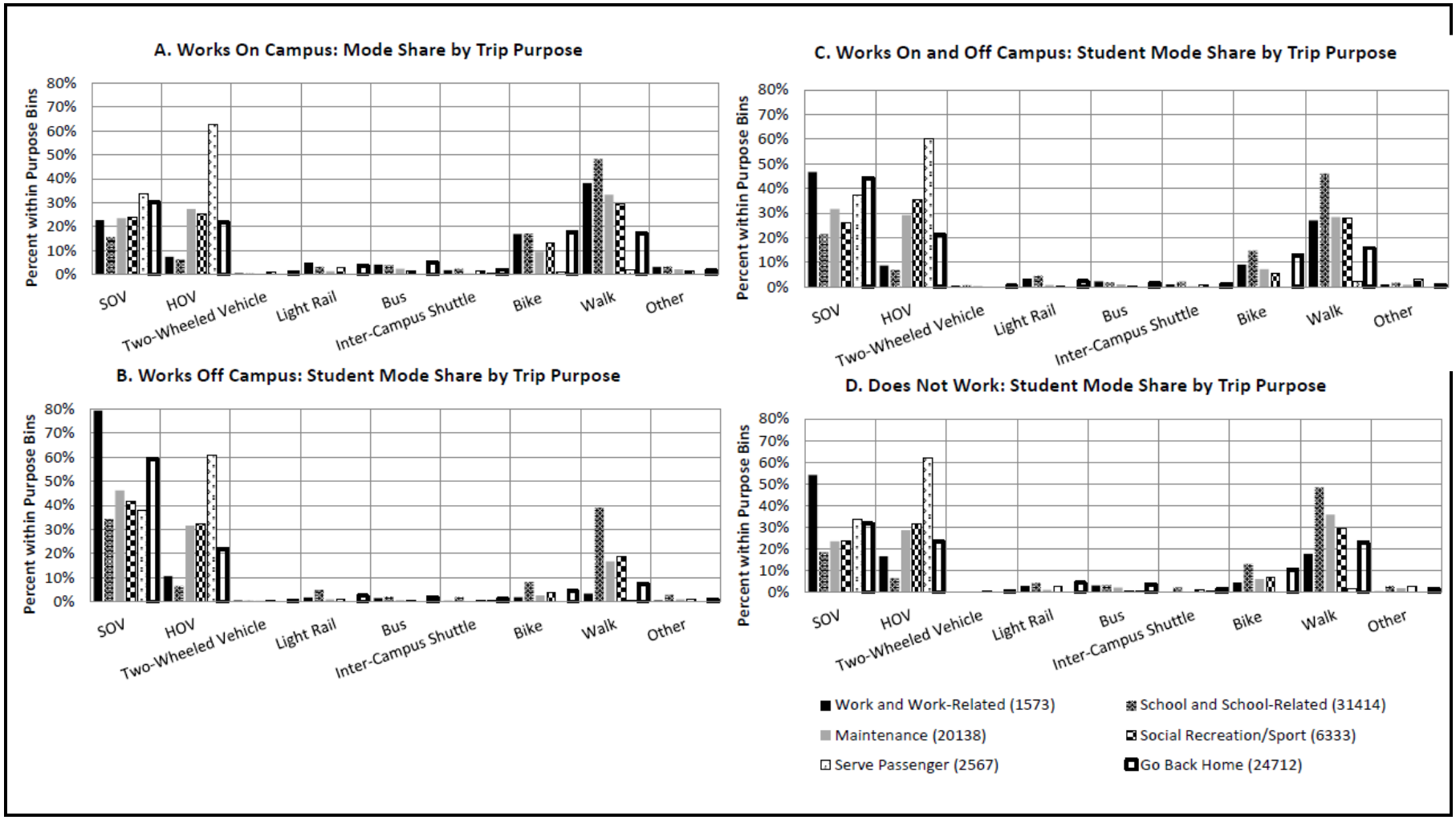


Figure 3.11 Mode Share Within Each Trip Purpose by Working Status

Not surprisingly, students who report working both on and off campus make about half of their work-related trips using SOV and the other half using some other mode. What is surprising is that students who report working neither on nor off campus still report some – though very few – work or work-related trips. Those work trips that are made by this segment are typically made using the SOV mode. Students who work on campus have a relatively low mode share for driving alone (SOV) compared to other market segments. This would imply that the students who work on campus probably live on or near campus as well. Students who work exclusively off campus tend to lean towards the personal auto modes (SOV and HOV) for nearly all the trip purposes and not just work-related trips. Students who do not work have a more balanced mode profile: no one mode has more than a 60% share in any trip purpose.

Table 3.8 Selected Travel Characteristics by Working Status

		Working Status			
		On-Campus Only	**Off-Campus Only**	**Both On and Off Campus**	**Does Not Work**
Trip Length (miles)	Work/Work-Related	3.8	9.7	6.5	7.2
	School/School-Related	3.2	5.9	4.2	4.2
	Eat Meal (Out of Home)	2.1	4.3	3.1	2.5
	Social Recreation/Sport	3.8	4.7	4.4	4.1
	Shopping	4.2	6.5	5.4	5.0
	Personal Business	5.5	6.2	4.2	4.6
	Serve Passengers	6.9	7.7	6.8	7.0
	Go Home	4.9	7.9	6.5	5.9
Travel Time (minutes)	Work/Work-Related	7.49	16.04	11.34	12.15
	School/School-Related	6.36	10.18	7.73	7.63
	Eat Meal (Out of Home)	4.70	8.26	6.37	5.34
	Social Recreation/Sport	7.87	9.10	8.59	8.12
	Shopping	8.01	11.51	10.09	9.05
	Personal Business	10.29	11.20	8.39	8.73
	Serve Passengers	11.99	13.55	12.97	12.84
	Go Home	9.28	13.49	11.34	10.50
Trip Rate	Work/Work-Related	0.63	0.60	0.84	0.07
	School/School-Related	1.39	1.17	1.42	1.36
	Eat Meal (Out of Home)	0.50	0.47	0.62	0.50
	Social Recreation/Sport	0.30	0.30	0.40	0.28
	Shopping	0.22	0.23	0.25	0.21
	Personal Business	0.18	0.22	0.26	0.16
	Serve Passengers	0.09	0.13	0.15	0.11
	Go Home	1.20	1.19	1.35	1.07

Working status and place of employment will undoubtedly have an influence on the travel distances, times, and trip rates to various activity types. Table 3.8 shows that students who work only on campus travel shorter distances for nearly every trip type (besides personal business and serving passengers) than students with any other working status. The short distances traveled by this group for eating meals, shopping, social

recreation, and going home shows that students who work on campus also choose to live, shop, play, and eat very close to campus: an important piece of information for retail and services located near campus.

Surprisingly, the students who work both on and off campus have higher trip rates than any other segment for every type of trip. Based on what has been learned by examining travel patterns based on different living arrangements, one conjecture would be that students who work both on and off campus are likely the same students who are living on campus. Indeed, living so close to one's school activities would help to free up one's time for working multiple jobs. Otherwise, students who work off campus only have lower trip rates than any other group for school and school related trips as well as for eating a meal outside the home. Students who do not work at all have lower trip rates than anyone else to returning home, personal business, and shopping.

Table 3.9 Daily Activity Participation by Working Status

		Working Status			
		On-Campus Only	**Off-Campus Only**	**Both On and Off Campus**	**Does Not Work**
Average Time Spent Daily (min)	In Home	818.9	784.1	764.7	900.1
	Travel	111.6	132.8	138.7	131.6
	Work/Work Related	147.9	206.1	199.8	20.6
	School/School-Related	221.1	175.0	196.3	223.6
	Eat Meal	35.2	33.4	39.3	37.6
	Shopping	14.8	12.9	13.2	18.3
	Social Recreation/Sport	44.3	43.1	42.6	45.9
	Personal Business	16.2	18.3	18.4	17.6
	Serve Passengers	3.2	5.8	4.5	7.9
	Other Activities	26.9	28.3	22.6	36.8
Average Portion of the Day Spent	In Home	57%	54%	53%	63%
	Travel	8%	9%	10%	9%
	Work/Work Related	10%	14%	14%	1%
	School/School-Related	15%	12%	14%	16%
	Eat Meal	2%	2%	3%	3%
	Shopping	1%	1%	1%	1%
	Social Recreation/Sport	3%	3%	3%	3%
	Personal Business	1%	1%	1%	1%
	Serve Passengers	0%	0%	0%	1%
	Other Activities	2%	2%	2%	3%
Percent of the Segment that Participated	In Home	100%	100%	100%	100%
	Travel	100%	100%	100%	100%
	Work/Work Related	27%	40%	42%	47%
	School/School-Related	77%	71%	73%	68%
	Eat Meal	64%	36%	43%	35%
	Shopping	18%	20%	19%	24%
	Social Recreation/Sport	32%	20%	26%	23%
	Personal Business	17%	15%	14%	15%
	Serve Passengers	4%	11%	5%	9%
	Other Activities	19%	23%	17%	13%

Table 3.9 shows the daily activity participation in different activity types by varying work status. One can see that students who do not work spend slightly more time per day than any other students in every activity type besides working. Compared to other students who work, students who work only on campus spend more time at school-related activities, less time working, and less time traveling. In general, it seems that a student's working status has very little effect on what portion of the day is spent in shopping, social recreation, or personal business. It does, however, have an effect on the portion of the day that is spent in home, traveling, working, and at school-related activities. Students who work both on and off campus spend the greatest portion of their day (10% or about 140 minutes) traveling.

Just like Table 3.7, Table 3.9 also displays the portion of the market segment that participated in each activity on the travel day. That is, for example, what percentage of students who work only on campus participated in work or a work-related activity on the travel day? The data present in this table only includes those students who made at least one trip, and the assumption was made that students began the day at home. The portion of students who participated in at-home activities and in travel is therefore 100%. Only 27% of students who work only on campus participated in a work activity on the travel day. However, 47% of the students who report working neither on nor off campus reported participation in a work-related activity on the travel day. The students who work only off campus, which is by far the largest group, have a larger portion of daily participation in work and a lower portion of daily participation in school than those students who work only on campus. Students who work only on campus have the highest daily participation rate in school, social recreation, eating meals outside the home, and personal business. On the other hand, they have the lowest daily participation in shopping, and in serving passengers.

3.6 Exploration of Intra-Campus Trips

One of the elements of ASU Travel and Mode Use Survey which distinguish it from other campus travel surveys is the capture of intra-campus trips. Students were asked to include their intra-campus trips in the daily trip diary, though there is some evidence to suggest that the capture rate for these types of trips is lower than that for other trip types. The presence of intra-campus trips on the distributions presented in this section have some effects, including shortening the overall trip length and duration averages, increasing the non-motorized mode shares, and increasing the total number of trips for most students. If one is interested in observing trips made only by students to and from campus and non-campus based then these affects will detrimentally impact the analysis. However, if one is curious as to the overall picture of student travel behaviors, these trips should be included, as they make up a large portion of daily trips undertaken by students.

Table 3.10 shows the percent of trips made by each student group that are intra-campus trips. Data in this table is unweighted in order to get a better sense of the true number of trips that were reported. The number of intra-campus trips made generally reflects the behaviors that have been observed throughout this section. About 25% of the trips made by undergraduate students are intra-campus trips while only about 14% of the trips made by graduate students are intra-campus. Students who live on campus and who work only on campus – as would be expected – have a much higher percent of their trips as intra-campus trips. Students who do not work at all also have a higher percent of intra-campus trips than other students.

Table 3.10 Intra-Campus Trip Counts for Various Student Groups

Student Group	Intra-Campus Trips	Total Trips	% Intra- Campus
Undergraduates	9323	37129	25.1%
Graduate Students	860	6244	13.8%
Lives on Campus	5058	8798	57.5%
Lives Off Campus with Family	2918	20254	14.4%
Lives Off Campus with Roommates	1509	9638	15.7%
Lives Off Campus with Both	210	1218	17.2%
Lives Alone	488	3465	14.1%
Works On Campus Only	2382	7174	33.2%
Works Off Campus Only	3028	20291	14.9%
Works On and Off Campus	840	3197	26.3%
Does Not Work	3933	12711	30.9%

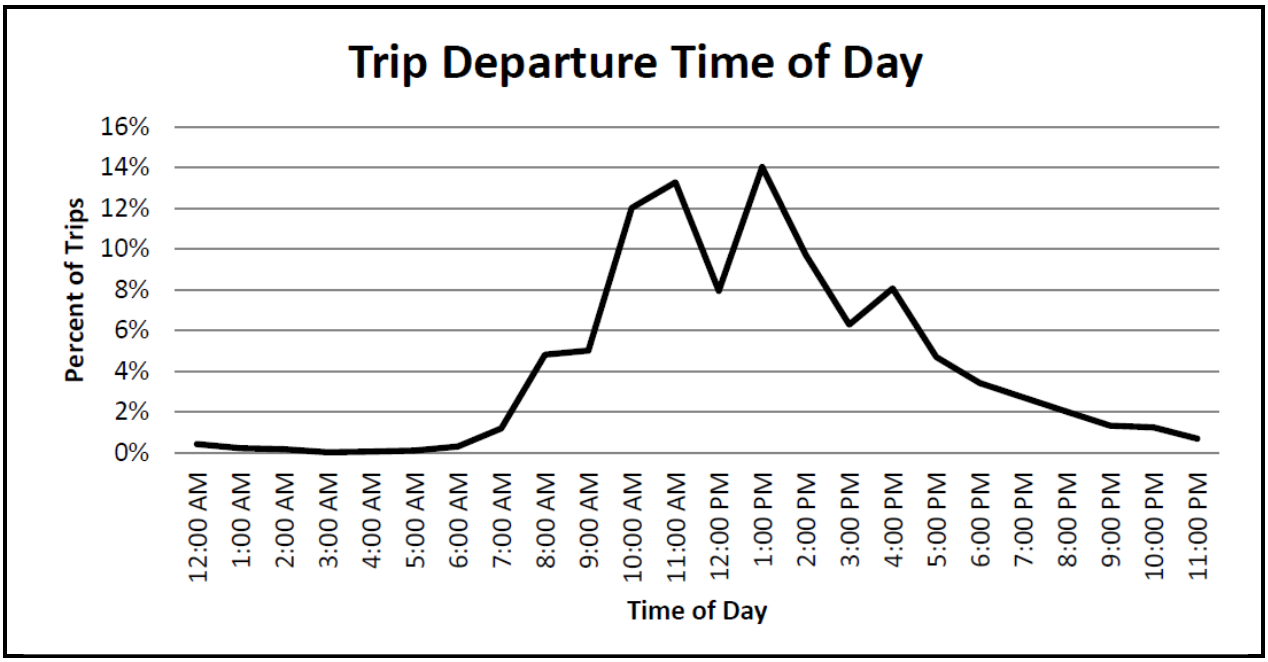


Figure 3.12 Time of Day Distribution for Intra-Campus Trips

Figure 3.12 shows the time of day distribution of intra-campus trips while Figure 3.13 provides the mode choice distribution for intra-campus trips only. As is probably expected, the bulk of the intra-campus trips take place during mid-day when most classes are likely to take place. Even after classes are done at the end of the day, however, students are still making intra-campus trips. As many as 2% of the total intra-campus trips reported began between 8:00 and 9:00 PM. The very early morning hours, however, are not popular

times for intra-campus trips. The mode choice distribution for intra- campus trips that is shown in Figure 3.13 reveals that, as would be expected, the non- motorized modes (bike and walk) make up the vast majority of mode choices for intra- campus trips. This is intuitive and consistent with the short distances that are experienced for intra-campus trips. The "other" mode share also has a sizable portion of the intra- campus trips, suggesting that "other" likely includes a great deal of alternative non- motorized modes, such as skateboarding, roller-blading, etc.

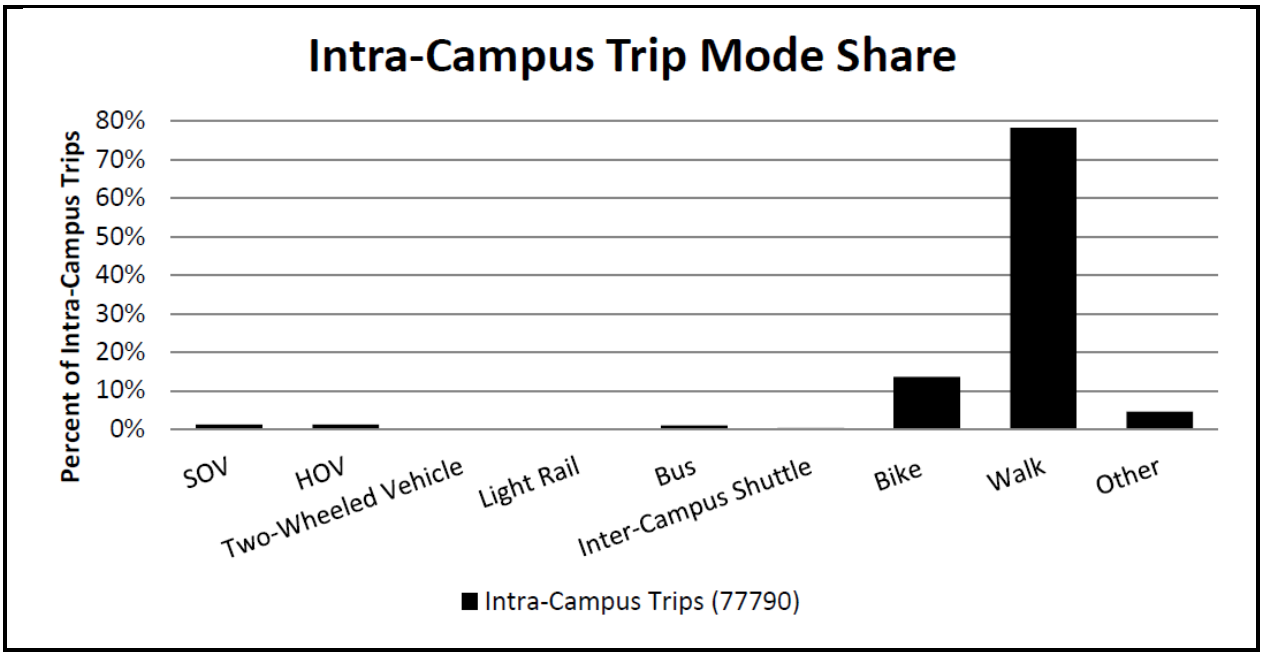


Figure 3.13 Mode Share for Intra-Campus Student Trips

In summary, this chapter has outlined not only the quantifiable differences between travel behavior of students and the general working adult, but also the differences between travel behaviors of different types of students. It would seem that younger students who live on campus have activity schedules, travel modes, activity participation patterns, and space-time travel constraints that vary greatly from those of older students who live off campus. Those students who live off campus with family members again vary from those who live off campus with roommates. Even still, undergraduates vary a great deal from graduate students, no matter their age or living arrangements. This evidence seems to show that there is merit in incorporating student travel patterns into regional travel models in places where students make up a significant portion of the traveling population.

4. ASU Student Travel Demand Model Update

ASU submodel consists of the trip generation, location choice for trip distribution and mode choice models for ASU student trips. Since the main model accounts with faculty and staff population through NHTS, this submodel is focusing on the student population. The submodel essentially converts enrollment by campus into trips and distributes those trips to production zones using a logit formulation in which all traffic analysis zones (TAZ's) are alternatives. Inputs to the location choice model are socio-economic data, percent of development in a zone, mode choice logsums, distance and time skims, and estimated constants. After distributing the trips, the mode choice model is used in the regional model.

4.1 Trip Generation Model

The submodel aims to model student travel segmented by campus of attendance, student level (graduate and undergraduate), living arrangement (off-campus and on-campus students) and time of day (peak and off-peak). In many major universities, however, the number of graduate students living on campus is very small, making it difficult to obtain an appropriate sample size for the market segment. The submodel presented here will therefore deal only with off-campus graduate students, off-campus undergraduates, and on-campus undergraduates. Figure 4.1 shows the disaggregation for the trip rate estimation.

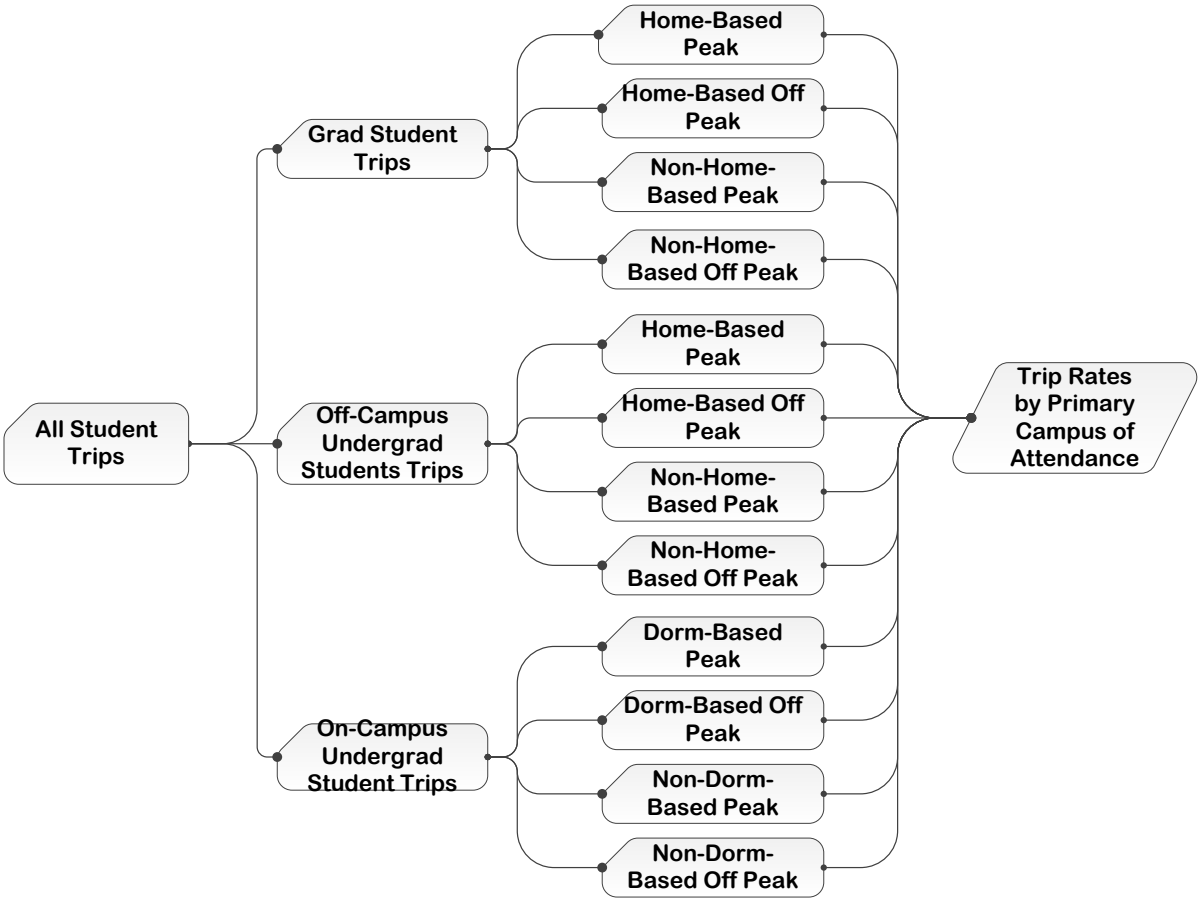


Figure 4.1 Disaggregation of ASU-Based Trips

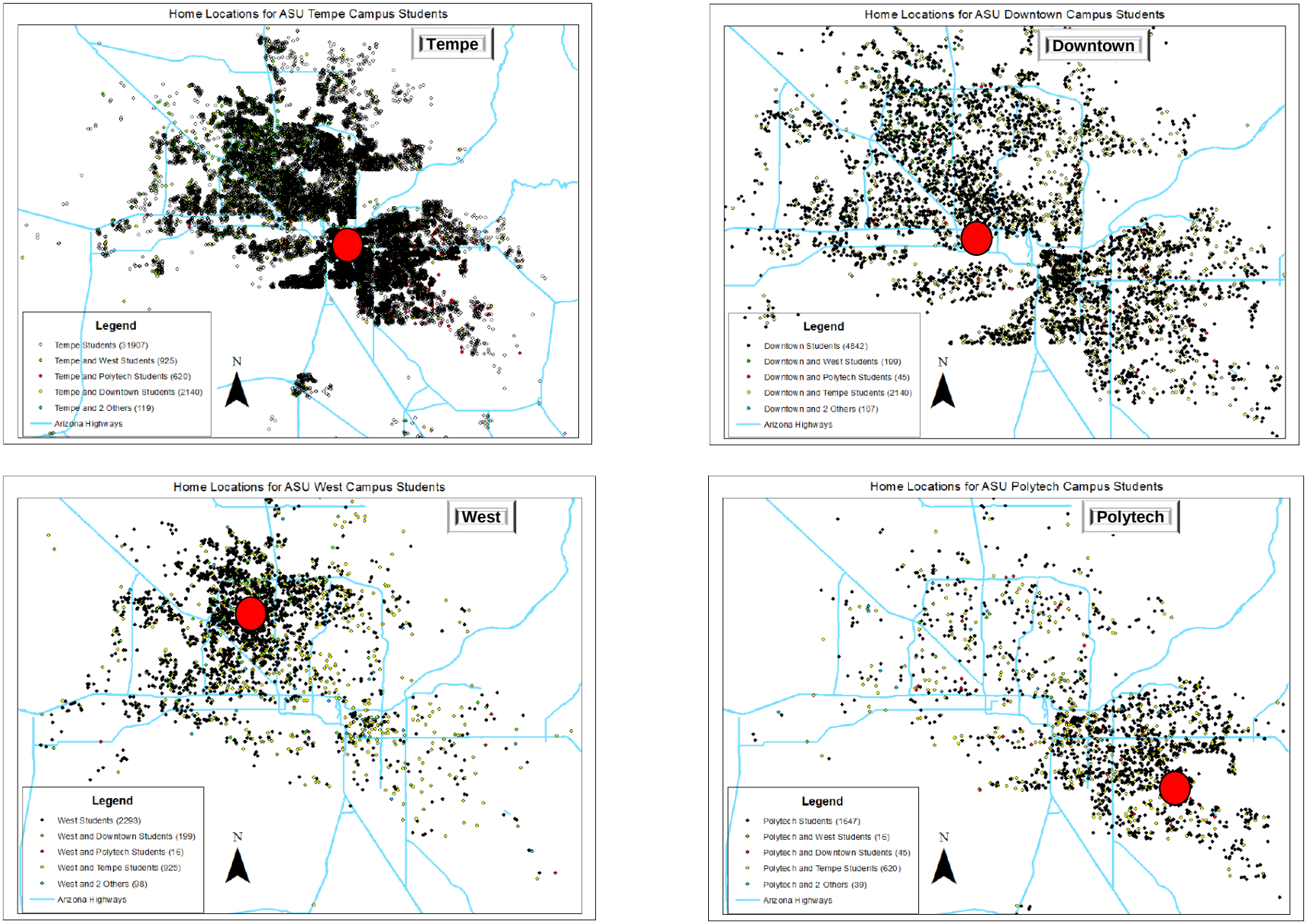


Figure 4.2 Home Locations of ASU Students by Campus

At the trip generation level, disaggregation by primary campus of attendance is performed in order to reflect the varying spatial distributions of travel by students at different campuses. The maps in Figure 4.2 display the home locations of students who attend each of the four ASU campuses. These home locations were acquired using the addresses of students provided in the survey supplementary data from ASU registrar's office. One can see that, with the exception of the Tempe Campus, each campus attracts students who live in a specific portion of the county. The Tempe Campus, and to a lesser degree the Downtown Campus, attract students from all over the metropolitan area. In the case of the Tempe Campus, this is most likely due to the many programs of study offered that can't be found at the smaller satellite campuses. Though each campus does offer some unique programs, the Tempe Campus offers a much greater number. In the case of the Downtown campus, this larger spatial spread of student homes is likely due to the centrality of the campus itself.

Justification for disaggregating students by affiliation is provided in Chapter 3, where the travel characteristics of off-campus undergraduates, on-campus undergraduates, and graduate students are compared. The survey shows that undergraduate students living on campus are generally younger, more likely to be transit captive, and more mobile than other segments, making multiple trips each day to classrooms, their on-campus housing, and the other attractions within walking distance to a typical large university. Compared to graduate students (who are all off-campus in this analysis), undergraduates have a different time of day trip distribution pattern and tend to be less likely to go full days without visiting ASU. For these and other reasons, it was considered prudent to disaggregate the submodel to allow for different travel choice devices among these different segments of students.

Lastly, the submodel is separated into two times of day: peak travel and off-peak travel. The travel decisions that are made during peak travel times are often very different from those made during non-peak times. For example, peak travel is usually undertaken for the purpose of traveling to and from mandatory activities – those activities such as work and school with unmovable start times which the traveler is required to attend. Off peak travel often consists of maintenance activities – those activities required for the upkeep of house or family, but not subject to rigid start times – or discretionary activities – those completed purely based on preference, usually simply for fun. These different types of travel will lend themselves to different location choice motivators. For example, a mandatory or peak time trip likely has a set location that cannot be changed by the traveler, whereas the traveler is typically free to choose where his or her maintenance and discretionary activities occur, often choosing locations either close to home or close to work or school.

4.1.1 Model Framework

The trip generation model addresses all ASU-based student trips, including both home-based and non-home-based ASU trips. Student travel data available is controlled for weekday trips (Tuesday – Thursday) for the purpose of computing trip rates. This is done with a view to eliminate any bias that might be induced by days of the week that are adjacent to the weekend. Trip rates are computed to convert student enrollment into peak and off-peak ASU-based trips. Enrollments are segmented by student type into off-campus undergraduate (home based or non-home based), on-campus undergraduate (dorm-based or non-dorm based) and graduate students (home based or non-home based).

An assumption made here is that graduate students do not live on-campus. At ASU campus, only 1.1% of graduate students who completed the survey reported living on campus. However, this assumption can be

relaxed easily to accommodate on-campus graduate students as well if that is the case for other universities. Trip rates vary by time-of-day (peak and off-peak periods), campus location, trip type, student type and living arrangements. These different trip rates can be further divided into additional segments, depending on the sensitivity desired in the overall regional travel demand model.

The submodel that is proposed here is based on the existing regional travel model's traffic analysis zones (TAZ's), but any method of spatial segmentation of the region can be applied. In the proposed submodel, campus enrollments are first apportioned to various campus TAZs. This can be done by developing an intensity factor that measures the relative 'attractiveness' of each TAZ within a campus. TAZ intensity is similar to a size term that takes into account the activity and land use specific to each TAZ, including parking spaces and classroom seats. Once the trip rates are computed by market segment, trip attractions or productions at each campus TAZ are calculated as: the enrollment for a category in a given campus multiplied by trip rate. While ASU is the attraction end for off-campus student trips (graduate and undergraduate), it serves as the production end for students who live in dorms. This procedure results in the number of trips being attracted or produced in a given time period (peak or off peak) at each campus TAZ by each group of students.

The trip attraction intensity factor being proposed for the submodel is a composite measure of classroom seats and parking spaces. The structure of the proposed intensity factor is:

Intensity = classroom seats + Y x parking spaces

In the above equation, Y is a turn-over rate for parking spaces computed as the number of campus trips made per parking episode. It is generally assumed that one episode of parking at the campus does not necessarily translate to one campus trip. For example, a student may park on campus and then go to class, then the library, another class, a study meeting, or any other number of ASU-based trips before returning to his or her vehicle.

The above formulation is simply representative of the variables that would influence the intensity factor for calculating trip attractions to campus. The intensity factor used to calculate campus trip productions is calculated simply based on the number of dormitories in each zone. Once the intensity has been calculated for each zone, the number of trips attracted or produced at each zone is determined by the percentage of total campus intensity that that zone represents.

4.1.2 Application of the Trip Generation Model

ASU Travel and Mode Use Survey provides a rich sample dataset for the calculation of trip rates by different trip times of day, purpose, location, etc. The project team was able to use this rich dataset to its advantage for trip generation calculations in the submodel. Unlike in other models of regional travel, the project team was able to use the combined secondary institutional data from ASU to determine the number of students in each group that would be represented by the model. Therefore, trip generation could be performed simply by determining the number of each sub-group of trips made daily by each sub-group of students and applying those rates to the appropriate population of students. For example, we can determine the total number of home-based ASU trips made by graduate students during the off-peak period per day per graduate student. The trip rates that were calculated were further disaggregated by primary campus of attendance to reflect

the varying travel behavior choices of students attending each of the four different ASU campuses in Maricopa County.

4.1.2.1 Filters Applied for Trip Rate Calculations

Trip rate calculations were based only on a very carefully filtered sample of trips. In order to determine the trip rate for a specific sub-group of trips and students, trips of that type and made only by those students needed to first be identified. This filtering process is based on the same process that was described in Chapter 2, though some extra filters needed to be applied for the rigorous process used in this model estimation. The filtering began by separating students from faculty and staff for a total of 9,499 students in the survey and a total of 43,373 trips captured.

Filters were first applied by removing trips that were flagged as erroneous and students that reported one trip or zero trips incorrectly. In addition to these initial filters and because on-campus graduate students were not considered in this model estimation, on-campus graduate students were removed from the dataset. There were a total of 8 graduate students in the survey sample who indicated living on campus. These students made a combined total of 50 trips on the travel day. The extremely small sample size of on-campus graduate students was one of the main factors in deciding not to model on-campus graduate students separately.

As shown in Figure 4.3 that persons were completely filtered out of the dataset if 30% or more of their trips were flagged as erroneous. That means that anyone with less than 30% of their trips flagged was still included in the dataset along with their non-flagged trips. For the purpose of a trip rate calculation, this system leads to a misrepresentation of the number of trips made by certain students. Therefore, for the purpose of trip rate estimations, all students with at least one trip filtered from the dataset were removed along with all their trips. This thoroughly filtered dataset was used for both trip rate estimation and location choice model estimation. The final number of students and trips in the model estimation dataset are described in Table 4.1.

Table 4.1 Number of Persons and Trips Available in the Modeling Dataset

Market Segment	Number of Students	Number of Trips
On-Campus Undergraduates	1,246	7,560
Off-Campus Undergraduates	5,873	23,933
Off-Campus Graduate Students	1,506	5,657
Totals	8,625	37,150

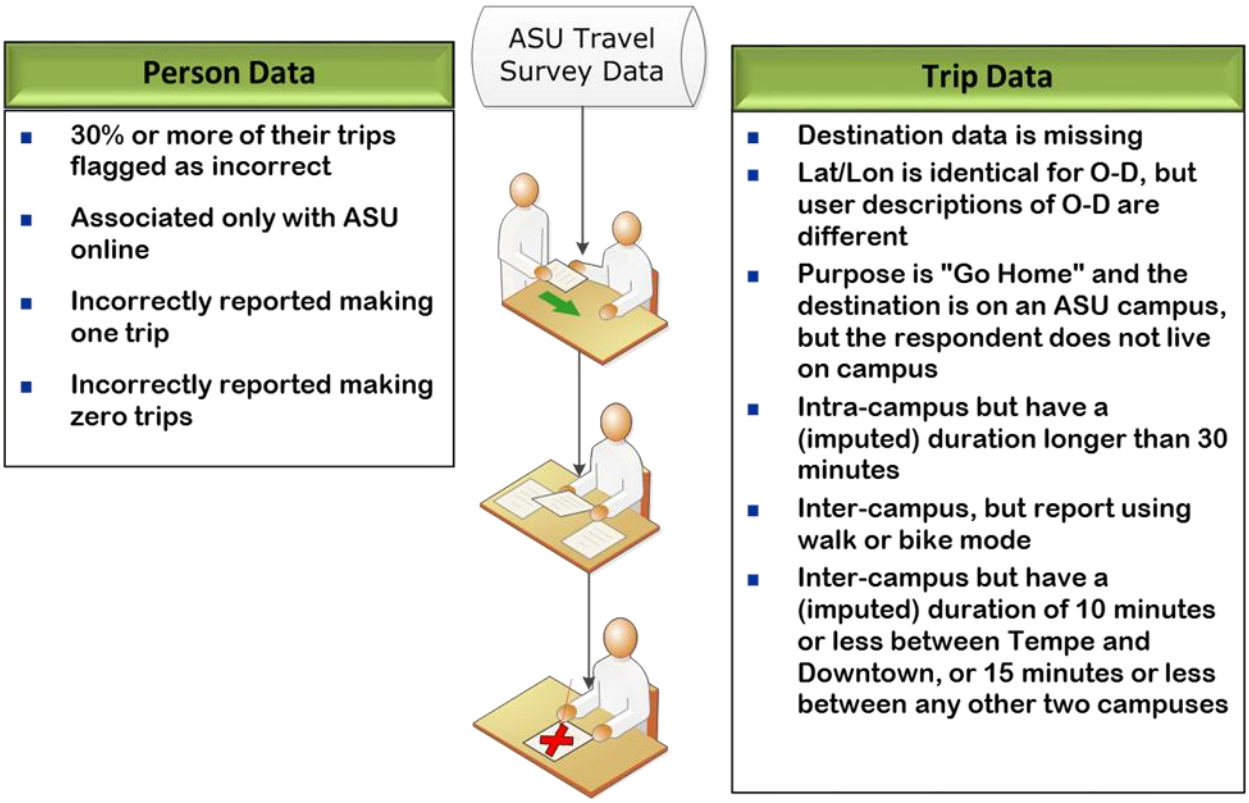


Figure 4.3 Filtering for Trip Rate Calculation

4.1.2.2 Identifying ASU-Based Trips

The model being estimated in this endeavor focuses on ASU-based trips. It is therefore necessary to identify which of the trips in the thoroughly filtered modeling dataset are ASU-based. In other words, the researchers needed to decide which trips had at least one end on an ASU campus. The two methods employed to identify ASU-based trips are referred to here as the "GIS method" and the "description method." As shown in Figures 4.4 and 4.5, the GIS method employs the geo-located trip ends provided by the survey respondents and a geographic information system (GIS) to match the trip end locations with known ASU campus locations. The description method uses the respondent-provided descriptions of their trips' origins and destinations to identify trips that may have been ASU-based and not identified by the GIS method.

The first step in identifying ASU-based trips using the GIS method is to identify the areas that represent ASU campuses in the GIS system. The researchers identified the locations of ASU campuses in Google Maps by finding the latitude and longitude coordinates of the corners of polygons representing campuses. Polygons covered any and all ASU buildings or reserved parking areas and did not include any other non-ASU buildings or parking areas. Because of this, each campus polygon is really a grouping of polygons.

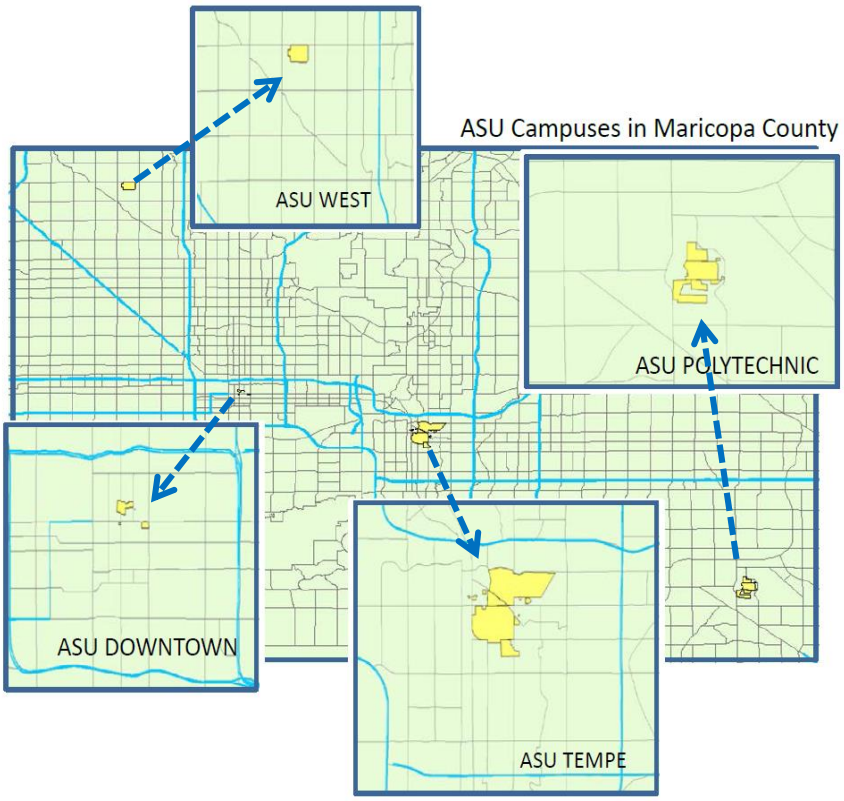


Figure 4.4 ASU Campus Polygons

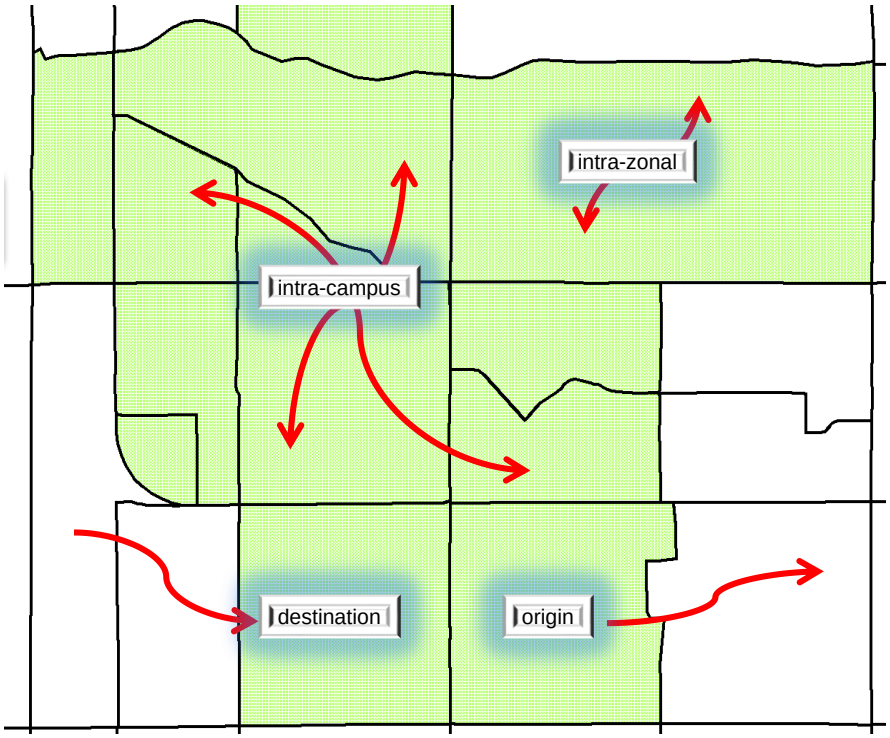


Figure 4.5 Example of ASU-based Trips using GIS Method

While taking the survey, respondents were asked to place their trip ends on the mapping feature. It is difficult to say whether respondents were able to exactly place their trip ends, leading to the need to be flexible when classifying trips based on trip ends. For this reason, a buffer was applied to ASU campus polygons. The size of the buffer was tested and varied in order to reach the optimal buffer size. Table 4.2 displays the number of trips that would be identified as ASU-based trips with different buffer sizes. The table also shows the percent change in number of ASU-based trips identified with each increase in the campus polygon buffer.

It is interesting to note that the number of trips with a trip end on the West campus does not change at all until the buffer reaches 40 feet. The downtown campus has the greatest variability in number of trip ends. The downtown campus, however, is the least isolated of the four ASU campuses, and is the most vulnerable to having ASU-based trips falsely identified. The additional number of trips identified between a 10-foot and a 15-foot buffer is approximately 1% for each campus besides West. The number of additional trips identified with buffers greater than 15 feet is modest until the buffer reaches 40 feet. For this reason, 15 feet was chosen as the buffer area. The number of trips that can be considered ASU-based is increased by applying a 15-foot buffer, but not so dramatically that ASU-based trips are likely to be falsely identified. ASU-based trips that are identified using the GIS method are given ASU-based designation if and only if at least one trip end lies within a campus polygon or its buffer.

Table 4.2 Campus Polygon Buffer Size Sensitivity

Buffer Size (ft)	Number of ASU-Based Trips	Percent Change
10	12,783	-
15	12,911	1.00%
20	12,980	0.53%
25	13,069	0.69%
30	13,154	0.65%
35	13,259	0.80%
40	13,543	2.14%
45	13,635	0.68%
50	13,695	0.44%

As shown in Figure 4.6, the description method of identifying ASU-based trips employs the origin and destination descriptions provided by the respondents during the survey administration. Respondents were asked to provide a description for each of their trip ends in their own words. Trips that were already identified as ASU-based using the GIS method were not considered using the description method. The first step in the description method was to search the origin descriptions for words that would indicate an ASU trip, for example “ASU,” “campus,” “the university,” etc. The same words were then searched in the destination descriptions. If a trip was not selected in the first step and the student indicates that he or she works only on campus, the origin and destination descriptions were searched for words that would indicate a work trip end. Finally, if a trip was not selected in steps one and two and the student lives on campus, the origin and destination descriptions were searched for words that would indicate a home trip end. Table 4.3 shows the results of both the GIS method and the description method.

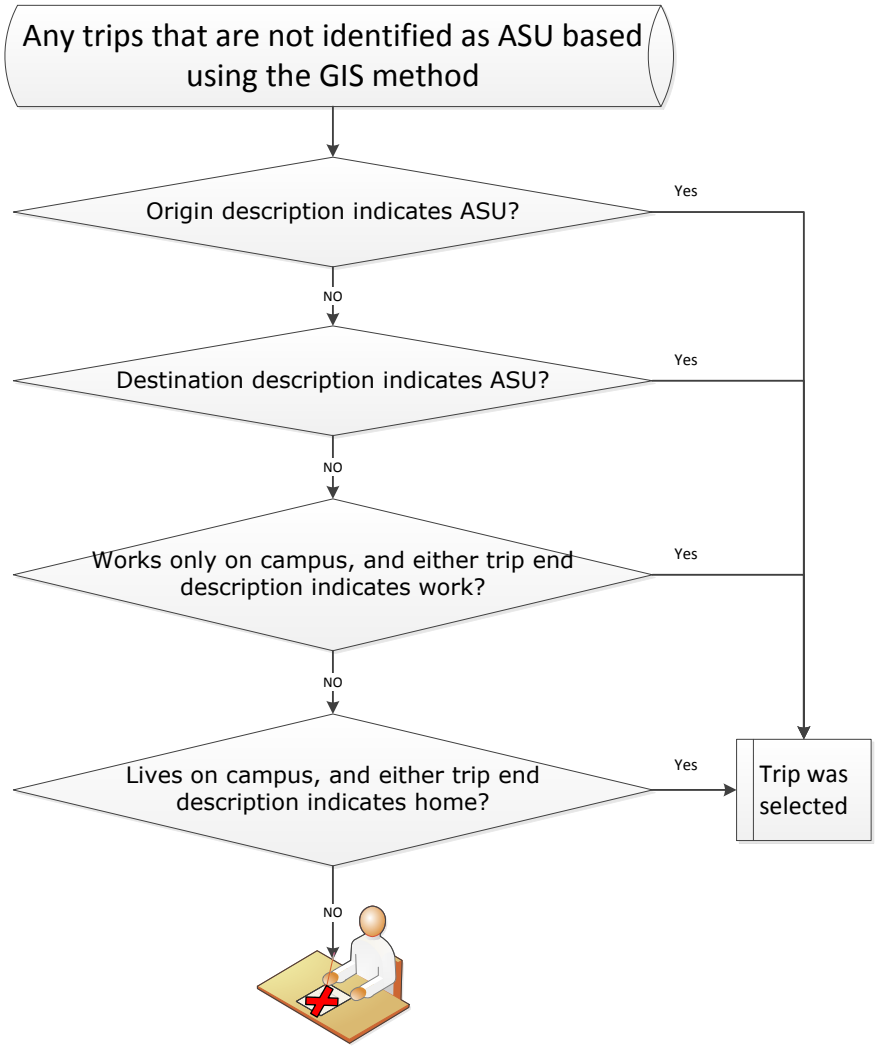


Figure 4.6 Description Method of Identifying ASU-based Trips

Table 4.3 ASU-Based Trips by Method of Identification

Market Segment	ASU-Based Trip Identified by:		Total ASU-Based Trips	Total Trips
	GIS Method	Description Method		
On-Campus Undergrads	6,509	428	6,937	7,560
Off-Campus Undergrads	10,465	1,800	12,265	23,933
Graduate Students	2,470	411	2,881	5,657
Total Students	19,444	2,639	22,083	37,150

4.1.2.3 Identifying Home-Based Trips

Because home-based and non-home based ASU trips are being modeled independently, it is necessary to identify which trips are home-based. Similar to the description method for identifying ASU-based trips, the identification of home-based trips is based on the respondent-provided descriptions of their trip ends. As shown in Figure 4.7, the first step in the identification of home-based trips was to search the origin descriptions of ASU-based trips for words that would indicate a home trip, for example "home," "the house," "my place," etc. The destination descriptions were then searched for the same key words, and any trip that was found in this step was identified as a home-based ASU trip. Those ASU-based trips that were not identified in this first step and that were made by an on-campus student were then searched for words that would indicate the dorm. Finally, any trip that was given the purpose "return home" and had not yet been identified as a home-based trip was examined to see if it could be classified as such. For example, a trip with an origin description of "the apartment" may not have been identified in the previous two steps could have been identified as home-based in step three. In the end, 3,987 on-campus undergraduate trips, 5,469 off-campus undergraduate trips, and 1,370 graduate student trips were identified as home-based.

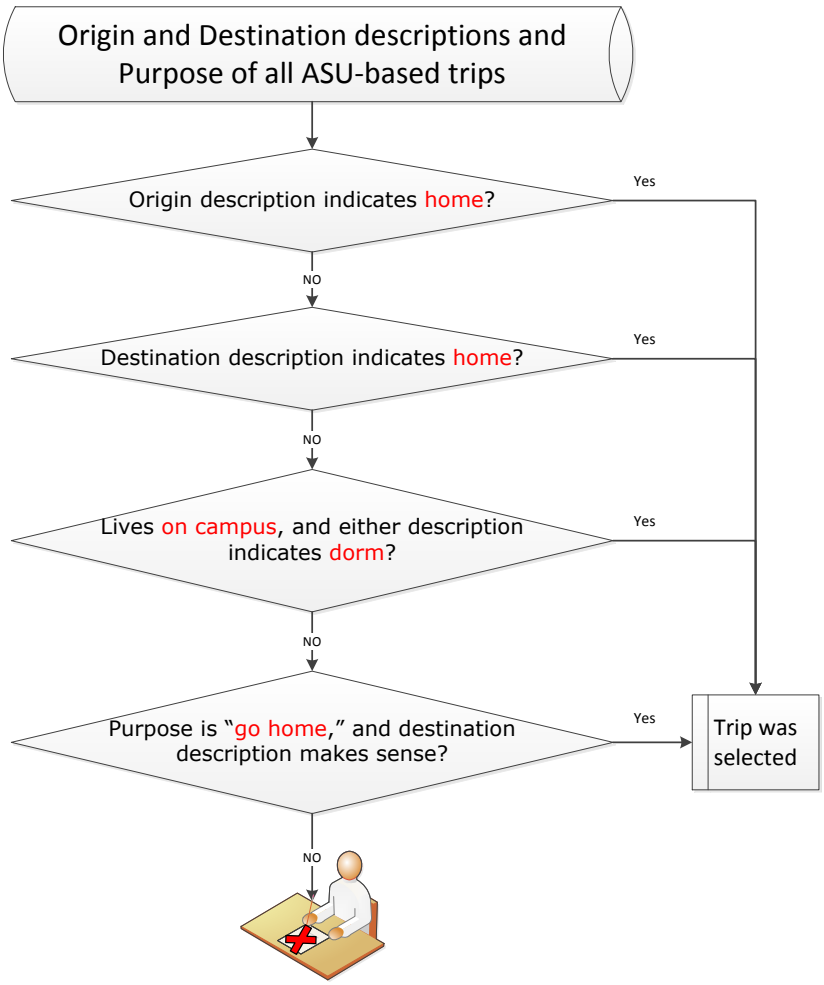


Figure 4.7 Identifying Home-Based ASU Trips

4.1.2.4 Consideration of Intra-Zonal Trips

At the beginning of the modeling exercise, it was determined that the model would incorporate intra-campus trips in order to accurately represent short-distance and non-motorized trips made by students. However, many intra-campus trips are also intra-zonal trips. That is, they often have both their origin and destination inside the same MAG TAZ. Two separate methods for incorporating intra-zonal trips were tested and considered. The first method, which is called "method A," is to calculate the number of intra-zonal trips in each zone separately and add them to the resulting trips from the model. The second method, "method B," includes intra-zonal trips together with all other trips in the modeling process.

Method A begins by calculating trip rates for inter-zonal and intra-zonal trips separately. Trips are identified as inter-zonal home-based ASU if they 1) have one trip end on an ASU campus, 2) have the other trip end at home, and 3) have the two trip ends in two different TAZ's. The determination of which trip ends are ASU-based and which are home-based is described above. Trips are intra-zonal home-based is they 1) have one trip end on an ASU campus, 2) have the other trip end at home, and 3) have both trip ends in the same MAG TAZ. Intra-zonal home-based trips occur mostly for on-campus students, but there are some MAG TAZ's that include both ASU buildings and residential neighborhoods, making it possible for an off-campus student to travel from home to campus without changing TAZ's. Inter-zonal non-home based and intra-zonal non-home based are classified similarly. Method B simply includes all trips, whether inter-zonal or intra-zonal, together in the trip rate calculations. The results of the two methods are shown in Table 4.4 below.

Table 4.4 Results of Two Methods for Intra-Zonal Trip Consideration

Method A

		Observed Trips	Predicted, Before Dummy Assertion	Predicted, After Dummy Assertion
Home-Based ASU Trips	Total Trips	885	16,119	16,119
	Intra-Zonal Trips	5	167	167
	Percent Intra-Zonal	0.6%	1.0%	1.0%
Non-Home Based ASU Trips	Total Trips	662	10,632	10,632
	Intra-Zonal Trips	245	3,677	3,677
	Percent Intra-Zonal	37.0%	34.6%	34.6%

Method B

		Observed Trips	Predicted, Before Dummy Assertion	Predicted, After Dummy Assertion
Home-Based ASU Trips	Total Trips	885	16,119	16,119
	Intra-Zonal Trips Percent	5	120	42
	Intra-Zonal	0.6%	0.7%	0.3%
Non-Home Based ASU Trips	Total Trips	662	10,632	10,632
	Intra-Zonal Trips	245	723	1,063
	Percent Intra-Zonal	37.0%	6.8%	10.0%

These methods were evaluated using the location choice models on a randomly chosen subset of trips from the modeling dataset. One of the methods used for obtaining accuracy in the location choice models was to assert distance dummy variables. The process is described in more detail below. The assertion of distance

dummy variables allows the modelers to have more control over the distances traveled in the final set of trip origin-destination (O-D) pairs. Therefore, using Method B, the number of intra-campus trips predicted will change after the assertion of distance dummy variables.

4.1.2.5 Trip Rates

As stated, the trips were disaggregated into forty eight trip types for the purpose of trip generation rate calculations. Trip rates were calculated by student type, home-based or non-home based, and peak or off-peak. In addition to this, trips were disaggregated by the student's primary campus. The results of the trip rate calculations are displayed in Table 4.5. The rates in the table are expressed in trips per student per day. One should note that, in the case of on-campus undergraduate students, home-based means dorm-based. In these trips, ASU end of the trip is considered the production end.

Table 4.5 shows some interesting dynamics between the different student segments in terms of their mobility. In general, on-campus undergraduate students are much more mobile to and from ASU than other groups. This is to be expected. For off-campus undergraduate and graduate students, the Tempe campus captures more trips per student than other campuses.

Table 4.5 Trip Generation Rates

Campus (Number of Trips)	Home-Based Peak	Home-Based Off Peak	Non-Home-Based Peak	Non-Home-Based Off Peak
Off-Campus Graduate Students				
Downtown (1,215)	0.2787	0.3041	0.3150	0.3553
Polytechnic (259)	0.1407	0.3358	0.3186	0.4716
Tempe (6,696)	0.5191	0.6191	0.5885	0.7629
West (404)	0.1097	0.2175	0.2587	0.0671
Off-Campus Undergraduate Students				
Downtown (2,764)	0.4683	0.4699	0.4313	0.7216
Polytechnic (1,343)	0.5323	0.5886	0.4434	0.6690
Tempe (17,554)	0.5722	0.6447	0.6434	0.9928
West (1,284)	0.3903	0.4624	0.3976	0.5636
On-Campus Undergraduate Students				
Downtown (604)	1.0361	1.8047	0.8170	1.2826
Polytechnic (400)	1.4042	2.2623	0.5903	1.3027
Tempe (4,284)	1.2952	2.1495	1.0343	1.8676
West (54)	1.2303	1.8100	0.5834	1.4590

4.1.3 Allocating ASU Trip Ends to TAZs

The trips being modeled in this exercise have one end on an ASU campus and the other end either at home or a non-home activity location. For all off-campus student trips, ASU trip end represents the attraction and it is the job of the location choice models to determine the location of the production trip end. For on-campus

undergraduate students, ASU trip end represents the production and location choice models are deployed to determine the attraction trip end location. Before the location choice models are estimated, however, it is necessary to determine exactly which traffic analysis zone (TAZ) holds ASU trip end. For this determination, the intensity calculation presented earlier in this section is deployed.

In the regional travel model deployed by MAG, ASU is represented by multiple TAZ's. For this analysis, any TAZ which contained an ASU classroom building, office building, dormitory, or designated parking lot was considered an ASU TAZ. However, all ASU TAZ's do not have the same level of attractiveness for students. For example, if an ASU TAZ contains only a dormitory, there is rarely a reason for an off-campus student to travel to that TAZ for school purposes. Attractiveness of each ASU TAZ was measured in terms of number of classroom seats and number of parking spaces. As noted above, classroom seats will typically have a greater turn-over rate than parking spaces. The parking factor for this analysis was calculated as follows, where *s* is a student and *N* is the set of all students who have at least one intra-campus trip in the travel day:

$$\forall s \in N, P_s = \frac{\sum Parking\ Episodes}{\sum Intracampus\ Trips}$$

$$\bar{P} = \frac{\sum_s P_s}{N}$$

Using the weighted modeling dataset, $\bar{P}$, or the average parking factor, is equal to 0.765 parking episodes per intra-campus trip. Recognizing that some students likely failed to report all of their short intra-campus trips, this parking factor was rounded to 0.75, making the final equation for intensity of ASU TAZ$_i$ (I_i) as follows:

$$I_i = Classroom\ Seats_i + (0.75 \times Parking\ Spaces_i)$$

The intensity calculation for finding the production zone of on-campus students is dependent only on the number of dormitories in each zone.

The West campus and Polytechnic campus are both located entirely within one TAZ. For the Tempe and Downtown campuses, however, the number of classroom seats, parking spaces, and dormitories in each ASU TAZ varies. Figures 4.8 and 4.9 show the allocation of ASU buildings and parking areas to the MAG model's TAZ's. One can see from these figures that some ASU TAZ's have very little attractiveness, justifying the need to identify the different attractiveness levels for each TAZ on the Tempe and Downtown campuses.

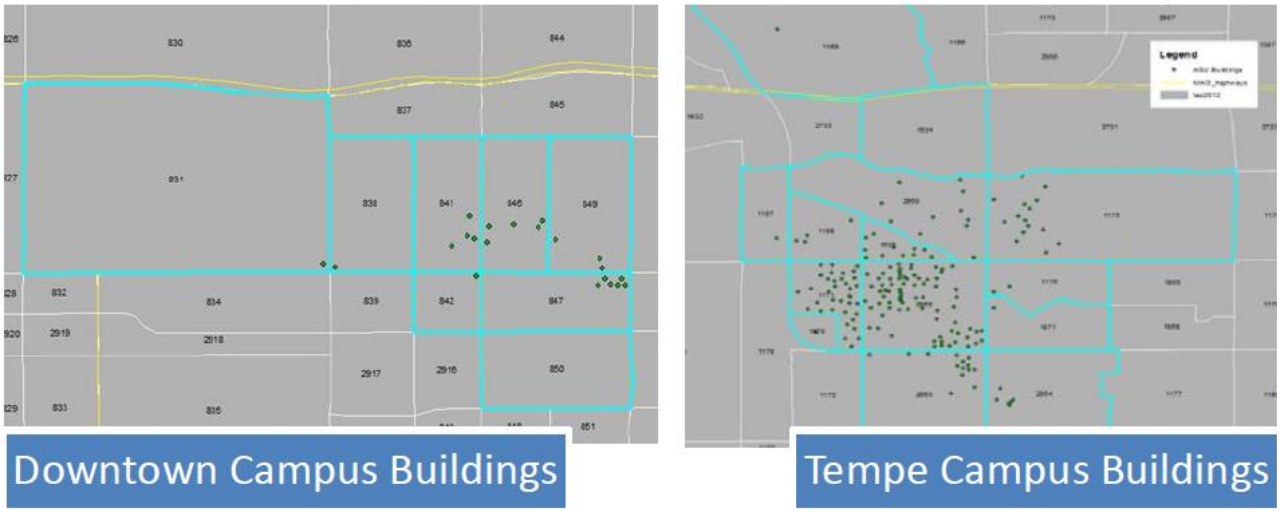


Figure 4.8 Campus Buildings Allocated to Each TAZ

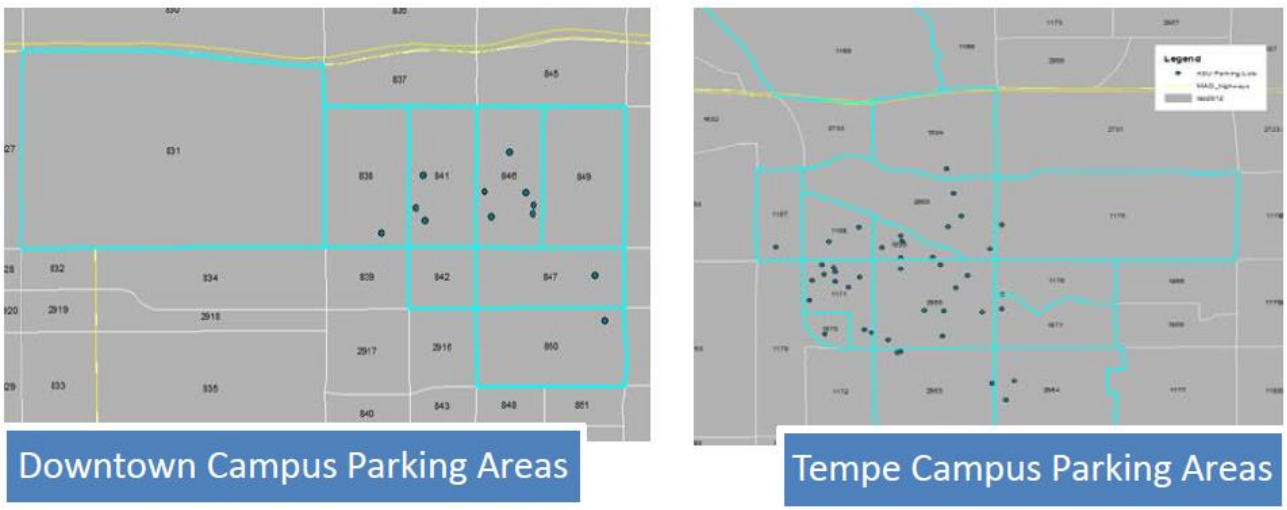


Figure 4.9 ASU Parking Areas Allocated to Each TAZ

The final step in allocating all ASU trip ends to an ASU TAZ is to determine enrollment in each TAZ using each zone's intensity. Percentage of total campus intensity is calculated for each zone, and the enrollment in that zone is calculated in proportion from its percent campus intensity. These calculations are illustrated in the following equations:

$$\%Intensity_{TAZ} = \frac{Intensity_{TAZ}}{\sum_{TAZs\ on\ the\ Campus} Intensity_{TAZ}}$$

$$Enrollment_{TAZ} = Campus\ Enrollment\ \times \%Intensity_{TAZ}$$

As alluded to previously, whether ASU trip end is an attraction or a production end varies by the type of trip and the type of student making the trip. For all graduate students and off-campus undergraduate students, the home-based (HB) and non-home based trips (NHB) have their attraction at ASU-end of the trip. For on-campus undergraduate students, ASU end of the non-dorm based trip (NDB) is the attraction end. However, ASU trip end is the production for on-campus students' dorm-based (DB) trips. The number of attractions or productions from each ASU TAZ is calculated as the enrollment for that zone times the appropriate trip rate. Figure 4.10 shows the trip generation procedure and the final calculation for total attractions or productions at each ASU TAZ is shown in Tables 4.6 through 4.8. Note that some TAZ's have zero trips attached to them. This is because, although there is one or more ASU building in that zone, the building(s) do not have any classroom seats, meaning that they are not allocated any of the campus intensity and therefore any of the trips.

Tables 4.6 through 4.8 represent the allocation of trip end locations for one end of each ASU-based trip in the model. The allocation of the other end of the trip is handled by the location choice models described in the following section. Note that, because intra-campus and inter-campus trips are also considered in this model, the location choice model could well allocate the other end of the trip to the same ASU campus or to some other ASU campus.

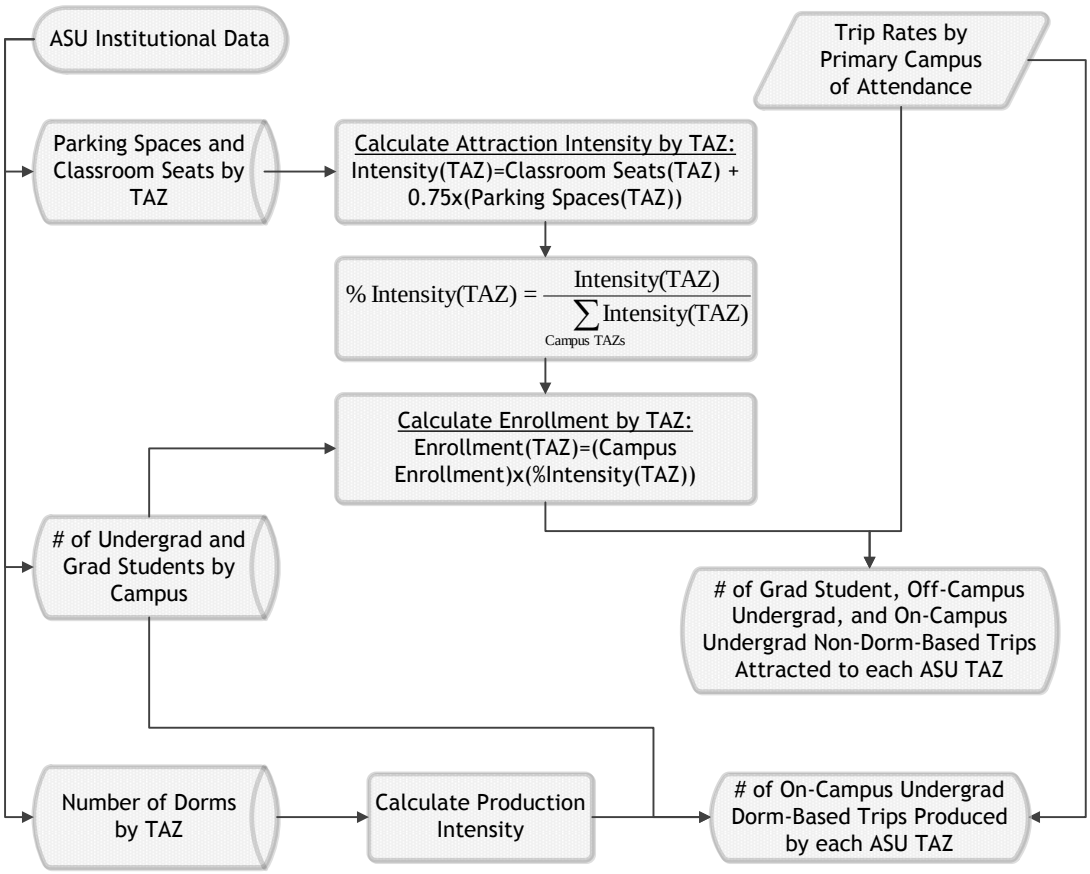


Figure 4.10 Trip Generation Procedure

Table 4.6 Allocation to ASU TAZ's: Off Campus Undergraduates

ASU TAZ	Campus	Trip Type			
		HB Peak	HB Off Peak	NHB Peak	NHB Off Peak
831	Downtown	0	0	0	0
838	Downtown	48	48	44	74
841	Downtown	64	64	59	99
842	Downtown	0	0	0	0
846	Downtown	2271	2278	2091	3499
847	Downtown	883	886	813	1360
849	Downtown	0	0	0	0
850	Downtown	39	39	36	60
1925	Polytech	1727	1909	1438	2170
1167	Tempe	127	143	143	221
1168	Tempe	341	384	383	591
1169	Tempe	36	41	41	63
1171	Tempe	4327	4875	4865	7508
1175	Tempe	383	432	431	666
1176	Tempe	67	76	76	117
1634	Tempe	643	725	724	1117
1635	Tempe	1502	1692	1689	2606
1870	Tempe	297	335	334	516
1871	Tempe	7	8	8	12
2900	Tempe	2249	2534	2528	3902
2953	Tempe	153	172	172	265
2954	Tempe	83	93	93	144
2955	Tempe	9078	10228	10208	15751
591	West	1510	1789	1539	2181
Sum		25835	28751	27715	42922

Table 4.7 Allocation to ASU TAZ's: Graduate Students

ASU TAZ	Campus	Trip Type			
		HB Peak	HB Off Peak	NHB Peak	NHB Off Peak
831	Downtown	0	0	0	0
838	Downtown	8	9	9	10
841	Downtown	11	12	12	14
842	Downtown	0	0	0	0
846	Downtown	401	438	453	512
847	Downtown	156	170	176	199
849	Downtown	0	0	0	0
850	Downtown	6	7	7	8
1925	Polytech	135	323	307	454
1167	Tempe	34	41	39	50
1168	Tempe	91	109	104	135
1169	Tempe	9	11	11	14
1171	Tempe	1166	1391	1322	1714
1175	Tempe	103	123	117	152
1176	Tempe	18	21	20	26
1634	Tempe	173	207	196	255
1635	Tempe	404	482	459	595
1870	Tempe	80	95	91	117
1871	Tempe	1	2	2	2
2900	Tempe	606	723	687	891
2953	Tempe	41	49	46	60
2954	Tempe	22	26	25	32
2955	Tempe	2447	2918	2774	3596
591	West	126	250	297	77
Sum		6038	7407	7154	8913

Table 4.8 Allocation to ASU TAZ's: On Campus Undergraduates

ASU TAZ	Campus	Trip Type			
		DB Peak	DB Off Peak	NDB Peak	NDB Off Peak
831	Downtown	0	0	0	0
838	Downtown	0	0	19	31
841	Downtown	0	0	26	41
842	Downtown	0	0	0	0
846	Downtown	1716	2989	929	1459
847	Downtown	0	0	361	567
849	Downtown	0	0	0	0
850	Downtown	0	0	16	25
1925	Polytech	1068	1721	449	991
1167	Tempe	0	0	54	97
1168	Tempe	445	739	144	261
1169	Tempe	0	0	15	27
1171	Tempe	1782	2957	1834	3313
1175	Tempe	0	0	162	293
1176	Tempe	0	0	28	52
1634	Tempe	0	0	273	492
1635	Tempe	2227	3697	636	1150
1870	Tempe	0	0	126	227
1871	Tempe	445	739	3	5
2900	Tempe	0	0	953	1721
2953	Tempe	1336	2218	64	117
2954	Tempe	0	0	35	63
2955	Tempe	4009	6654	3849	6950
591	West	1117	1643	529	1324
Sum		14145	23357	10505	19206

4.2 Location Choice Model

Trip distribution models are increasingly being specified and deployed as destination/location choice models as such formulations offer behavioral interpretation and sensitivity to a number of explanatory factors. The destination choice models for ASU students constitute multinomial logit models. The destination choice models essentially distribute trips generated by each ASU TAZ to production zones using a logit formulation in which all eligible TAZs in the region serve as possible alternatives. The inputs to these models include mode choice logsums, distance and time skims (as a measure of spatial separation between ASU zones and each zone in the regional model), and socio-economic characteristics of each analysis zone. Previous section provided a description for the trip generation portion of the model, which allocated the number of trips having their attraction ends on each ASU TAZ and the number of each trip type that must be produced in the application portion of the modeling process.

4.2.1 Model Framework

The segmentation for the trip generation process is carried through to the location choice step and a separate location choice model is estimated for each segment. A schematic of the segmentation is shown in Figure 4.11. One will note that home-based location choice models are not estimated separately for the peak and off peak periods. In a home-based campus trip, ASU campus is the trip attraction, making the other trip end the home. In a non-home-based trip, the non-campus end may vary at different times of day. For example, if a student needs to make a trip to the grocery store during peak travel times, he or she may simply choose the closest grocery store to avoid traffic. At other times of day, however, the student may venture farther or

to a more attractive store. This variation of location choice by time of day does not exist for home trips. The location choice model estimation, therefore, is not performed separately for peak and off-peak trips. As only one location choice model is estimated for both peak and off-peak periods, it is prudent to use average logsums and average distances in the estimation of these models.

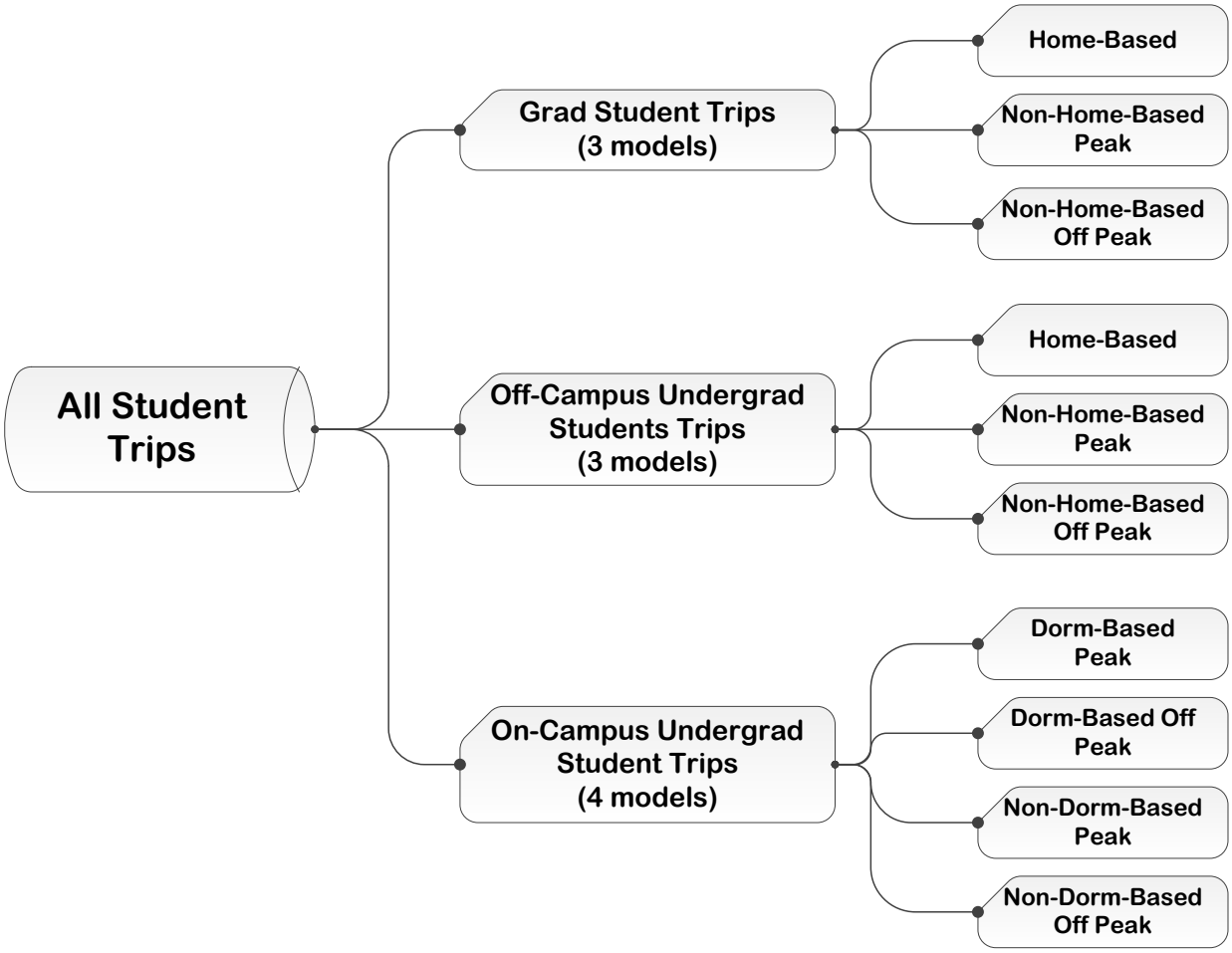


Figure 4.11 Market Segmentation for Location Choice Models

When estimating destination choice models for each of the market segments, the choice sets are limited to consider only those TAZs in the regional travel model that are feasible alternatives. For example, when estimating destination choice models for home-based ASU trips, only TAZs with at least one household are considered possible candidates for inclusion in the choice set, thereby eliminating unreasonable choices (for example, students choosing an industrial/warehouse area as their home TAZ). In application mode, however, all TAZs are feasible choices. The TAZs with no households are naturally eliminated as they are identified as less attractive by the estimated models. In this way, the need to generate choice sets specific to different trip types is avoided.

For estimating the destination choice models, 29 random feasible TAZ choices are generated for each survey record and combined with the chosen TAZ to form the choice set. The model estimation uses the comparison of the chosen zone to the 29 non-chosen zones to calculate the logit model. The multinomial logit model being used is described using the following equation:

$$P_{Z1} = \frac{e_{Z1}}{\sum_{i=1}^{30} e^{U_{Zi}}}$$

In the above formula, P_{Z1} represents the probability of choosing zone 1 while U_{Z1} and U_{Zi} represent the utility of choosing zone 1 and zone i, respectively. The utility of choosing a zone is estimated as a linear combination of coefficients calculated in the model and the zone's spatial (distance from campus, distance from city center), demographic (number of households), economic (number of jobs of varying industries), and accessibility measures. Accessibility of each zone is represented by the mode choice logsums of that zone. Though a mode choice model is not proposed in this research, logsums can be acquired from the larger regional model into which the destination choice models are integrated.

The use of mode choice logsums as a measure of accessibility in the destination choice model equates to a nested model of both location and mode choice, with logsums providing information on the utility of travel across all potential modes of transportation, according to the preferences and perceptions of travel time and cost for transportation system users. In a nested logit model of mode choice, the composite utility provided by all sub-modes of a nest is termed the logsum (also called inclusive value parameter) and is defined, for example, as:

$$Logsum_{Auto} = -\ln(e^{U_{SOV}} + e^{U_{HOV}})$$

$$Logsum_{Transit} = -\ln(e^{U_{Bus}} + e^{U_{Rail}})$$

Typical logsum coefficients range from 0 – 1, where a value of 1 for a nest indicates that all the lower level choices are not sub-choices, but are equally competitive to the alternatives in the upper nest. For example, if every transit trip in the dataset was made using bus and none were made using rail, the logsum coefficient for the bus mode would be equal to 1. A value of 0 for a logsum coefficient indicates that all the choices in the lower level nest are perfect substitutes to each other, or – in other words – there is no preference between modes. The incorporation of these logsums as coefficients in the location choice model facilitates the understanding of location choice as a decision made co-dependently with mode choice. One may choose to travel farther if the mode is personal auto as compared to transit, however, one may choose personal auto over transit if the location is farther away.

Once the destination choice models are estimated, they are validated and calibrated as necessary by comparing the trip length distributions predicted by the models with observed trip length distributions for each market segment for which data is available. The destination choice models are calibrated by assertion of coefficients on selected distance "dummy" variables. A distance dummy variable is equal to 1 if the trip in question lies within a certain distance range and equal to 0 otherwise. For example, the on-campus undergraduate market segment might have an unusually large number of trips within the distance band 5-

10 miles from the campus, while percent of trips in the adjacent distance bands on either side of this category is considerably smaller. The reason for this might be that a student recreation hub falls within that particular distance band, and this special circumstance might not be captured by any explanatory variables used in the model. Such unique situations can be handled by asserting distance-based dummy variables that account for the 'attractiveness' of a particular destination that falls within a specific distance band for a market segment of interest. The research team chose for this endeavor to calibrate the location choice models based on data replication rather than true validation. In a validation, a certain portion of the sampled data is typical withheld from the modeling dataset and then results of the estimated model are compared to observed results of this "hold-out" data. In this case, the researchers decided it would be best not to reduce the sample sizes used for modeling any more than necessary.

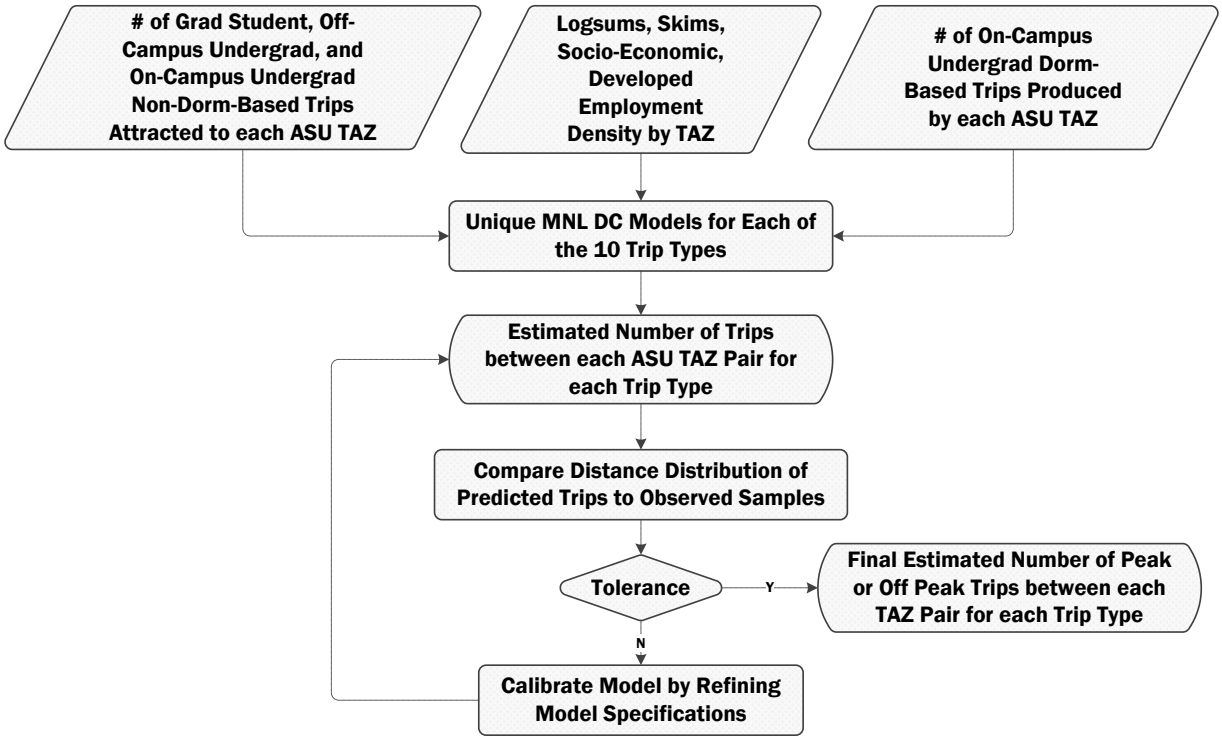


Figure 4.12 Location Choice Estimation and Calibration

The models are therefore validated based on how well they are able to replicate observed patterns. Figure 4.12 shows the process of estimation and calibration of location choice models. A program is developed in Microsoft Excel which allows one to view the results of trip length distribution based solely on the results of the estimated mode choice model. The program then allows the researchers to adjust the coefficients for various distance dummy variables until the estimated trip length distribution closely matches the trip length distribution observed in the survey results. These asserted variables are used only for fine-tuning the model. The distance distribution results of the estimated portion of the model must closely resemble the observed distribution before distance dummy variable assertion can take place. The submodels created here are implemented into the regional travel demand model and will therefore be validated again at a regional level.

4.2.2 Model Estimation

The trips used for estimating the location choice models were selected from the same dataset used thus far in the modeling process. The trips were already therefore filtered and sorted between home-based and non-home based ASU trips. The trips were further filtered to remove those that took place on Monday or Friday (leaving only Tuesday through Thursday trips). In addition, any home-based trips made by off-campus students had to have their home trip ends on a MAG TAZ with at least one non-group quarters household according to the zonal socio-economic data. The number of trips used for modeling each trip type is presented in Table 4.9.

Table 4.9 Model Estimation Sample Sizes

Model Type	Off Campus Undergraduates	On Campus Undergraduates	Graduate Students
Home-Based	3119	--	886
Non-Home Based Peak	1814	--	501
Non-Home Based Off Peak	2797	--	662
Dorm-Based Peak	--	427	--
Dorm-Based Off Peak	--	714	--
Non-Dorm Based Peak	--	665	--
Non-Dorm Based Off Peak	--	1209	--

For each trip type, certain considerations had to be made for which TAZ's would be allowed to be considered for each trip end. For all trips made by off-campus students (including graduate students) and non-dorm based trips for on-campus students, ASU trip end, which is the attraction trip end, must be located in an ASU TAZ with at least one classroom or parking location. For on-campus students' dorm-based trips, ASU end – the production end – must be located on an ASU TAZ with at least one dormitory. These dorm-based trips can have their attraction ends at any TAZ in the MAG region. The production ends, or non-ASU trip ends, of on-campus students' non-dorm based trips, off-campus undergraduates' non-home based trips, and graduate students' non-home based trips, must be TAZ's with at least one employee according to the MAG socio-economic data. Finally, the production end for off-campus undergraduates' and graduate students' home-based trips must be located on a non-ASU TAZ with at least one household. For each trip that was used for modeling, a choice set was constructed for modeling the production zone (or, in the case of dorm-based trips, the attraction zone). The choice set consisted of the chosen TAZ and 29 randomly selected TAZ's that meet the requirements of the specific trip type.

The logsum calculated in the mode choice models was used to estimate the destination choice (LC) models. Using this method, the model estimation takes on an iterative approach. The logsum variables calculated in the mode choice model are input into the LC models. The LC models are then calibrated and a validation if performed to match the trip length distribution of the observed trip set. These trip length distributions are then fed into the mode choice model, in which new logsum coefficients can be calculated. Figure 4.13 displays this iterative process.

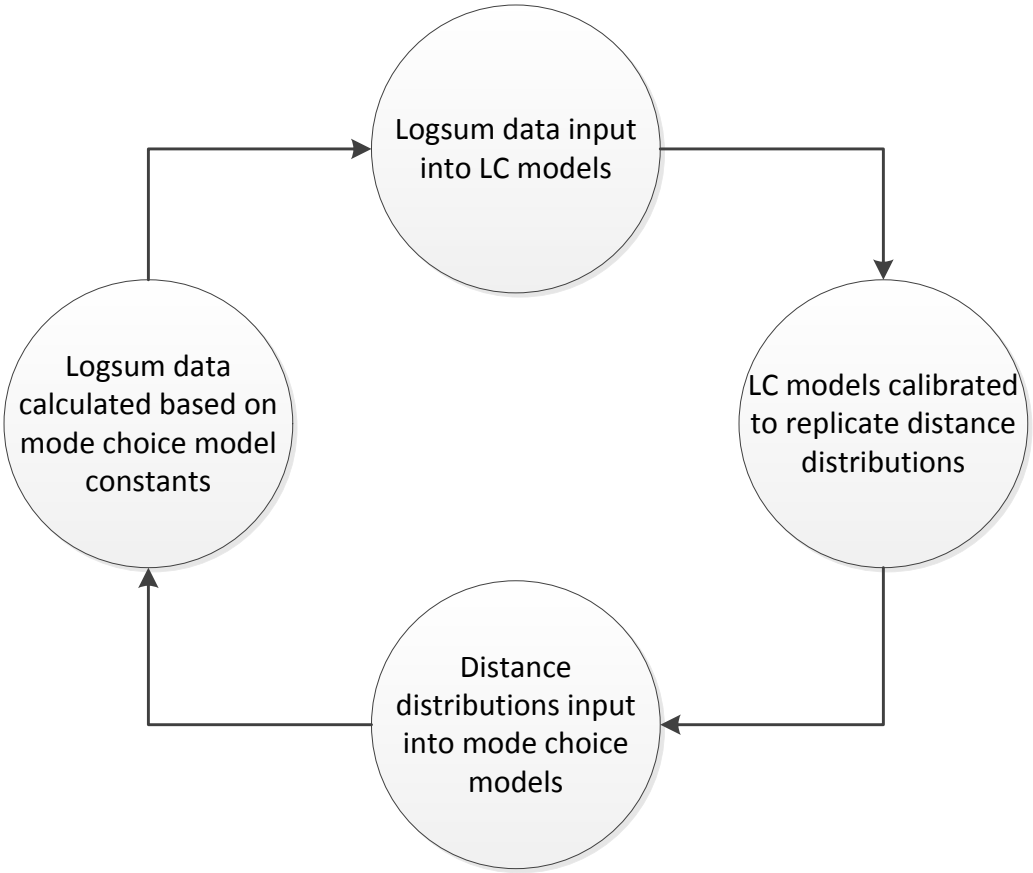


Figure 4.13 Iterative Process of Model Estimation

4.2.3 Location Choice Models for Graduate Students

Location choice models for each trip type were estimated using the NLogit software package. The variables used to estimate the models included socio-demographic information, distances between zones, travel times, and logsums. The three models estimated for graduate student trips, including home-based, non-home based peak, and non-home based off peak, are described below.

As described, home-based trips are not separated by time of day. Therefore, the travel times, trip lengths, and logsums that are dependent on time of day were simply averaged. In this model estimation, multiple combinations of variables were used to describe the chosen TAZ. The final estimation contains only those variables that were statistically significant and that made sense. Once the model was estimated, the resulting estimated trip length distribution was compared to the observed trip length distribution. The model was then calibrated by asserting dummy variables for various distance bins. The model was estimated with a ρ^2 coefficient of 0.521, indicating that the model explains 52.1% of the variability in chosen trip end. Table 4.10 shows the estimated model coefficients as well as the asserted dummy variables in the graduate student home-based ASU trip model.

Table 4.10 Graduate Students Model: Home Location

Explanatory Variables	Coefficient	t-Statistic
Average log sum	1.397	29.778
Number of residential households in the TAZ	0.000762	12.069
Total retail employment in the TAZ	0.000249	1.665
Indicator for having developed employment density in the highest quartile	0.147	1.460
Proportion of the population that is residential	0.987	4.028
Proportion of residential households in the lowest income quintile	-1.353	-4.494
Share of the zone that is developed	1.352	4.137
Percent of regional employment accessible within 30 minutes using transit	11.808	1.947
Asserted Indicator Dummy Variables		
Trip is intra-campus	0.650	
Trip is intra-zonal	-0.230	
Average distance ≤ 1 mile	5.050	
Average distance > 1 and ≤ to 2.5 miles	6.200	
Average distance > 2.5 and ≤ 5 miles	6.050	
Average distance > 5 and ≤ 7.5 miles	4.850	
Average distance > 7.5 and ≤ 10 miles	4.900	
Average distance > 10 and ≤ 15 miles	5.200	
Average distance > 15 and ≤ 20 miles	5.150	
Average distance > 20 and ≤ 25 miles	4.400	
Average distance > 25 and ≤ 30 miles	5.900	
Average distance > 30 and ≤ 35 miles	3.500	
Average distance > 35 and ≤ 40 miles	5.100	
Average distance > 40 and ≤ 45 miles	5.100	
Average distance > 45 miles	6.500	

The variables described in Table 4.10 refer to each TAZ which is present in the choice set for each trip being modeled. TAZ socio-economic data provided by MAG included number of residential, group quarters, transient, and seasonal households in each TAZ. The data also provided the number of employees of several different industry classifications including retail, construction, office and others. The percentage of each TAZ that is developed was also included in the provided data. The "developed employment density" is calculated as the number of employees per developed land area. Accessibility measures were developed using the average travel time for personal vehicle and for transit and the number of employees in each TAZ. One can see that the proportion of households in the TAZ that are in the lowest of 5 income segments (quintiles) acts negatively on the graduate student home location choice in that TAZ. The number of employees – or employment opportunities – that one would be able to reach within 30 minutes using transit compared to the total employment opportunities in the region was used as a variable in this model. The distance distribution of predicted graduate student home-based trips is presented in Figure 4.14A before the assertion of distance dummy variables and in Figure 4.14B after. In both figures, the predicted results are compared to the observed trips.

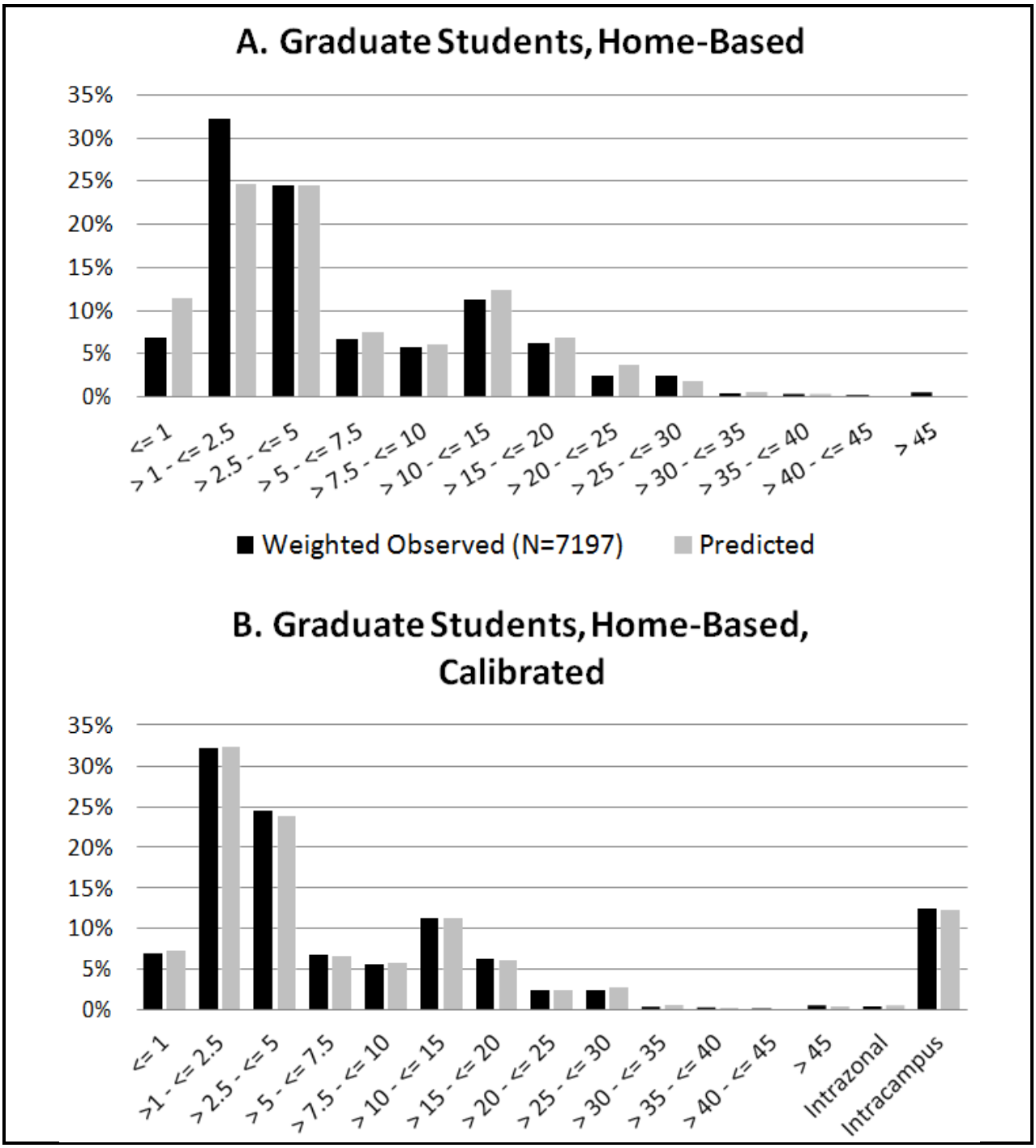


Figure 4.14 Observed and Predicted Trip Lengths: Graduate Student Home-Based

Similar to the estimation for graduate students' home-based trips, graduate students non-home based peak and off peak trips were estimated using a multinomial choice set-up in NLogit. The estimated model was then calibrated by asserting coefficients for indicator variables (also called dummy variables). The model estimated for non-home based peak trips is shown in Table 4.11. This model had a ρ^2 statistic of 0.703, implying that 70% of the variability in location choice can be explained by this estimated model. In this estimation, as may be expected, the propensity for choosing a zone as a non-home based trip end location was negatively

affected by having a highly residential population (as opposed to transient or seasonal) and positively affected by having a higher proportion of employment classified as either public or retail. More developed zones and those with higher employment densities were more likely to be chosen. Figure 4.14 showed that a large portion of home-based trips were distributed to zones between 1 and 5 miles from the attraction zone but Figure 4.15 shows the distance distribution to non-home based peak locations is more heavily skewed toward short distance trips. Similar to Figure 4.14, Figure 4.15A shows the comparison of observed and predicted distance distributions using the uncalibrated non-home based peak model while Figure 4.15B shows the same for the calibrated model.

Table 4.11 Graduate Students Model: Non-Home Based Peak Location

Estimated Explanatory Variables	Coefficient	t-Statistic
Peak log sum	1.289	19.951
Proportion of the population that is residential	-0.668	-3.229
Proportion of the employment that is public	2.249	7.078
Proportion of the employment that is retail	1.068	3.602
Share of the zone that is developed	1.550	3.460
Indicator for having employment density in the highest quartile	0.598	3.413
Asserted Indicator Dummy Variables		
Trip is intra-campus	0.400	
Trip is intra-zonal	1.600	
Peak distance ≤1 mile	5.900	
Peak distance > 1 and ≤ 2.5 miles	5.850	
Peak distance > 2.5 and ≤ 5 miles	5.300	
Peak distance > 5 and ≤ 7.5 miles	5.100	
Peak distance > 7.5 and ≤ 10 miles	5.300	
Peak distance > 10 and ≤ 15 miles	5.250	
Peak distance > 15 and ≤ 20 miles	5.150	
Peak distance > 20 and ≤ 25 miles	5.450	
Peak distance > 25 and ≤ 30 miles	6.700	
Peak distance > 30 and ≤ 35 miles	-5.000	
Peak distance > 35 and ≤ 40 miles	-5.000	
Peak distance > 40 and ≤ 45 miles	-5.000	
Peak distance > 45 miles	-10.000	

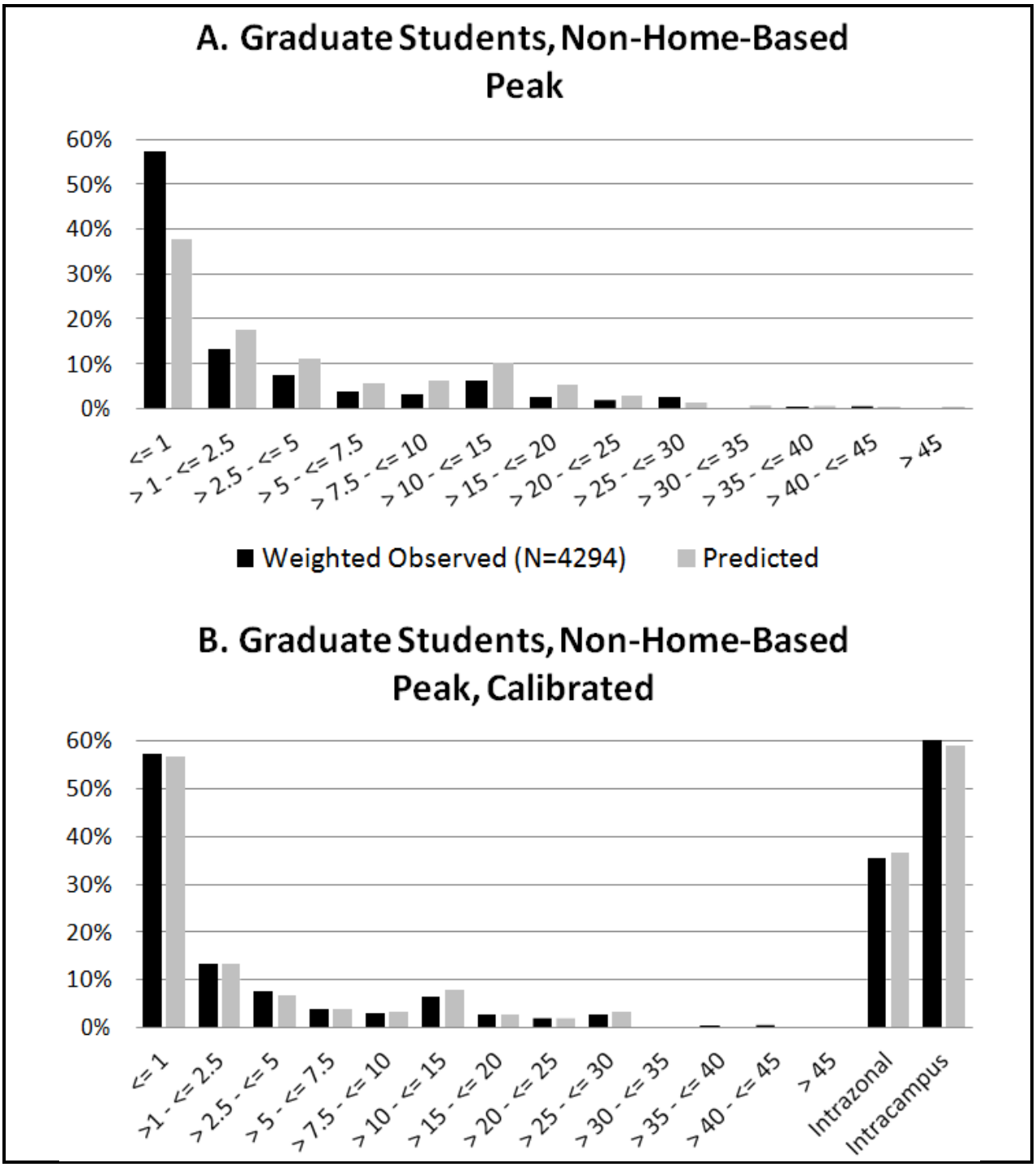


Figure 4.15 Observed and Predicted Trip Lengths: Graduate Students Non-Home Based Peak

The final model estimated for graduate student trips was the non-home based off peak location choice model. The estimated model coefficients are described in Table 4.12. Like the non-home based peak trips, the non-home based off peak trips are heavily skewed toward short distance trips. Also similar to the peak trips, the non-home based off peak trips are positively affected by higher proportions of public and retail employment. Residential population acts negatively on the propensity to choose a zone for non-home based off peak trips. Figure 4.16 shows the comparison of observed and predicted trip length distributions for both the uncalibrated and calibrated models.

Table 4.12 Graduate Students Model: Non-Home Based Off Peak Location

Explanatory Variables	Coefficient	t-Statistic
Off peak log sum	1.493	23.507
Proportion of employment that is public	2.803	8.971
Proportion of employment that is retail	1.511	5.036
Total population	0.000276	2.212
Proportion of the population that is residential	-1.201	-5.644
Share of the zone that is developed	2.220	4.690
Indicator for having employment density in the highest quartile	0.568	3.373
Number of residential households in the highest income quintile	0.000945	1.813
Off peak distance is greater than 2.5 and less than or equal to 5 miles	-0.204	-3.337
Asserted Indicator Dummy Variables		
Trip is intra-campus	0.250	
Trip is intra-zonal	1.100	
Off peak distance ≤ 1 mile	5.720	
Off peak distance > 1 and ≤ 2.5 miles	5.650	
Off peak distance > 2.5 and ≤ 5 miles	5.750	
Off peak distance > 5 and ≤ 7.5 miles	5.150	
Off peak distance > 7.5 and ≤ 10 miles	5.000	
Off peak distance > 10 and ≤ 15 miles	5.200	
Off peak distance > 15 and ≤ 20 miles	5.150	
Off peak distance > 20 and ≤ 25 miles	4.750	
Off peak distance > 25 and ≤ 30 miles	6.000	
Off peak distance > 30 and ≤ 35 miles	0.000	
Off peak distance > 35 and ≤ 40 miles	0.000	
Off peak distance > 40 and ≤ 45 miles	0.000	
Off peak distance > 45 miles	-10.000	

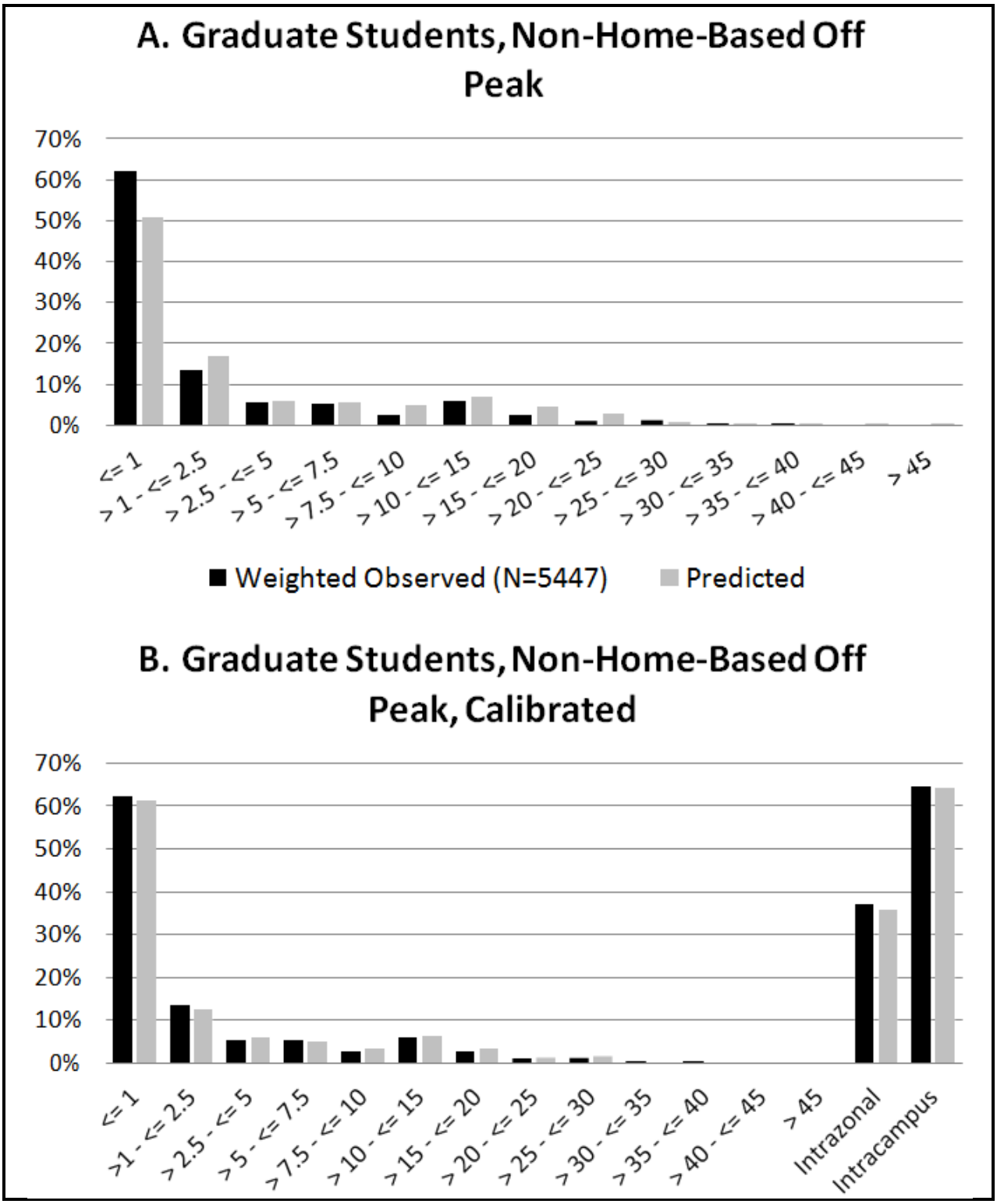


Figure 4.16 Observed and Predicted Trip Lengths: Graduate Students Non-Home Based Off Peak

4.2.4 Location Choice Models for Off Campus Undergraduate Students

Like the models estimated to predict graduate student location choice, off-campus undergraduate trip location choice models were measured for home-based, non-home based peak, and non-home based off peak trips. Again, one model is estimated for both peak and off peak home-based trips so that the predicted home locations of off-campus undergraduates do not become dependent on time of day. Models were estimated in the same fashion, with ASU end of the trip representing the attraction zone. The production zone is being predicted in the location choice models presented here. The results for the home-based ASU location choice model are provided in Table 4.13 while comparative distance distributions before and after model calibration are shown in Figure 4.17, the ρ^2 statistic for the home-based model is 0.405.

Table 4.13 Off Campus Undergraduates Model: Home Location

Explanatory Variables	Coefficient	t-Statistic
Average log sum	1.157	56.814
Residential population	0.000272	24.241
Group quarters population	-0.000244	-2.125
Total retail employment	0.000150	2.056
Total office employment	-0.000221	-5.082
Proportion of residential households in the 4th income quintile	1.715	7.870
Share of the zone that is developed	0.614	4.331
Indicator for having population density in the highest quartile	0.106	1.910
Indicator for having employment density in the lowest quartile	-0.756	-1.936
Proportion of households that are multi-family	0.520	5.857
Asserted Indicator Dummy Variables		
Trip is intra-campus	-0.800	
Trip is intra-zonal	0.000	
Average distance ≤ 1 mile	3.370	
Average distance > 1 and ≤ 2.5 miles	3.950	
Average distance > 2.5 and ≤ 5 miles	3.400	
Average distance > 5 and ≤ 7.5 miles	2.500	
Average distance > 7.5 and ≤ 10 miles	2.710	
Average distance > 10 and ≤ 15 miles	2.600	
Average distance > 15 and ≤ 20 miles	2.850	
Average distance > 20 and ≤ 25 miles	3.100	
Average distance > 25 and ≤ 30 miles	3.800	
Average distance > 30 and ≤ 35 miles	1.550	
Average distance > 35 and ≤ 40 miles	3.300	
Average distance > 40 and ≤ 45 miles	3.100	
Average distance > 45 miles	-12.000	

One can see that the off-campus student's choice of home location is influenced negatively by the presence of group quarters. Since group quarters include dormitories and all the students whose trips are modeled here are off-campus students, it would make sense that the presence of group quarters would indicate that off-campus students do not live in that zone. Off-campus undergraduate student home location choice is also

impacted negatively by the presence of office employment and a very low employment density. The distance distribution shows that a large portion of off-campus undergraduate students choose their home locations within 1 to 5 miles of campus. Very few choose to live more than 30 miles from campus.

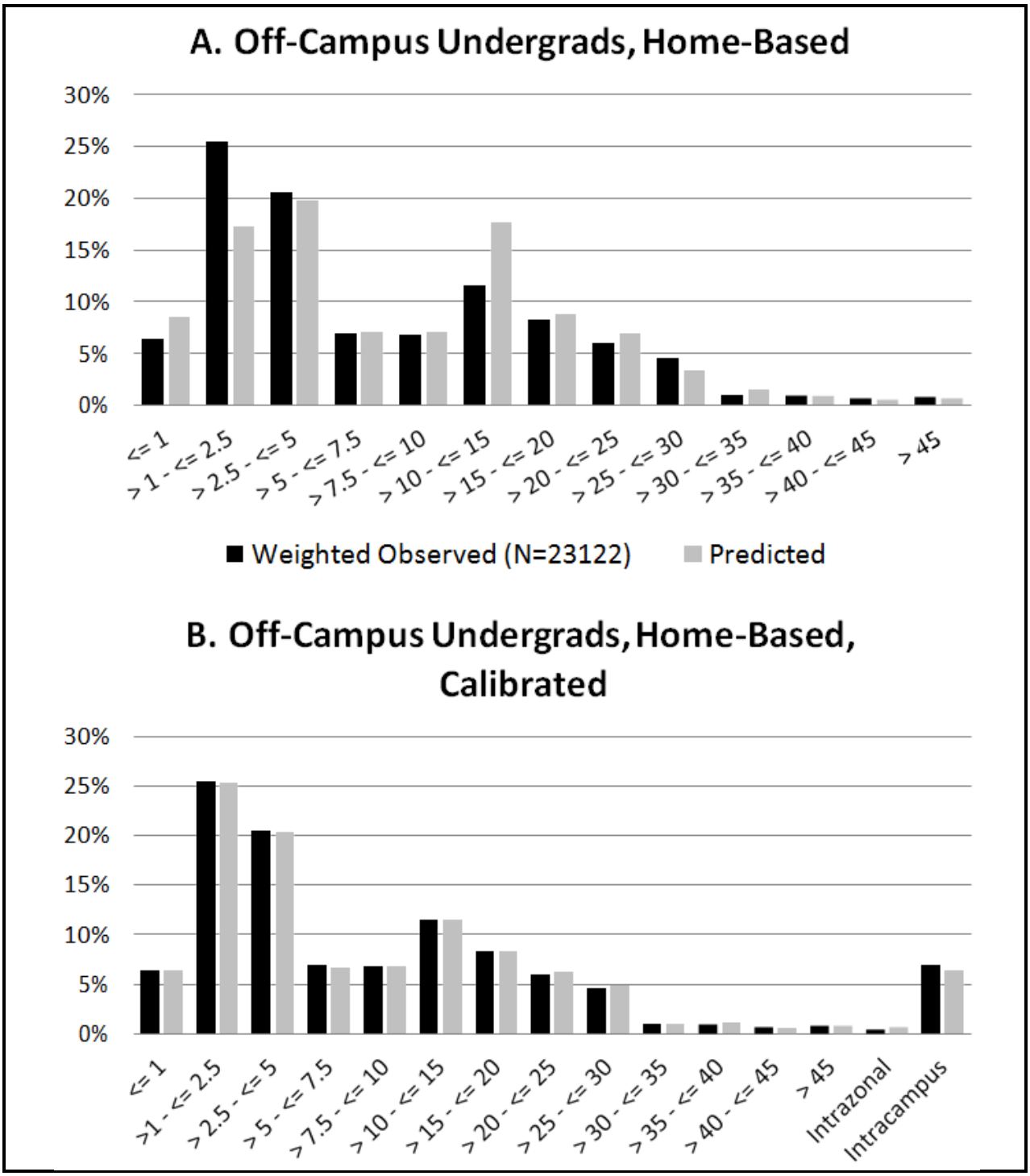


Figure 4.17 Observed and Predicted Trip Lengths: Off-Campus Undergraduate Students Home-Based

The results of location choice modeling for non-home based peak trips of off-campus students are presented in Table 4.14. The variables that are included in this particular model estimation include both piece-wise defined variables and interaction variables. The variable that is described as the "peak distance if distance is greater than 2.5 and less than or equal to 5" is a piecewise defined variable, as the value is zero unless the peak distance is between 2.5 and 5. Between 2.5 and 5 miles, the value of the function is the peak distance. The coefficient of this variable is negative, meaning it has a dampening effect on student travel to zones between 2.5 and 5 miles from campus. An interaction term is one in which two variables are combined with each other to make one variable in the linear equation. In one of the interaction terms included in this model, the distance is multiplied by an indicator variable for a zone with population density in the highest quartile. In this case, when the zone is not in the highest population density quartile, the distance is multiplied by 0. In the case where the zone is in the highest quartile, the distance is multiplied by 1. The coefficient applied to this interaction term is positive, indicating that a student is willing to travel farther away to reach a zone with a high population density. The second interaction term included in this model is distance multiplied by the proportion of households that are group quarters. The coefficient on this term is positive, which may indicate that students are willing to travel to zones with a higher proportion of group quarters households if that zone is farther away. The ρ^2 statistic in which this model resulted was 0.673, indicating that approximately 67% of the variability in location choices is explained by the model.

Table 4.14 Off Campus Undergraduates Model: Non-Home Based Peak Location

Explanatory Variables	Coefficient	t-Statistic
Peak log sum	1.566	39.430
Residential population	0.000126	3.682
Total retail employment	0.000986	12.325
Total office employment	-0.000084	-1.508
Number of households in the lowest income quintile	-0.001227	-4.114
Proportion of households that are single-family	-0.523	-4.415
Share of the zone that is developed	1.182	4.757
Indicator for having population density in the lowest quartile	-0.560	-3.627
Indicator for having employment density in the 3rd of 4 quartiles (mid-high)	0.174	1.843
Peak distance if distance is > 2.5 and ≤ to 5 mi.	-0.187	-5.847
Peak distance X Indicator for having population density in the highest quartile	0.015	2.067
Peak distance X Proportion of households that are group quarters	0.130	12.376
Asserted Indicator Dummy Variables		
Trip is intra-campus	0.450	
Trip is intra-zonal	2.200	
Peak distance ≤ to 1 mile	5.350	
Peak distance > 1 and ≤ 2.5 miles	5.200	
Peak distance > 2.5 and ≤ 5 miles	5.600	
Peak distance > 5 and ≤ 7.5 miles	4.800	
Peak distance > 7.5 and ≤ 10 miles	5.000	
Peak distance > 10 and ≤ 15 miles	5.000	
Peak distance > 15 and ≤ 20 miles	5.100	
Peak distance > 20 and ≤ 25 miles	5.100	
Peak distance > 25 and ≤ 30 miles	6.100	
Peak distance > 30 and ≤ 35 miles	-9.500	
Peak distance > 35 and ≤ 40 miles	-9.500	
Peak distance > 40 and ≤45 miles	-9.500	
Peak distance > 45 miles	-10.000	

Table 4.14 shows that, like in the off-campus undergraduate home location choice model, the presence of office employment acts negatively on the propensity of off- campus undergraduates to travel to a zone for non-home based peak trips. This is also true of the presence of very low income households. Off-campus undergraduate non-home based peak trip location choice is also negatively impacted by a very low population density and by a high proportion of households classified as single-family homes. These two variables go hand-in-hand, as a higher proportion of single-family housing units typically coincides with a lower population density. Figure 4.18 shows that, like graduate students, off-campus undergraduates tend to prefer non-home peak trip locations shorter distances from campus.

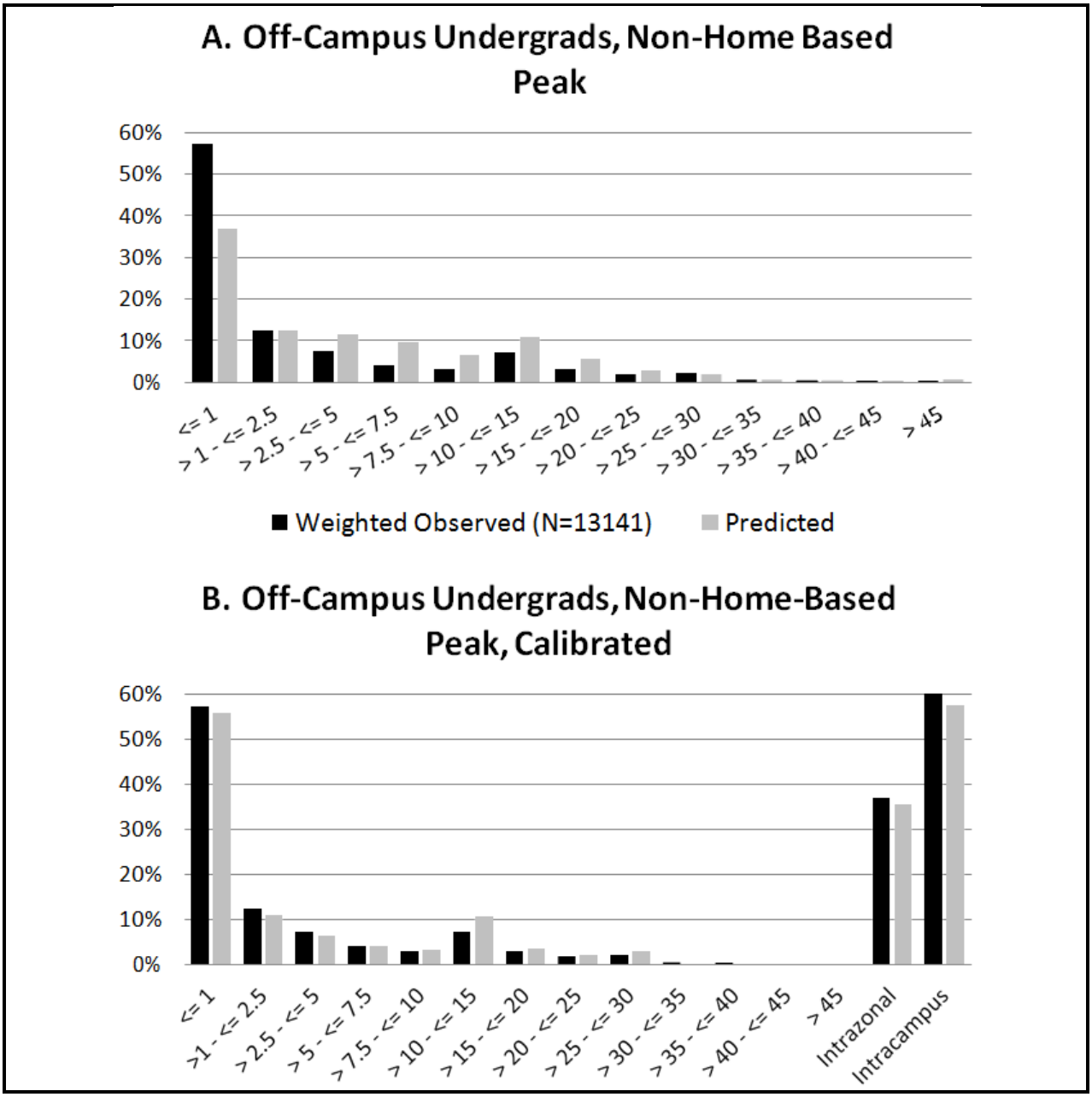


Figure 4.18 Observed and Predicted Trip Lengths: Off Campus Undergraduate Students Non-Home Based Peak

The final model estimated for off-campus undergraduate students is their off peak non-home based production location choice. The estimated model is described in Table 4.15 and distance distributions are shown in Figure 4.19. Just like in the non-home based peak model, a piecewise defined function that is equal to zero unless the off peak distance is greater than 2.5 miles and less than or equal to 5 miles was found to be significant. This variable again has a negative coefficient, indicating a fewer number of trips made with their locations 2.5 to 5 miles from campus. Also like the peak model, an interaction term combining distance and the proportion of households that are group quarters was found to be significant in this off-peak model. The ρ^2 statistic for this estimated model is 0.716. This model shows that zones with office employment and with a high proportion of multi-family households are less likely to attract non-home based off peak trips from off-campus undergraduates. It is interesting to note that the model for peak trip location showed a negative correlation with the proportion of households that are single-family while this off peak trip shows a negative correlation with the proportion of households that are multi-family. This just goes to show that the trips being made by off-campus undergraduates during the peak hour are very difference from those being made in the off-peak period. Figures 4.18 and 4.19 show that off-campus undergraduate non-home based trips are skewed toward the shorter distances. In these two trip categories, between 60% and 70% of the total trips observed are intra-campus and approximately 40% are intra-zonal. These short distance trips are prime candidates to be captured by alternative and non-motorized modes of transport.

Table 4.15 Off Campus Undergraduates Model: Non-Home Based Off Peak Location

Explanatory Variables	Coefficient	t-Statistic
Off peak log sum	1.837	50.219
Total retail employment	0.001006	12.894
Total office employment	-0.000099	-2.134
Number of households in the highest income quintile	0.000530	2.394
Proportion of households that are multi-family	-0.556	-4.039
Share of zone that is developed	1.733	6.875
Indicator for having population density in the highest quartile	0.511	6.323
Indicator for having employment density in the highest quartile	0.183	2.193
Off peak distance if distance is > 2.5 and ≤ 5 mi.	-0.252	-8.854
Off peak distance X Proportion of households that are group quarters	0.140	14.997
Asserted Indicator Dummy Variables		
Trip is intra-campus	0.965	
Trip is intra-zonal	1.860	
Off peak distance ≤ 1 mile	5.250	
Off peak distance > 1 and ≤ 2.5 miles	4.820	
Off peak distance > 2.5 and ≤ 5 miles	5.900	
Off peak distance > 5 and ≤ 7.5 miles	4.650	
Off peak distance > 7.5 and ≤ 10 miles	4.700	
Off peak distance > 10 and ≤ 15 miles	4.800	
Off peak distance > 15 and ≤ 20 miles	5.200	
Off peak distance > 20 and ≤ 25 miles	5.200	
Off peak distance > 25 and ≤ 30 miles	5.700	
Off peak distance > 30 and ≤ 35 miles	0.000	
Off peak distance > 35 and ≤ 40 miles	0.000	
Off peak distance > 40 and ≤45 miles	0.000	
Off peak distance > 45 miles	-10.000	

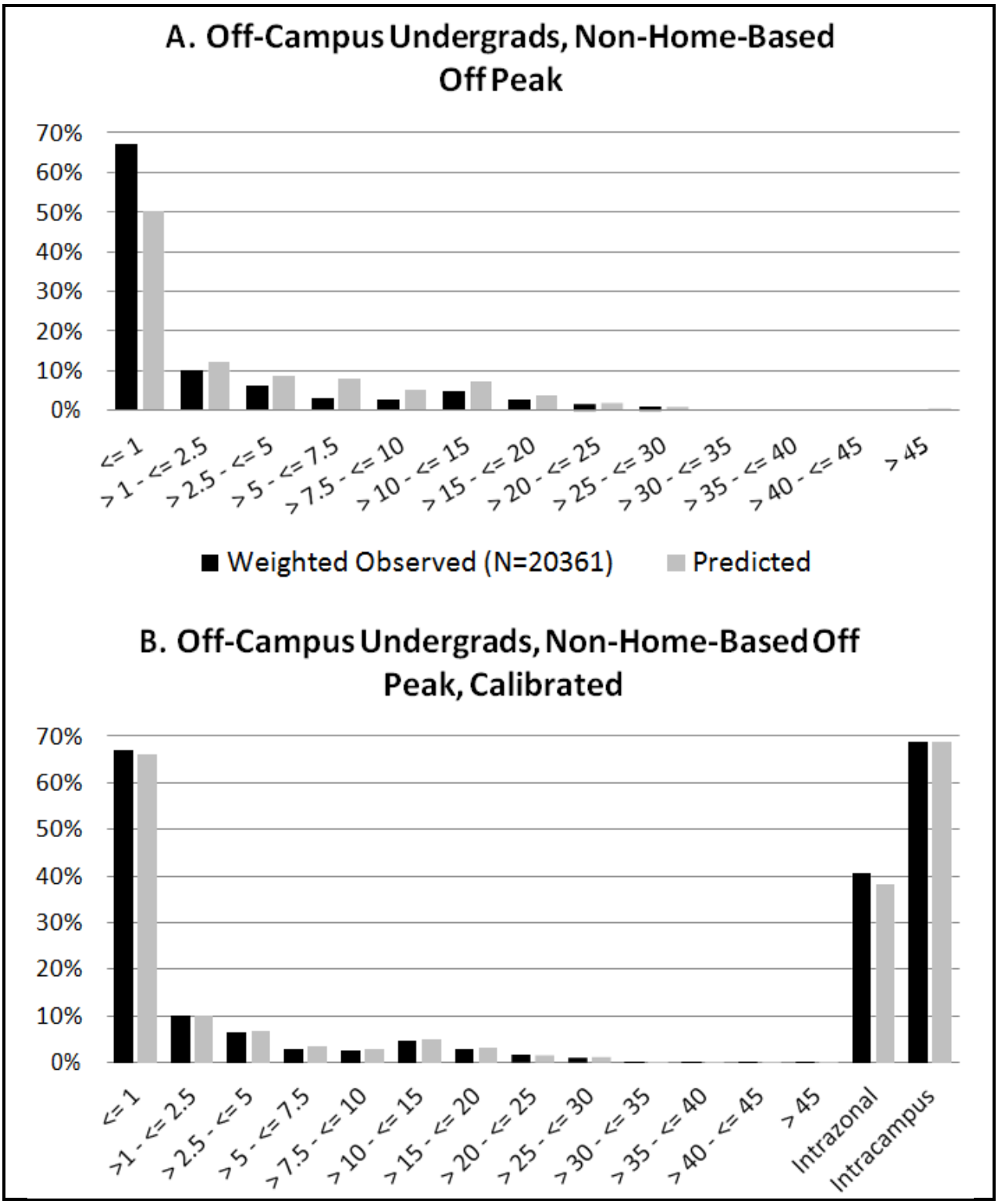


Figure 4.19 Observed and Predicted Trip Lengths: Off Campus Undergraduate Students Non-Home Based Off Peak

4.2.5 Location Choice Models for On-Campus Undergraduate Students

Off campus students in this modeling effort make their home-based trips such that ASU end is the non-home end. ASU end of the trip has its location assigned using the intensity calculations described previously. In the case of on-campus students' dorm- based trips, however, it is the home end that is also ASU end, and therefore the end that has its location assigned based on intensity calculations. Therefore, the dorm-based trips are not in danger of having their home location choice vary based on time of day and there is no need to combine the peak and off peak models. This is why on-campus undergraduate students have four separate models estimated for their trip location choice: dorm-based peak, dorm-based off peak, non-dorm based peak, and non-dorm based off peak.

Table 4.16 shows the results of the estimated location choice model for on-campus students' dorm-based peak trips. These trips have their production ends on an ASU campus and can have their attraction ends at any TAZ in the MAG region. The model results in a ρ^2 statistic of 0.756. One can see that these trip locations are heavily positively influenced by the presence of high income households and negatively influenced by low population densities. Even though these trip ends are allowed to occur at any TAZ in the region, they are heavily skewed toward short distance trips, with nearly 60% of the observed trips occurring less than a mile from the dorm location. This could imply a general preference for closer locations or it could imply a greater share of non- motorized trips. Figure 4.20 shows distance distributions for on-campus students' dorm-based peak trips.

Table 4.16 On-Campus Undergraduates Model: Dorm-Based Peak Location

Explanatory Variables	Coefficient	t-Statistic
Peak log sum	1.566	21.449
Developed population density	0.000078	5.507
Total retail employment	0.000837	4.311
Indicator for having population density in the lowest quartile	-1.395	-2.886
Proportion of residential households in the highest income quintile	1.639	3.632
Indicator for having employment density in the 3rd of 4 quartiles (mid-high)	0.714	3.684
Total employment	0.000255	3.989
Peak distance X Proportion of households that are group quarters	0.112	4.549
Asserted Indicator Dummy Variables		
Trip is intra-campus	0.800	
Trip is intra-zonal	0.800	
Peak distance ≤ 1 mile	7.000	
Peak distance > 1 and ≤ 2.5 miles	6.500	
Peak distance > 2.5 and ≤ 5 miles	5.600	
Peak distance > 5 and ≤ 7.5 miles	5.900	
Peak distance > 7.5 and ≤ 10 miles	5.200	
Peak distance > 10 and ≤ 15 miles	5.800	
Peak distance > 15 and ≤ 20 miles	4.900	
Peak distance > 20 and ≤ 25 miles	5.600	
Peak distance > 25 and ≤ 30 miles	7.000	
Peak distance > 30 and ≤ 35 miles	5.900	
Peak distance > 35 and ≤ 40 miles	7.000	
Peak distance > 40 and ≤ 45 miles	-10.000	
Peak distance > 45 miles	-10.000	

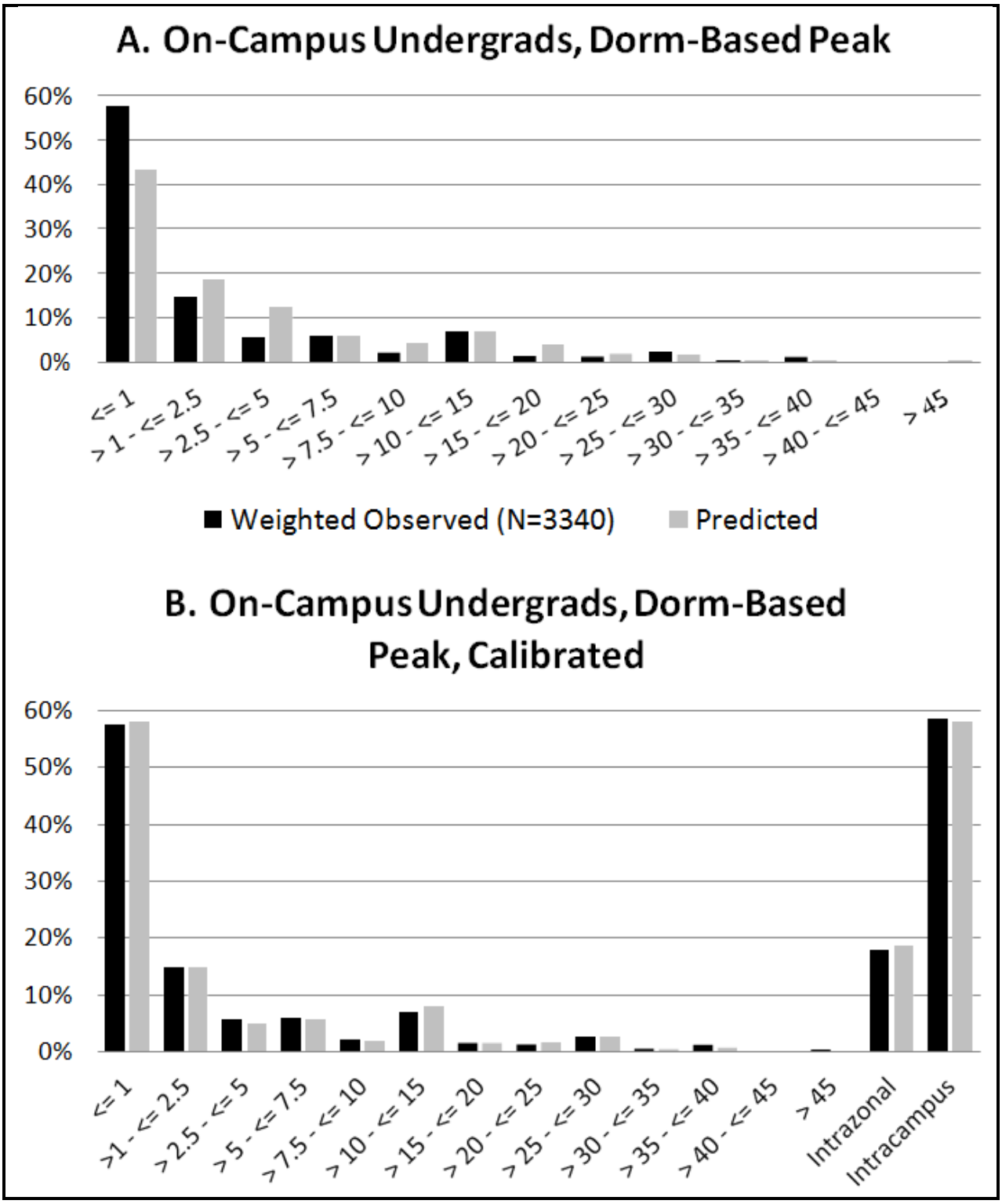


Figure 4.20 Observed and Predicted Trip Lengths: On Campus Undergraduate Students Dorm-Based Peak

Table 4.17 shows the results of the estimated location choice model for the same type of trip in the off peak period. Again, the attraction end of the trip is allowed to take place in any TAZ in the region. This model resulted in a ρ^2 statistic of 0.756, identical to the ρ^2 statistic in the final dorm-based peak model. The model coefficients reveal that the choice of off peak dorm-based location is negatively impacted by a low population density, a high proportion of industrial employment, and a low employment density.

It is positively impacted by higher population densities, multi-family households, and high income households. Similar to the dorm-based peak trips, these dorm-based off peak trips are heavily skewed toward short distance trips as shown in Figure 4.21.

Table 4.17 On Campus Undergraduates Model: Dorm-Based Off Peak Location

Explanatory Variables	Coefficient	t-Statistic
Off peak log sum	1.705	28.132
Developed population density	0.000041	3.082
Total retail employment	0.000654	4.252
Proportion of households that are multi-family	0.884	3.407
Indicator for having population density in the lowest quartile	-1.214	-3.134
Proportion of residential households with income in the highest quintile	1.214	3.279
Proportion of employment that is industrial	-1.091	-2.719
Total employment	0.000225	4.110
Indicator for having employment density in the lowest quartile	-2.256	-2.093
Off peak distance X Proportion of households that are group quarters	0.135	7.644
Asserted Indicator Dummy Variables		
Trip is intra-campus	0.475	
Trip is intra-zonal	0.800	
Off peak distance is ≤ 1 mile	5.800	
Off peak distance > 1 and ≤ 2.5 miles	5.100	
Off peak distance > 2.5 and ≤ 5 miles	4.540	
Off peak distance > 5 and ≤ 7.5 miles	4.200	
Off peak distance > 7.5 and ≤ 10 miles	4.200	
Off peak distance > 10 and ≤ 15 miles	4.500	
Off peak distance > 15 and ≤ 20 miles	4.200	
Off peak distance > 20 and ≤ 25 miles	4.300	
Off peak distance > 25 and ≤ 30 miles	5.500	
Off peak distance > 30 and ≤ 35 miles	6.000	
Off peak distance > 35 and ≤ 40 miles	0.000	
Off peak distance > 40 and ≤ 45 miles	-10.000	
Off peak distance > 45 miles	-10.000	

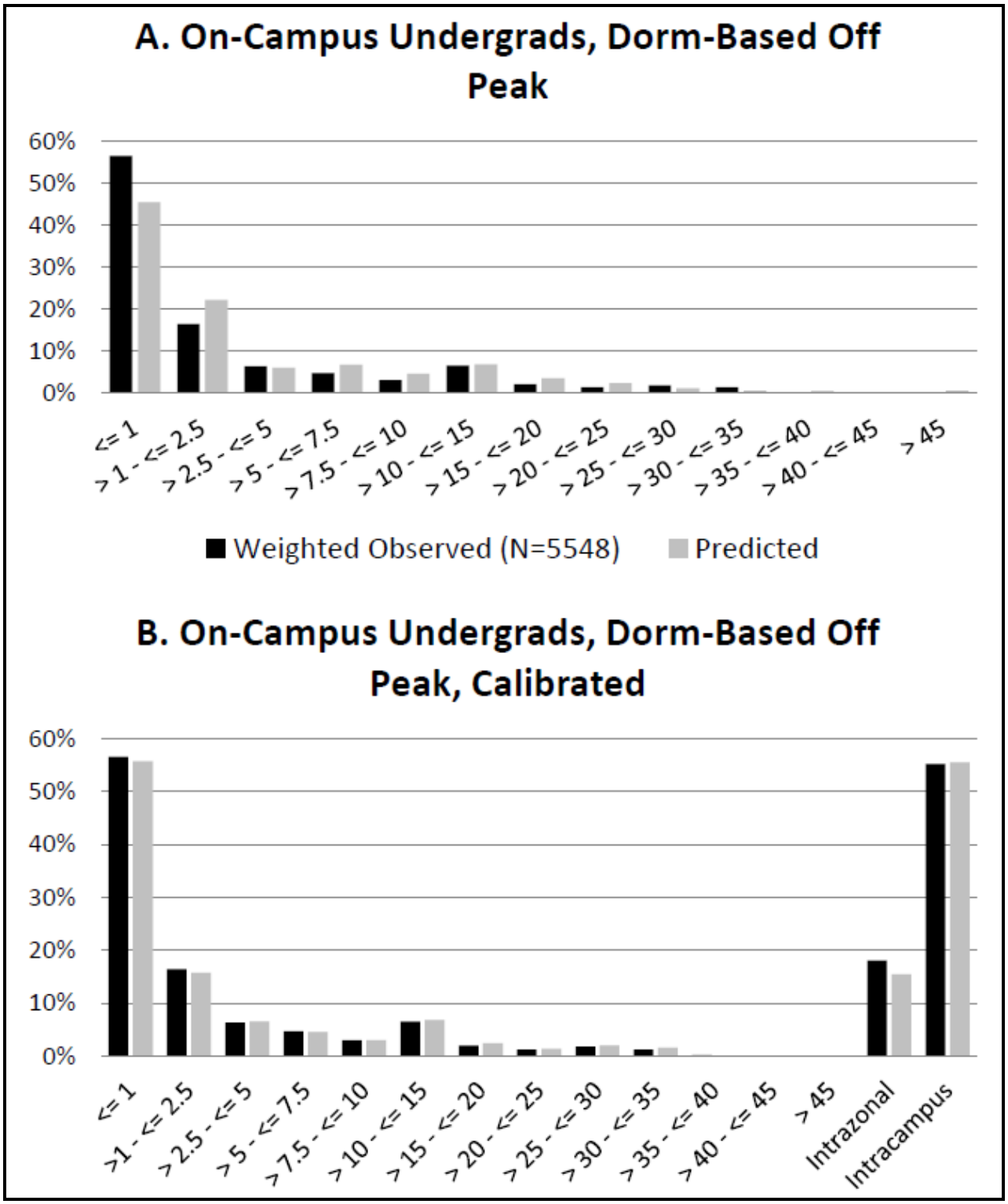


Figure 4.21 Observed and Predicted Trip Lengths: On Campus Undergraduate Students Dorm-Based Off Peak

The trips that were modeled for the on campus students' non-dorm based peak were similar to the off-campus students' non-home based peak trips in that the attraction end was located on an ASU campus (at a known location) and the production end is being modeled here. The production end can be any TAZ in the region with at least one employee.

Table 4.18 shows the results of the non-dorm based peak trip location choice model, with a ρ^2 statistic of 0.871. For a location choice model of this nature, 0.871 is quite a high goodness of fit statistic. These non-dorm based peak trips are surprisingly averse to locations with a high residential proportion of the population. Zones that do not have a high proportion of residential population are likely, in the context of on-campus student trips, those that contain a lot of hotel or seasonal population. These trips are also not likely to be located in zones with low population density. As shown in Figure 4.22, the non-dorm based peak trips seems to be even more heavily skewed toward short distances than the dorm-based trips, with about 80% of the observed trips intra-campus and 45% intra-zonal.

Table 4.18 On-Campus Undergraduates Model: Non-Dorm Based Peak Location

Explanatory Variables	Coefficient	t-Statistic
Peak log sum	1.521	16.126
Proportion of the population that is residential	-1.682	-5.968
Proportion of employment that is public	2.175	5.725
Indicator for having population density in the lowest quartile	-0.721	-2.161
Share of the zone that is developed	1.219	2.302
Proportion of regional employment accessible within 50 minutes using transit	3.368	1.036
Peak distance X Proportion of households that are group quarters	0.113	3.679
Asserted Indicator Dummy Variables		
Trip is intra-campus	1.200	
Trip is intra-zonal	1.350	
Peak distance ≤ 1 mile	6.650	
Peak distance > 1 and ≤ 2.5 miles	7.000	
Peak distance > 2.5 and ≤ 5 miles	6.200	
Peak distance > 5 and ≤ 7.5 miles	7.000	
Peak distance > 7.5 and ≤ 10 miles	5.600	
Peak distance > 10 and ≤ 15 miles	6.600	
Peak distance > 15 and ≤ 20 miles	6.200	
Peak distance > 20 and ≤ 25 miles	6.100	
Peak distance > 25 and ≤ 30 miles	6.300	
Peak distance > 30 and ≤ 35 miles	0.000	
Peak distance > 35 and ≤ 40 miles	-10.000	
Peak distance > 40 and ≤45 miles	-10.000	
Peak distance > 45 miles	-10.000	

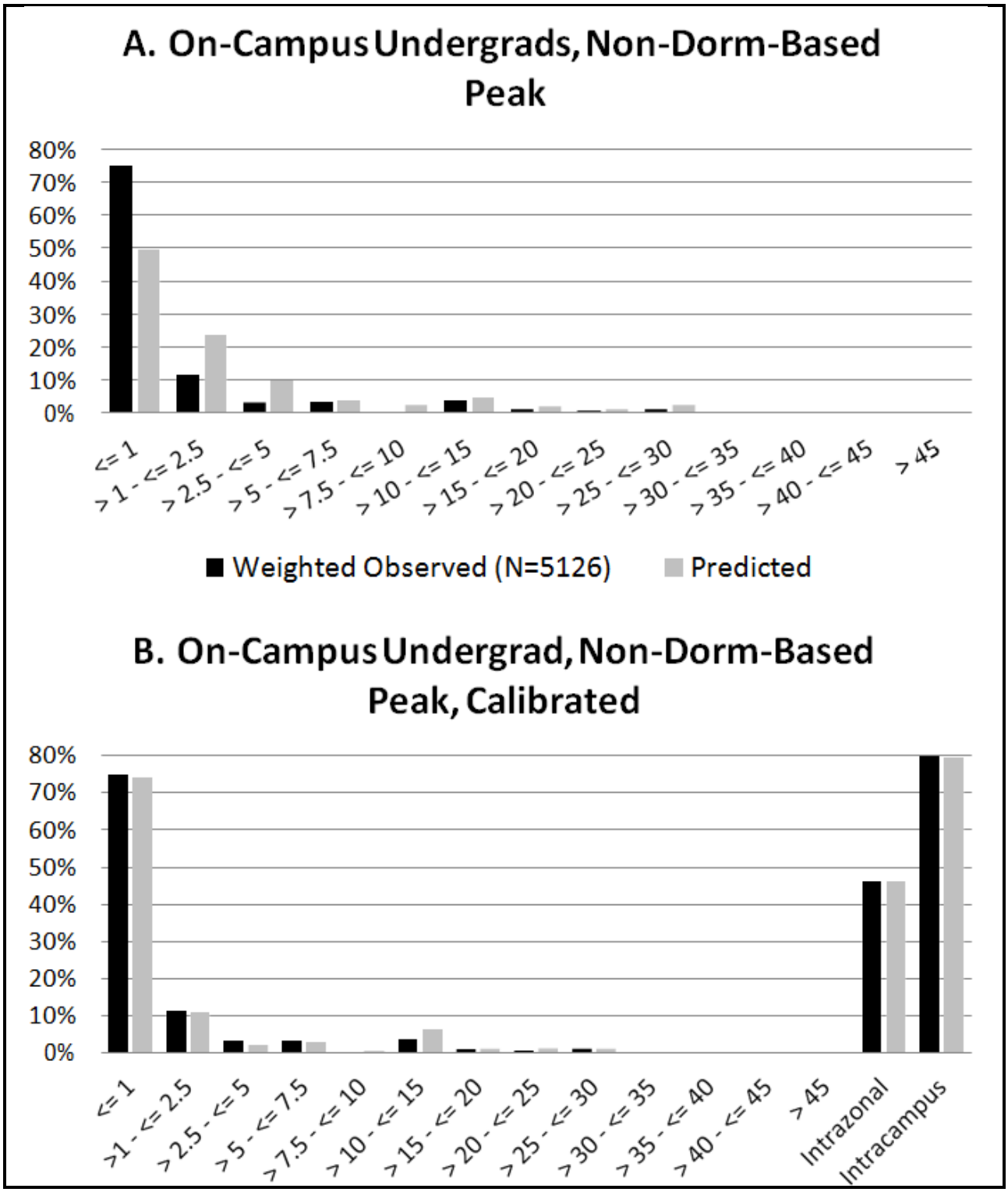


Figure 4.22 Observed and Predicted Trip Lengths: On Campus Undergraduate Students Non-Dorm Based Peak

Table 4.19 shows the non-dorm based off peak location choice model for on-campus undergraduate students for. These trips have similar characteristics to the non- dorm based peak trips presented above, varying only in time of day. The model is estimated with a ρ^2 statistic of 0.911, the best goodness of fit measure of all the location choice models estimated in this research effort. One can see that the choice of production zone for non-dorm based off peak trips is heavily influenced by the percent of regional employment that is accessible within 30 minutes using transit. The choice is negatively influenced by a low employment density and, like the peak trips, by a high proportion of population that is residential. As shown in Figure 4.23, more than 80% of these non-dorm based off peak trips are intra-campus and about 50% are intra-zonal.

Table 4.19 On Campus Undergraduates Model: Non-Dorm Based Off Peak Location

Explanatory Variables	Coefficient	t-Statistic
Off peak log sum	1.728	21.051
Proportion of employment that is public	2.478	7.464
Proportion of the population that is residential	-1.492	-6.046
Indicator for having employment density in the lowest quartile	-3.443	-2.703
Total population	0.000367	2.551
Share of the zone that's developed	1.952	3.823
Proportion of employment that is retail	1.411	4.191
% of regional employment accessible within 30 minutes using transit	26.883	2.839
Off peak distance X Proportion of households that are group quarters	0.144	7.272
Asserted Indicator Dummy Variables		
Trip is intra-campus	0.200	
Trip is intra-zonal	1.200	
Off peak distance ≤ 1 mile	10.770	
Off peak distance > 1 and ≤ 2.5 miles	10.050	
Off peak distance > 2.5 and ≤ 5 miles	9.400	
Off peak distance > 5 and ≤ 7.5 miles	9.400	
Off peak distance > 7.5 and ≤ 10 miles	9.000	
Off peak distance > 10 and ≤ 15 miles	8.500	
Off peak distance > 15 and ≤ 20 miles	3.000	
Off peak distance > 20 and ≤ 25 miles	1.000	
Off peak distance > 25 and ≤ 30 miles	-8.000	
Off peak distance > 30 and ≤ 35 miles	-10.000	
Off peak distance > 35 and ≤ 40 miles	0.000	
Off peak distance > 40 and ≤ 45 miles	-10.000	
Off peak distance > 45 miles	-20.000	

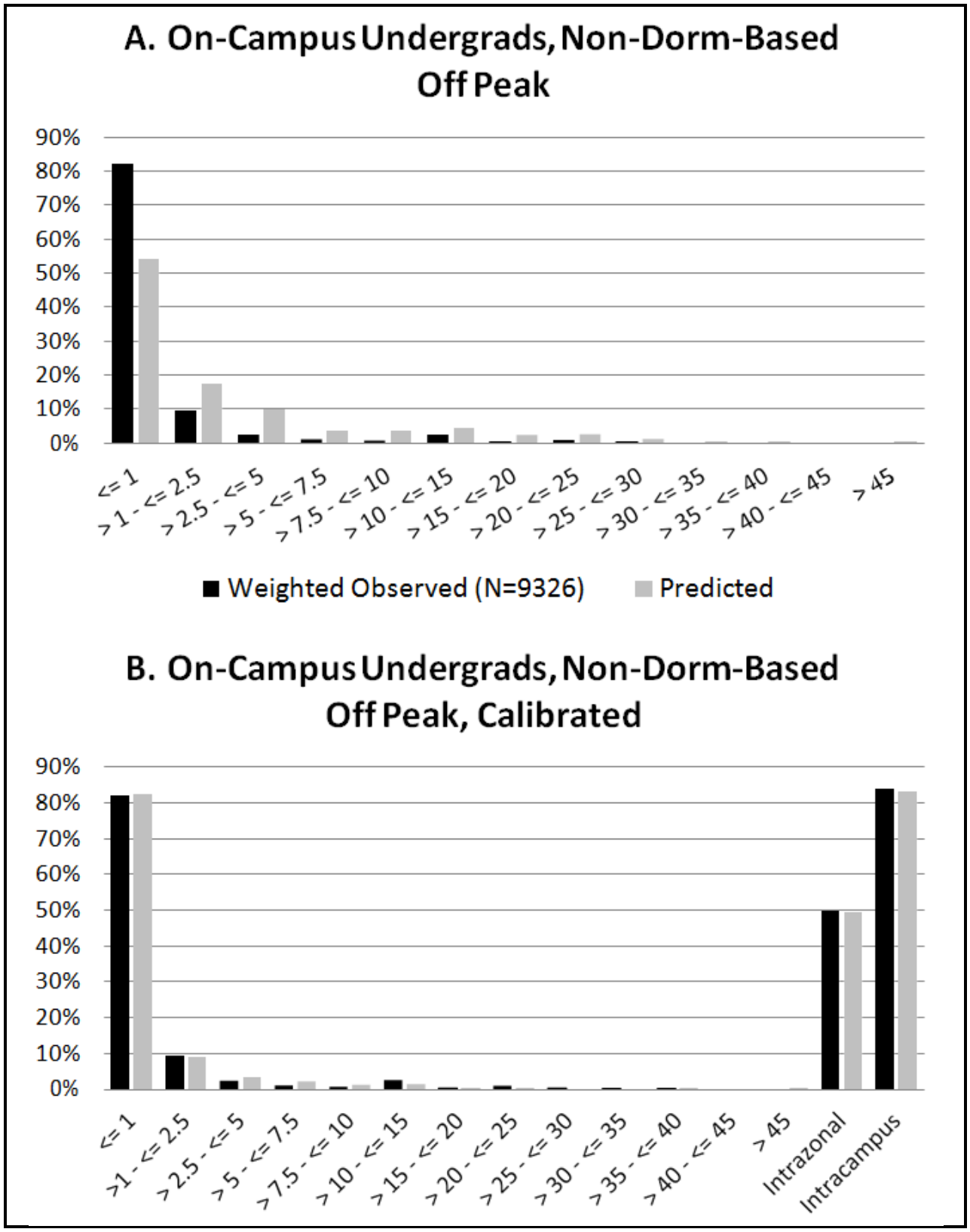


Figure 4.23 Observed and Predicted Trip Lengths: On Campus Undergraduate Students Non-Dorm Based Off Peak

The calibration method used in the estimation of these location choice models was to assert coefficients on dummy variables for trip distance and indicators for intra-campus and intra-zonal trips. In terms of the inclusion of logical and statistically significant variables and goodness of fit statistics, the models performed well before the calibration coefficients were applied. While the assertion of a few coefficients is not detrimental to the theoretical health of the models, the argument could be made that the number of coefficients asserted with these models is likely to result in over fitting. While the number of observations is still much greater than the number of variables, a better method of location choice calibration could be found. The trip distance distributions that result from the final calibrated models reflect quite closely the observed trip distance distributions. However, future research should focus on finding an effective and technically rigorous method of location choice model calibration.

The location choice models presented here are certainly subject to parking availability on campus. The allocation of ASU trip end location is based on availability of parking as well as availability of classroom seats. The models are not, however, sensitive to parking pricing. In a ASU setting where innovative travel demand management techniques are often implemented and tested, it is important to employ a location choice model that can predict the effects of variable parking strategies. Future research should look into ways in which parking pricing sensitivity can be incorporated into the location choice models.

4.3 Mode Choice Model

The previous ASU mode choice model did not have student type and living arrangement but was only for all ASU student trips during the peak period. The new ASU mode choice model adopts the alternatives and nesting structure of the non-ASU model, with one exception - ASU has four key campus locations across the Phoenix area. They include the main ASU campus in Tempe, plus satellite campuses in downtown Phoenix, West Phoenix, and the polytechnic campus in Mesa. These locations are connected via an ASU shuttle service, which is available for free to ASU students. ASU mode choice model structure shown in Figure 4.24 was extended to explicitly consider walk-access ASU shuttles as a transit mode. This structural change required that ASU shuttles be coded as part of the transit network. The mode choice model is specified in a Utility Expression Calculator file.

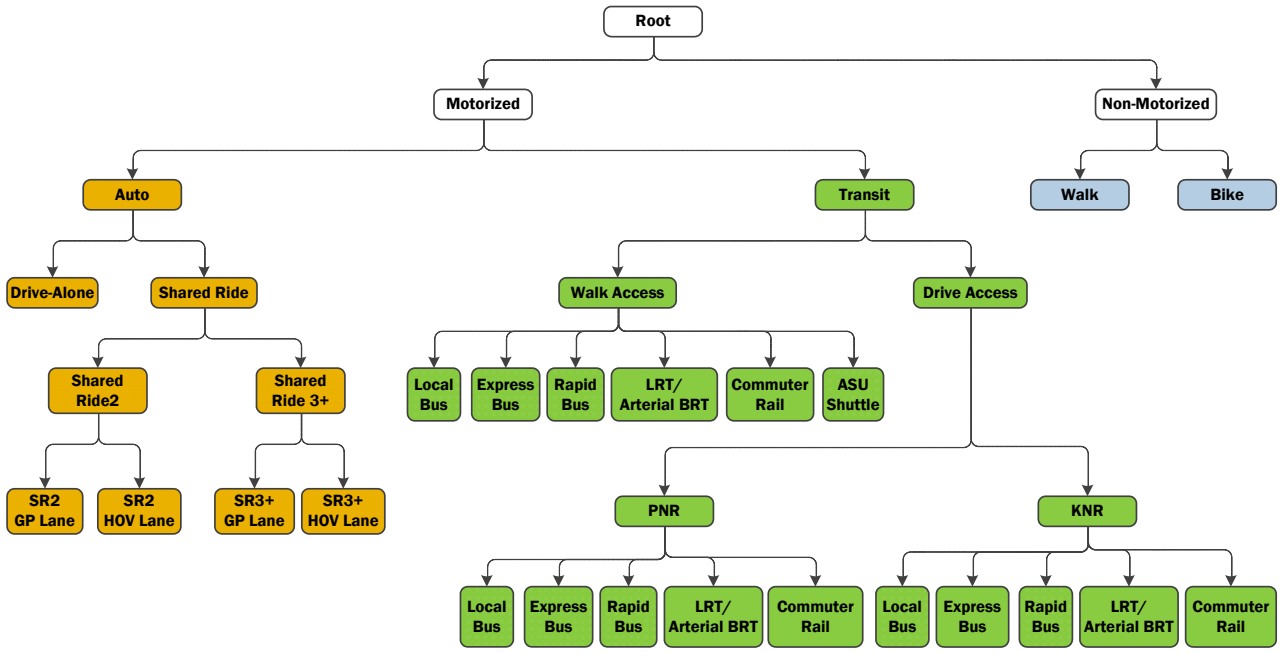


Figure 4.24 Mode Choice Nested Logit Model Structure

In this section, new six ASU mode choice models by student type, living arrangement and time period were developed such as graduate students (Peak and Off Peak), off-campus undergraduate students (Peak and Off Peak) and on-campus undergraduate students (Peak and Off Peak). Some minor enhancements to the model specification had been performed so that the calibration and validation targets were met with a greater degree of accuracy. The calibration and validation targets were revisited and ensured that they accurately represented ground-truth conditions. Based on the updated targets, a few very minor adjustments to model constants and dummy variable coefficients are performed. Upon completing these efforts, the model was ran a number of times to compare the outputs from the location choice and mode choice models with the calibration and validation targets. Figure 4.25 shows the mode choice model calibration procedure.

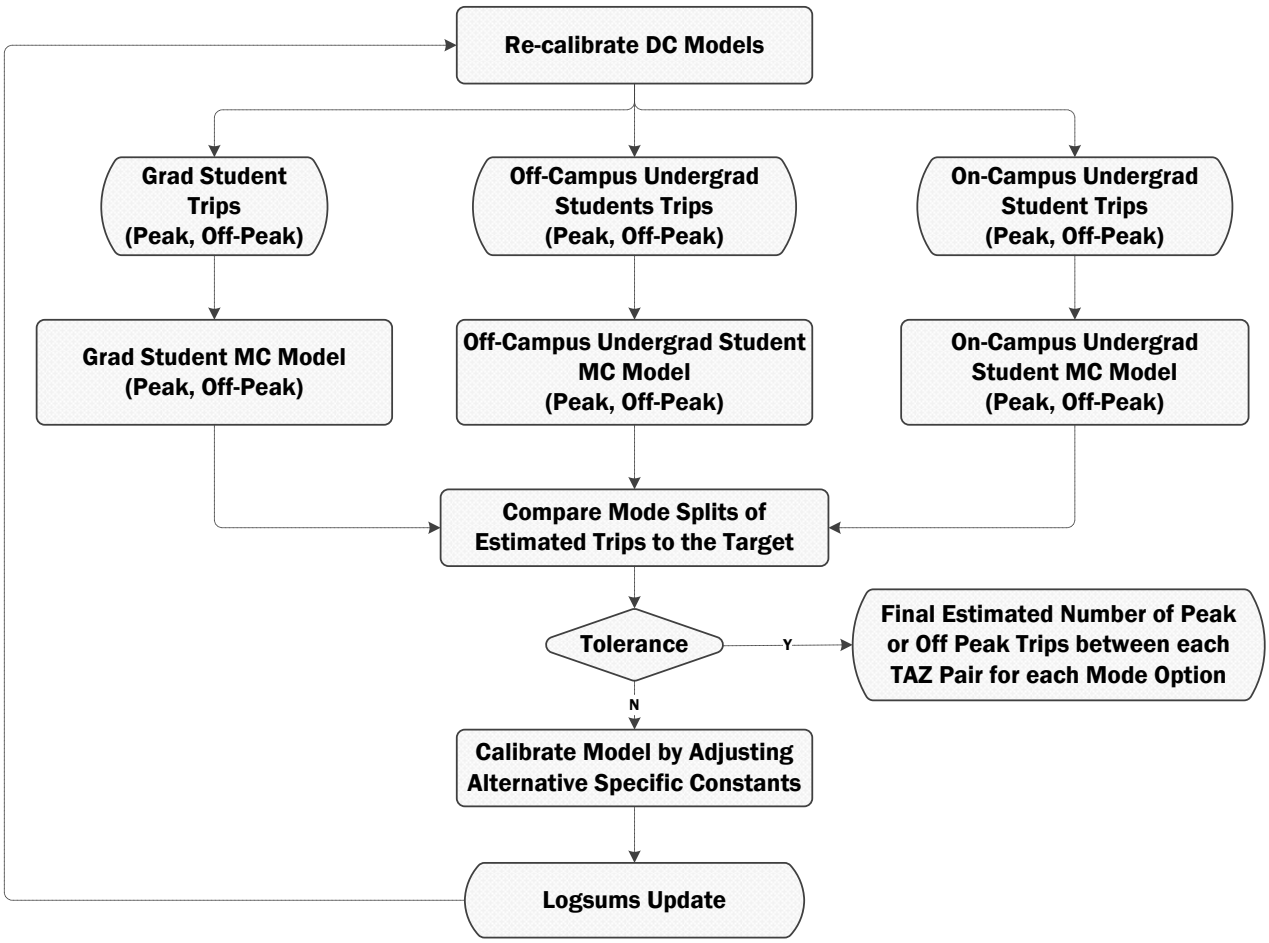


Figure 4.25 Mode Choice Model Calibration Procedure

As shown in Figure 4.25, the mode choice model was calibrated by adjusting alternative specific constants shown in Table 4.20. Except for on-campus undergraduate students, most of existing utility coefficients were kept due to the lack of detail information of vehicle occupancy and type of transit in the survey data. Utility coefficients for on-campus undergraduate students had been relaxed to make more willingness to walk because they're less likely to own a car:

- Short Walk Access Time Coefficient = -0.01250 (Old: -0.0500)
- Long Walk Access Time Coefficient = -0.02500 (Old: -0.0750)

Table 4.20 Mode Choice Model Alternative Specific Constant Calibrated

Alternative Specific Constant	Peak			Off-Peak		
	Graduate	Off -Campus Undergrads	On-Campus Undergrads	Graduate	Off -Campus Undergrads	On-Campus Undergrads
Auto	0.5500	0.0800	1.2500	0.4200	0.3300	0.4000
Shared Ride	-1.1000	-1.1500	-0.2400	-1.3800	-1.0500	0.0000
Shared Ride 3+	-0.5244	-0.5244	-0.5244	-0.5244	-0.5244	-0.5244
Transit	-0.2500	0.0000	-0.2200	-0.0800	-0.0800	-0.5800
Drive Access	-1.8000	-1.8000	-1.2500	-1.1523	-1.1523	-1.1523
Kiss and Ride	-0.3465	-0.2000	-0.2200	-0.3465	-0.3465	-0.3465
Non-Motorized	1.9500	1.7000	1.9500	1.6800	1.1810	1.9172
Bike	-1.3500	-1.7500	-1.1000	-1.3000	-1.6050	-1.5981
Express Bus	-2.0000	-2.0000	-2.2000	-1.7500	-1.7500	-1.7500
Rapid Bus	-2.0000	-2.0000	-2.2000	-1.7500	-1.7500	-1.7500
Urban Rail/BRT	0.7000	0.5000	1.1500	0.3184	0.3584	0.9584
ASU Shuttle	6.2500	3.1500	2.7500	4.5928	4.5928	5.1928
Local Bus: Walk Access	0.4000	-	-	-	-	-
Local Bus: Drive Access	-	0.1500	1.1000	-	-	-

Since details of vehicle occupancy and type of transit (local/express/rapid) were not collected in this travel survey, the following mode aggregations were made for comparison of market shares from the submodel and the survey, and Figure 4.26 shows the comparison of target and modeled shares:

- (shared ride 2-person taking general purpose lane: SR2GP) + (shared ride 2-person taking HOV lane: SR2HOV) + (shared ride 3+person taking general purpose lane: SR3GP) + (shared ride 3+person taking HOV lane: SR3HOV) = (shared ride 2+person: SR2+)
- (walk-access to local bus: WLK-LOC) + (walk-access to express bus: WLK-EXP) + (walk-access to rapid bus: WLK-RAP) = (walk-access to bus: WALK BUS)
- (park-and-ride to local bus: PNR-LOC) + (park-and-ride to express bus: PNR-EXP) + (park-and-ride to express bus: PNR-RAP) = (park-and-ride to bus: PNR BUS)
- (kiss-and-ride to local bus: KNR-LOC) + (kiss-and-ride to express bus: KNR-EXP) + (kiss-and-ride to rapid bus: KNR-RAP) = (kiss-and-ride to bus: KNR BUS)
- (walk-access to urban rail: WLK-URB) + (walk-access to commuter rail: WLK-COM) = (walk-access to rail: WALK RAIL)
- (park-and-ride to urban rail: PNR-URB) + (park-and-ride to commuter rail: PNR-COM) = (park-and-ride to rail: PNR RAIL)
- (kiss-and-ride to urban rail: KNR-URB) + (kiss-and-ride to commuter rail: KNR-COM) = (kiss-and-ride to rail: KNR RAIL)

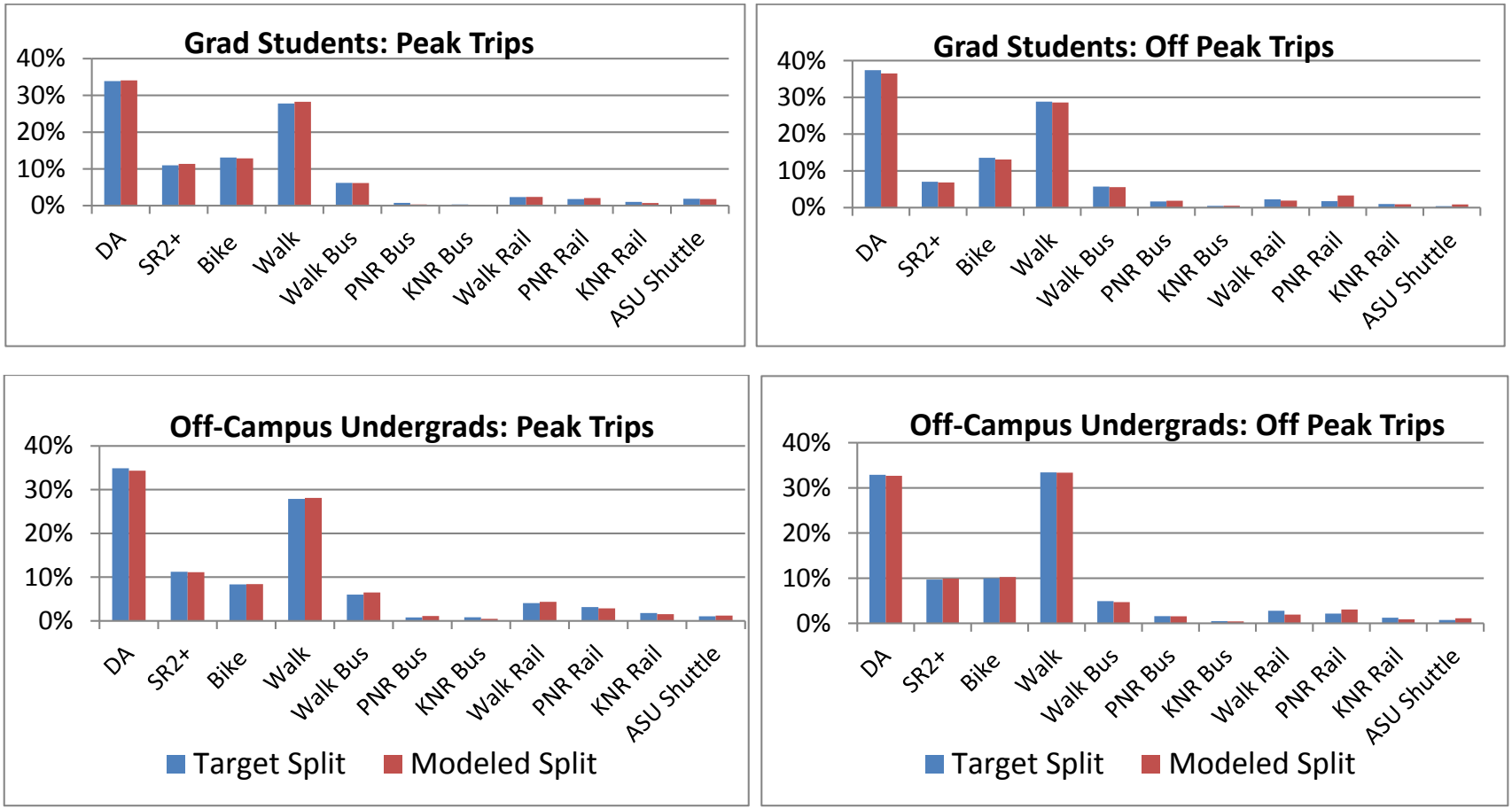


Figure 4.26 Mode Choice Model Calibration Results

5. Conclusions

This report has attempted to present ASU travel survey design and administration, analysis of observed ASU student travel characteristics, and ASU student travel demand model update.

Universities are recognized as special generators in transportation planning processes; however, university populations remain under-studied in the travel behavior analysis arena. This study is based on a comprehensive survey of ASU population of staff, students, and faculty. A web-based travel survey was administered to the entire university population which collected comprehensive socio-economic, demographic, and travel activity data. The report includes detailed information on the survey administration process, survey instrument design and questionnaire content, and survey sample profile in terms of response rates and trip rates. A synthetic population generation procedure was deployed to weight the survey sample and correct for non-response biases.

A number of lessons were learned from ASU survey experience. These may be briefly summarized as follows:

- Coordination with University Administration: The administration of a travel survey to the entire university population requires close coordination with university administrative authorities. University officials are able to deploy surveys on a university-wide basis, lend credibility to the survey effort, and provide secondary data, including control distributions that are critical to the computation of weights.
- Technology Considerations: Most universities and colleges now have personalized portals through which members of the university community access course materials, university resources, and personal information. Using this portal to engage the community in the survey proved to be extremely helpful. The online web-based travel survey should meet appropriate standards and be compliant so as to be accessible for the disabled. Individuals who are blind, in particular, may not be able to take online web-based travel surveys that are non-compliant. When deploying a web-based travel survey, due consideration should also be given to web browser and mobile device compatibility.
- User Considerations in a University Environment: In a university environment, members of the community are likely to be wary of surveys that ask for personal information and details of all daily activities (with time of day information). Students may think that the university is trying to invade their privacy. Appropriate language should be incorporated to alleviate such concerns. It should also be recognized that students are students. While most will take the survey seriously and do a good job of providing responses, there are a number of students who simply provide erroneous and frivolous information in response to the survey.
- Planning and Design of Survey – a Process Oriented Approach: There is no shortcut to the implementation of a robust and successful travel survey in a university environment. A deliberate and collaborative process-oriented approach must be followed to ensure that all constituents are engaged and supportive of the effort. Despite the best efforts and intentions of the project team, response rates for university surveys are likely to be low. Future research efforts should be aimed at identifying methods to motivate participation on the part of a student population that is often not very engaged. For this study, it was found that a tangible incentive such as the chance to win a new iPad was successful at increasing response rates.

- Survey Features: As members of a university community are likely to be technology-savvy, a survey that exploits the availability of technology to enhance the user experience is likely to be successful. Error checks and logical consistency checks may be built into the survey instrument to ensure that erroneous and miscoded data are minimized. In ASU travel survey, it appears that reminder messages did not have an appreciable impact on the response rate. Future research should explore the impacts of reminders received from various entities and through a variety of channels. In the opening page to the survey, respondents should be given an accurate and fair assessment of the time it will take to complete the survey. Respondents appreciate having a status bar showing percent completion in each screen of the survey and desire the flexibility to leave and return to the survey at the point where they left off.

Analysis of observed ASU student travel characteristics describes the trip making, activity participations, and trip chaining behaviors of undergraduate and graduate students at ASU, one of the largest universities in North America. Several notable patterns come to light through the analysis presented in this document:

- Students versus Other Adults: The survey conducted at ASU included not only students but also staff and faculty. ASU staff members were taken as representative of the typical working adult, for which most regional travel models tend to be tailored. This analysis finds that students do indeed differ from other adults. This is especially noticeable in the analysis of travel time of day, in which ASU staff display the classic AM and PM peak travel times while student travel tends to be more spread out across the day, with the majority of trips taking place at mid-day. In addition, students are less likely to travel great distances during the morning and evening typical commute times. Students also tend to make on average more trips in a day that ASU staff. When compared to other adults, therefore, students' trips are shorter, more frequent, and more likely to take place at off-peak travel times. These differences make university students an excellent target for policy changes meant to increase use of certain travel modes, understanding that alternative modes of travel targeted during off-peak times in a university area will attract more student trips.
- Undergraduate versus Graduate Students: Perhaps quite obviously, graduate students tend to be older than undergraduate students and taken as a group have more household responsibilities and are more likely to be working while attending school. Graduate students therefore display travel behaviors closer to other non-student adults as compared to undergraduate students. Although undergraduates are more mobile in general than graduate students, making more daily campus-based trips, they do not necessarily make more non-campus based trips. There is very little difference in the percent of undergraduate and graduate students who participate in mandatory (be they work-related or school-related) or maintenance activities in a given day. However, a noticeably larger portion of undergraduate students than graduate students participate in discretionary activities. The time of day in which undergraduates participate in school or work activities tends to be spread throughout the day, from early in the morning to late at night. Graduate students, on the other hand, tend to participate in school and work activities during the typical working hours in the middle of the day – from 7:00 AM to 8:00 PM. Trip-chaining behavior is very similar between undergraduates and graduate students. Although undergraduates tend to make more home-based trip chains overall than graduate students, graduate students' home-based trip chains tend to last longer. Both segments make on average 2.59 stops for each trip chain. Undergraduate students' trip chains are more likely to include a

stop at an ASU campus compared to graduate students. These patterns combine to reveal that graduate students are the group whose travel behavior more closely resembles the typical working adults'. In an area with fewer resources for incorporating student travel into a regional demand model, it would be more beneficial to focus the work on undergraduate students and use existing models of travel for graduate students.

- Patterns across Living Arrangements: Arizona State University is largely a commuter campus, with a majority of its students living off campus. These off-campus students can live with roommates, with family members, with both roommates and family members, or by themselves. There is little difference between the times of day of travel of students with varying living arrangements; however those students who live on campus are more likely to have a high proportion of their travel in the middle of the day. Students who live alone typically use the single-occupancy personal vehicle mode for all types of trips more often than students with other living arrangements. Students who live on campus overwhelming choose the walk mode for work-related trips, implying that these students likely work on or near campus. Students who live with family members tend to travel farther away from home while students who live with only roommates tend to stay closer to home. This implies that students who live only with roommates choose housing that is closer to campus. Students who live on campus have the highest daily trip rate to social recreation activities while students who live with family have the lowest. The participation rate in the serving passengers activity is especially telling across the various living arrangement groups; only 4% of on-campus students participated in serving passengers on the travel day compared to 11% of students who live with family. Students who live alone or with only roommates also had a very low participation rate in serving passengers. These patterns can lead one to conclude that students who live with their families are more likely to have household responsibilities and constraints on their travel activities. Students who live on campus, live alone, or live only with roommates tend to exercise more independence in their travel behavior choices.
- Patterns across Working Status: Similar to the comparison across living arrangements, there is little difference between the travel times of day of students of varying working status. However, students who do not work tend to have a greater proportion of their travel during the middle of the day. As can be expected, students who work only off campus choose the single-occupancy personal vehicle mode for their work-based and school-based trips more than other students. Unsurprisingly, students who work both on and off campus have the greatest daily trip rate while those who do not work have the least. Students that work only off campus have average travel times for trips of every purpose that are higher than those for students who work only on campus. The choice of working location therefore affects the travel to all other trip types, not only work-related trips. The portion of students who work only on campus that participated in a work-related activity on the travel day was much lower than other students while the portion that participated in school-related activities was much higher. This implies that students who work only on campus have extra time available (perhaps time saved from shorter work-related trips) for school-related activities. A much greater portion of students who work only on campus participated in social recreation activities on the travel day as compared to students with any other working status. These activity patterns can imply that students who work on campus have more discretionary time available to them and make shorter trips in general, making them prime targets for policies that hope to increase the use of alternative travel modes near universities.

The collected data was used to construct a submodel of ASU student travel. This study was undertaken in order to improve the accuracy of the MAG model through the disaggregation of travelers as well as through the inclusion of ASU as a special generator of travel. Only the trips that were made by students to and from ASU were included in the model. This study provided the travel modeling community with interesting and valuable insights into the process, regardless of the results of the modeling itself. The outcomes and lessons learned are summarized as follows:

- Integration with the Regional Travel Demand Model: It is important to consider from the beginning of the modeling process the points at which the submodel will interact with the regional model and to allow those interactions to take place seamlessly. All definitions of trips, productions, attractions, etc. should agree across models and software coding. The time that is necessary to accomplish this model interaction should not be underestimated. In order to more seamlessly combine the two models, the mode choice model applied to ASU-based student travel did not differ structurally from the regional model.
- Delineation between Trips in the Submodel and Trips in the Regional Model: One of the greatest challenges in estimating the university submodel was deciding which trips should be applied to the submodel and which trips should be left to the regional model to estimate. At the outset of the modeling effort, researchers should agree about whether the submodel will include intra-campus trips, intra-zonal trips, non-campus based trips, trips made by on-campus students, etc. The difference between trip attractions and trip productions can become cumbersome to define, especially when considering students who live on campus. In the case of on-campus students, trips that are made to and from the dormitory have ASU trip end as its production while trips made to and from any other campus location have ASU trip end as its attraction. This differentiation should be clearly defined and kept in mind from the process beginning to end.
- Variations among Student Market Segments: student travel patterns differ a great deal between student groups. The modeling process includes the decision of which student types and which trip types to group together. Here, trip generation was performed for graduate students, off-campus undergraduate students, and on-campus graduate students at each campus separately for each trip type (home-based or non-home based) and time of day. This disaggregation resulted in a total of 48 different trip rate calculations.
- Aggregation of Trips by Type: Although it is important to keep in mind the differences between groups of students, it is also important to recognize the similarities of certain trip types. If one were to create a separate location choice model for every student type and every trip type for each different campus, the number of models being estimated would grow to an unwieldy size. In this modeling endeavor, location choice models were estimated separately for graduate students, off-campus undergraduate students and on-campus undergraduate students separately. Home-based trips where ASU was the attraction were not estimated separately for peak and off-peak periods, though home-based (or dorm-based) trips where ASU was the production end were. Location choice models were not estimated separately for each of the different ASU campuses. This level of disaggregation allowed the model to reflect the differences in student types and trip types without overloading the processing power of the model software and without creating undue confusion with a vast number of model components.

- Use of Mode Choice Model Logsums: The traditional modeling process involves the application of a trip generation model, followed by a location choice model, and then a mode choice model. In reality, however, location choice and mode choice are not decisions that are made entirely independently. One may first choose a location and then decide what mode to take to reach it, or one may first decide on a mode (especially if one is captive to a certain mode) and then decide the location. In order to reflect this duality in the decision-making process, the location choice models included logsums resulting from the MAG mode choice model as variables. Each location choice model that was estimated revealed a coefficient on the logsum variable that was highly relevant, or that explained a great deal of the variability in location choice.
- Model Calibration Techniques: In any modeling endeavor it is important to not only estimate the model, but also to undergo the validation and calibration process. Validation of a model refers to the comparison between what is estimated and what is observed in the field while calibration refers to the adjustment of the estimated model to make predicted outcomes more closely resemble observed patterns. In this case, it was decided that the specific location (traffic analysis zone) chosen by the location choice model was less important than the distance that was chosen for travel. The validation therefore compared observed travel distances to predicted travel distances. Rather than remove a "hold-out sample" of the modeling dataset prior to model estimation (which would be the procedure for a true validation), the entire sample was used to estimate models and then the same entire sample was used to compare results. Calibration was achieved by asserting coefficients on certain distance indicator variables, as well as indicator variables for intra-campus trips and intra-zonal trips. The figures provided in the location choice model section of this document show that estimated models very closely matched travel distance distributions before calibration took place, making the assertion of the distance indicator variables more of a "fine tuning" process of model calibration. One could argue that the calibration implemented here was more than simply fine tuning and instead more closely resembles model over-fitting. Future research should focus on testing effective and technically rigorous methods for location choice model calibration.
- Variables Used in Location Choice: Traditionally, variables that are used for model estimation are those variables that have the largest "t-statistic" values, or that explain the greatest amount of variability in the choices. In this case, the modeling effort strived to include variables that not only explained a great deal of choice variability, but also that made a great deal of sense intuitively. In some cases, interaction variables – variables that are calculated as the interaction of two separate indicators – were used. For example, the location choice model for off-campus undergraduates' non-home based peak trips included a variable that was the multiplicative interaction between travel distance and an indicator for a zone with a high population density. The coefficient on this variable was positive and the t-statistic revealed it to be highly explanatory. This variable and its positive coefficient reveal that off-campus undergraduate students are more willing to travel farther distances for their non-home based campus trips if the destination is an area with a high population density (such as a downtown urban area).
- Mode Choice Update: New six ASU mode choice models by student type, living arrangement and time period were developed such as graduate students (Peak and Off Peak), off-campus undergraduate students (Peak and Off Peak) and on-campus undergraduate students (Peak and Off Peak). Except for on-campus undergraduate students, most of existing utility coefficients

were kept due to the lack of detail information of vehicle occupancy and type of transit in the survey data. Due to lack of the details of vehicle occupancy and type of transit (local/express/rapid), the mode aggregations were made for comparison of market shares from the submodel and the survey.

6. References

Kaplowitz, Michael D., Timothy D. Hadlock, and Ralph Levine. A Comparison of Web and Mail Survey Response Rates. Public Opinion Quarterly, Vol. 68, No. 1, 2004, pp 94-101

Miller, J. Results of the 2011-12 Campus Travel Survey. University of California, Davis Institute of Transportation Studies, June, 2012, Research Report – UCD-ITS-RR-12-08, URL: http://www.its.ucdavis.edu/?page_id=10063&pub_id=1644

Sarah Elia Volosin. A Study of University Student Travel Behavior, PH.D. Dissertation, Arizona State University, November 2014.

Sheehan, Kim B. E-mail Survey Response Rates: A Review, Journal of Computer-Mediated Communication, Vol. 6, No. 2, 2001

Solomon, David J. Conducting Web-Based Surveys, Practical Assessment Research and Evaluation, Vol. 7, No. 19, 2001

Truell, Allen D., James E. Bartlett, and Melody W. Alexander. Response Rate, Speed, and Completeness: A Comparison of Internet-Based and Mail Surveys. Behavior Research Methods, Instruments, and Computers, Vol. 34, No. 1, 2002, pp 46-49

Appendix A: Survey Instrument Design

The Maricopa Association of Governments (MAG) and Valley Metro, the agencies responsible for transportation planning and transit operations in the region, are conducting a survey of ASU students, faculty, and staff to better understand and plan ASU community's transportation needs. Your participation in this survey will help improve the sustainability and efficiency of the transportation system for ASU and the Greater Phoenix Metropolitan area.

As thanks for completing this survey, you will be entered into a raffle to win an Apple iPad 2. One lucky student and one lucky staff member will be notified by email the week of 7 May 2012.

For questions about the survey, please contact: Principal Investigator, Prof. Ram Pendyala, at ram.pendyala@asu.edu or 480-727-9164 For questions about your rights as a participant in this research or if you feel you have been placed at risk, please contact: the Chair of the Human Subjects Institutional Review Board (IRB), through ASU Research Compliance Office, at (480) 965-6788. This survey has received IRB approval (ref: 0703001709) and you may read the privacy policy here. Completion of the questionnaire is considered as your consent to participate in the survey.

Footer

For technical help: asu@rsgsurvey.com

To learn more about the survey: Prof. Ram Pendyala (as hyperlink)

Remove phone #'s

Learn more….

About the importance of this survey:

The Maricopa Association of Governments (MAG) (http://www.azmag.gov) and Valley Metro (http://www.valleymetro.org), the agencies responsible for transportation planning and transit operations in the region, have awarded a research project to the School of Sustainable Engineering and the Built Environment at ASU to collect data about travel undertaken by students, staff, and faculty of ASU. The data collected in this survey will be used to develop and update mathematical models that estimate traffic volumes, parking needs, and transit usage associated with the different ASU campuses. MAG and Valley Metro will also use the survey data and the resulting mathematical models to plan future transportation improvements and transit investments that will have a direct impact on ASU. In addition, ASU will use the data to better meet the mobility and parking needs of ASU community.

About taking this survey:

This survey will take about 15 minutes of your time and will ask you about your trips over the course of a day, your typical work and class schedule, and your transportation options and preferences at ASU. **As thanks for completing this survey, you will be entered into a raffle to win an Apple iPad 2**. One lucky student and one lucky staff member will be notified by email the week of 7 May 2012. All information collected will remain confidential and will not be shared, published, or disseminated in any way that will allow responses to be associated with individual participants. Survey data and results will be reported purely in aggregate statistical form to ensure privacy. There are no risks involved in participating in the survey and you may read the privacy policy here.

Who is conducting this survey:

The Maricopa Association of Governments (MAG) (http://www.azmag.gov), Valley Metro (http://www.valleymetro.org), the School of Sustainable Engineering and the Built Environment at ASU (http://engineering.asu.edu/sebe), and Resource Systems Group, Inc (http://www.rsginc.com) are jointly conducting this study.

[SECTION A: About You]

We would like to ask you some general questions. This information is used to help understand the demographic and socio-economic characteristics of ASU community. Please be assured that all information is strictly confidential (click here to view our privacy policy).

What category best represents your affiliation with ASU?

- ☐ Freshman
- ☐ Sophomore
- ☐ Junior
- ☐ Senior
- ☐ Graduate Student
- ☐ ASU staff or faculty

[If ASU staff or faculty]

What category best represents your job?

- ☐ Academic Professional
- ☐ Academic Professional with Administrative Appointment
- ☐ Administrative Staff
- ☐ Administrative Executive
- ☐ Classified Staff
- ☐ Faculty
- ☐ Faculty with Administrative Appointment
- ☐ Post Doctoral Fellow
- ☐ Service Professional

At which campus are you primarily based?

- ☐ Phoenix Downtown Campus
- ☐ Polytechnic Campus

- ☐ Tempe Campus
- ☐ West Campus

[If Downtown Campus]

What college are you affiliated with?

- ☐ Walter Cronkite School of Journalism and Mass Communication
- ☐ School of Letters and Sciences
- ☐ College of Nursing and Health Innovation
- ☐ College of Public Programs
- ☐ Mary Lou Fulton Teachers College
- ☐ Graduate College
- ☐ Barrett, the Honors College
- ☐ University College

[If Polytechnic Campus]

What college are you affiliated with?

- ☐ W.P. Carey School of Business
- ☐ School of Letters and Sciences
- ☐ College of Nursing and Health Innovation
- ☐ Mary Lou Fulton Teachers College
- ☐ College of Technology and Innovation
- ☐ Graduate College
- ☐ Barrett, the Honors College
- ☐ University College

[If Tempe Campus]

What college are you affiliated with?

- ☐ W.P. Carey School of Business

- ☐ Herberger Institute for Design and the Arts
- ☐ Ira A. Fulton Schools of Engineering
- ☐ Graduate College
- ☐ Sandra Day O'Connor College of Law
- ☐ School of Letters and Sciences
- ☐ College of Liberal Arts and Sciences
- ☐ School of Sustainability
- ☐ Mary Lou Fulton Teachers College
- ☐ Barrett, the Honors College
- ☐ University College

[If West Campus]

What college are you affiliated with?

- ☐ W.P. Carey School of Business
- ☐ New College of Interdisciplinary Arts and Sciences
- ☐ Mary Lou Fulton Teachers College
- ☐ Graduate College
- ☐ Barrett, the Honors College
- ☐ University College

[If ASU student]

Are you employed ON-campus (e.g., research/teaching assistant, assistant in college library, cashier in on-campus store, etc.)?

- ☐ Yes
- ☐ No

[If ASU student]

Are you employed OFF-campus (e.g., waitress in a restaurant, etc.)?

Please also include any regular internships or volunteer jobs if they are off-campus.

- ☐ Yes
- ☐ No

[If ASU student]

Do you live on-campus or off-campus?

- ☐ On-campus
- ☐ Off-campus

[If student lives on-campus]

On which campus is your residence hall located?

- ☐ Phoenix Downtown Campus
- ☐ Polytechnic Campus
- ☐ Tempe Campus
- ☐ West Campus

[If student and lives at polytechnic campus]

In which residence hall do you live?

- ☐ Bell Res Hall
- ☐ Dean Res Hall
- ☐ Desert Village (North)
- ☐ Desert Village (South)
- ☐ Desert Village (West)
- ☐ Eagle Res Hall
- ☐ Falcon Res Hall
- ☐ Mustang Hall
- ☐ Palo Blanco Hall

- ☐ Phantom Hall
- ☐ Talon Res Hall

[If student and lives at Tempe campus]

In which residence hall do you live?

- ☐ Acacia Hall (Hassayampa Village)
- ☐ Acourtia Hall (Hassayampa Village)
- ☐ Adelphi Commons
- ☐ Arroyo Hall (Hassayampa Village)
- ☐ Barrett Honors Complex
- ☐ Best Hall
- ☐ Cholla Apartments
- ☐ Chuparosa Hall (Hassayampa Village)
- ☐ Hayden Hall
- ☐ Irish Hall
- ☐ Jojoba Hall (Hassayampa Village)
- ☐ Manzanita Hall
- ☐ McClintock Hall
- ☐ Mesquite Hall (Hassayampa Village)
- ☐ Mohave Hall (Hassayampa Village)
- ☐ Palo Verde (East)
- ☐ Palo Verde (Main)
- ☐ Palo Verde (West)
- ☐ San Pablo Res Hall
- ☐ University Towers
- ☐ Verbena Hall (Hassayampa Village)
- ☐ Vista Del Sol

[If student and lives at Tempe campus]

In which residence hall do you live?

- ☐ Las Casas Res Hall (A Wing)
- ☐ Las Casas Res Hall (B Wing)
- ☐ Las Casas Res Hall (C Wing)
- ☐ Las Casas Res Hall (D Wing)

[If non-student or student who lives OFF campus]

Please use the interactive map to identify the location of <u>your home</u>.

The exact address of your home will NOT be entered into the study database. Instead, the nearest cross streets to your home location will be entered into the study database and used in all analyses.

What is your gender?

- ☐ Female
- ☐ Male

What is your age?

- ☐ 16 - 19
- ☐ 20 - 24
- ☐ 25 - 29
- ☐ 30 - 34
- ☐ 35 - 39
- ☐ 40 - 44
- ☐ 45 - 49
- ☐ 50 - 54
- ☐ 55 - 59
- ☐ 60 - 64
- ☐ 65 - 69
- ☐ 70 - 74
- ☐ 75 - 79
- ☐ 80 or higher

Are you of Hispanic or Latino origin?

- ☐ Yes
- ☐ No
- ☐ Prefer not to answer

What is your race?

- ☐ African American or Black
- ☐ American Indian or Alaskan Native
- ☐ Asian
- ☐ White or Caucasian
- ☐ Other
- ☐ Prefer not to answer

[Non-students and students who live OFF campus]

How many OTHER people live in your household who are 18 OR OLDER?

Please include everyone who normally resides with you.

- ☐ 0 (I am the only adult)
- ☐ 1 other adult
- ☐ 2 other adults
- ☐ 3 other adults
- ☐ 4 other adults
- ☐ 5 other adults
- ☐ 6 other adults
- ☐ 7 or more other adults

[Non-students and students who live OFF campus]

How many CHILDREN UNDER AGE 18 live in your household?

- ☐ 0 (no minors)
- ☐ 1 minor
- ☐ 2 minors
- ☐ 3 minors
- ☐ 4 minors
- ☐ 5 or more minors

[Students who live OFF campus and who have other people in the household]

Who do you live with?

- ☐ Partner/Spouse and/or family members

- ☐ Roommates (non-family members)
- ☐ Both

Do you have a valid driver's license?

- ☐ Yes
- ☐ No

Do you have a smart phone?

- ☐ Yes
- ☐ No

[If has smart phone]

Would you be willing to provide the location information saved on your Smartphone in a future study of this type (not in this study), as long as your confidentiality and anonymity are guaranteed?

- ☐ Yes
- ☐ No
- ☐ Maybe, but I would need to find out more details first

Do you have a condition that substantially limits your mobility or physical capabilities?

- ☐ Yes
- ☐ No
- ☐ Prefer not to answer

[SECTION B: Household Vehicles]

[Students who live ON campus] **How many motor vehicles do you have with you on-campus?**

[Non-students and students who live OFF campus] **How many motor vehicles (in working order) are there in your household?**

Please include all cars, pickup trucks, minivans, and motorcycles/scooters to which your household has regular access, whether owned, leased, or a company vehicle.

- ☐ 0 (no vehicles)
- ☐ 1 vehicle
- ☐ 2 vehicles
- ☐ 3 vehicles
- ☐ 4 vehicles
- ☐ 5 or more vehicles

[If has vehicles in household and non-student/student who lives OFF campus]

Please tell us about the vehicle(s) in your household.

How often use to travel to/from campus?

- ☐ Daily
- ☐ 4-5 days a week
- ☐ 2-3 days a week
- ☐ One day a week
- ☐ Less than weekly
- ☐ Never

Year drop-down list

Make drop-down list

Model drop-down list

[SECTION C. All of the Trips You Made on a Specific Day]

Thank you for your answers so far. Now we would like to ask you a few questions about the trips you made and the places you went yesterday, or the most recent weekday (for example, if today is Sunday, please provide details about the trips you made on Friday).

Specifically, we would like to know about any trips you made yesterday. A trip consists of any travel of at least 5 minutes by air, car, bus, bike, walking, or other means AND any change of address or location. Some example trips include: walking from the library to class, biking to an off-campus coffee shop, going for a run in South Mountain Park, taking the bus to a volunteer job, and riding the intercampus shuttle to another ASU campus, etc.

Did you make any trips yesterday (or the most recent weekday)?

- ☐ Yes

- ☐ No

[If did not make any trips yesterday and non-student/student who lives off-campus]

Why didn't you travel or make any trips yesterday? Please select all that apply.

- ☐ I worked from home for pay (e.g., home-based business or telecommuting)
- ☐ I worked around the home (not for pay)
- ☐ I studied from home
- ☐ I was not scheduled to work yesterday and stayed home
- ☐ I took a vacation/personal day and stayed home
- ☐ I was sick or I cared for a sick/unwell member of my household
- ☐ Other, please specify:

Please list all the places you went yesterday (or the most recent weekday).

Please locate each place you went yesterday (or the most recent weekday).

- ☐ Select the button of the place you want to locate
- ☐ Then search for an address or business by typing in the box below
- ☐ OR you can click on the map with the hand to zoom to a location. Once you are zoomed in enough you can click to place the marker.

Please tell us about your trip from X to Y.

Viewing trip 1 of N trip(s) total.

Time departed from X (5 minute increments)

Time arrived at Y (5 minute increments)

Main Purpose of Trip

- ☐ Work
- ☐ Work - related business
- ☐ School (attend class)
- ☐ School - related activity (e.g., library, homework, study group, etc.)
- ☐ Eat meal

- ☐ Shopping
- ☐ Social Recreation/Sport
- ☐ Personal Business (i.e., Bank, Post Office, etc.)
- ☐ Pick-up / Drop-off adult passenger
- ☐ Pick-up / Drop-off child
- ☐ Switch type of transportation (i.e., change from bus to light rail)
- ☐ Go back to home (or dorm)
- ☐ Other

Main Way Traveled on Trip

- ☐ Drive alone
- ☐ Drive with passenger(s)
- ☐ Ride in a car as a passenger
- ☐ Drive motorcycle or scooter
- ☐ Light Rail
- ☐ Valley Metro Bus
- ☐ Neighborhood FLASH
- ☐ Tempe ORBIT
- ☐ Intercampus Shuttle
- ☐ Ride my bicycle
- ☐ Walk
- ☐ Other (skateboard, rollerblade, etc)

[If auto used as primary travel mode]

- ☐ Vehicle used:
- ☐ Parking lot used:
- ☐ Time to find parking space:
- ☐ Time to walk from parking space to final destination:

[If Transit used as primary travel mode]

- ☐ How get to first stop to board bus/train:
- ☐ Time to get to first stop to board bus/train:
- ☐ First stop to board bus/train:
- ☐ Time waited at stop before boarding bus/train:
- ☐ Main bus route used:
- ☐ Last stop got off bus/train:
- ☐ How got from last stop to final destination:
- ☐ Time from last stop to get to final destination:

[SECTION D. Transportation Mode(s) To/From OFF-campus job]

[Section only shown to students with an OFF-campus job]

We would like to ask you some more questions about your off-campus job(s) in order to understand more about your trips to/from campus.

How many off-campus jobs do you have?

- ☐ 1 off-campus job
- ☐ 2 off-campus jobs
- ☐ 3 or more off-campus jobs

About how many hours per week do you work off-campus?

- ☐ Fewer than 10 hours
- ☐ 11-20 hours
- ☐ 21-30 hours
- ☐ 31-40 hours
- ☐ 40 or more hours per week

[If has more than 1 off-campus job]

How do you typically get to and from your primary off-campus workplace?

[If has 1 off-campus job]

How do you typically get to and from your off-campus workplace?

- ☐ Drive alone
- ☐ Drive with passenger(s)
- ☐ Ride in a car as a passenger
- ☐ Drive motorcycle or scooter
- ☐ Light Rail
- ☐ Valley Metro Bus
- ☐ Neighborhood FLASH
- ☐ Tempe ORBIT
- ☐ Intercampus Shuttle
- ☐ Ride my bicycle

- ☐ Walk
- ☐ Other (skateboard, rollerblade, etc)

[If has more than 1 off-campus job]

Please use the interactive map to identify the location of <u>your primary off-campus job</u>.
[If has 1 off-campus job]

Please use the interactive map to identify the location of <u>your off-campus job</u>.

The exact address will NOT be entered into the study database. Instead, the nearest cross streets will be entered into the study database and used in all analyses.

[SECTION E. Transportation Mode(s) To/From ASU Campus]

[Section E is NOT shown to students who live on campus]

We would like to ask you some more questions about your typical travel to/from campus.

In the last month, how have you traveled between your home and ASU? Please select all that apply.

- ☐ Drive alone
- ☐ Drive with passenger(s)
- ☐ Ride in a car as a passenger
- ☐ Drive motorcycle or scooter
- ☐ Light Rail
- ☐ Valley Metro Bus
- ☐ Neighborhood FLASH
- ☐ Tempe ORBIT
- ☐ Intercampus Shuttle
- ☐ Ride my bicycle
- ☐ Walk
- ☐ Other (skateboard, rollerblade, etc)

How often do you travel between your home and ASU?

- ☐ More than 5 days a week
- ☐ 5 days a week

- ☐ 4 days a week
- ☐ 2-3 days a week
- ☐ 1 day a week
- ☐ Less than 1 day a week

How long does it usually take you to travel one-way from your home to ASU (door-to-door)?

- ☐ Less than 5 minutes
- ☐ 5-10 minutes
- ☐ 10-15 minutes
- ☐ 15-20 minutes
- ☐ 20-25 minutes
- ☐ 25-30 minutes
- ☐ 30-35 minutes
- ☐ 35-40 minutes
- ☐ 40-45 minutes
- ☐ 45-50 minutes
- ☐ 50-55 minutes
- ☐ More than 60 minutes

[Show list of modes not used in the last month]

Which of the following modes could you use if you had to (but you don't currently) to travel between home and campus? Please select all that apply.

- ☐ Drive alone
- ☐ Drive with passenger(s)
- ☐ Ride in a car as a passenger
- ☐ Drive motorcycle or scooter
- ☐ Light Rail
- ☐ Valley Metro Bus
- ☐ Neighborhood FLASH
- ☐ Tempe ORBIT
- ☐ Intercampus Shuttle
- ☐ Ride my bicycle
- ☐ Walk
- ☐ None of the above

[SECTION F. Drives Personal Vehicle To/From ASU Campus – Section only shown to those who have driven (personal vehicle or motorcycle) to/from campus in the last month]

[If Downtown campus]

Select the parking lot or structure in which you generally park your car at the Phoenix Downtown Campus.

- ☐ 2nd Avenue Lot
- ☐ 3rd Avenue Lot
- ☐ 4th Avenue/Perimeter Lot
- ☐ AZ Republic Garage
- ☐ East Garage
- ☐ Fillmore Lot
- ☐ Heritage Square Garage
- ☐ Nursing and Health Innovation
- ☐ NHI2 Visitor Parking
- ☐ Taylor Place/McKinley Lot
- ☐ UC II Visitor Parking
- ☐ University Center Garage
- ☐ On-street (free or metered)
- ☐ Other

[If Downtown campus]

Which parking decal are you holding?

- ☐ AZ Republic Garage – Resident
- ☐ East Garage – Employee
- ☐ East Garage - Student
- ☐ Employee All Access Disabled
- ☐ Fourth Avenue / Perimeter Lot
- ☐ Heritage Square Garage
- ☐ Heritage Square Garage – Evening Only
- ☐ Motorcycle
- ☐ McKinley / Taylor Place Lot – Resident
- ☐ Nursing Healthcare Innovation Garage
- ☐ Student Disabled Permit
- ☐ Second Avenue Lot
- ☐ University Center Garage
- ☐ University Center Garage – Evening Only
- ☐ I don’t have a parking decal
- ☐ Other

[If Polytechnic campus]

Select the parking lot or structure in which you generally park your car at the Polytechnic Campus.

- ☐ CGCC Lot 90
- ☐ CGCC Lot 91
- ☐ CGCC Lot 92
- ☐ CGCC Lot 93
- ☐ CGCC Lot 94
- ☐ CGCC Lot 95
- ☐ Green Lot 5
- ☐ Green Lot 6
- ☐ Green Lot 8
- ☐ Green Lot 10
- ☐ Green Lot 12
- ☐ Green Lot 13
- ☐ Green Lot 14
- ☐ Green Lot 15
- ☐ Green Lot 30
- ☐ Green Lot 35
- ☐ Green Lot 37
- ☐ Green Lot 43
- ☐ Green Lot 46
- ☐ Green Lot 48
- ☐ Green Lot 49
- ☐ Lot 6 (Visitor)
- ☐ Lot 12 (Visitor)
- ☐ Lot 16
- ☐ Lot 29
- ☐ Lot 48 (Visitor)
- ☐ Perimeter Lot 1
- ☐ Perimeter Lot 2
- ☐ Perimeter Lot 24
- ☐ Perimeter Lot 27
- ☐ Perimeter Lot 32
- ☐ Perimeter Lot 33
- ☐ Perimeter Lot 36
- ☐ Perimeter Lot 50
- ☐ Perimeter Lot 54
- ☐ Perimeter Lot 55
- ☐ Red Lot 7
- ☐ Red Lot 51
- ☐ Red/Green Lot 16
- ☐ Resident Lot 42
- ☐ Resident Lot 47
- ☐ Resident Lot 96

- ☐ Resident Lot 97
- ☐ Resident Lot 98
- ☐ Resident Lot 99
- ☐ Restricted Lot 25
- ☐ Restricted Lot 28
- ☐ VA Lot
- ☐ On-street (free or metered)
- ☐ Other

[If Polytechnic campus]

Which parking decal are you holding?

- ☐ Green Lots
- ☐ Red Lots
- ☐ Motorcycle
- ☐ Perimeter Lots
- ☐ Polytechnic – Evening Only
- ☐ Polytechnic Disabled Parking
- ☐ Residence Hall
- ☐ I don't have a parking decal
- ☐ Other

[If Tempe campus]

Select the parking lot or structure in which you generally park your car at the Tempe Campus.

- ☐ 10th Street Parking Structure
- ☐ Apache Boulevard Structure
- ☐ Brickyard Parking Structure
- ☐ Chase Garage at Centerpoint
- ☐ Fulton Center Structure
- ☐ Lot 3
- ☐ Lot 9
- ☐ Lot 11
- ☐ Lot 13
- ☐ Lot 14
- ☐ Lot 15
- ☐ Lot 16
- ☐ Lot 17
- ☐ Lot 18
- ☐ Lot 19
- ☐ Lot 20

- ☐ Lot 27
- ☐ Lot 40 West
- ☐ Lot 41
- ☐ Lot 43
- ☐ Lot 45
- ☐ Lot 46
- ☐ Lot 47
- ☐ Lot 49
- ☐ Lot 50
- ☐ Lot 57
- ☐ Lot 58
- ☐ Lot 59
- ☐ Lot 59 East
- ☐ Lot 59 North
- ☐ Lot 60
- ☐ Lot 61
- ☐ Lot 62
- ☐ Lot 63
- ☐ Lot 65
- ☐ Lot 66
- ☐ Lot 72
- ☐ Packard Drive South Parking Structure
- ☐ Rural Road Structure
- ☐ Stadium Parking Structure
- ☐ Tyler Street Parking Structure
- ☐ University Towers Parking Structure
- ☐ Metered parking lots
- ☐ On-street (free or metered)
- ☐ Other

[If Tempe campus]

Which parking decal are you holding?

- ☐ 10th Street Structure
- ☐ 10th Street Structure – Evening Only
- ☐ 10th Street Structure – Resident
- ☐ Apache Blvd Structure
- ☐ Apache Blvd Structure – Evening Only
- ☐ Apache Blvd Structure – Resident
- ☐ ASU Fulton Center Structure
- ☐ Brickyard
- ☐ Chase Garage at Centerpoint
- ☐ Disabled All Access – Employee
- ☐ Disabled Parking Permit – Student

- ☐ Lot 3
- ☐ Lot 16
- ☐ Lot 58
- ☐ Lot 59
- ☐ Lot 59E
- ☐ Lot 59N
- ☐ Lot 72
- ☐ Motorcycle
- ☐ Packard Drive South Structure
- ☐ Residence Hall Surface Lots (50, 63)
- ☐ Rural Road Parking Structure
- ☐ Rural Road Structure – Resident
- ☐ Stadium Structure
- ☐ Stadium Structure – Resident
- ☐ Tyler Street Structure
- ☐ University Towers Structure
- ☐ I don't have a parking decal
- ☐ Other

[If West campus]

Select the parking lot or structure in which you generally park your car at the West Campus.

- ☐ Lot 1
- ☐ Lot 2
- ☐ Lot 3
- ☐ Lot 7
- ☐ Lot 12
- ☐ Lot 13
- ☐ Lot 14
- ☐ Lot 16
- ☐ Lot 17
- ☐ Lot 18
- ☐ Lot 19
- ☐ Lot 20
- ☐ North Zone Lot 10
- ☐ North Zone Lot 11
- ☐ Park Zone
- ☐ Metered lots
- ☐ On-street (free or metered)
- ☐ Other

[If West campus]

Which parking decal are you holding?

- ☐ Lot 7
- ☐ Lot 17
- ☐ Lot 19 – Residence Hall
- ☐ Motorcycle
- ☐ North Zone
- ☐ Park Zone
- ☐ South Zone
- ☐ West Campus Disabled Parking
- ☐ West Campus Evening Only
- ☐ I don't have a parking decal
- ☐ Other

[If "I don't have a parking decal"]

On average, how much do you pay for parking?

$ _____ per day/week/month/semester/year

[If "I don't have a parking decal"]

Who pays for your parking?

- ☐ I do
- ☐ [If student] My parents
- ☐ My employer
- ☐ Other, please specify:

How often do you <u>typically</u> use your vehicle in the middle of the work or school day?

- ☐ Never
- ☐ Once a day
- ☐ Twice a day
- ☐ Three times a day
- ☐ Four times a day
- ☐ Five times a day
- ☐ More than five times a day

Why do you drive a personal vehicle instead of using public transit (bus or rail) for your travel to and from ASU?

- ☐ Travel time on transit is too long
- ☐ Transit does not run early or late enough
- ☐ Transit does not run often enough
- ☐ Transit is less reliable than driving
- ☐ Too far to get to transit station/stop
- ☐ Transit is not safe enough
- ☐ Transit is too crowded
- ☐ Transit is uncomfortable
- ☐ I don't know enough about public transit options
- ☐ Transit is too dirty
- ☐ It would have required too many transfers to make the trip by transit
- ☐ I don't like taking public transportation
- ☐ I need my personal vehicle for other reasons

[If needs vehicle]

Why do you need access to your personal vehicle during the day?

Please select all that apply.

- ☐ Need car for work-related trips
- ☐ Running errands
- ☐ Cannot carry what I need on transit
- ☐ Need car because transit doesn't run early/late enough
- ☐ Need to pick-up/drop-off my kids/spouse
- ☐ Need car to match my flexible schedule
- ☐ Other, please specify:

[SECTION G. Transit Questions]

[If non-student or student who lives OFF-campus]

How familiar are you with public transit (bus or rail) service (e.g., stop locations, frequency of service, and routes) between home and ASU campus?

- ☐ Very familiar
- ☐ Somewhat familiar
- ☐ Not familiar

[If student]

Do you have a transit pass (also called a U-Pass) that is valid for use in Spring 2012?

- ☐ Yes
- ☐ No

[If non-student]

Do you have a transit pass (also called an Employee Pass or Platinum Pass) that is valid for use in Spring 2012?

- ☐ Yes
- ☐ No

[If has a transit pass]

Who pays for your transit fare or pass?

- ☐ I do

[If student] My parents

- ☐ My employer
- ☐ Other, please specify:

[Does not have a transit pass]

Why didn't you purchase a transit pass in Spring 2012?

- ☐ Please select all that apply.
- ☐ Too busy to purchase one
- ☐ The cost savings is not enough to justify buying a pass
- ☐ I am not sure if I will use transit enough to justify the cost of a pass
- ☐ A pass is too expensive
- ☐ I am afraid I will lose the pass
- ☐ Other (please specify) _____

SECTION G. Additional Transit Questions – Asked of students who live ON-campus who commute by transit to their OFF campus job by transit, asked of students who live OFF-campus, and asked of non-students (transit = light rail, valley metro bus, neighborhood FLASH, Tempe ORBIT)

[If does not have a transit pass] When you use public transit to travel to and from ASU, how much do you pay one-way in transit fare? $ _____

[If non-student or student who lives OFF-campus] For the new few questions, please think about your trip by transit (bus and/or rail) to get from your home to campus?

[If student who lives ON campus and commutes to an OFF-campus job] For the new few questions, please think about your trip from campus to your OFF-campus job.

How do you get to the first transit stop or station?

- ☐ Drive (Park and Ride)
- ☐ Dropped off
- ☐ Walk
- ☐ Bicycle
- ☐ Scooter
- ☐ Other (skateboard, rollerblade, etc)

How long does it usually take you to get to the first transit stop or station?

- ☐ Less than 1 minute

- ☐ > 1-3 minutes
- ☐ > 3-5 minutes
- ☐ > 5-10 minutes
- ☐ > 10-15 minutes
- ☐ > 15-20 minutes
- ☐ > 20-25 minutes
- ☐ > 25-30 minutes
- ☐ More than 30 minutes

How long do you usually wait for the bus or train?

- ☐ Less than 1 minute
- ☐ > 1-3 minutes
- ☐ > 3-5 minutes
- ☐ > 5-10 minutes
- ☐ > 10-15 minutes
- ☐ > 15-20 minutes
- ☐ > 20-25 minutes
- ☐ > 25-30 minutes
- ☐ > More than 30 minutes

[If non-student or student who lives OFF-campus] **When you get off at the final stop, how long does it take you to reach the normal building you go to on campus?**

[If student who lives ON campus and commutes to an OFF-campus job] **When you get off at the final stop, how long does it take you to reach your off-campus workplace?**

- ☐ Less than 1 minute
- ☐ > 1-3 minutes
- ☐ > 3-5 minutes
- ☐ > 5-10 minutes
- ☐ > 10-15 minutes
- ☐ > 15-20 minutes
- ☐ > 20-25 minutes
- ☐ > 25-30 minutes
- ☐ More than 30 minutes

SECTION H. Your Opinions on Transportation

(All respondents; Statements will be shown in random order)

Please indicate how strongly you agree or disagree with each of the following statements.

(5=strongly agree; 4=agree; 3=neutral; 2=disagree; 1=strongly disagree)

- ☐ I am not afraid to ride transit.
- ☐ I'm the kind of person who rides transit.
- ☐ It's easy to plan a trip using transit.
- ☐ Transit is often dirty.
- ☐ More than saving time, I prefer to be productive when traveling.
- ☐ If it would save time, I would change my form of travel.
- ☐ As long as I am comfortable when traveling, I can tolerate delays.
- ☐ Protecting the environment is very important to me.
- ☐ My days of taking transit are over.

Please indicate how strongly you agree or disagree with each of the following statements.

(5=strongly agree; 4=agree; 3=neutral; 2=disagree; 1=strongly disagree)

- ☐ For me, my personal vehicle (car/motorcycle) is king! Nothing will replace my personal vehicle as my main mode of transportation
- ☐ Getting to and from transit station/stops is not pedestrian friendly and is very unpleasant
- ☐ I have to drive to get to transit anyway, so I may as well just drive my personal vehicle the whole way
- ☐ Privacy is important to me when I travel
- ☐ I currently make an effort to take public transit whenever I can
- ☐ My personal vehicle reflects who I am
- ☐ If I wanted to, I could use public transit more frequently
- ☐ I am willing to carpool or take public transit more frequently to reduce air pollution and carbon emissions from my vehicle
- ☐ I am willing to pay higher tolls if they are used to reduce air pollution and carbon emissions

SECTION I. Conclusion

What is your annual (before-tax) household income?

- ☐ $0 - $4,999
- ☐ $5,000 - $9,999
- ☐ $10,000 - $19,999
- ☐ $20,000 - $29,999
- ☐ $30,000 - $39,999
- ☐ $40,000 - $49,999
- ☐ $50,000 - $59,999
- ☐ $60,000 - $69,999
- ☐ $70,000 - $79,999
- ☐ $80,000 - $89,999

- ☐ $90,000 - $99,999
- ☐ $100,000 - $149,999
- ☐ $150,000 - $199,999
- ☐ More than $200,000

Thank you for your participation in the survey.

If you would like to be entered into the raffle to win an iPad 2 please enter your name and ASU email address below.

Name: _____

Email Address: _____

If you have any additional comments about transportation to/from ASU campus(es), please type them in the box below.

_____
_____
_____
_____

If you have any suggestions about how we can improve our surveys in the future, please type them in the box below. We welcome feedback for how to improve.

_____
_____
_____
_____

Thank you for your participation. All of your answers have been submitted. The winners of the iPad 2 raffle will be notified the week of 7 May 2012.

This study is being jointly conducted by: The Maricopa Association of Governments (MAG) (http://www.azmag.gov), Valley Metro (http://www.valleymetro.org), the School of Sustainable Engineering and the Built Environment at ASU (http://engineering.asu.edu/sebe), and Resource Systems Group, Inc (http://www.rsginc.com).

Appendix B: IRB Approval

ASU Knowledge Enterprise Development

Office of Research Integrity and Assurance

To:	Ram Pendyala ISTB2
From:	Mark Roosa, Chair Soc Beh IRB
Date:	03/29/2012
Committee Action:	**Exemption Granted**
IRB Action Date:	03/29/2012
IRB Protocol #:	1203007647
Study Title:	Arizona State University Travel Survey Design and Administration

The above-referenced protocol is considered exempt after review by the Institutional Review Board pursuant to Federal regulations, 45 CFR Part 46.101(b)(2) (4) .

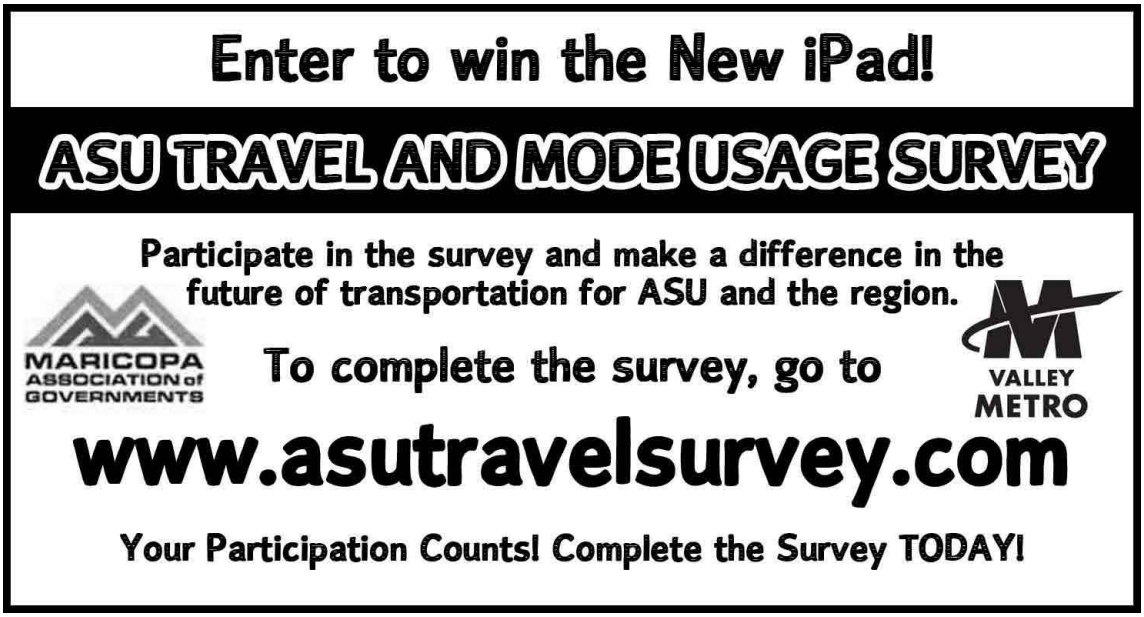
This part of the federal regulations requires that the information be recorded by investigators in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects. It is necessary that the information obtained not be such that if disclosed outside the research, it could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.

You should retain a copy of this letter for your records.

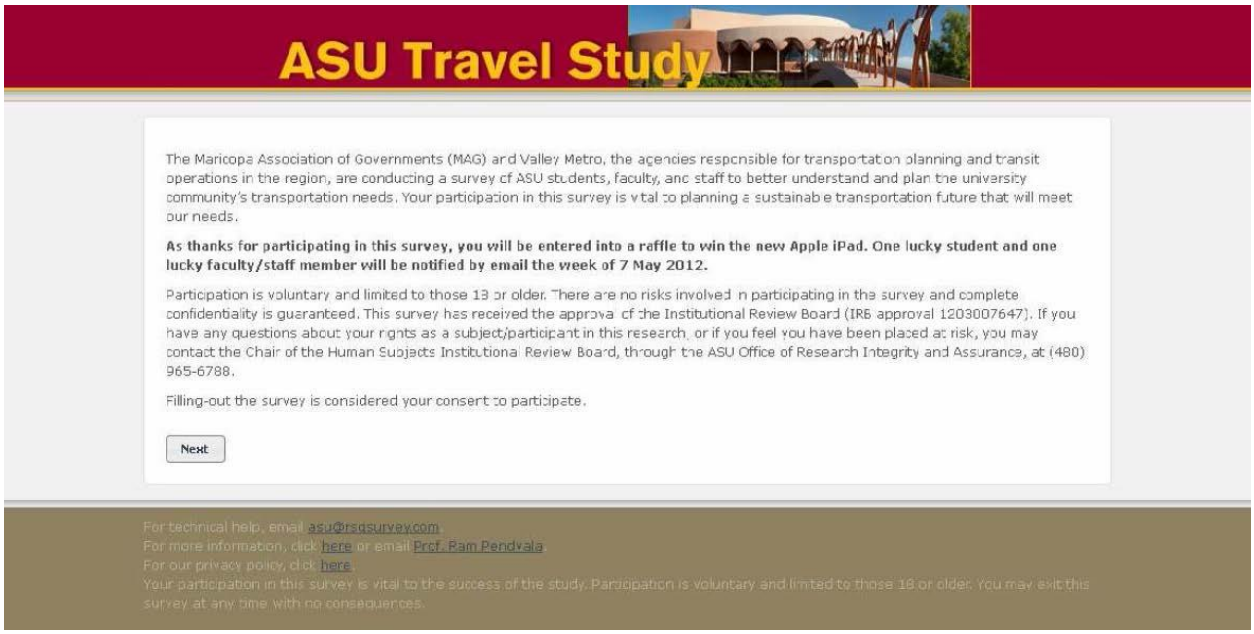
Appendix C: Publicity Materials

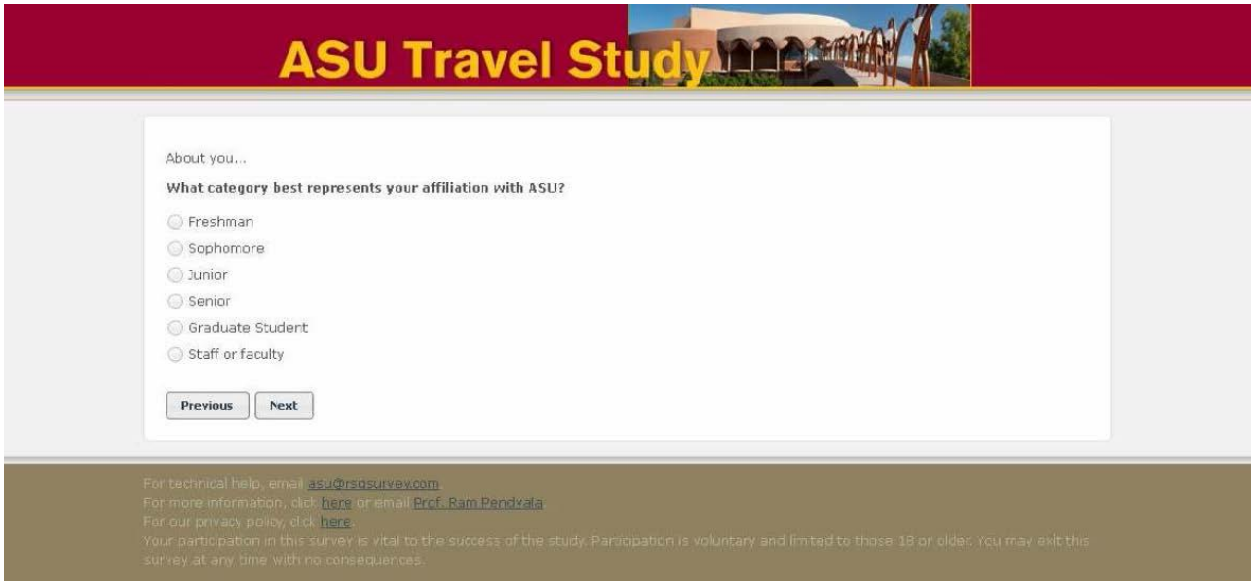
Flyer Posted and Distributed at All ASU Campuses

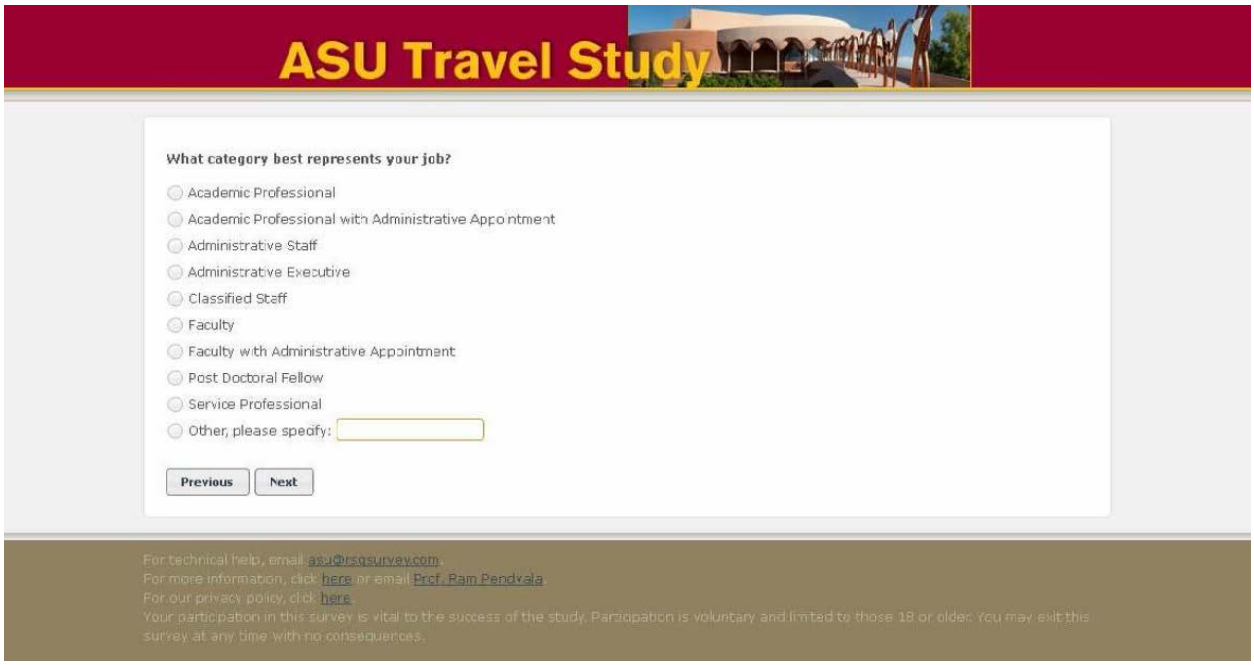
Advertisement in ASU State Press – Print and Online Editions



Appendix D: Screenshots of ASU Survey Website






ASU Travel Study
What category best represents your job?
Academic Professional
Academic Professional with Administrative Appointment
Administrative Staff
Administrative Executive
Classified Staff
Faculty
Faculty with Administrative Appointment
Post Doctoral Fellow
Service Professional
Other, please specify:
Previous
Next
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For our privacy policy, click here.
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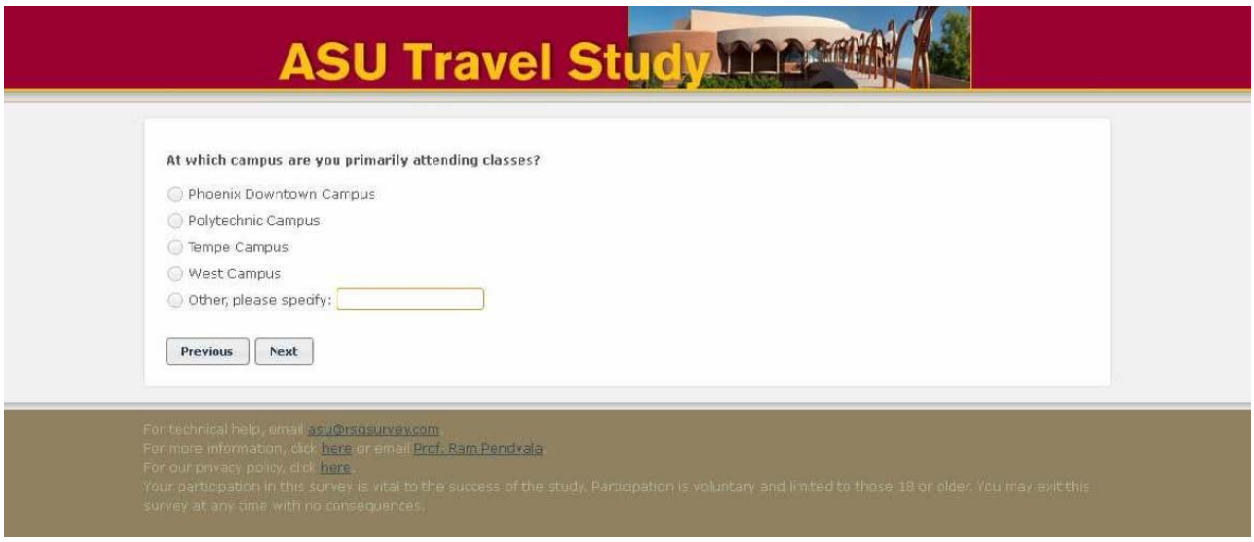
ASU Travel Study
At which campus are you primarily attending classes?
Phoenix Downtown Campus
Polytechnic Campus
Tempe Campus
West Campus
Other, please specify:
Previous
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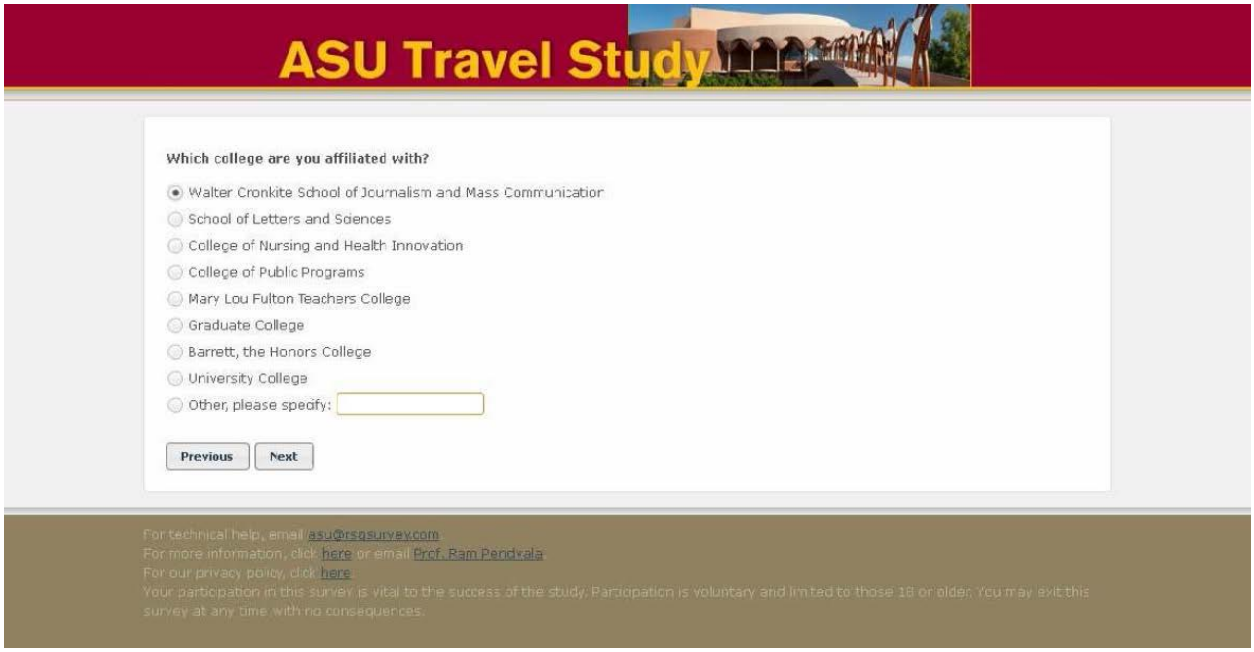
ASU Travel Study
Which college are you affiliated with?
Walter Cronkite School of Journalism and Mass Communication
School of Letters and Sciences
College of Nursing and Health Innovation
College of Public Programs
Mary Lou Fulton Teachers College
Graduate College
Barrett, the Honors College
University College
Other, please specify:
Previous
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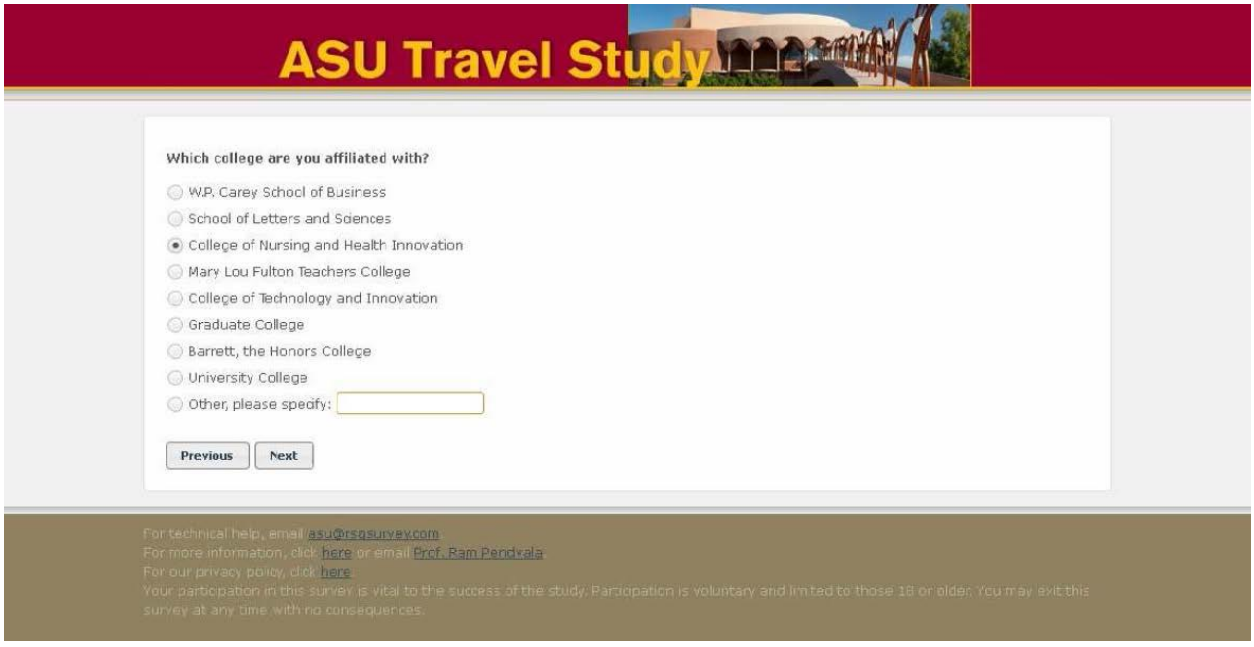
ASU Travel Study
Which college are you affiliated with?
W.P. Carey School of Business
School of Letters and Sciences
College of Nursing and Health Innovation
Mary Lou Fulton Teachers College
College of Technology and Innovation
Graduate College
Barrett, the Honors College
University College
Other, please specify:
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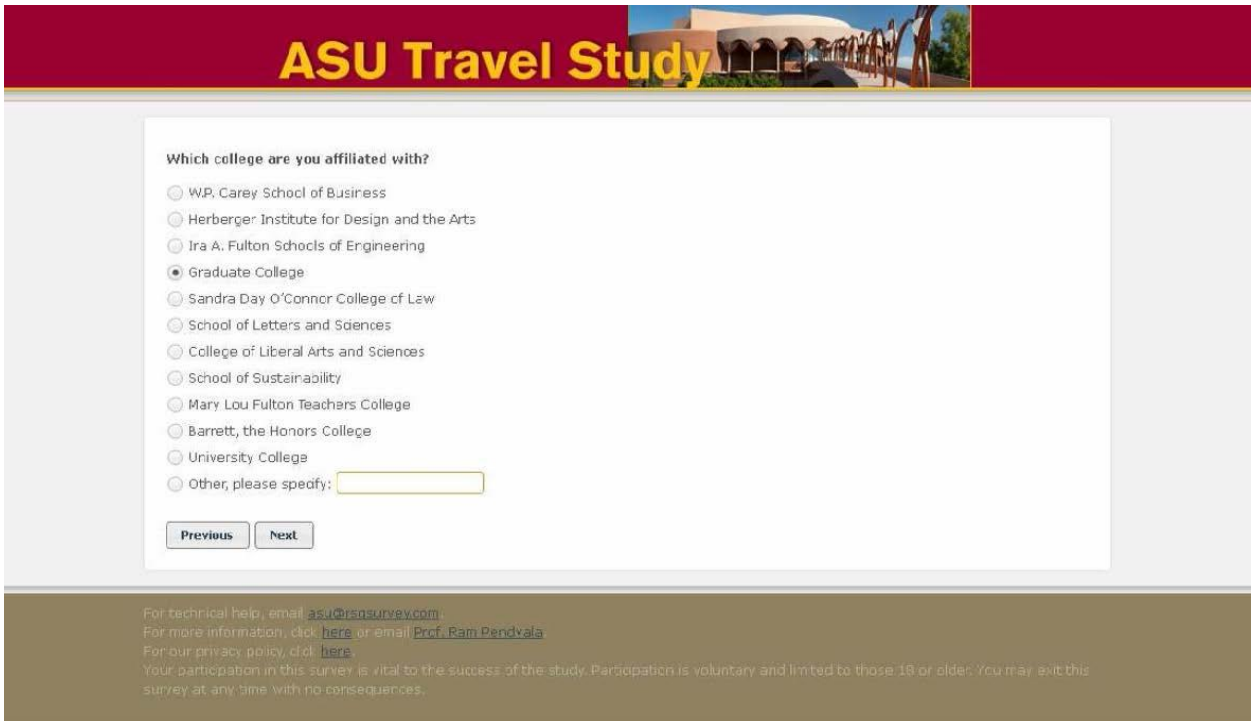
ASU Travel Study
Which college are you affiliated with?
W.P. Carey School of Business
Herberger Institute for Design and the Arts
Ira A. Fulton Schools of Engineering
Graduate College
Sandra Day O'Connor College of Law
School of Letters and Sciences
College of Liberal Arts and Sciences
School of Sustainability
Mary Lou Fulton Teachers College
Barrett, the Honors College
University College
Other, please specify:
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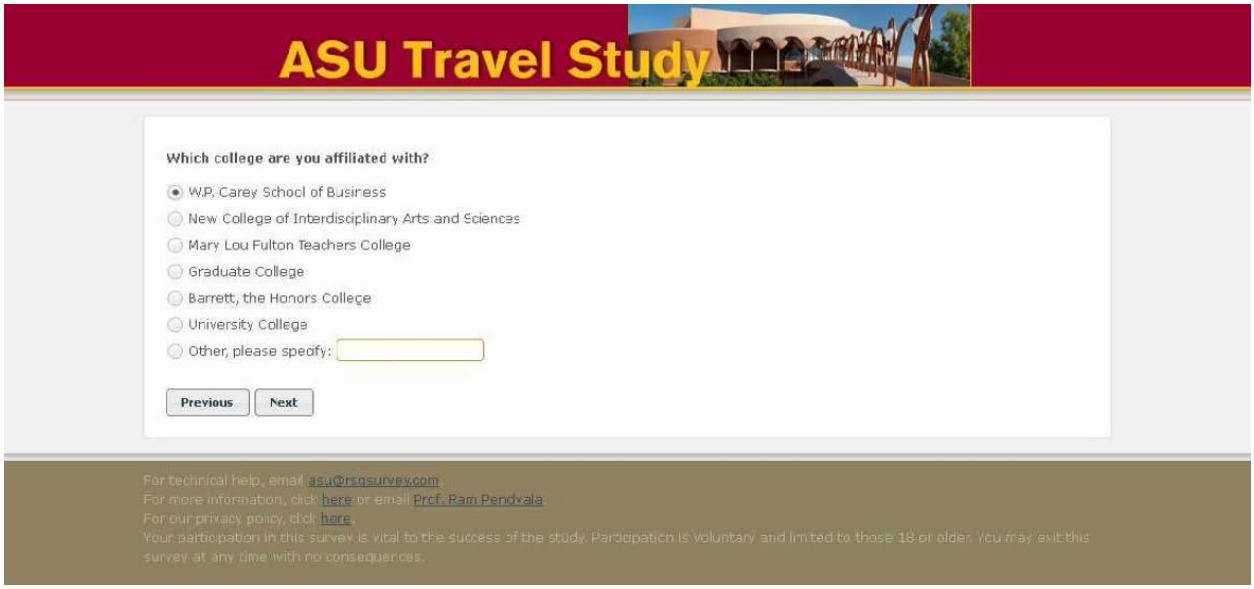
ASU Travel Study
Which college are you affiliated with?
W.P. Carey School of Business
New College of Interdisciplinary Arts and Sciences
Mary Lou Fulton Teachers College
Graduate College
Barrett, the Honors College
University College
Other, please specify:
Previous
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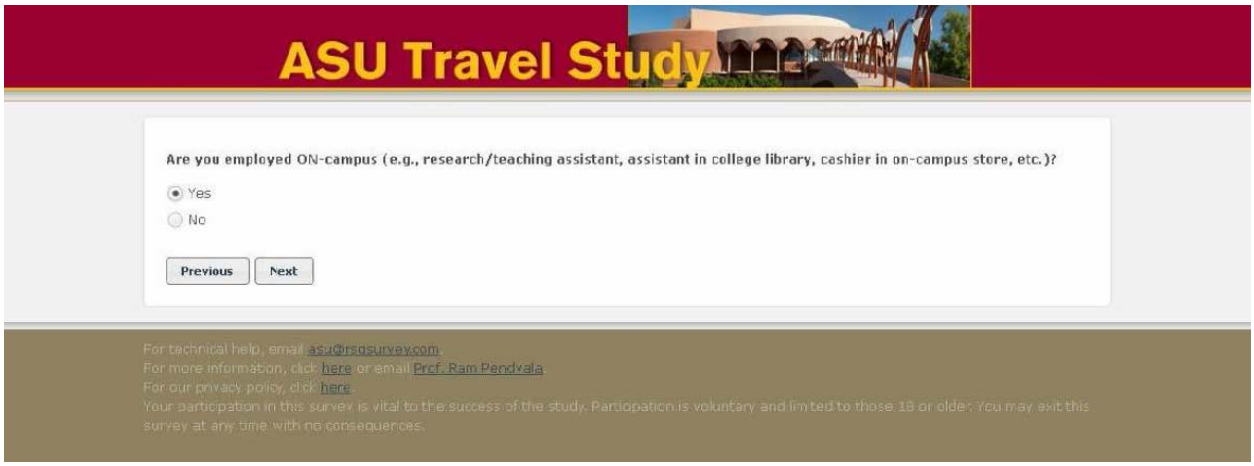
ASU Travel Study
Are you employed ON-campus (e.g., research/teaching assistant, assistant in college library, cashier in on-campus store, etc.)?
Yes
No
Previous
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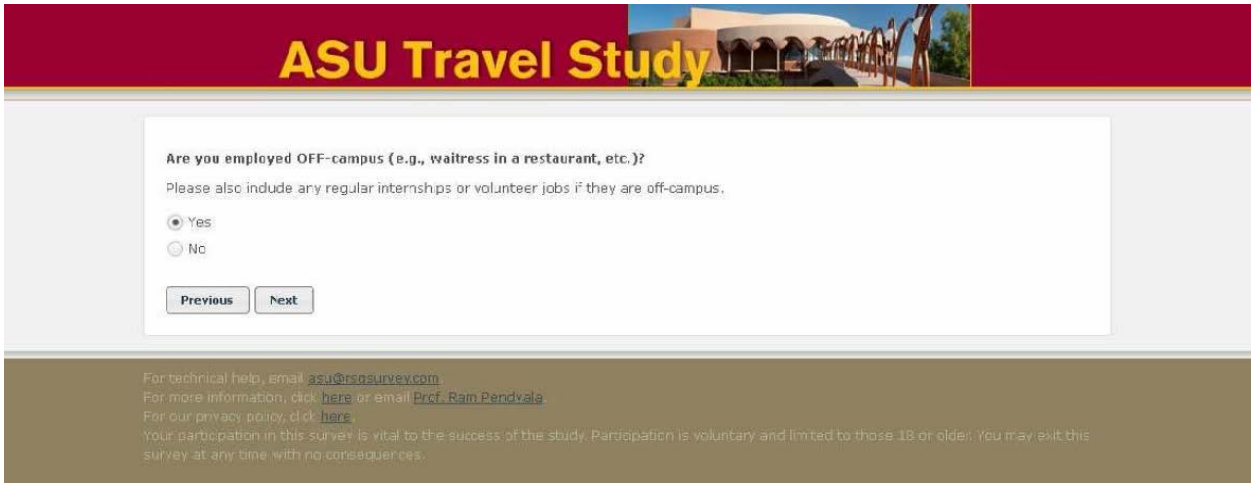
ASU Travel Study
Are you employed OFF-campus (e.g., waitress in a restaurant, etc.)?
Please also include any regular internships or volunteer jobs if they are off-campus.
Yes
No
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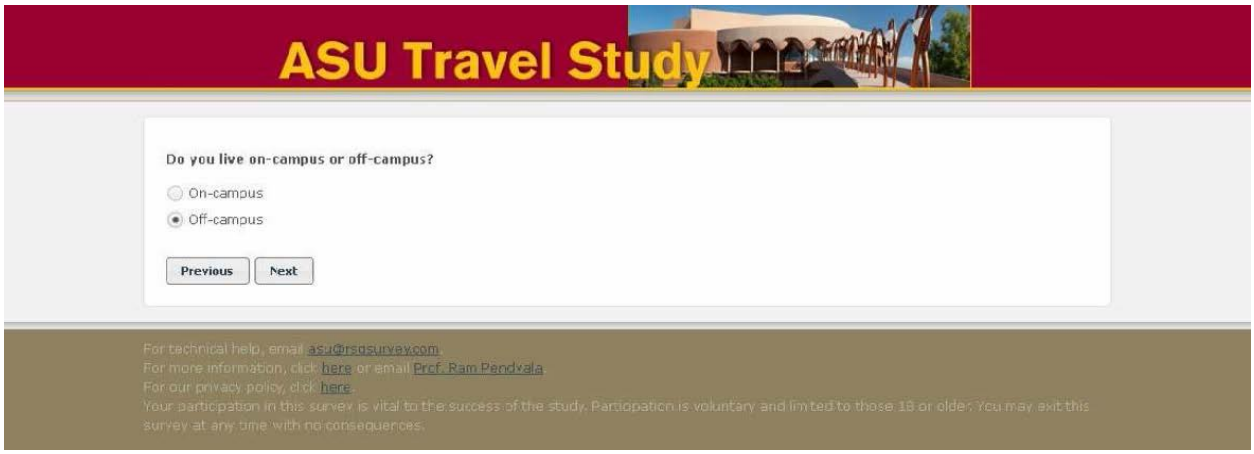
ASU Travel Study
Do you live on-campus or off-campus?
On-campus
Off-campus
Previous
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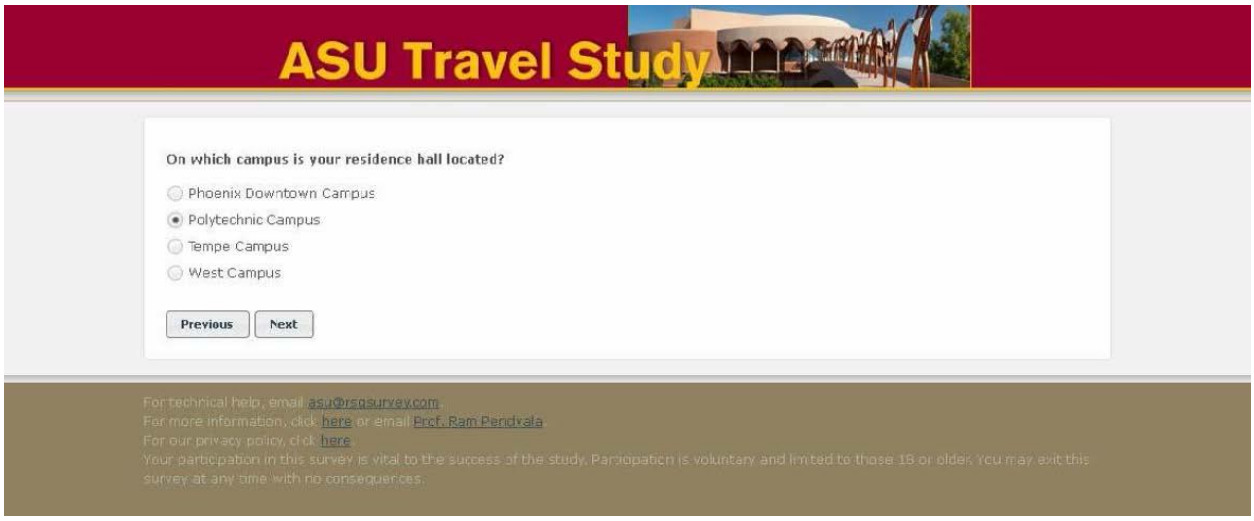
ASU Travel Study
On which campus is your residence hall located?
Phoenix Downtown Campus
Polytechnic Campus
Tempe Campus
West Campus
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Next
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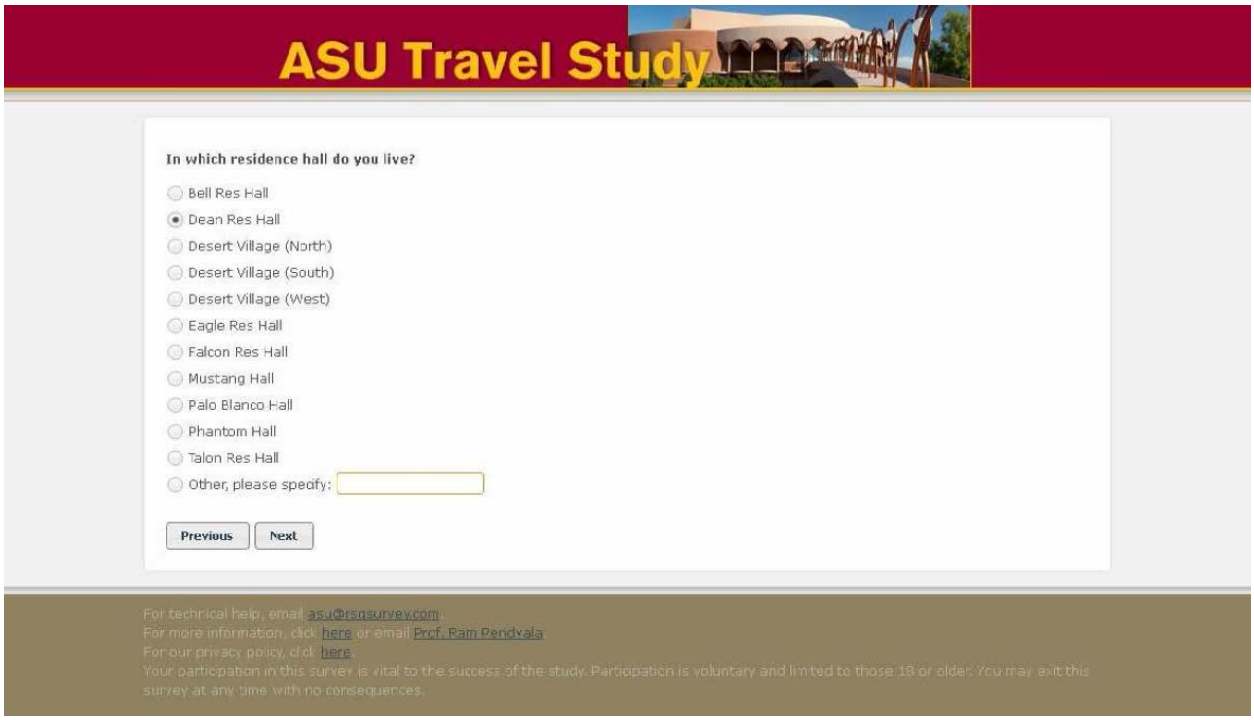
ASU Travel Study
In which residence hall do you live?
Bell Res Hall
Dean Res Hall
Desert Village (North)
Desert Village (South)
Desert Village (West)
Eagle Res Hall
Falcon Res Hall
Mustang Hall
Palo Blanco Hall
Phantom Hall
Talon Res Hall
Other, please specify:
Previous
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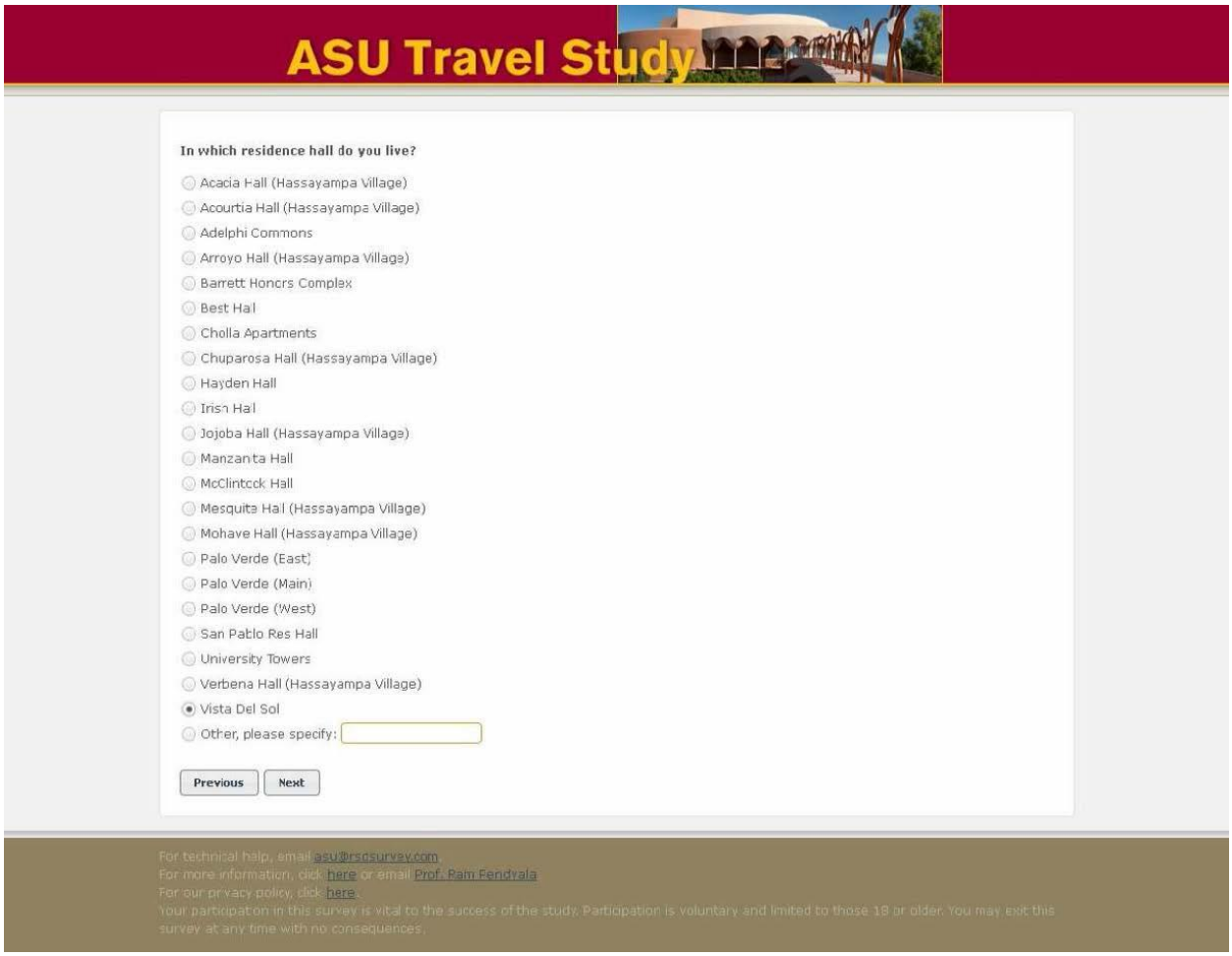
ASU Travel Study
In which residence hall do you live?
Acacia Hall (Hassayampa Village)
Acourtia Hall (Hassayampa Village)
Adelphi Commons
Arroyo Hall (Hassayampa Village)
Barrett Honors Complex
Best Hall
Cholla Apartments
Chuparosa Hall (Hassayampa Village)
Hayden Hall
Irish Hall
Jojoba Hall (Hassayampa Village)
Manzanita Hall
McClintock Hall
Mesquite Hall (Hassayampa Village)
Mohave Hall (Hassayampa Village)
Palo Verde (East)
Palo Verde (Main)
Palo Verde (West)
San Pablo Res Hall
University Towers
Verbena Hall (Hassayampa Village)
Vista Del Sol
Other, please specify:
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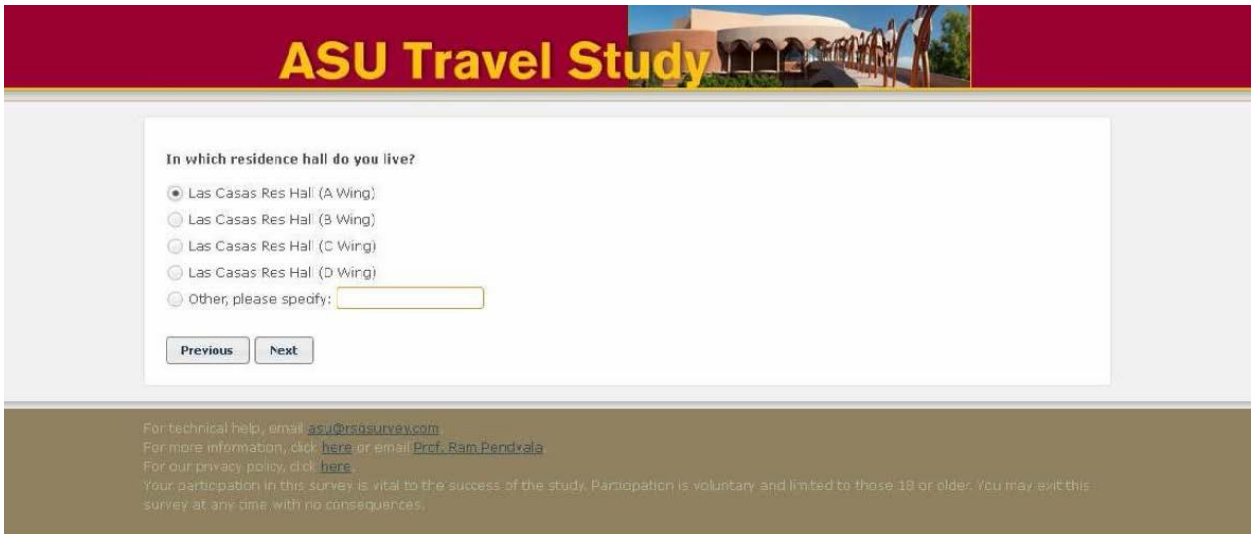
ASU Travel Study
In which residence hall do you live?
Las Casas Res Hall (A Wing)
Las Casas Res Hall (B Wing)
Las Casas Res Hall (C Wing)
Las Casas Res Hall (D Wing)
Other, please specify:
Previous
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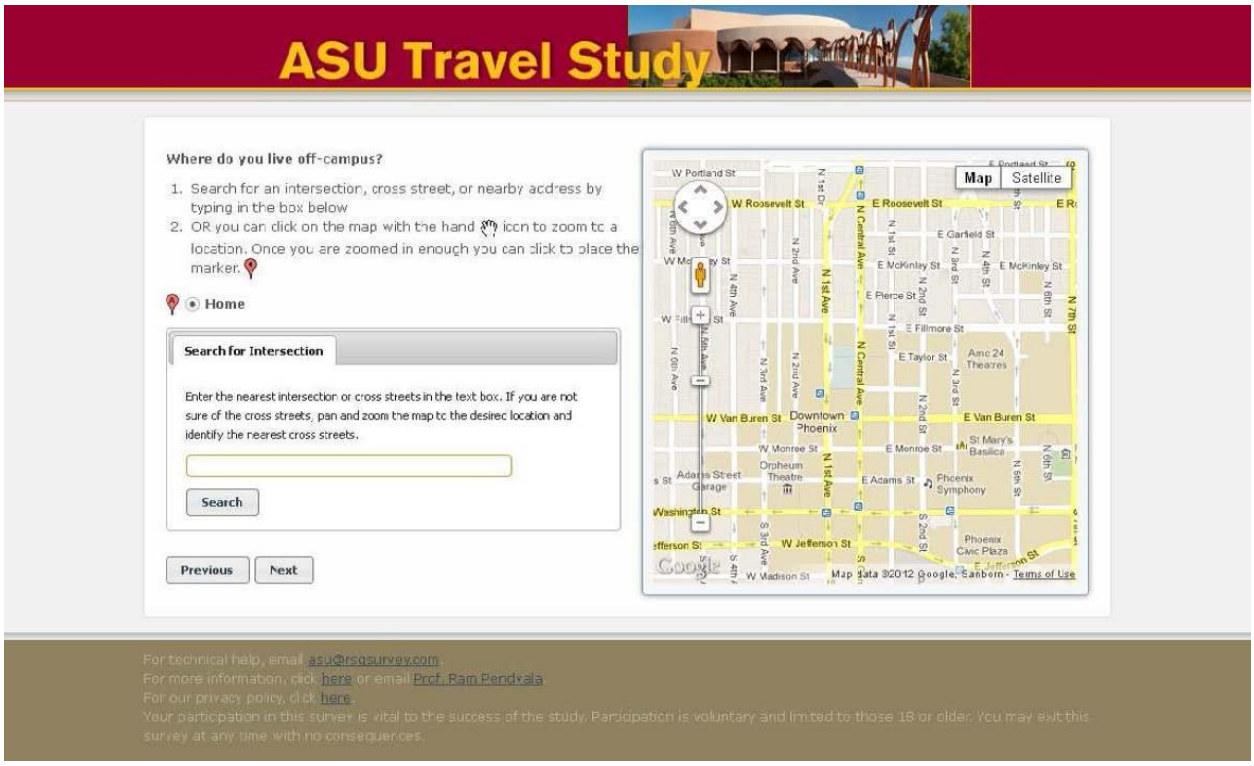
ASU Travel Study
Where do you live off-campus?
1. Search for an intersection, cross street, or nearby address by typing in the box below
2. OR you can click on the map with the hand icon to zoom to a location. Once you are zoomed in enough you can click to place the marker.
Home
Search for Intersection
Enter the nearest intersection or cross streets in the text box. If you are not sure of the cross streets, pan and zoom the map to the desired location and identify the nearest cross streets.
Search
Previous
Next
Map
Satellite
W Portland St
W Roosevelt St
E Roosevelt St
E Garfield St
E McKinley St
E Pierce St
E Fillmore St
E Taylor St
Amc 24 Theatres
W Van Buren St
Downtown Phoenix
E Van Buren St
W Monroe St
E Monroe St
St Mary's Basilica
Orpheum Theatre
E Adams St
Phoenix Symphony
Adams Street Garage
W Jefferson St
Phoenix Civic Plaza
W Madison St
Map data ©2012 Google, Sanborn - Terms of Use
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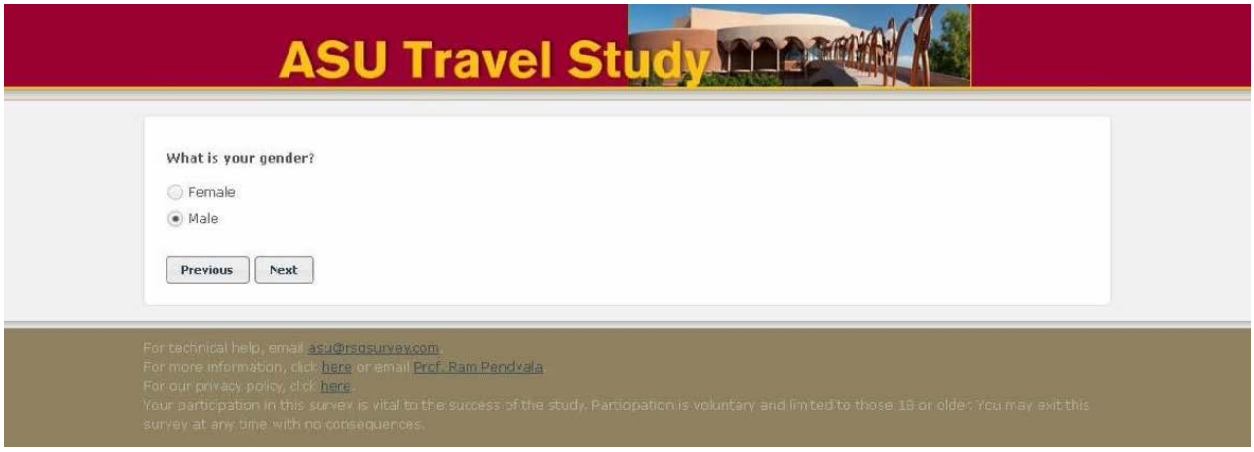
ASU Travel Study
What is your gender?
Female
Male
Previous
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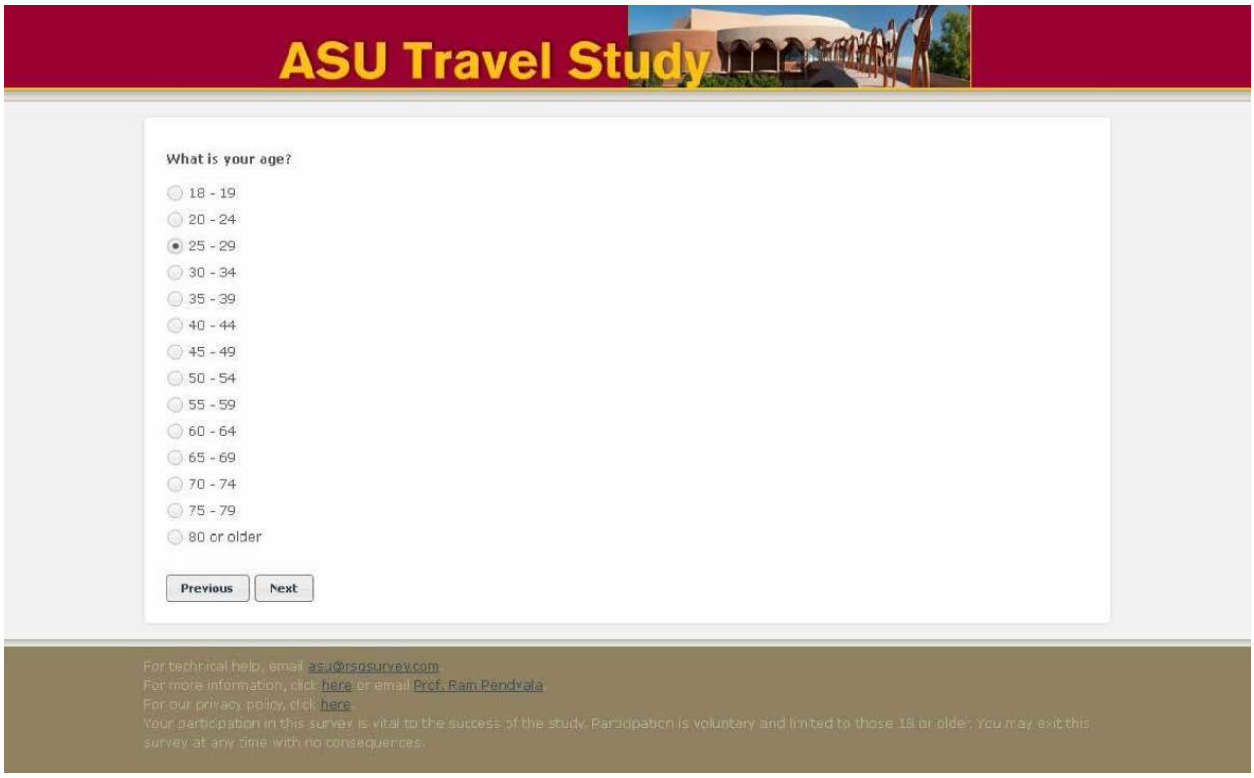
ASU Travel Study
What is your age?
18 - 19
20 - 24
25 - 29
30 - 34
35 - 39
40 - 44
45 - 49
50 - 54
55 - 59
60 - 64
65 - 69
70 - 74
75 - 79
80 or older
Previous
Next
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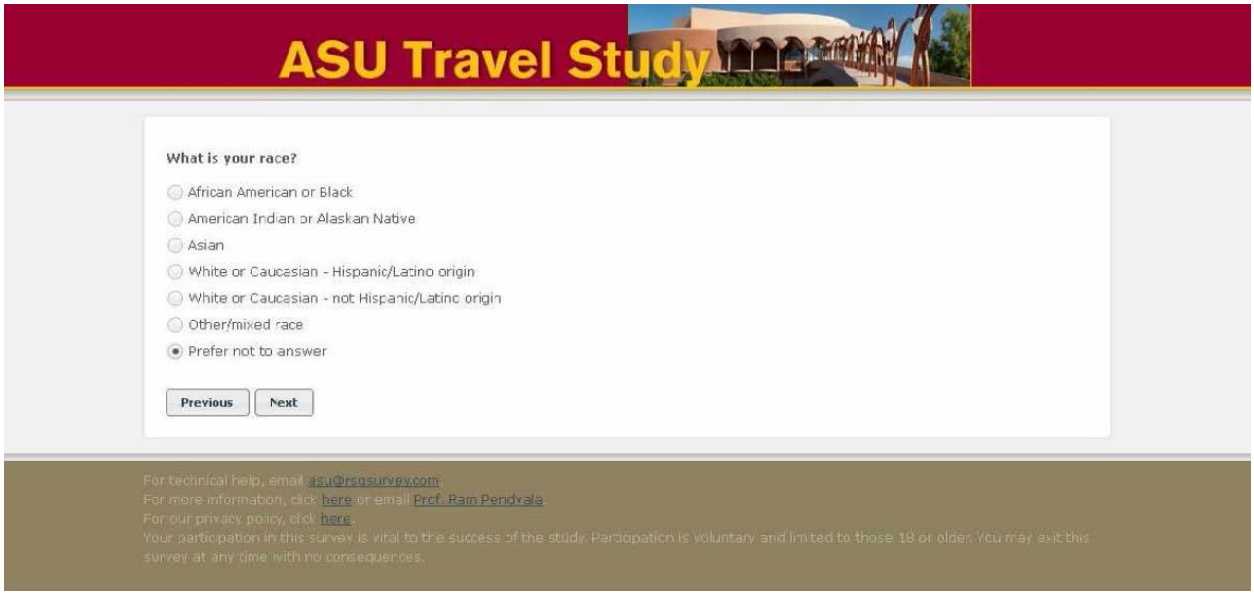
ASU Travel Study
What is your race?
African American or Black
American Indian or Alaskan Native
Asian
White or Caucasian - Hispanic/Latino origin
White or Caucasian - not Hispanic/Latino origin
Other/mixed race
Prefer not to answer
Previous
Next
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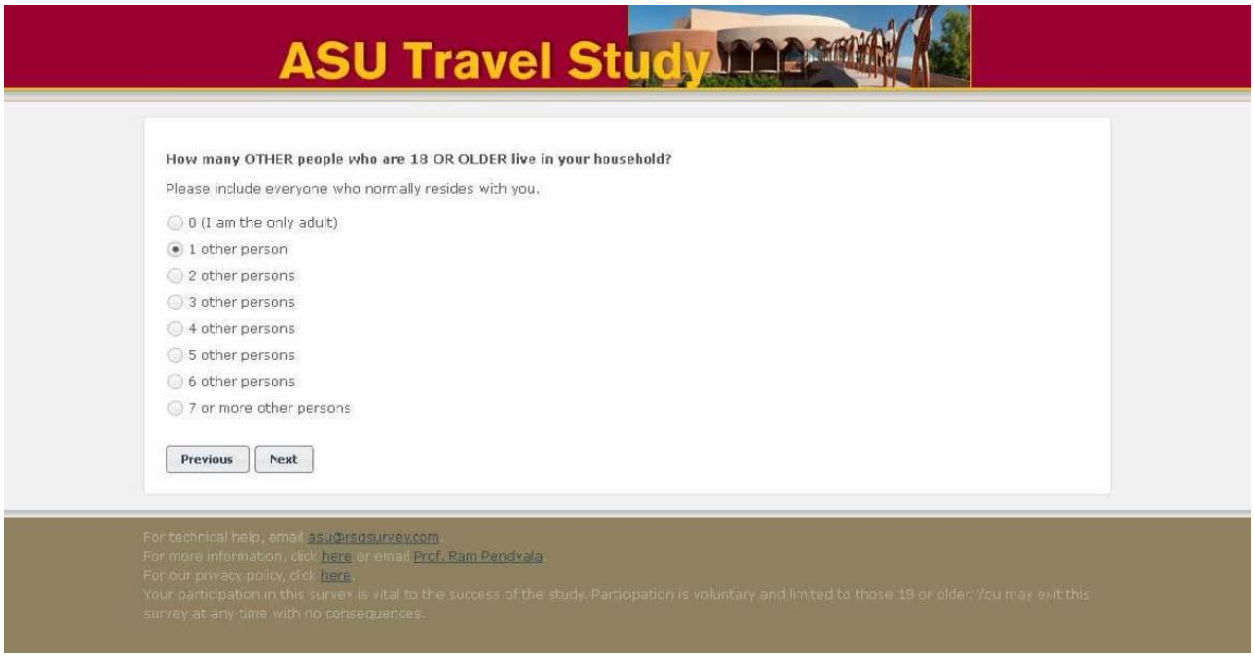
ASU Travel Study
How many OTHER people who are 18 OR OLDER live in your household?
Please include everyone who normally resides with you.
0 (I am the only adult)
1 other person
2 other persons
3 other persons
4 other persons
5 other persons
6 other persons
7 or more other persons
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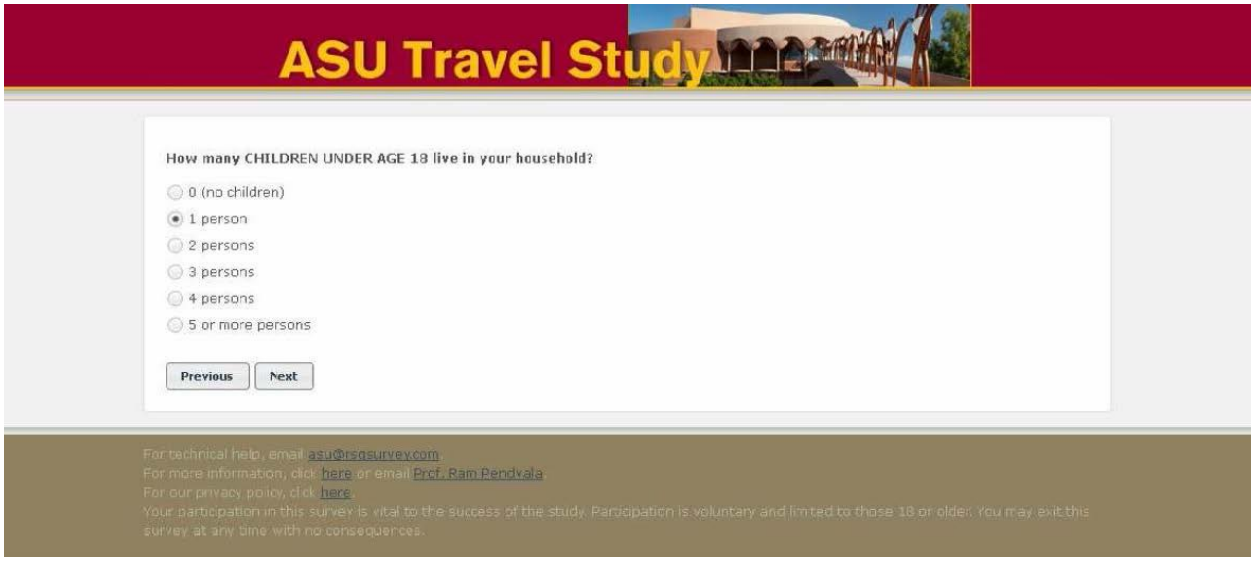
ASU Travel Study
How many CHILDREN UNDER AGE 18 live in your household?
0 (no children)
1 person
2 persons
3 persons
4 persons
5 or more persons
Previous
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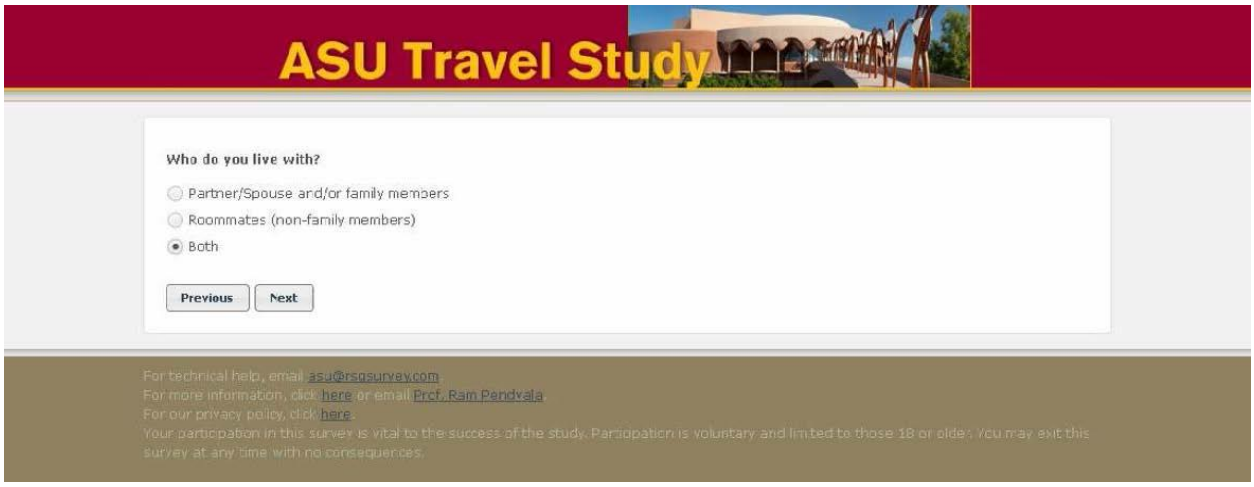
ASU Travel Study
Who do you live with?
Partner/Spouse and/or family members
Roommates (non-family members)
Both
Previous
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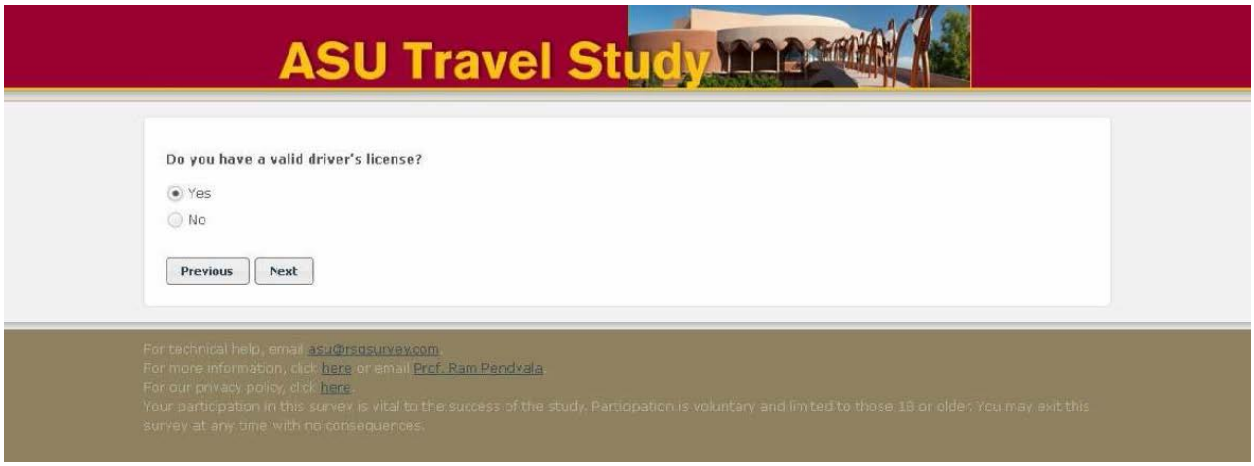
ASU Travel Study
Do you have a valid driver's license?
Yes
No
Previous
Next
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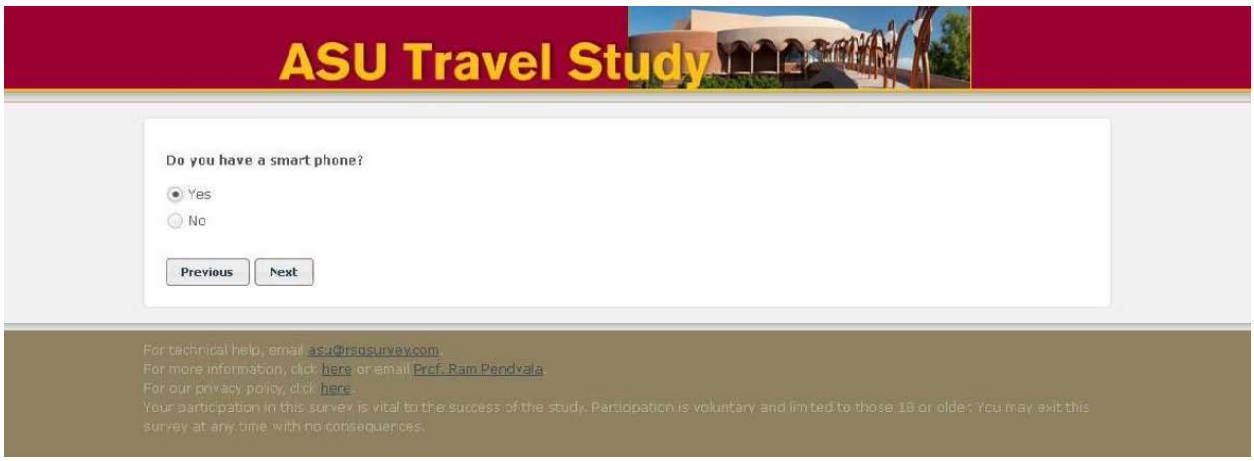
ASU Travel Study
Do you have a smart phone?
Yes
No
Previous
Next
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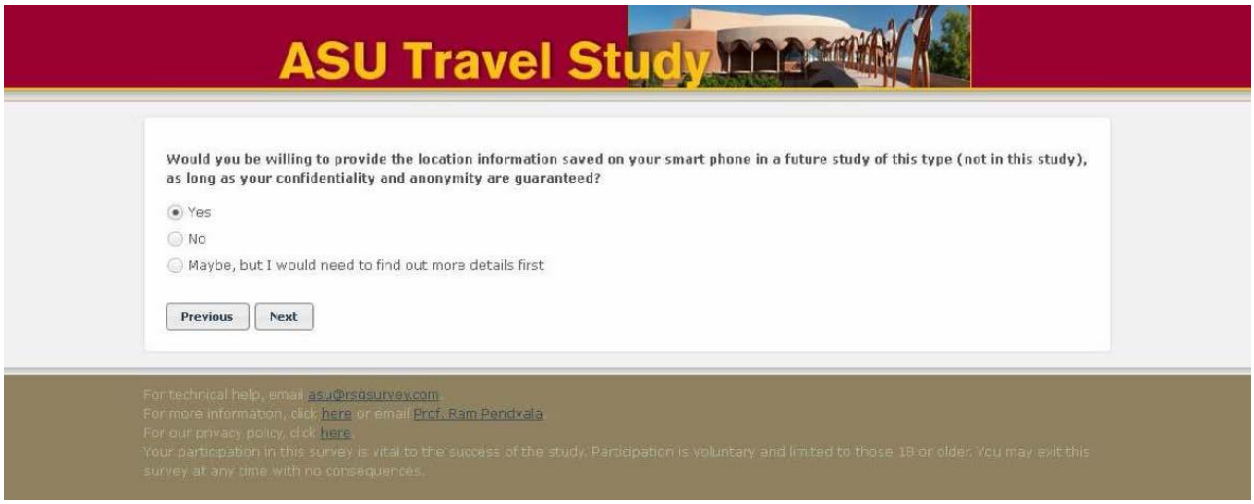
ASU Travel Study
Would you be willing to provide the location information saved on your smart phone in a future study of this type (not in this study), as long as your confidentiality and anonymity are guaranteed?
Yes
No
Maybe, but I would need to find out more details first
Previous
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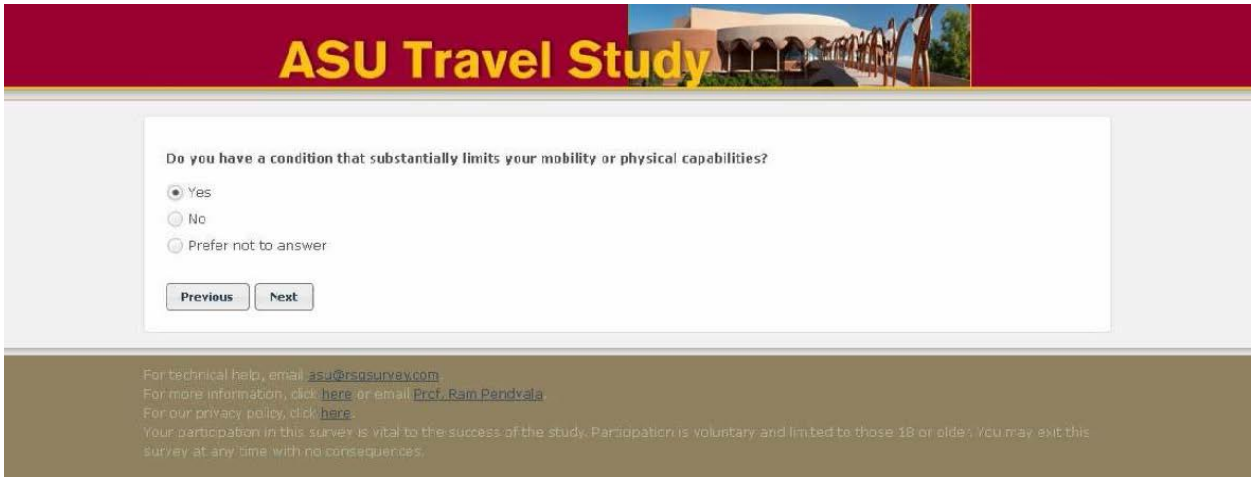
ASU Travel Study
Do you have a condition that substantially limits your mobility or physical capabilities?
Yes
No
Prefer not to answer
Previous
Next
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ASU Travel Study

Thank you for your answers so far. Now we would like to ask you a few questions about the trips you made and the places you went yesterday.

A trip consists of any movement by car, bus, bike, walking, or other means AND any change of address or location. Some example trips include: walking from the library to class, biking to an off-campus coffee shop, going for a run in South Mountain Park, taking the bus to a volunteer job, riding the intercampus shuttle to another ASU campus, etc.

Did you make any trips yesterday?

- (•) Yes
- ( ) No

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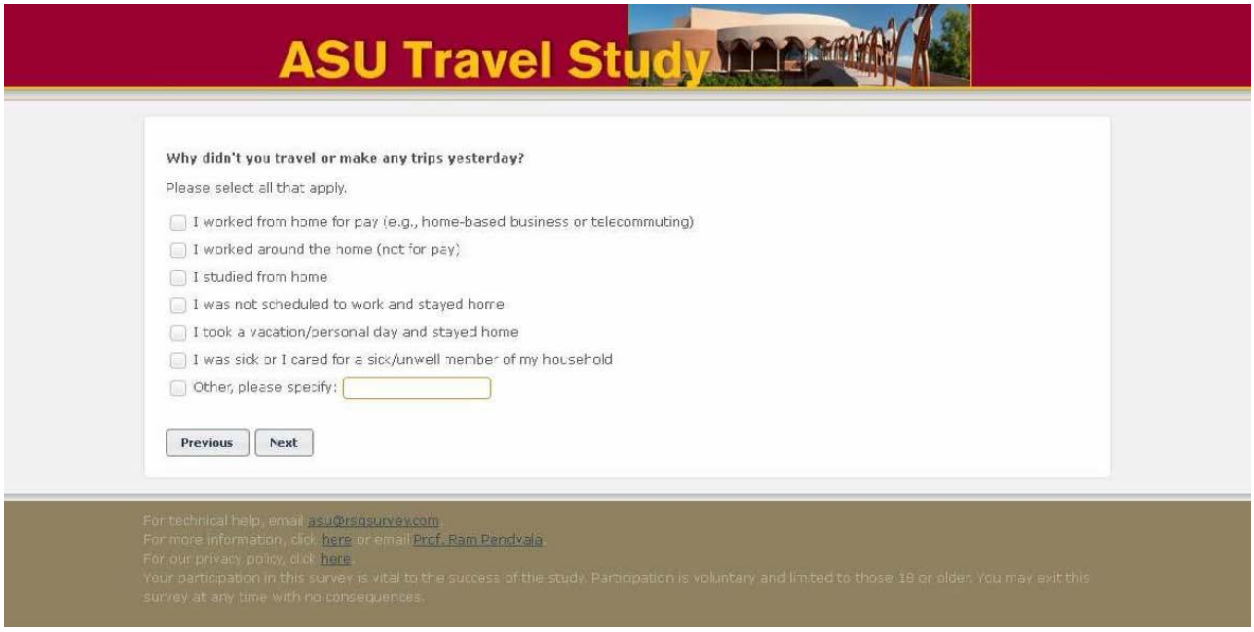

ASU Travel Study

Why didn't you travel or make any trips yesterday?

Please select all that apply.

- [ ] I worked from home for pay (e.g., home-based business or telecommuting)
- [ ] I worked around the home (not for pay)
- [ ] I studied from home
- [ ] I was not scheduled to work and stayed home
- [ ] I took a vacation/personal day and stayed home
- [ ] I was sick or I cared for a sick/unwell member of my household
- [ ] Other, please specify: _____

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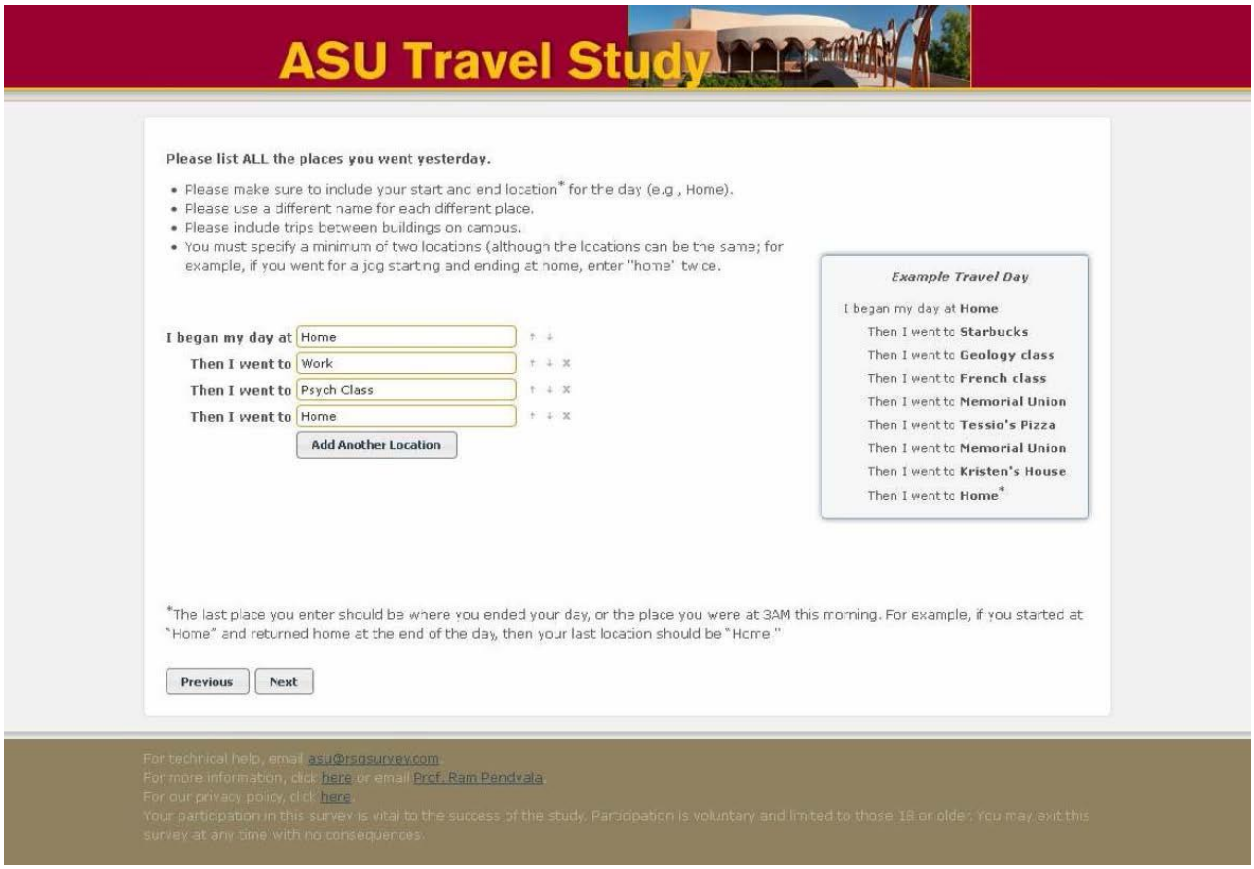
ASU Travel Study
Please list ALL the places you went yesterday.
• Please make sure to include your start and end location* for the day (e.g., Home).
• Please use a different name for each different place.
• Please include trips between buildings on campus.
• You must specify a minimum of two locations (although the locations can be the same; for example, if you went for a jog starting and ending at home, enter "home" twice.
I began my day at Home
Then I went to Work
Then I went to Psych Class
Then I went to Home
Add Another Location
Example Travel Day
I began my day at Home
Then I went to Starbucks
Then I went to Geology class
Then I went to French class
Then I went to Memorial Union
Then I went to Tessio's Pizza
Then I went to Memorial Union
Then I went to Kristen's House
Then I went to Home*
*The last place you enter should be where you ended your day, or the place you were at 3AM this morning. For example, if you started at "Home" and returned home at the end of the day, then your last location should be "Home."
Previous
Next
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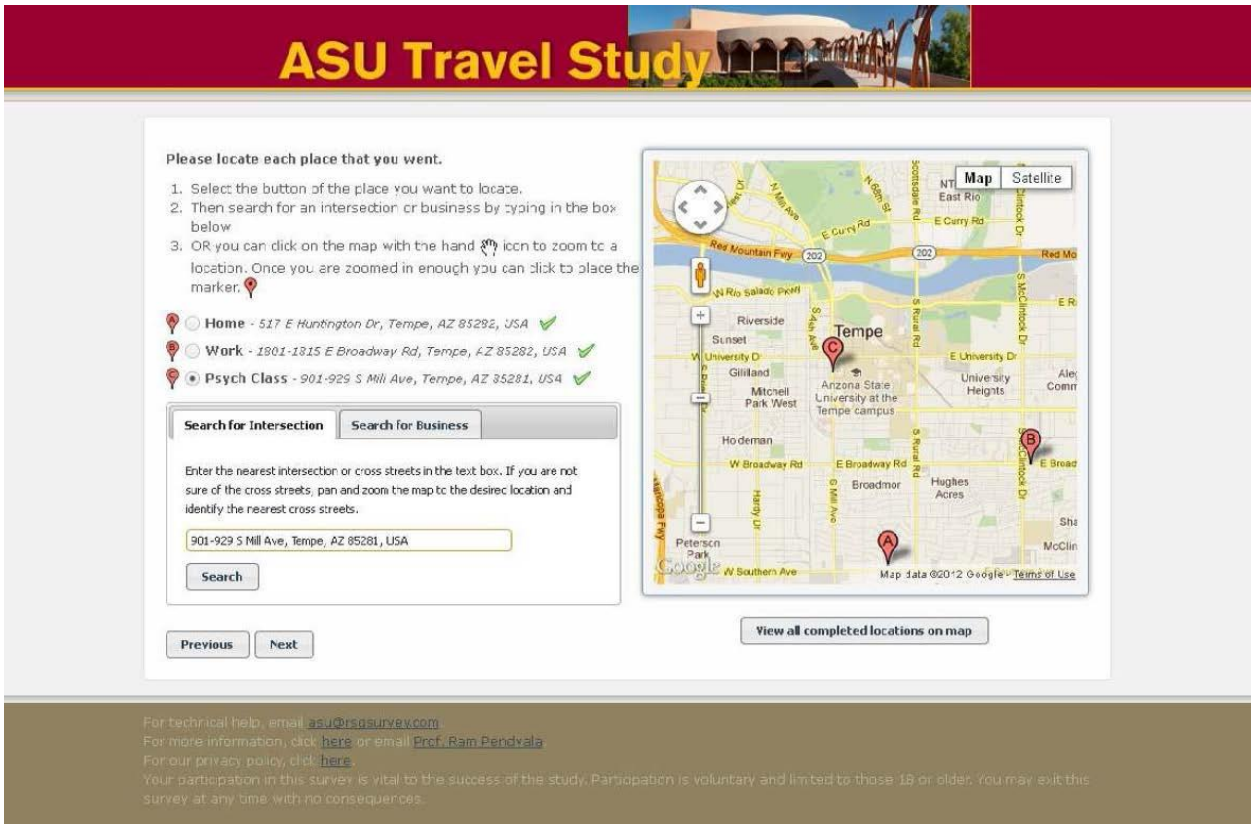
ASU Travel Study
Please locate each place that you went.
1. Select the button of the place you want to locate.
2. Then search for an intersection or business by typing in the box below
3. OR you can click on the map with the hand icon to zoom to a location. Once you are zoomed in enough you can click to place the marker.
Home - 517 E Huntington Dr, Tempe, AZ 85282, USA
Work - 1801-1815 E Broadway Rd, Tempe, AZ 85282, USA
Psych Class - 901-929 S Mill Ave, Tempe, AZ 85281, USA
Search for Intersection
Search for Business
Enter the nearest intersection or cross streets in the text box. If you are not sure of the cross streets, pan and zoom the map to the desired location and identify the nearest cross streets.
901-929 S Mill Ave, Tempe, AZ 85281, USA
Search
Map
Satellite
Tempe
Riverside
Sunset
Gilliland
Mitchell Park West
Arizona State University at the Tempe campus
University Heights
Hodeman
Broadmor
Hughes Acres
Peterson Park
E Curry Rd
Red Mountain Fwy
W Broadway Rd
E Broadway Rd
W Southern Ave
Map data ©2012 Google - Terms of Use
Previous
Next
View all completed locations on map
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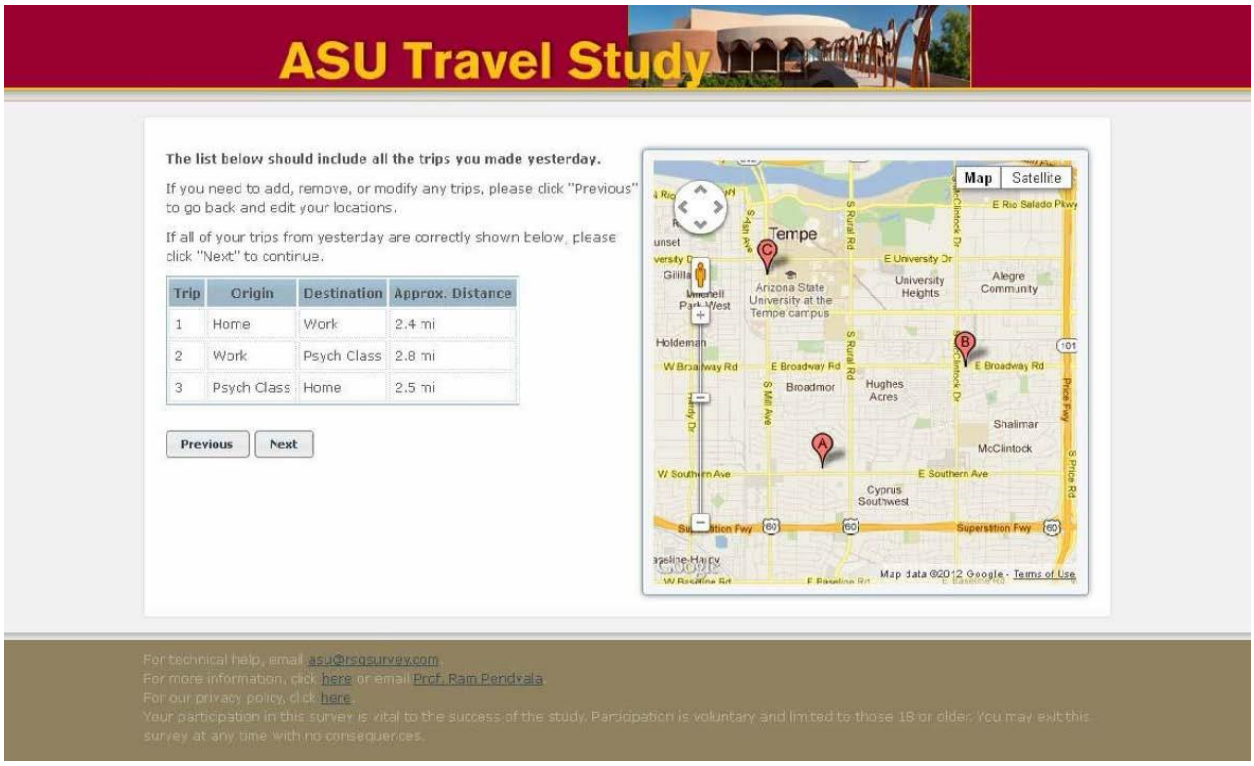
ASU Travel Study
The list below should include all the trips you made yesterday.
If you need to add, remove, or modify any trips, please click "Previous" to go back and edit your locations.
If all of your trips from yesterday are correctly shown below, please click "Next" to continue.
Trip | Origin | Destination | Approx. Distance
1 | Home | Work | 2.4 mi
2 | Work | Psych Class | 2.8 mi
3 | Psych Class | Home | 2.5 mi
Previous
Next
Map
Satellite
Tempe
Arizona State University at the Tempe campus
University Heights
Alegre Community
Broadmor
Hughes Acres
Shalimar
McClintock
Cyprus Southwest
Map data ©2012 Google - Terms of Use
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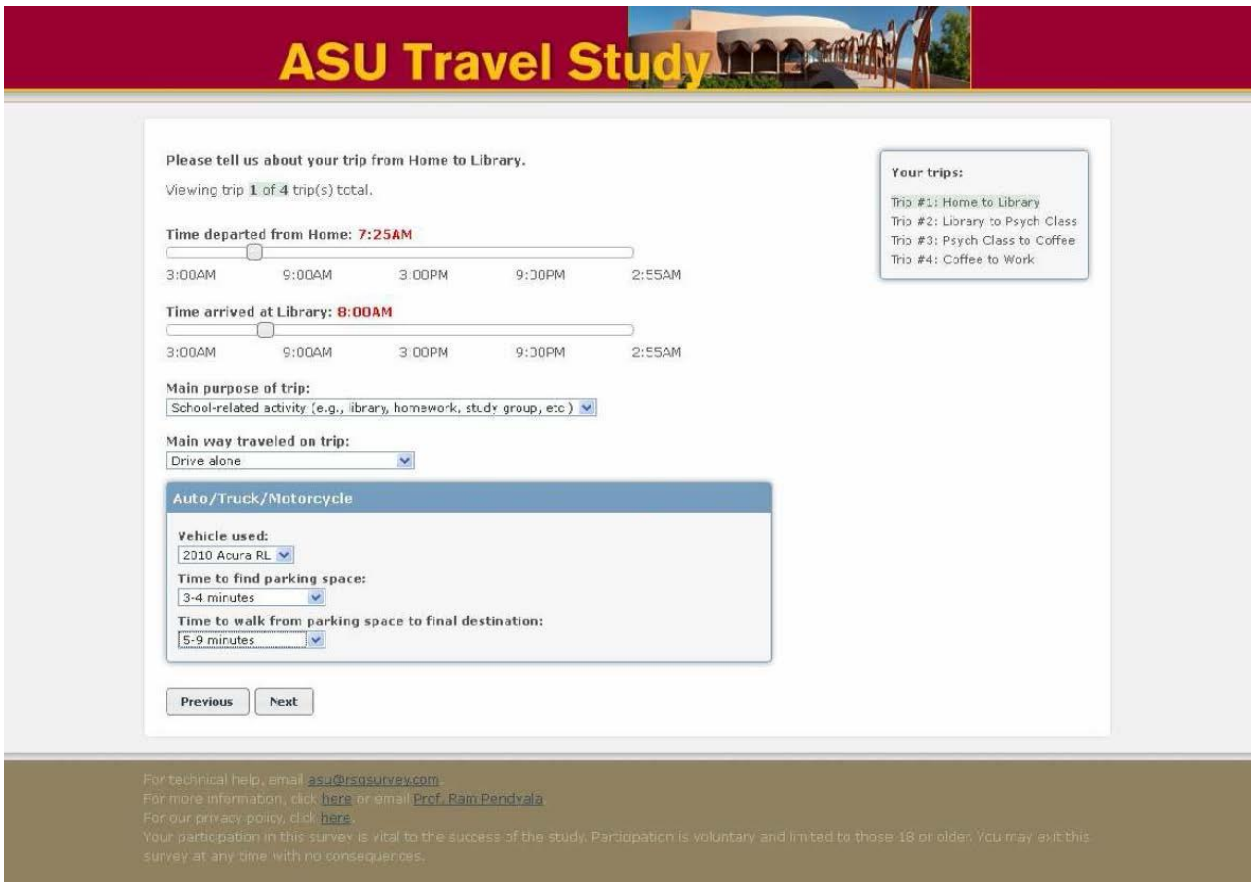
ASU Travel Study
Please tell us about your trip from Home to Library.
Viewing trip 1 of 4 trip(s) total.
Time departed from Home: 7:25AM
3:00AM 9:00AM 3:00PM 9:00PM 2:55AM
Time arrived at Library: 8:00AM
3:00AM 9:00AM 3:00PM 9:00PM 2:55AM
Main purpose of trip:
School-related activity (e.g., library, homework, study group, etc.)
Main way traveled on trip:
Drive alone
Auto/Truck/Motorcycle
Vehicle used:
2010 Acura RL
Time to find parking space:
3-4 minutes
Time to walk from parking space to final destination:
5-9 minutes
Previous
Next
Your trips:
Trip #1: Home to Library
Trip #2: Library to Psych Class
Trip #3: Psych Class to Coffee
Trip #4: Coffee to Work
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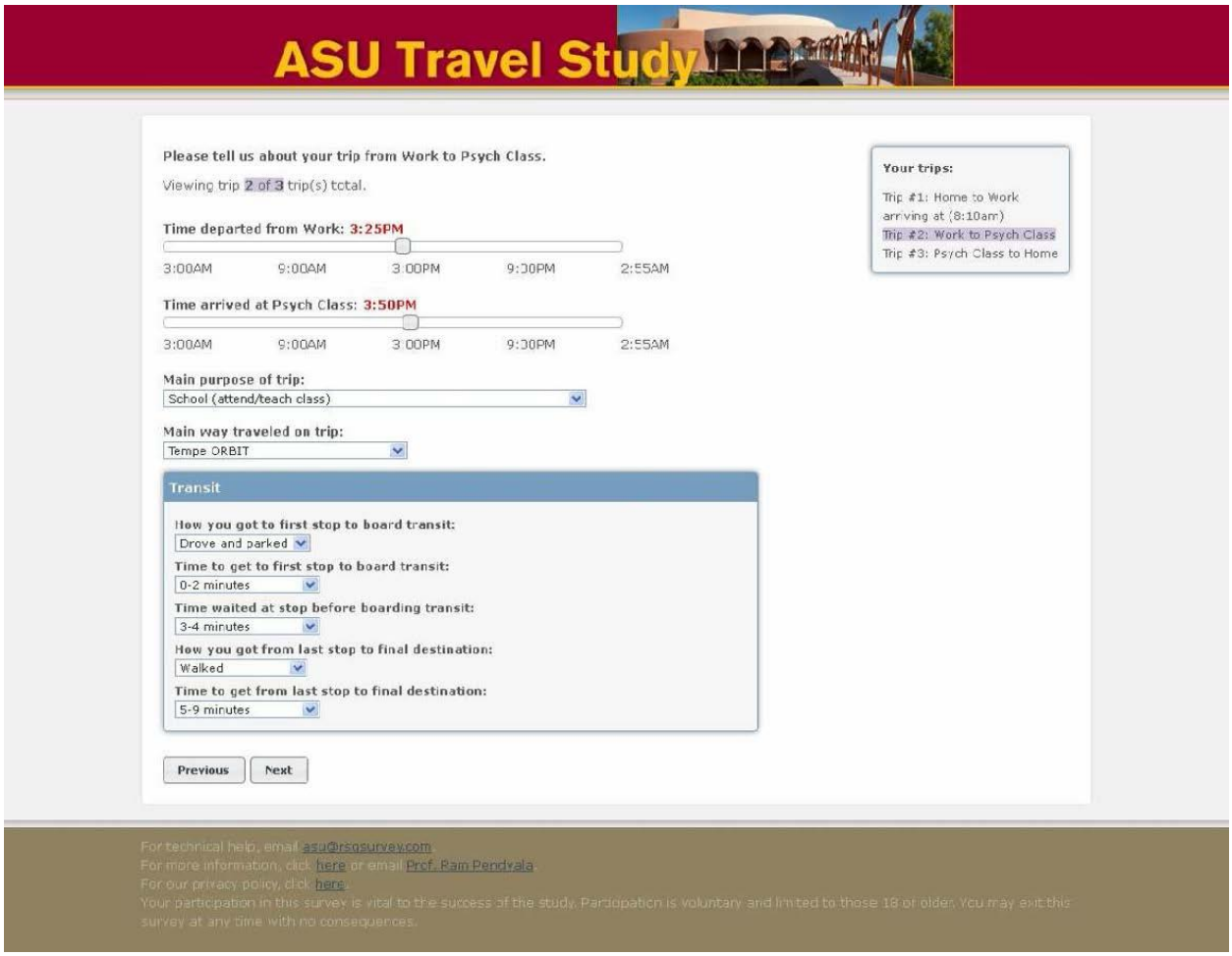
ASU Travel Study
Please tell us about your trip from Work to Psych Class.
Viewing trip 2 of 3 trip(s) total.
Time departed from Work: 3:25PM
3:00AM 9:00AM 3:00PM 9:00PM 2:55AM
Time arrived at Psych Class: 3:50PM
3:00AM 9:00AM 3:00PM 9:00PM 2:55AM
Main purpose of trip:
School (attend/teach class)
Main way traveled on trip:
Tempe ORBIT
Transit
How you got to first stop to board transit:
Drove and parked
Time to get to first stop to board transit:
0-2 minutes
Time waited at stop before boarding transit:
3-4 minutes
How you got from last stop to final destination:
Walked
Time to get from last stop to final destination:
5-9 minutes
Previous
Next
Your trips:
Trip #1: Home to Work arriving at (8:10am)
Trip #2: Work to Psych Class
Trip #3: Psych Class to Home
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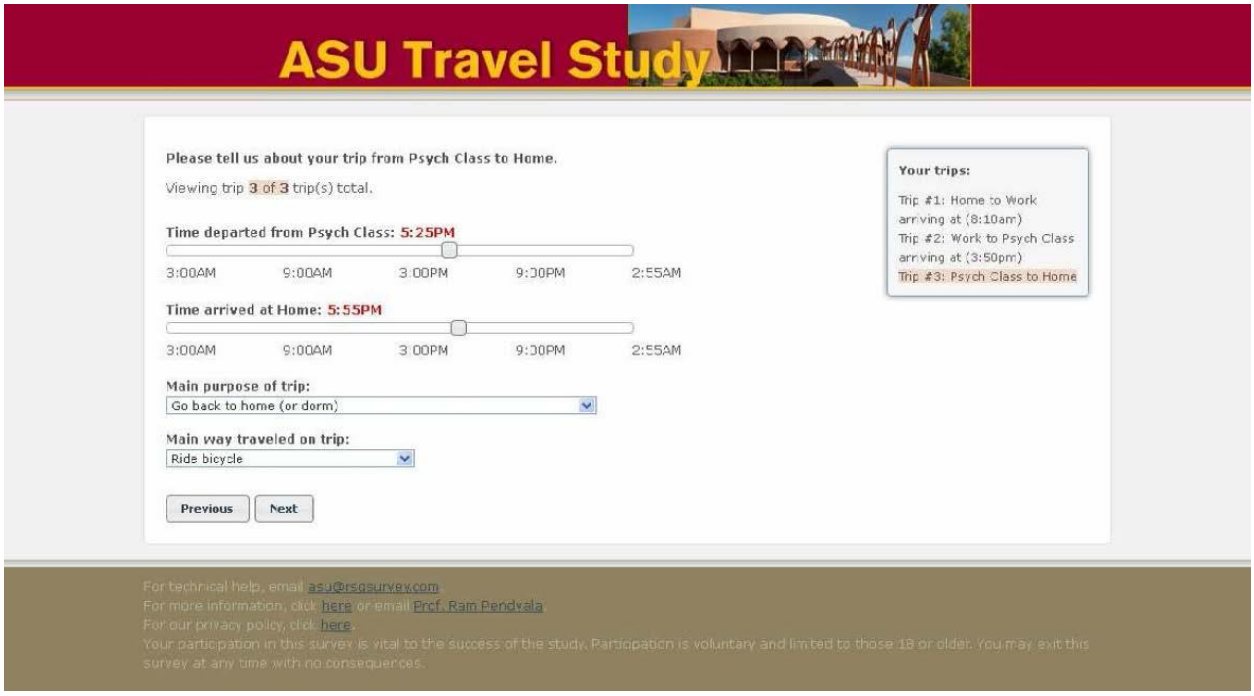
ASU Travel Study
Please tell us about your trip from Psych Class to Home.
Viewing trip 3 of 3 trip(s) total.
Time departed from Psych Class: 5:25PM
3:00AM 9:00AM 3:00PM 9:00PM 2:55AM
Time arrived at Home: 5:55PM
3:00AM 9:00AM 3:00PM 9:00PM 2:55AM
Main purpose of trip:
Go back to home (or dorm)
Main way traveled on trip:
Ride bicycle
Previous
Next
Your trips:
Trip #1: Home to Work arriving at (8:10am)
Trip #2: Work to Psych Class arriving at (3:50pm)
Trip #3: Psych Class to Home
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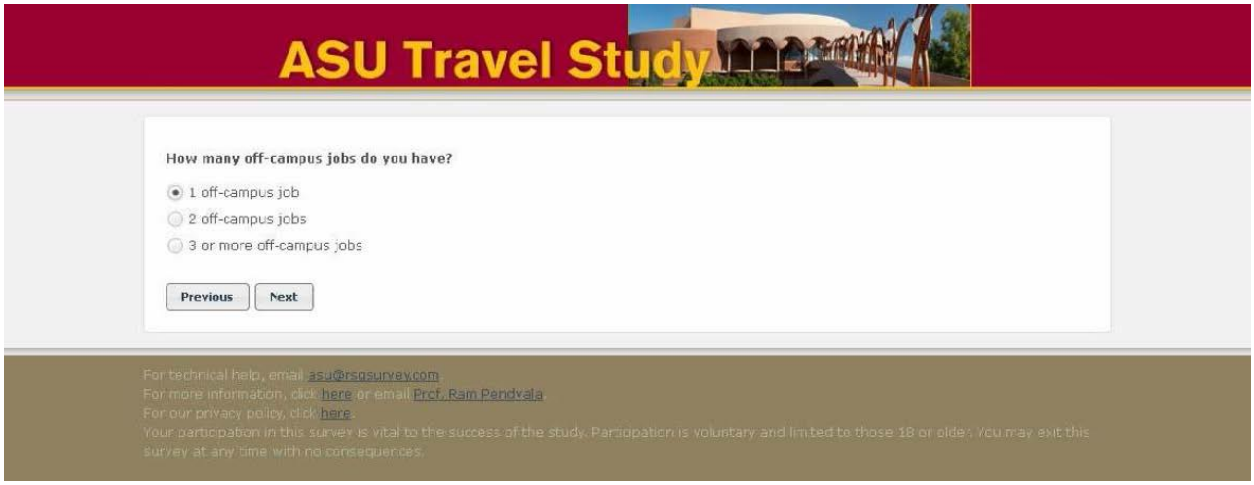
ASU Travel Study
How many off-campus jobs do you have?
1 off-campus job
2 off-campus jobs
3 or more off-campus jobs
Previous
Next
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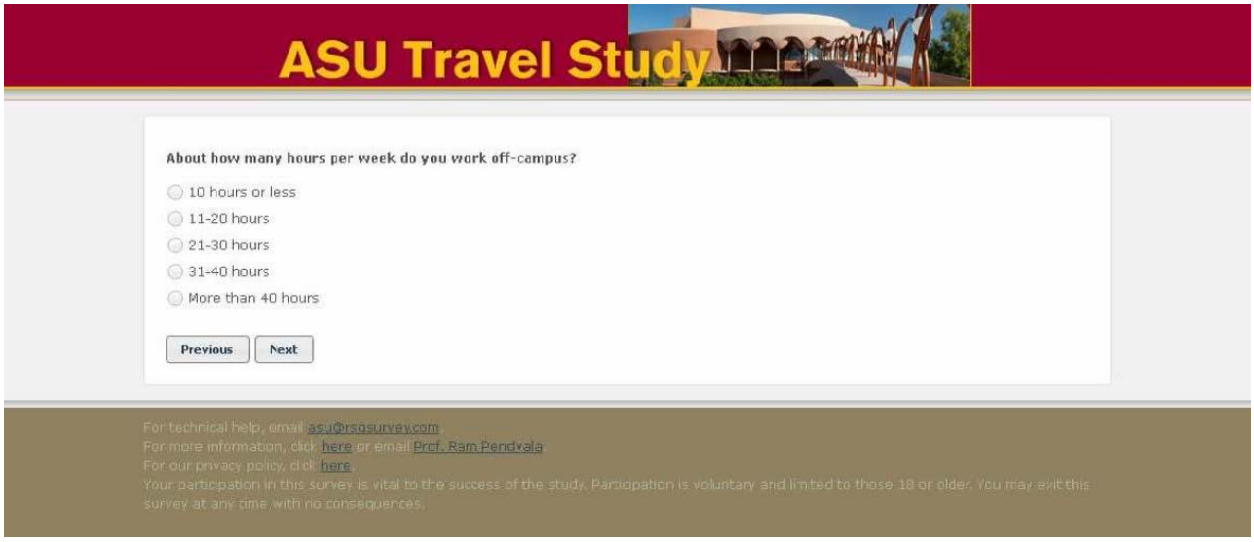
ASU Travel Study
About how many hours per week do you work off-campus?
10 hours or less
11-20 hours
21-30 hours
31-40 hours
More than 40 hours
Previous
Next
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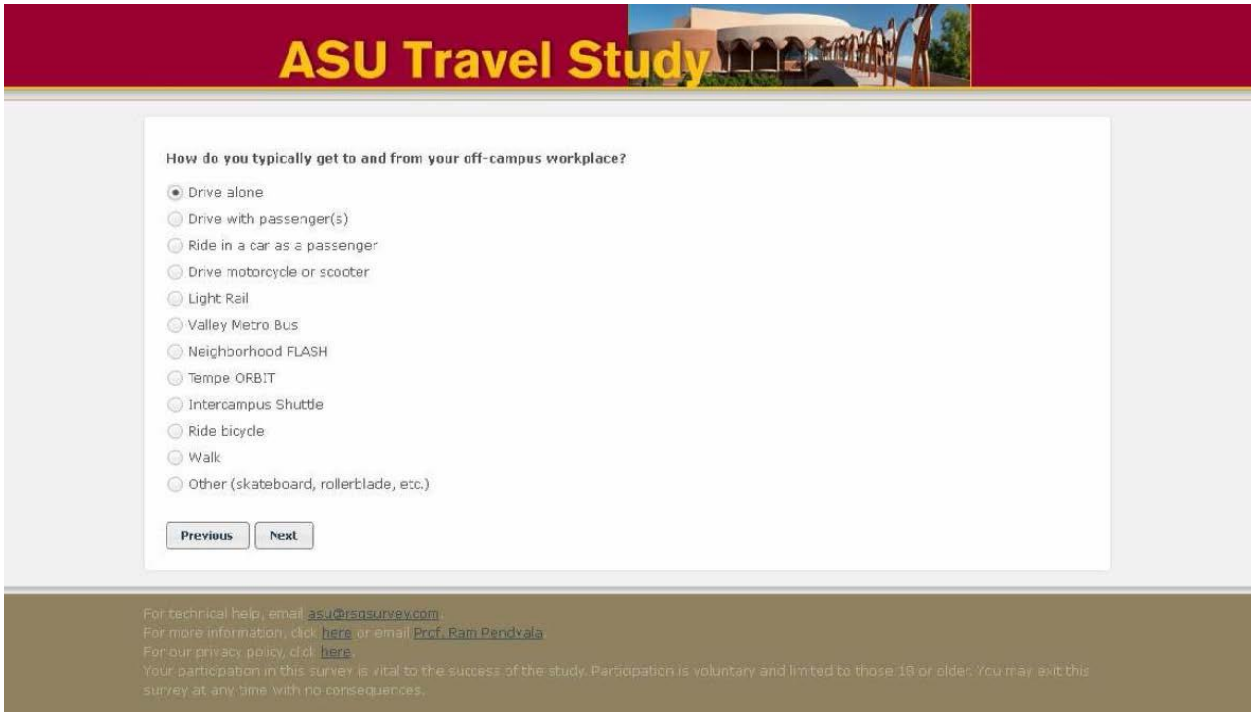
ASU Travel Study
How do you typically get to and from your off-campus workplace?
Drive alone
Drive with passenger(s)
Ride in a car as a passenger
Drive motorcycle or scooter
Light Rail
Valley Metro Bus
Neighborhood FLASH
Tempe ORBIT
Intercampus Shuttle
Ride bicycle
Walk
Other (skateboard, rollerblade, etc.)
Previous
Next
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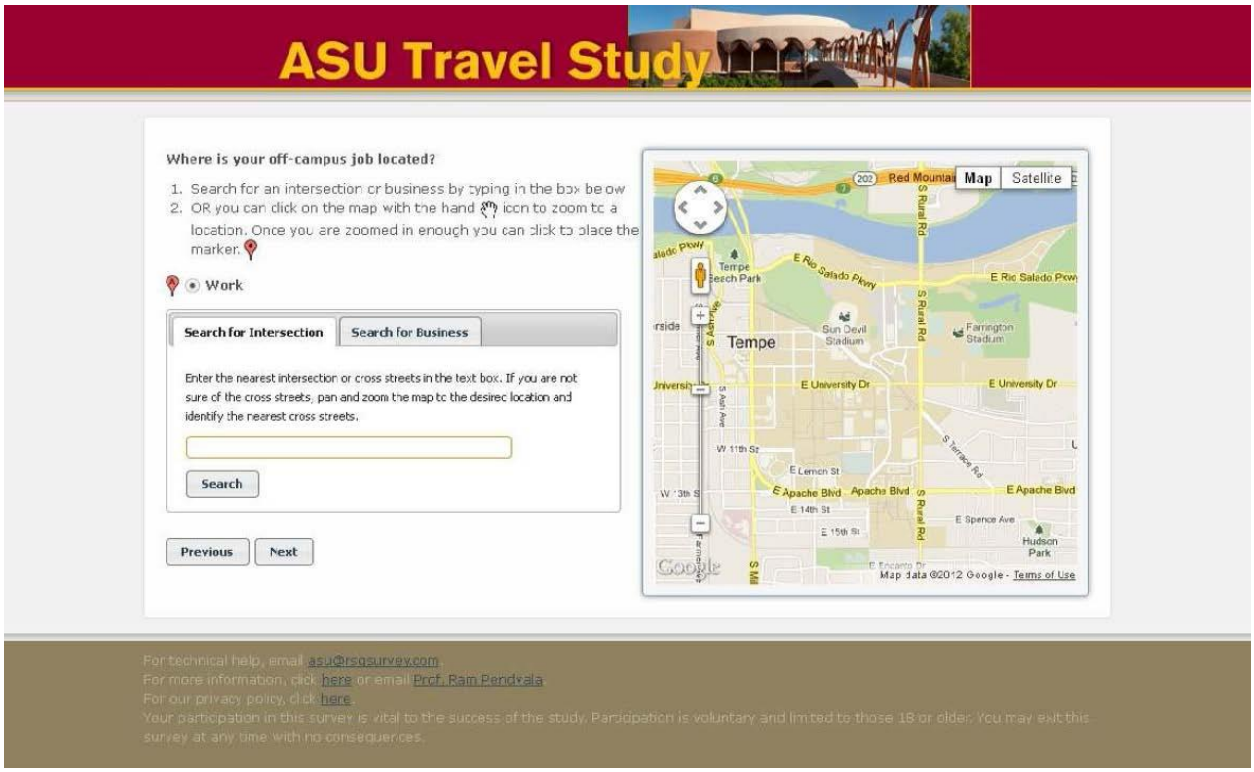
ASU Travel Study
Where is your off-campus job located?
1. Search for an intersection or business by typing in the box below
2. OR you can click on the map with the hand icon to zoom to a location. Once you are zoomed in enough you can click to place the marker.
Work
Search for Intersection
Search for Business
Enter the nearest intersection or cross streets in the text box. If you are not sure of the cross streets, pan and zoom the map to the desired location and identify the nearest cross streets.
Search
Previous
Next
Map
Satellite
Tempe
E Rio Salado Pkwy
E University Dr
E Apache Blvd
Map data ©2012 Google - Terms of Use
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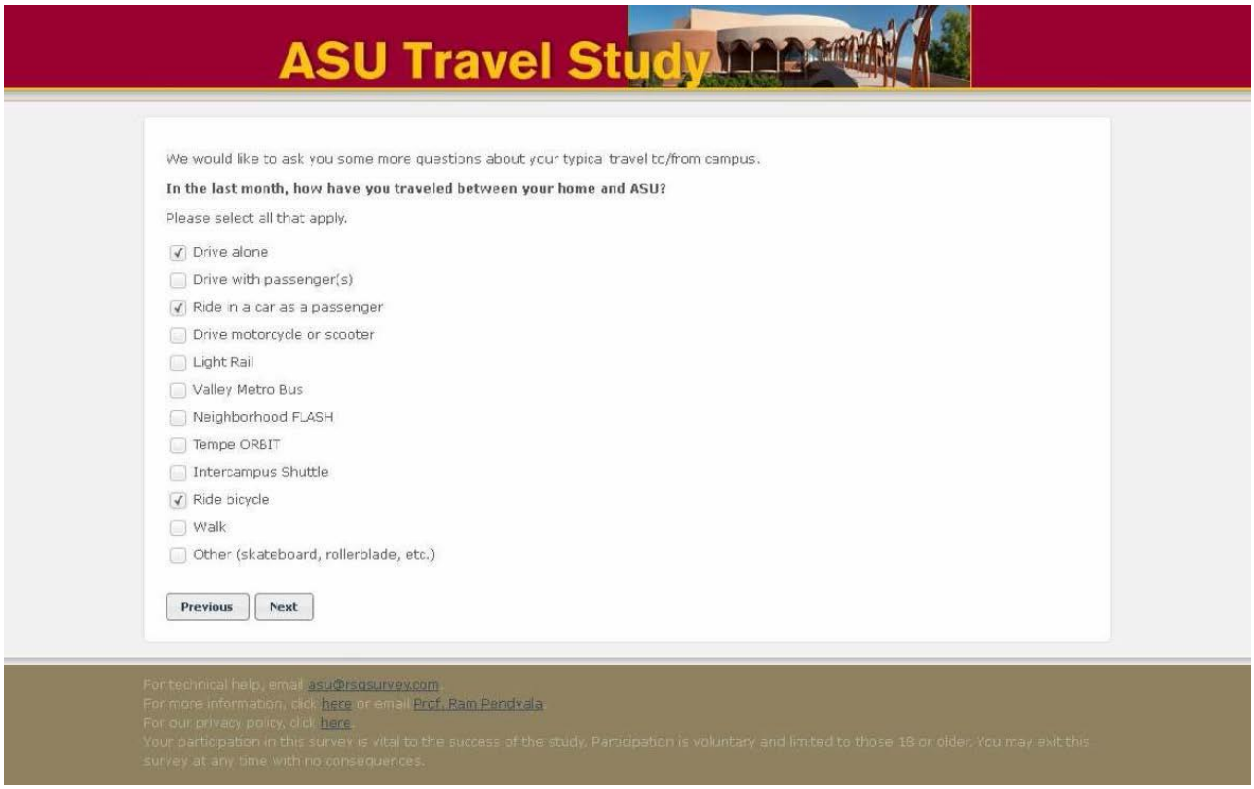
ASU Travel Study
We would like to ask you some more questions about your typical travel to/from campus.
In the last month, how have you traveled between your home and ASU?
Please select all that apply.
Drive alone
Drive with passenger(s)
Ride in a car as a passenger
Drive motorcycle or scooter
Light Rail
Valley Metro Bus
Neighborhood FLASH
Tempe ORBIT
Intercampus Shuttle
Ride bicycle
Walk
Other (skateboard, rollerblade, etc.)
Previous
Next
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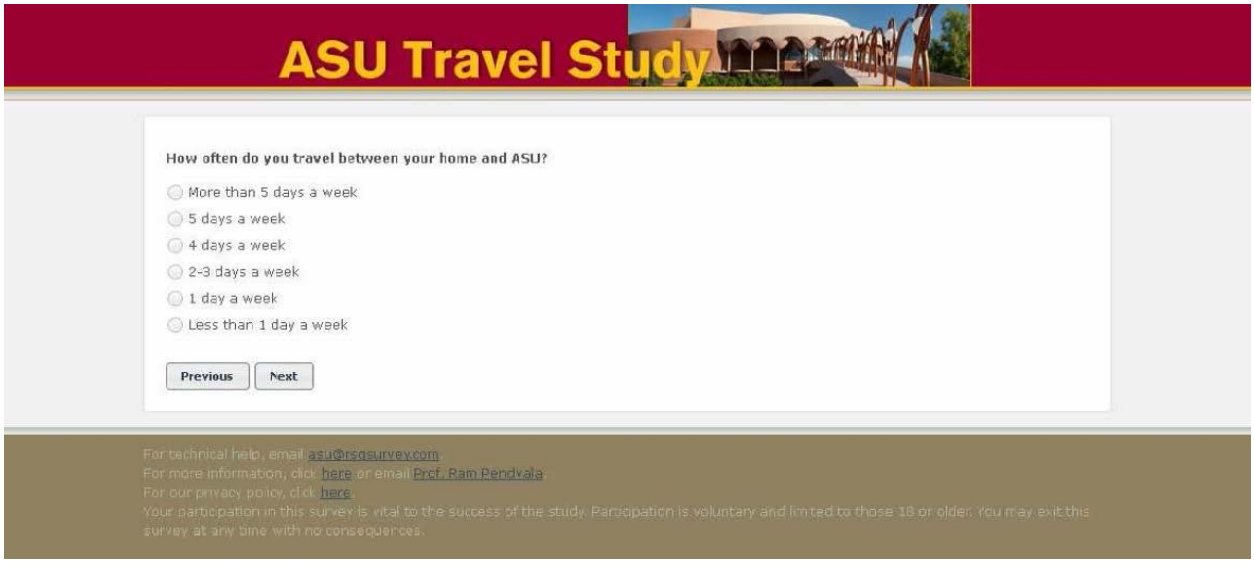
ASU Travel Study
How often do you travel between your home and ASU?
More than 5 days a week
5 days a week
4 days a week
2-3 days a week
1 day a week
Less than 1 day a week
Previous
Next
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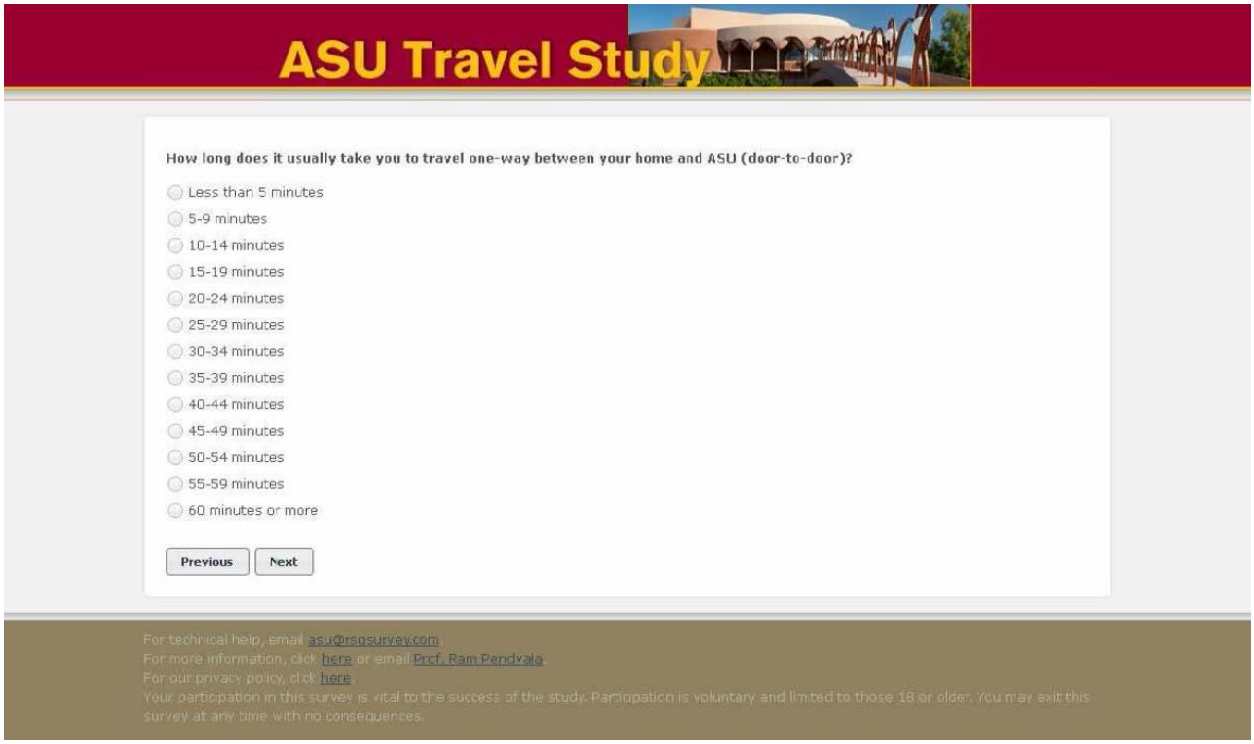
ASU Travel Study
How long does it usually take you to travel one-way between your home and ASU (door-to-door)?
Less than 5 minutes
5-9 minutes
10-14 minutes
15-19 minutes
20-24 minutes
25-29 minutes
30-34 minutes
35-39 minutes
40-44 minutes
45-49 minutes
50-54 minutes
55-59 minutes
60 minutes or more
Previous
Next
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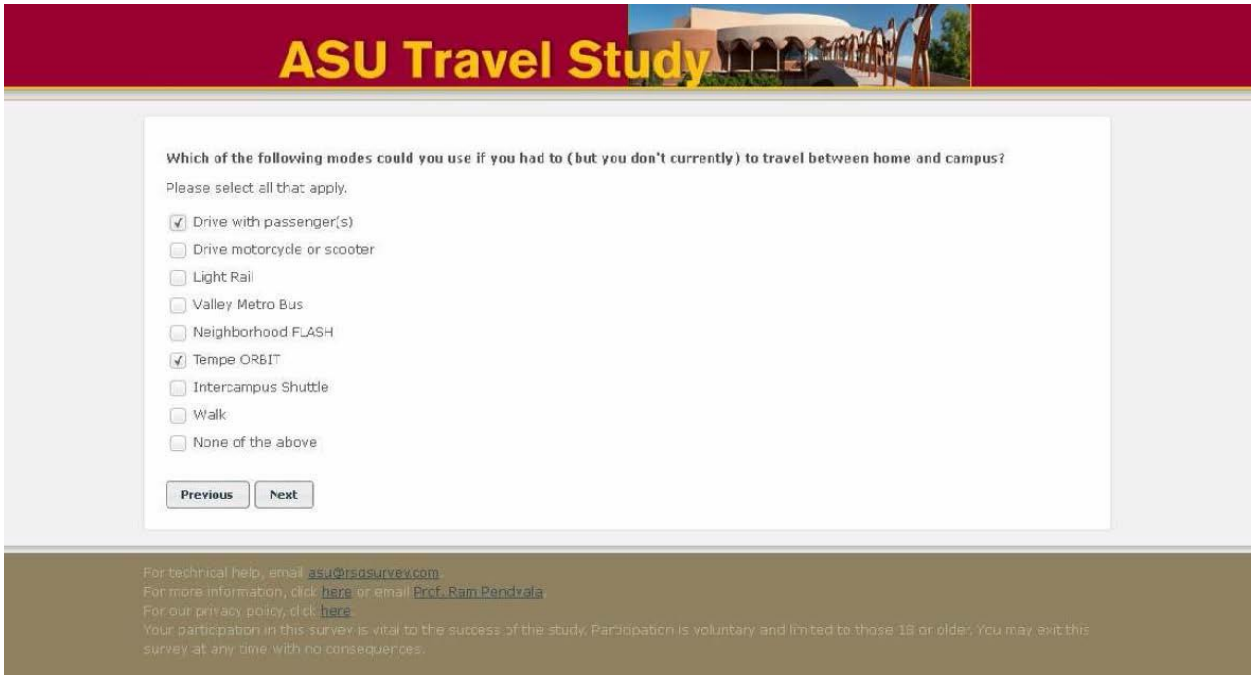
ASU Travel Study
Which of the following modes could you use if you had to (but you don't currently) to travel between home and campus?
Please select all that apply.
Drive with passenger(s)
Drive motorcycle or scooter
Light Rail
Valley Metro Bus
Neighborhood FLASH
Tempe ORBIT
Intercampus Shuttle
Walk
None of the above
Previous
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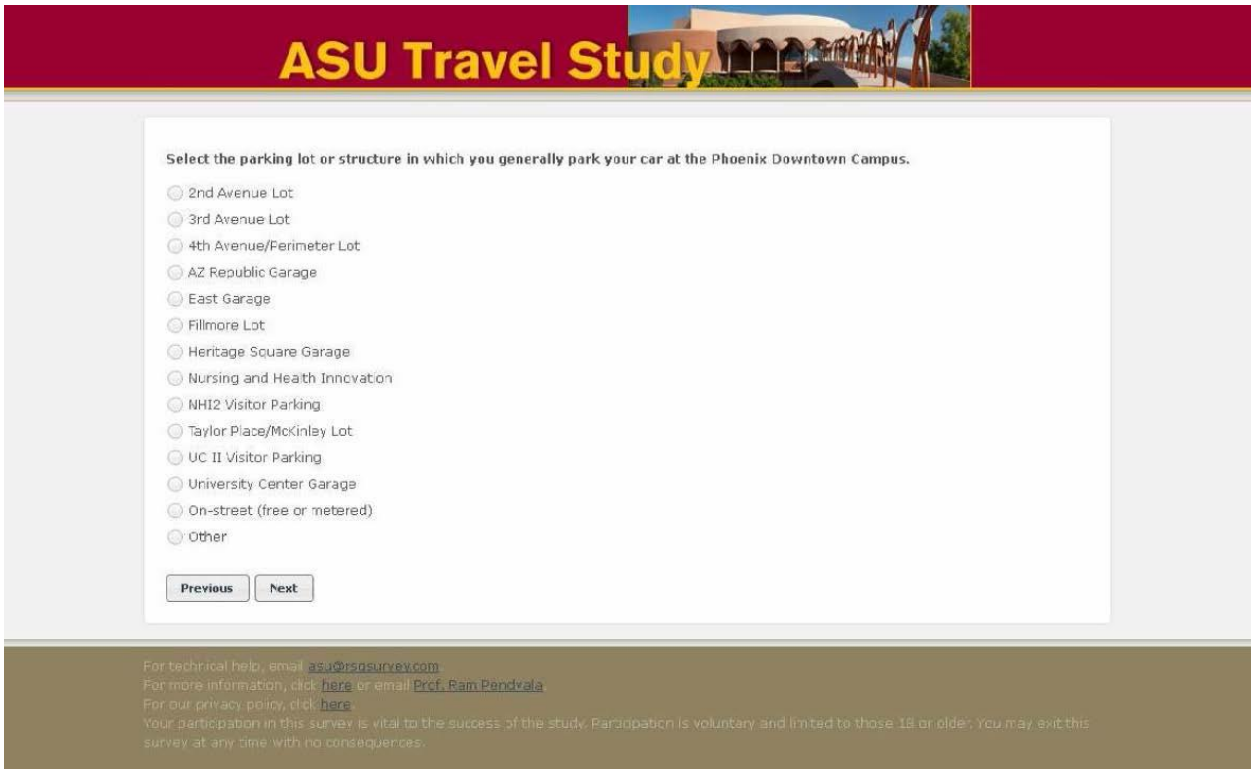
ASU Travel Study
Select the parking lot or structure in which you generally park your car at the Phoenix Downtown Campus.
2nd Avenue Lot
3rd Avenue Lot
4th Avenue/Perimeter Lot
AZ Republic Garage
East Garage
Fillmore Lot
Heritage Square Garage
Nursing and Health Innovation
NHI2 Visitor Parking
Taylor Place/McKinley Lot
UC II Visitor Parking
University Center Garage
On-street (free or metered)
Other
Previous
Next
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ASU Travel Study

Select the parking lot or structure in which you generally park your car at the Polytechnic Campus.

- CGCC Lot 90
- CGCC Lot 91
- CGCC Lot 92
- CGCC Lot 93
- CGCC Lot 94
- CGCC Lot 95
- Green Lot 5
- Green Lot 6
- Green Lot 8
- Green Lot 10
- Green Lot 12
- Green Lot 13
- Green Lot 14
- Green Lot 15
- Green Lot 30
- Green Lot 35
- Green Lot 37
- Green Lot 43
- Green Lot 46
- Green Lot 48
- Green Lot 49
- Lot 6 (Visitor)
- Lot 12 (Visitor)
- Lot 16
- Lot 29
- Lot 48 (Visitor)
- Perimeter Lot 1
- Perimeter Lot 2
- Perimeter Lot 24
- Perimeter Lot 27
- Perimeter Lot 32
- Perimeter Lot 33
- Perimeter Lot 36
- Perimeter Lot 50
- Perimeter Lot 54
- Perimeter Lot 55
- Red Lot 7
- Red Lot 51
- Red/Green Lot 16
- Resident Lot 42
- Resident Lot 47
- Resident Lot 96
- Resident Lot 97
- Resident Lot 98
- Resident Lot 99
- Restricted Lot 25
- Restricted Lot 28
- VA Lot
- On-street (free or metered)
- Other

Previous | Next

ASU Travel Study

Select the parking lot or structure in which you generally park your car at the Tempe Campus.

- 10th Street Parking Structure
- Apache Boulevard Structure
- Brickyard Parking Structure
- Chase Garage at Centerpoint
- Fulton Center Structure
- Lot 3
- Lot 9
- Lot 11
- Lot 13
- Lot 14
- Lot 15
- Lot 16
- Lot 17
- Lot 18
- Lot 19
- Lot 20
- Lot 27
- Lot 40 West
- Lot 41
- Lot 43
- Lot 45
- Lot 46
- Lot 47
- Lot 49
- Lot 50
- Lot 57
- Lot 58
- Lot 59
- Lot 59 East
- Lot 59 North
- Lot 60
- Lot 61
- Lot 62
- Lot 63
- Lot 65
- Lot 66
- Lot 72
- Packard Drive South Parking Structure
- Rural Road Structure
- Stadium Parking Structure
- Tyler Street Parking Structure
- University Towers Parking Structure
- Metered parking lots
- On-street (free or metered)
- Other

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ASU Travel Study

Select the parking lot or structure in which you generally park your car at the West Campus.

- Lot 1
- Lot 2
- Lot 3
- Lot 7
- Lot 12
- Lot 13
- Lot 14
- Lot 16
- Lot 17
- Lot 18
- Lot 19
- Lot 20
- North Zone Lot 10
- North Zone Lot 11
- Park Zone
- Metered lots
- On-street (free or metered)
- Other

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ASU Travel Study

Which parking decal are you holding?

- AZ Republic Garage – Resident
- East Garage – Employee
- East Garage - Student
- Employee All Access Disabled
- Fourth Avenue / Perimeter Lot
- Heritage Square Garage
- Heritage Square Garage – Evening Only
- Motorcycle
- McKinley / Taylor Place Lot – Resident
- Nursing Healthcare Innovation Garage
- Student Disabled Permit
- Second Avenue Lot
- University Center Garage
- University Center Garage – Evening Only
- I don't have a parking decal
- Other

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ASU Travel Study

Which parking decal are you holding?

- Green Lots
- Red Lots
- Motorcycle
- Perimeter Lots
- Polytechnic – Evening Only
- Polytechnic Disabled Parking
- Residence Hall
- I don't have a parking decal
- Other

Previous Next

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ASU Travel Study

Which parking decal are you holding?

- 10th Street Structure
- 10th Street Structure – Evening Only
- 10th Street Structure – Resident
- Apache Blvd Structure
- Apache Blvd Structure – Evening Only
- Apache Blvd Structure – Resident
- ASU Fulton Center Structure
- Brickyard
- Chase Garage at Centerpoint
- Disabled All Access – Employee
- Disabled Parking Permit – Student
- Lot 3
- Lot 16
- Lot 58
- Lot 59
- Lot 59E
- Lot 59N
- Lot 72
- Motorcycle
- Packard Drive South Structure
- Residence Hall Surface Lots (50, 63)
- Rural Road Parking Structure
- Rural Road Structure – Resident
- Stadium Structure
- Stadium Structure – Resident
- Tyler Street Structure
- University Towers Structure
- I don't have a parking decal
- Other

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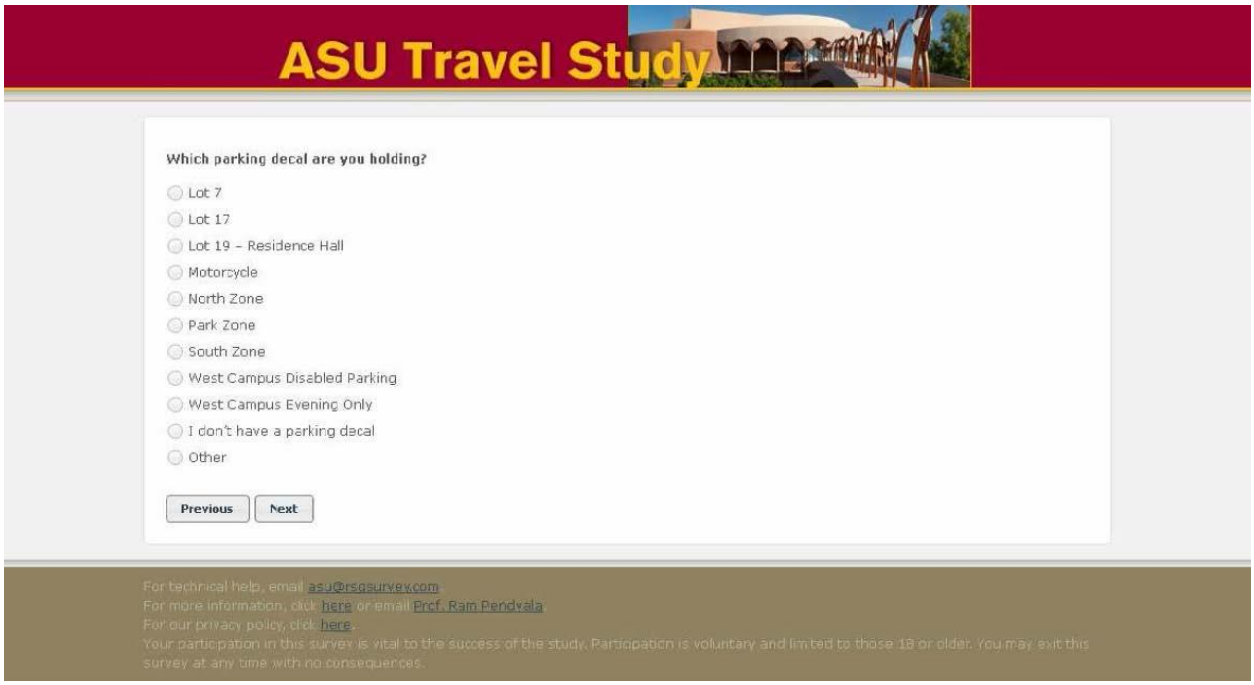
ASU Travel Study
Which parking decal are you holding?
Lot 7
Lot 17
Lot 19 - Residence Hall
Motorcycle
North Zone
Park Zone
South Zone
West Campus Disabled Parking
West Campus Evening Only
I don't have a parking decal
Other
Previous
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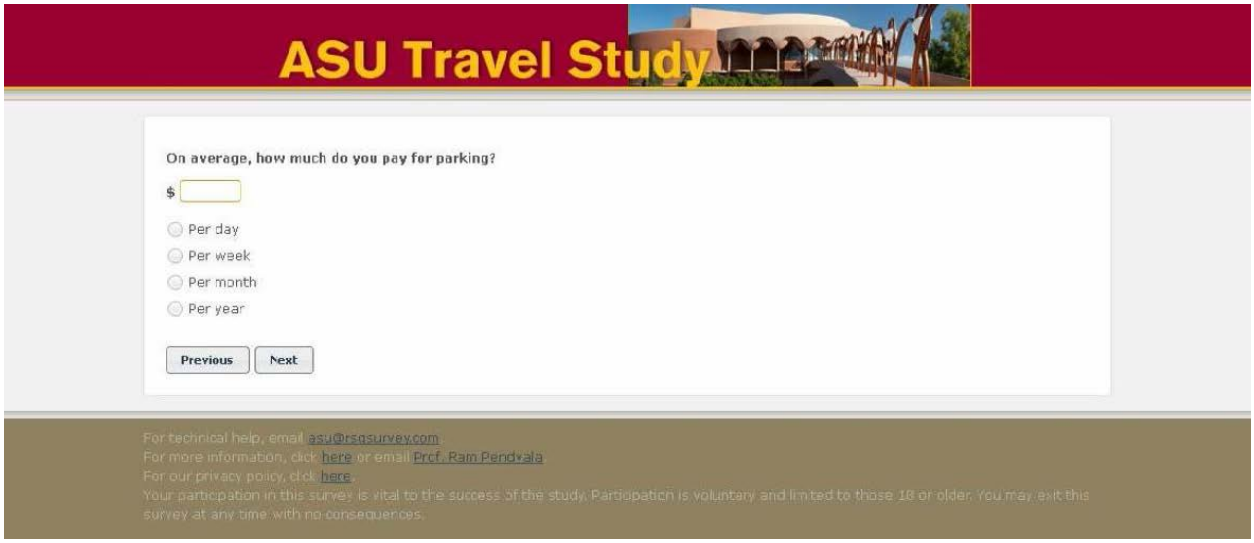
ASU Travel Study
On average, how much do you pay for parking?
$
Per day
Per week
Per month
Per year
Previous
Next
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ASU Travel Study
Who pays for your parking?
I do
My parents
My employer
Other, please specify:
Previous
Next
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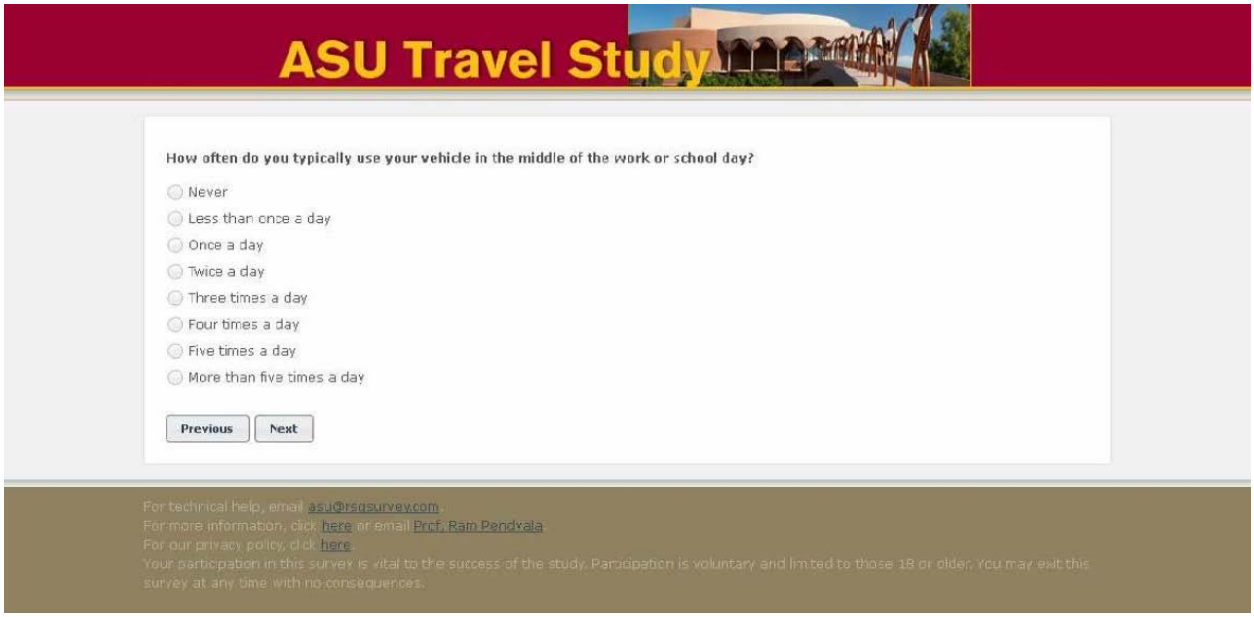
ASU Travel Study
How often do you typically use your vehicle in the middle of the work or school day?
Never
Less than once a day
Once a day
Twice a day
Three times a day
Four times a day
Five times a day
More than five times a day
Previous
Next
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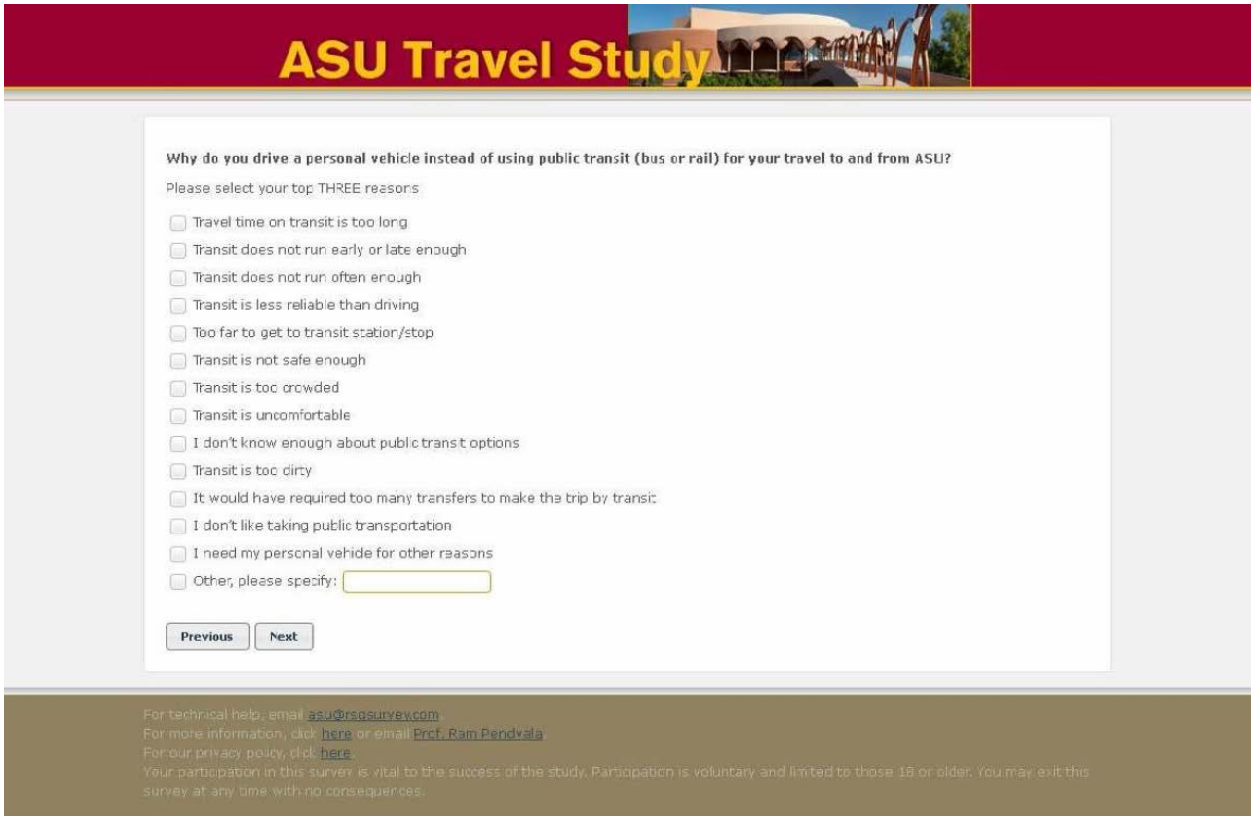
ASU Travel Study
Why do you drive a personal vehicle instead of using public transit (bus or rail) for your travel to and from ASU?
Please select your top THREE reasons
Travel time on transit is too long
Transit does not run early or late enough
Transit does not run often enough
Transit is less reliable than driving
Too far to get to transit station/stop
Transit is not safe enough
Transit is too crowded
Transit is uncomfortable
I don't know enough about public transit options
Transit is too dirty
It would have required too many transfers to make the trip by transit
I don't like taking public transportation
I need my personal vehicle for other reasons
Other, please specify:
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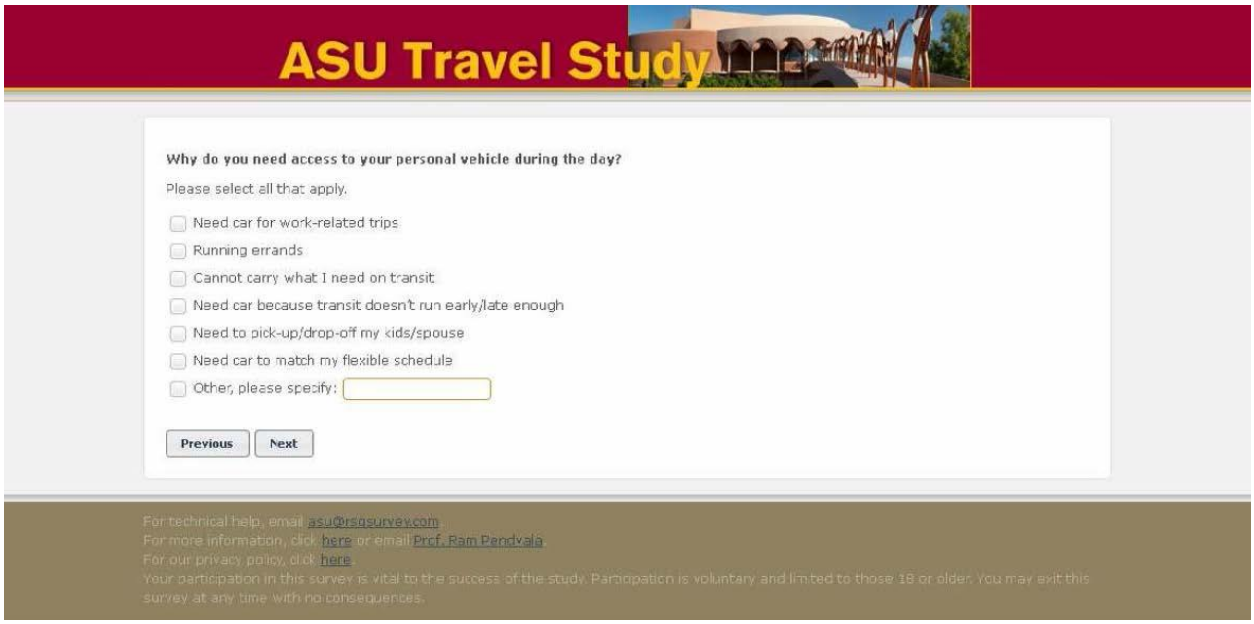
ASU Travel Study
Why do you need access to your personal vehicle during the day?
Please select all that apply.
Need car for work-related trips
Running errands
Cannot carry what I need on transit
Need car because transit doesn't run early/late enough
Need to pick-up/drop-off my kids/spouse
Need car to match my flexible schedule
Other, please specify:
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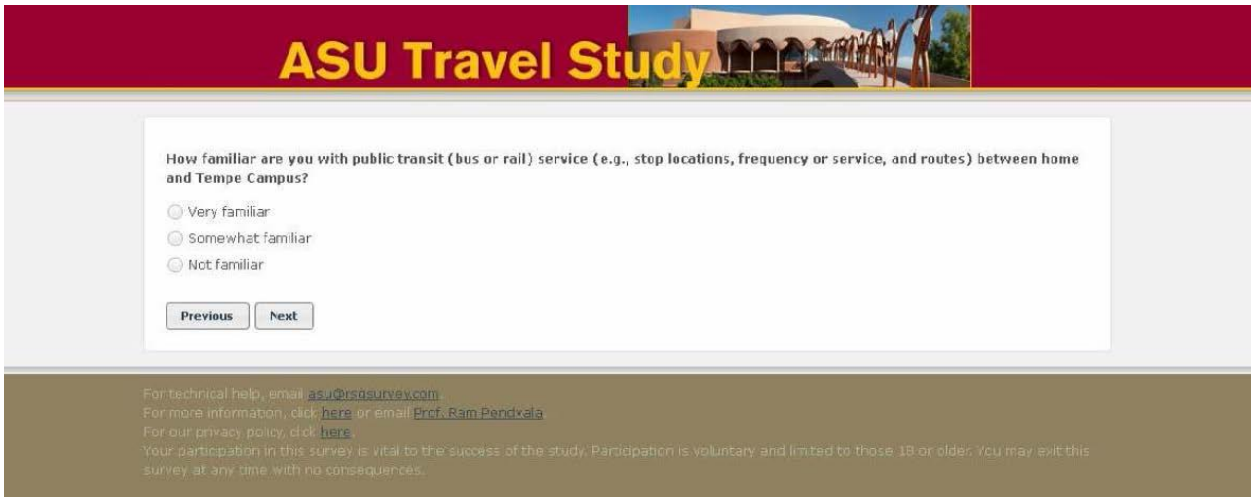
ASU Travel Study
How familiar are you with public transit (bus or rail) service (e.g., stop locations, frequency or service, and routes) between home and Tempe Campus?
Very familiar
Somewhat familiar
Not familiar
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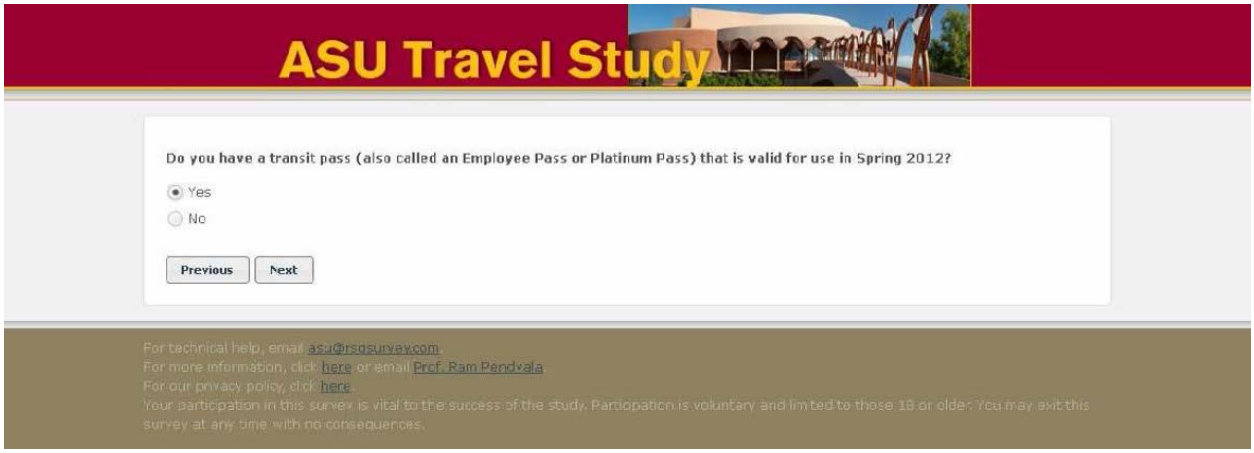
ASU Travel Study
Do you have a transit pass (also called an Employee Pass or Platinum Pass) that is valid for use in Spring 2012?
Yes
No
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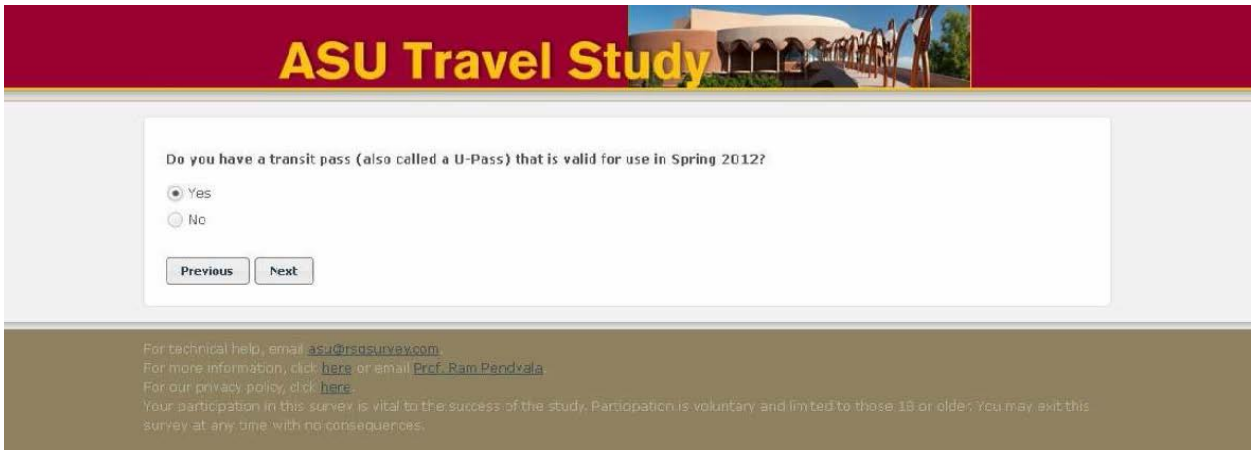
ASU Travel Study
Do you have a transit pass (also called a U-Pass) that is valid for use in Spring 2012?
Yes
No
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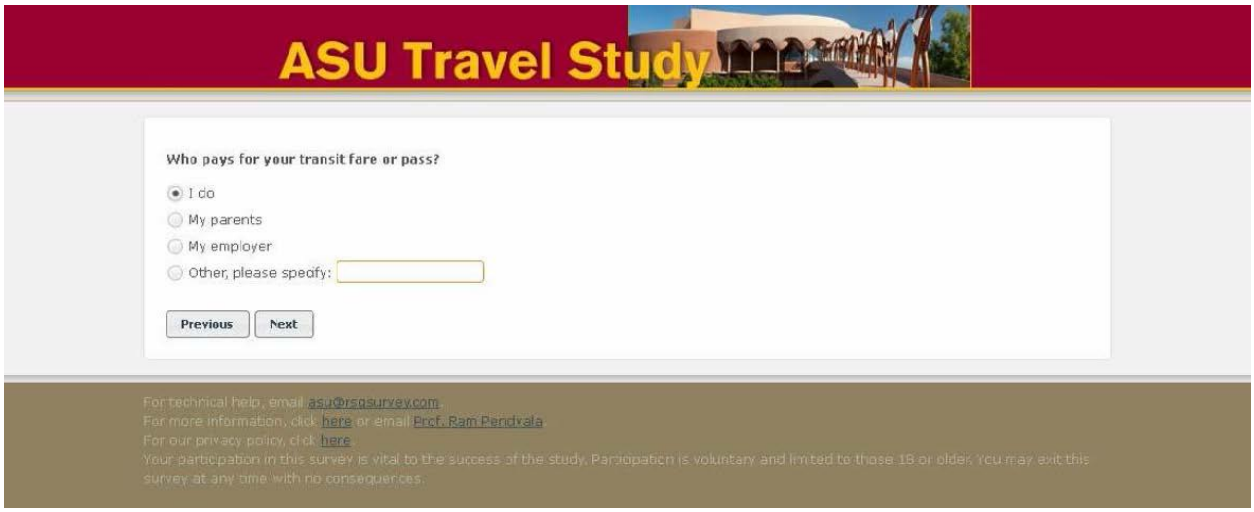
ASU Travel Study
Who pays for your transit fare or pass?
I do
My parents
My employer
Other, please specify:
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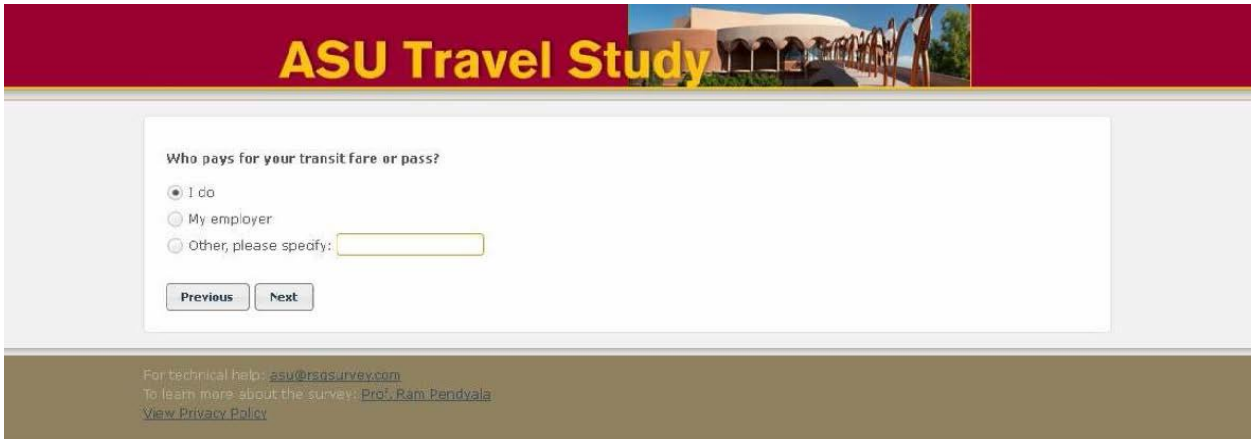
ASU Travel Study
Who pays for your transit fare or pass?
I do
My employer
Other, please specify:
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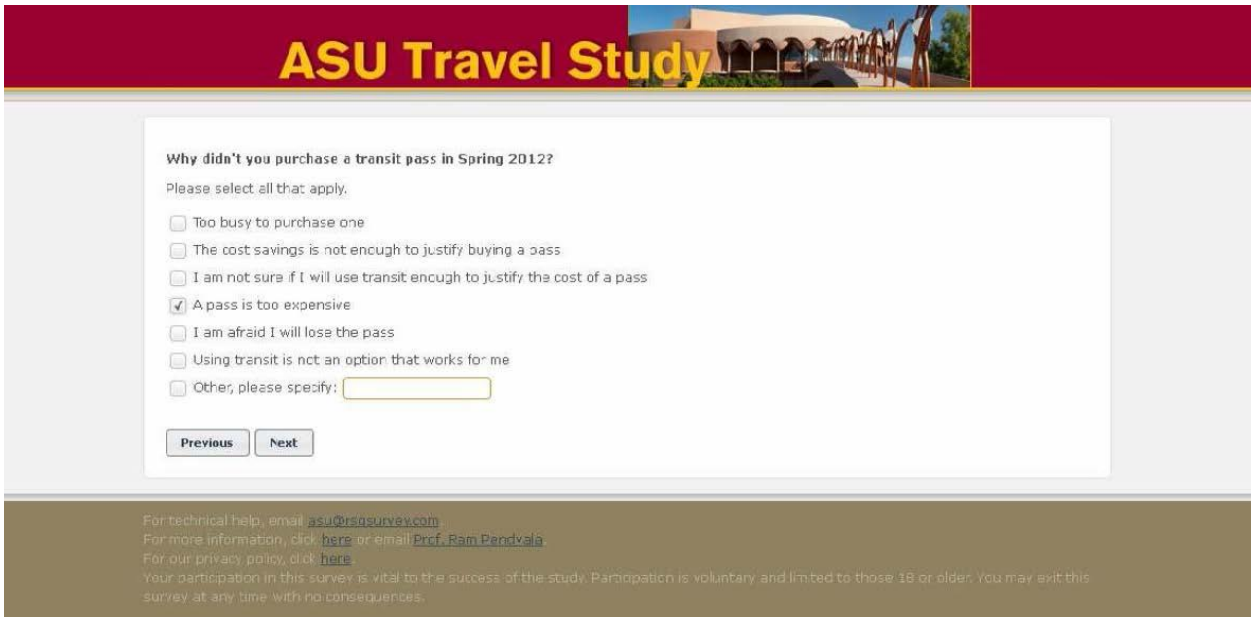
ASU Travel Study
Why didn't you purchase a transit pass in Spring 2012?
Please select all that apply.
Too busy to purchase one
The cost savings is not enough to justify buying a pass
I am not sure if I will use transit enough to justify the cost of a pass
A pass is too expensive
I am afraid I will lose the pass
Using transit is not an option that works for me
Other, please specify:
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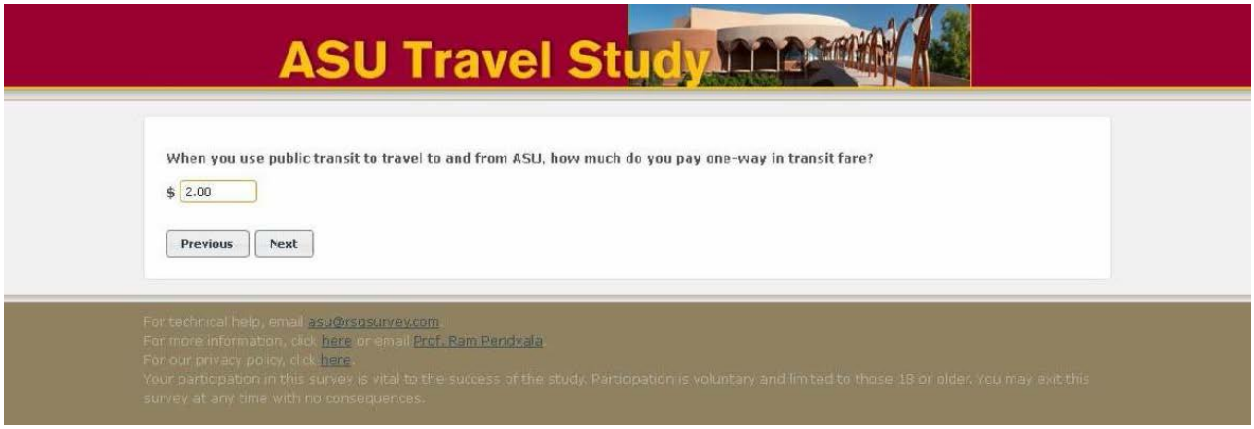
ASU Travel Study
When you use public transit to travel to and from ASU, how much do you pay one-way in transit fare?
$ 2.00
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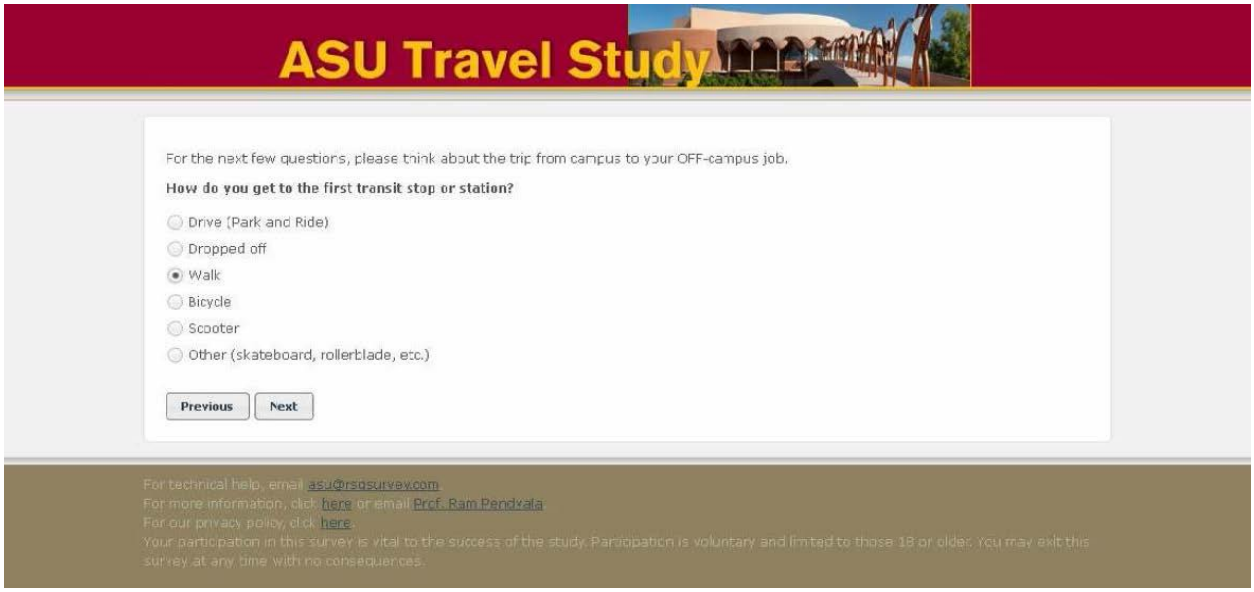
ASU Travel Study
For the next few questions, please think about the trip from campus to your OFF-campus job.
How do you get to the first transit stop or station?
Drive (Park and Ride)
Dropped off
Walk
Bicycle
Scooter
Other (skateboard, rollerblade, etc.)
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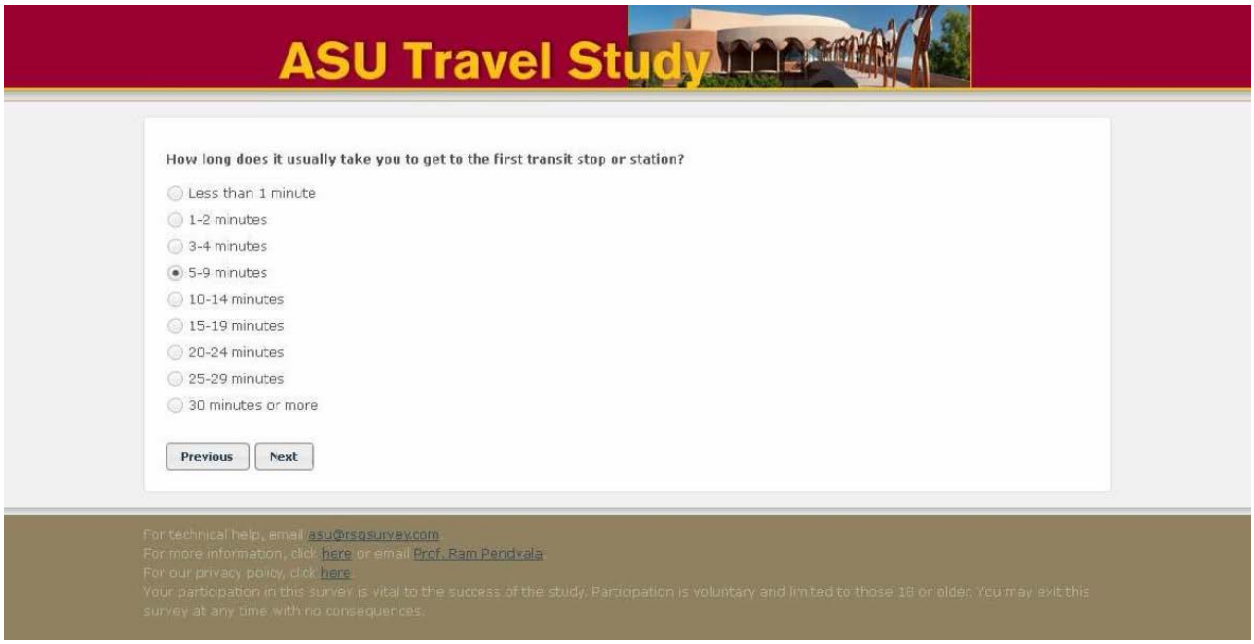
ASU Travel Study
How long does it usually take you to get to the first transit stop or station?
Less than 1 minute
1-2 minutes
3-4 minutes
5-9 minutes
10-14 minutes
15-19 minutes
20-24 minutes
25-29 minutes
30 minutes or more
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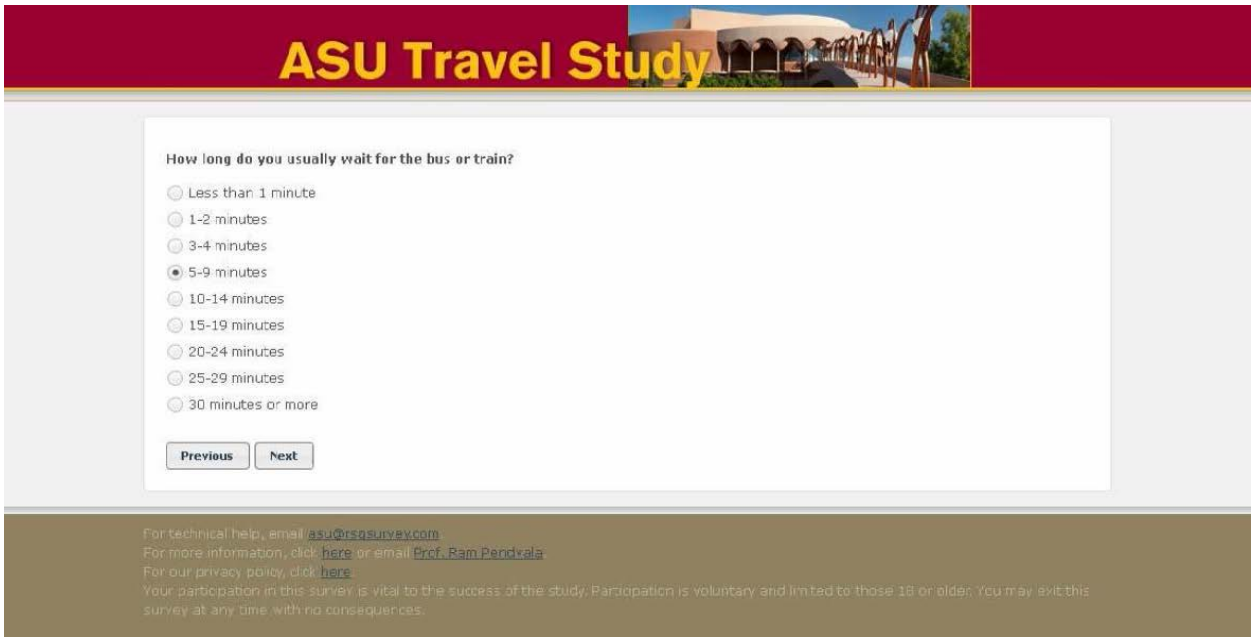
ASU Travel Study
How long do you usually wait for the bus or train?
Less than 1 minute
1-2 minutes
3-4 minutes
5-9 minutes
10-14 minutes
15-19 minutes
20-24 minutes
25-29 minutes
30 minutes or more
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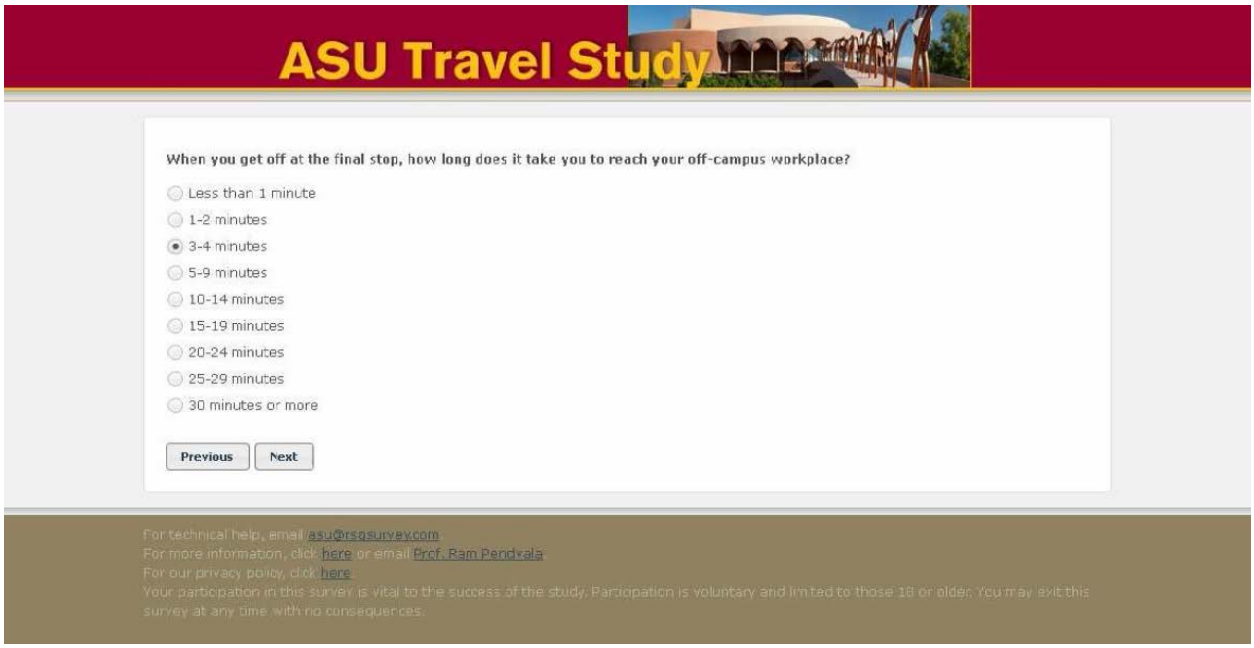
ASU Travel Study
When you get off at the final stop, how long does it take you to reach your off-campus workplace?
Less than 1 minute
1-2 minutes
3-4 minutes
5-9 minutes
10-14 minutes
15-19 minutes
20-24 minutes
25-29 minutes
30 minutes or more
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ASU Travel Study

Please indicate how strongly you agree or disagree with each of the following statements.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
As long as I am comfortable when traveling, I can tolerate delays	●	○	○	○	○
More than saving time, I prefer to be productive when traveling	○	●	○	○	○
My days of taking transit are over	○	●	○	○	○
I am not afraid to ride transit	○	○	○	●	○
I'm the kind of person who rides transit	○	○	●	○	○
Protecting the environment is very important to me	○	○	○	○	●
It's easy to plan a trip using transit	○	○	○	○	●
Transit is often dirty	○	●	○	○	○
If it would save time, I would change my form of travel	○	○	○	●	○

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ASU Travel Study

Please indicate how strongly you agree or disagree with each of the following statements.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
My personal vehicle reflects who I am	○	○	●	○	○
For me, my personal vehicle (car/motorcycle) is king! Nothing will replace my personal vehicle as my main mode of transportation	○	○	○	●	○
I am willing to carpool or take public transit more frequently to reduce air pollution and carbon emissions from my vehicle	○	●	○	○	○
Privacy is important to me when I travel	●	○	○	○	○
If I wanted to, I could use public transit more frequently	○	○	○	○	●
I have to drive to get to transit anyway, so I may as well just drive my personal vehicle the whole way	○	○	●	○	○
I am willing to pay higher tolls if they are used to reduce air pollution and carbon emissions	○	○	○	○	●
Getting to and from transit stations/stops is not pedestrian friendly and is very unpleasant	○	○	○	○	●
I currently make an effort to take public transit wherever I can	○	○	●	○	○

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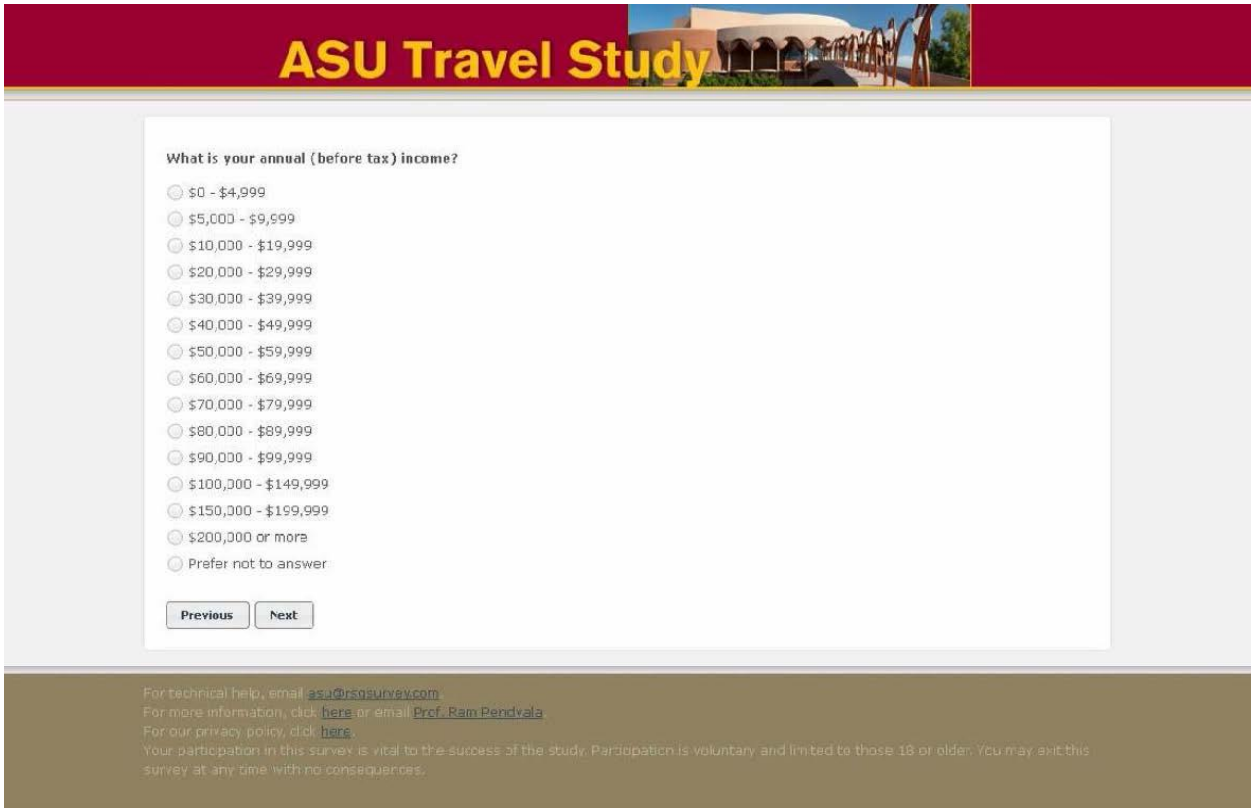
ASU Travel Study
What is your annual (before tax) income?
$0 - $4,999
$5,000 - $9,999
$10,000 - $19,999
$20,000 - $29,999
$30,000 - $39,999
$40,000 - $49,999
$50,000 - $59,999
$60,000 - $69,999
$70,000 - $79,999
$80,000 - $89,999
$90,000 - $99,999
$100,000 - $149,999
$150,000 - $199,999
$200,000 or more
Prefer not to answer
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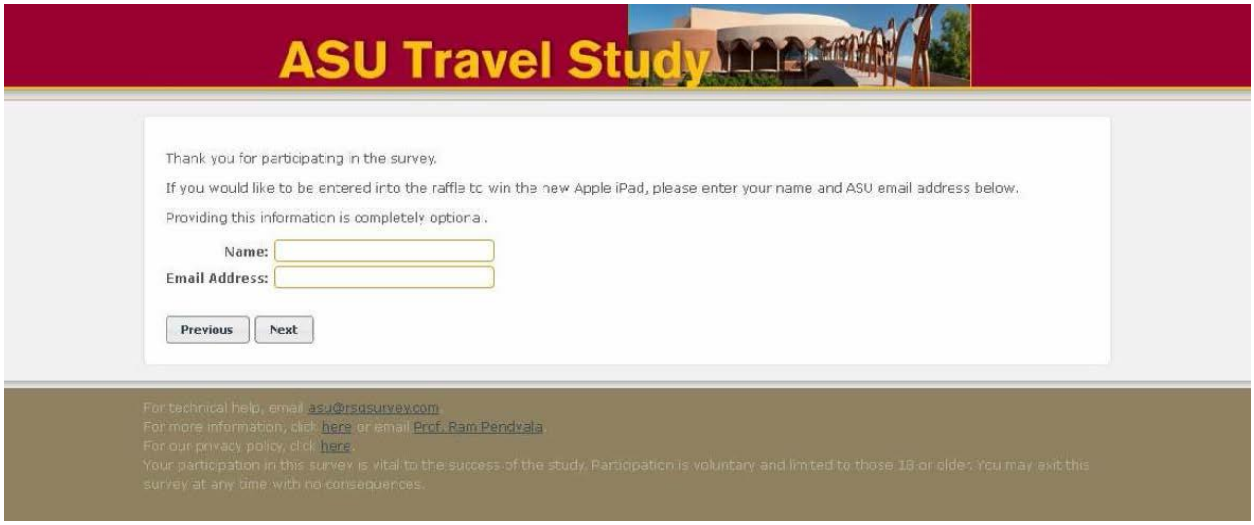
ASU Travel Study
Thank you for participating in the survey.
If you would like to be entered into the raffle to win the new Apple iPad, please enter your name and ASU email address below.
Providing this information is completely optional.
Name:
Email Address:
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ASU Travel Study
If you have any additional comments about transportation to/from the ASU campus(es), please type them in the box below.
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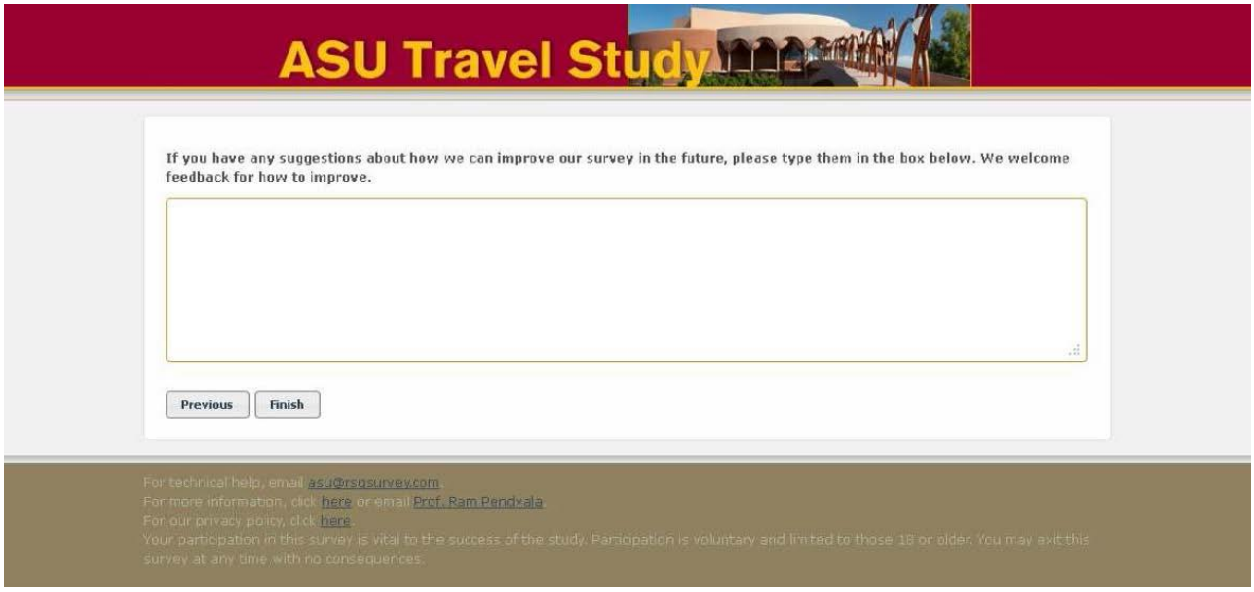
ASU Travel Study
If you have any suggestions about how we can improve our survey in the future, please type them in the box below. We welcome feedback for how to improve.
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Finish
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ASU Travel Study

Thank you for your participation. All of your answers have been submitted. The winners of the new Apple iPad raffle will be notified the week of 7 May 2012.

This study is being jointly conducted by: The Maricopa Association of Governments (MAG) (http://www.azmag.gov), Valley Metro (http://www.valleymetro.org), the School of Sustainable Engineering and the Built Environment at ASU (http://engineering.asu.edu/sebe), and Resource Systems Group, Inc (http://www.rsginc.com).

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