MEASURING THE TRAVEL CHARACTERISTICS OF A UNIVERSITY POPULATION: Experiences from the Design and Administration of a Web-based Travel Survey

Sarah E. Volosin ***(corresponding author)***
Arizona State University, School of Sustainable Engineering and the Built Environment
Room ECG252, Tempe, AZ 85287-5306. Tel: (480) 965-3589; Fax: (480) 965-0557
Email: sarah.volosin@asu.edu

Ram M. Pendyala
Arizona State University, School of Sustainable Engineering and the Built Environment
Room ECG252, Tempe, AZ 85287-5306. Tel: (480) 727-9164; Fax: (480) 965-0557
Email: ram.pendyala@asu.edu

James Kerrigan
Resource Systems Group, Inc.
180 Battery Street, Suite 350, Burlington, VT 05401. Tel: (802) 295-4999; Fax: (802)-295-1006
Email: jkerrigan@rsginc.com

Elizabeth Greene
Resource Systems Group, Inc.
55 Railroad Row, White River Junction, VT 05001. Tel: (802) 295-4999; Fax: (802) 295-1006
Email: egreene@rsginc.com

Vladimir Livshits
Maricopa Association of Governments
302 N First Avenue, Suite 300, Phoenix, AZ 85003. Tel: (602) 452-5079; Fax: (602) 254-6490
Email: vlivshits@azmag.gov

Jothan Samuelson
Maricopa Association of Governments
302 N First Avenue, Suite 300, Phoenix, AZ 85003. Tel: (602) 452-5079; Fax: (602) 254-6490
Email: jsamuelson@azmag.gov

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ABSTRACT

Institutions of higher education, particularly those with large student enrollments, constitute special generators that contribute in a variety of ways to the travel demand in a region. Despite the importance of university population travel characteristics in understanding and modeling activity-travel patterns and mode choice behavior in a region, such populations remain under-studied in the activity-travel behavior analysis arena. Traditional household travel surveys rarely capture or include a sample of university students that is large enough to infer travel behavior characteristics for this specific market segment. This paper reports on the process followed and experiences gained in the conduct of a comprehensive activity-travel survey at Arizona State University, one the largest universities in North America. An online survey was administered to the entire university population, including staff, students, and faculty, during a three week period and the resulting data set serves as a valuable resource for modeling and analyzing university-generated travel demand. This paper focuses on the survey design and administration process, as well as the assembly and weighting of the resulting data set. Adopting a carefully planned survey process that involves close coordination with the university administration proved critical to the collection of a usable and rich travel survey data set for the university population.

Keywords: travel survey, web-based survey, student travel, university population travel, under-studied population, travel characteristics measurement

INTRODUCTION

University populations may be considered under-studied populations in the activity-travel behavior analysis domain. In many cities and metropolitan areas around the world, universities generate travel demand with unique characteristics due to the distinctive socio-economic and demographic profile of student populations, heterogeneity in population characteristics and living/work arrangements, and time-space constraints governed by class schedules. Despite the importance of universities as special traffic generators, there is limited research and even more limited data about the travel characteristics of university populations. This paper aims to fill this critical gap by reporting on findings from and experiences gained in the conduct of a comprehensive activity-travel survey at Arizona State University.

There are a number of reasons why university populations have remained an under-studied population. University populations, and university students in particular, are inevitably under-represented in traditional regional household travel surveys. For example, in the 2008-2009 National Household Travel Survey (NHTS) conducted in the United States, only about one percent of the respondent sample of 260,000 individuals could be classified as college students (individuals 18 years of age or older who reported at least one "school" trip) (FHWA, 2009). Population statistics, however, suggest that, of the 314 million people in the United States in 2012, about 21.6 million (7%) were enrolled in institutions of higher education (NCES, 2012; US Census Bureau, 2012). Although it is recognized that these statistics are not directly comparable, the disparity may be treated as an indicator of the extent to which university student populations are under-represented in household travel surveys.

The under-representation of university student populations in travel survey samples and the difficulty in administering travel surveys to such populations may be attributed to a number of reasons. In general, university student populations are younger in age and may not be fully engaged and in tune with civic processes (Behrens, et al, 2008). As such, they are more likely to ignore surveys with which they do not personally identify. As noted by Behrens, et al (2008), university student populations include those living in group quarters (like dormitories) and such populations are often not included in sampling frames. University students tend to be a mobile group, frequently changing their residential locations and residential living arrangements. It is difficult for sources of sampling frames to stay current for such a mobile population and to be all-inclusive in their representation of the population. As a result, sampling frames themselves are deficient in representing student populations.

Recognizing the importance of measuring university student population travel characteristics, there have been a few studies in the recent past focusing on measuring and analyzing university/college student travel demand. Greene, et al (2013) provide a meta-analysis of three university population travel surveys, one of which is the Arizona State University travel survey and constitutes the focus of this paper. Khattak, et al (2012) report on a series of university student travel surveys conducted in Virginia. In the first round of surveys conducted in 2009, travel data was collected from student populations at four different universities using a computer-assisted telephone interview (CATI) as an extension of the 2008-2009 National Household Travel Survey of the US Department of Transportation. In the second round of surveys in 2010, the CATI was converted to a fully online web-based survey and data was collected from two universities in Virginia. Miller (2012) reports on the results of the 2011-2012 University of California-Davis campus travel survey which, unlike some of the other university travel surveys, was administered not only to students, but also to faculty and staff. Akar, et al (2012) report on a travel survey that was administered to a sample of students, faculty, and staff

at Ohio State University in Columbus. The Ohio State University survey focused heavily on mode choice and the factors contributing to mode usage behavior. The six-week Mobidrive data set (Axhausen, et al, 2002) includes a small sample of university students facilitating the analysis of day-to-day variability in student travel behavior (Susilo and Kitamura, 2005).

Due to the hard-to-reach nature of the university student population, it is important to document the process followed and lessons learned in the conduct of university student population surveys. This paper is a comprehensive report on the Arizona State University travel survey conducted in Spring 2012. The paper includes a detailed description of the survey process, survey design and administration, and data preparation and weighting.

SURVEY CONTEXT

Arizona State University (ASU) is a comprehensive research university based in the Greater Phoenix Metropolitan region in Arizona. ASU has three established satellite campuses in the Greater Phoenix region and is one of the largest public universities in the nation with more than 70,000 students attending its four campuses. In the Fall of 2010, Arizona State University had a total (unduplicated) enrollment of 70,440 students of which 56,562 were undergraduate students and 13,878 were graduate students. Nearly 17 percent of the undergraduate students were part-time students; the corresponding percent for graduate students was 32 percent suggesting that there is a large group of graduate students who presumably work full time while enhancing their educational credentials on a part-time basis.

The main campus of the institution is located in Tempe, a city of about 165,000 people that adjoins the city of Phoenix. The Greater Phoenix metropolitan region is largely encompassed by Maricopa County, the largest county in Arizona with a population of nearly four million people. The main Tempe campus, situated in the heart of the region, continues to have the highest enrollment among the four campuses with a Fall 2010 duplicated enrollment of 58,371 students. The three branch campuses are located in Downtown Phoenix, Glendale (in the western part of the region), and Mesa (in the eastern part of the region) with duplicated enrollments of 13,567, 11,813, and 9,752 respectively. It should be noted that the number of students attending different campuses adds up to a value substantially larger than 70,440 because of the double- and triple-counting of students who attend classes on multiple campuses.

Over the past several years, the university has built new dormitory facilities with a view to enhancing the residential community on campus. In Fall 2010, ASU was home to just over 13,000 students living on campus in various on-campus housing and dormitory facilities. More than 57,000 students lived off-campus – either alone, with roommates, or with family – making ASU an institution with a large commuter population. For this reason, the university campuses are dotted with large parking facilities and structures, priced at various levels. The City of Tempe operates free circulator bus services that serve Tempe Campus and connect a number of off-campus housing and apartment complexes within the city. The University operates a free inter-campus shuttle service so that students, faculty, and staff can travel between branch campuses. ASU students are eligible to purchase a highly subsidized transit pass for $200 per year, providing access to unlimited transit rides on bus and light rail services in the entire metropolitan region (a comparable full-cost equivalent assuming two transit trips per day is $936).

For faculty and staff, data is available for Fall 2009 when Arizona State University was home to 12,142 employees. The employee count includes 2,991 faculty members (with teaching and/or research responsibilities) and 9,151 staff and non-faculty administrators. The

approximately 9,000 staff are almost equally split among the three broad categories of professionals, classified staff, and graduate assistants (ASU, 2012).

The travel demand generated by a large university such as Arizona State University includes far more than regular student, faculty, and staff travel; it also includes the many trips attributed to visitors, event attendees, delivery of goods and services, and other special purposes. The travel survey reported in this paper does not include such travel within its scope. Rather, the travel survey focuses exclusively on personal travel of the University community, i.e., weekday activities and trips undertaken by faculty, staff, and students.

DESIGN OF A ROBUST SURVEY PROCESS

The overall survey process is depicted in Figure 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 rather complex. 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 university population travel survey.

At the outset, the project team contacted three major entities of the ASU survey administration to facilitate coordination of the survey effort: the Office of the Provost, Parking and Transit Services (PTS), and the University Technology Office (UTO). The University Office of the Provost is in charge of all academic and student affairs at the university. 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 this office, which is the only entity on campus authorized to send out mass e-mail messages requesting participation in the survey. The ASU Parking and Transit Services (PTS) office conducts its own surveys on a periodic basis (they do not conduct the equivalent of travel diary surveys) and has a plethora of secondary data: parking capacity and price levels, number of parking permits sold, number of subsidized transit passes sold, 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. The ASU PTS office distributes news and announcements to the entire university population on a frequent and regular cycle, and 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 web-based online travel 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 the UTO. Moreover, the UTO is the custodian of MyASU, the portal through which all students and employees access their accounts, records, and information. Within the MyASU portal, the University Technology Office included a link to the survey with a “To-Do” item in the task list that could not be dismissed until the individual actually completed the survey. 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 able to move forward with the design of the survey itself. The survey instrument design went through many iterations of review and refinement. After the project team, in consultation with the three university entities, was satisfied with the survey design, content, and administration protocol, the entire survey was submitted to the 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 survey was then subjected to a pre-test that closely mimicked the real survey administration protocol. A convenience sample of faculty, staff, and students (in the School of Sustainable Engineering and the Built Environment) was recruited to participate in the pre-test. The invitation was sent to 75 students (50 undergraduate and 25 graduate students), 30 faculty members, and 20 staff members. A total of 78 responses were received in the pre-test (36 undergraduates, 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. Based on the open-ended feedback received from the pretest respondents, and a thorough analysis of the pretest data, the survey instrument was revised through an iterative process, and subjected to a final IRB approval prior to deployment.

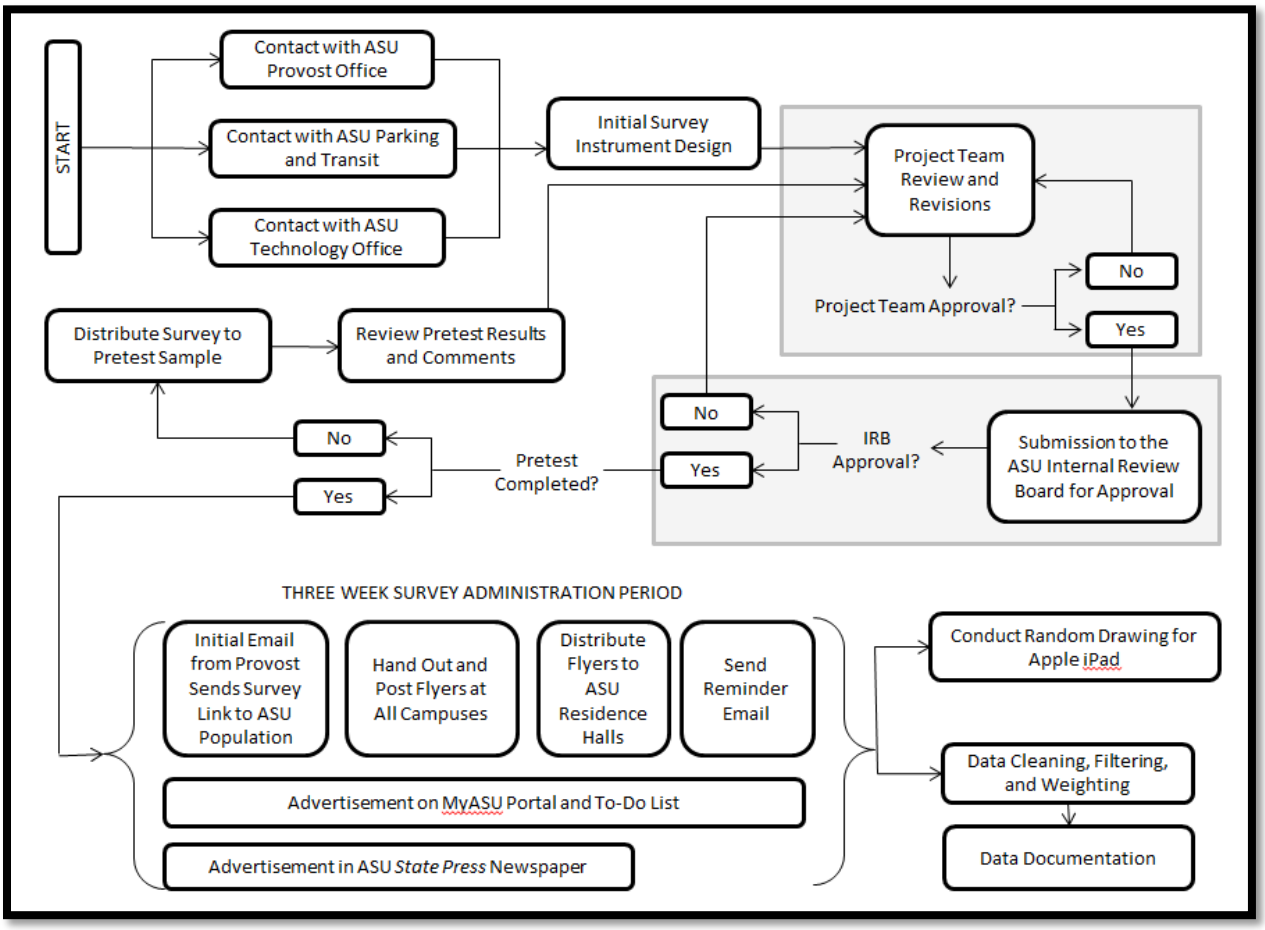

FIGURE 1. Schematic Depicting Overall Survey Process

The survey administration is described in detail later. The survey was deployed in the field for a period of three weeks, selected such that it would represent typical or normal working days at the university, well clear of spring break and the final exams. At the end of the three-week period, the data collected through the online survey was retrieved, subjected to an extensive cleaning and quality check process, and appended with weights to ensure that the weighted sample is representative of the university population.

DESIGN OF ONLINE SURVEY

One of the key decision elements in the survey design involved a determination of whether to collect *all* trips made by individuals over the course of a travel survey day or to 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), the study team decided against doing so, instead obtaining comprehensive information about the activity-travel patterns of the university population. It was felt that the data collected in this survey would be useful to develop specific models for the university population that could be integrated into the activity-based travel demand microsimulation model that will be adopted by the local planning organization. The project team also 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 future modeling efforts, as the spatial resolution of models continues to become increasingly fine-grained.

Figure 2 presents a schematic of the information content 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. Recognizing that respondents may have questions about the survey, every survey screen was given a footnote with contact information for the study team.

The first set of questions involved collecting information about the campus affiliation of the respondents. Respondents were asked to identify the campus where they went to school and worked (primarily), the college or school with which they most closely affiliated themselves, and their level in school or job class. All respondents were then asked to identify their residential and work locations (both on-campus and off-campus for students) and provide detailed socio-economic and demographic information about themselves and their households. As students living together as roommates may be confused as to what constitutes a household, the survey questions that would typically ask for household information were worded carefully to try and minimize such confusion. Socio-economic and demographic data was collected on such items as personal income (household income if living with family, parents, or guardians), race, gender, age, living arrangements, driver license holding, and transit pass holding.

The travel diary portion of the survey followed. In this portion, 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 survey day. Respondents were asked to provide travel information for the previous day (yesterday); 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, they were asked to identify the reasons. The survey instrument then skipped the diary portion for these respondents, routing them directly to the subsequent stage of the survey.

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 locations visited through the course of the travel survey day and then asked to provide detailed information for each trip between these locations. Information collected included start and end times of the trip, mode of transportation (including access and egress modes where applicable), trip purpose, wait and

transfer times, parking search time, 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. It was not possible to implement error trapping in the context of this element of the survey. Given the ease of use of the interface and the flexibility afforded the respondents in providing approximate locations, the study team hoped that 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 3.

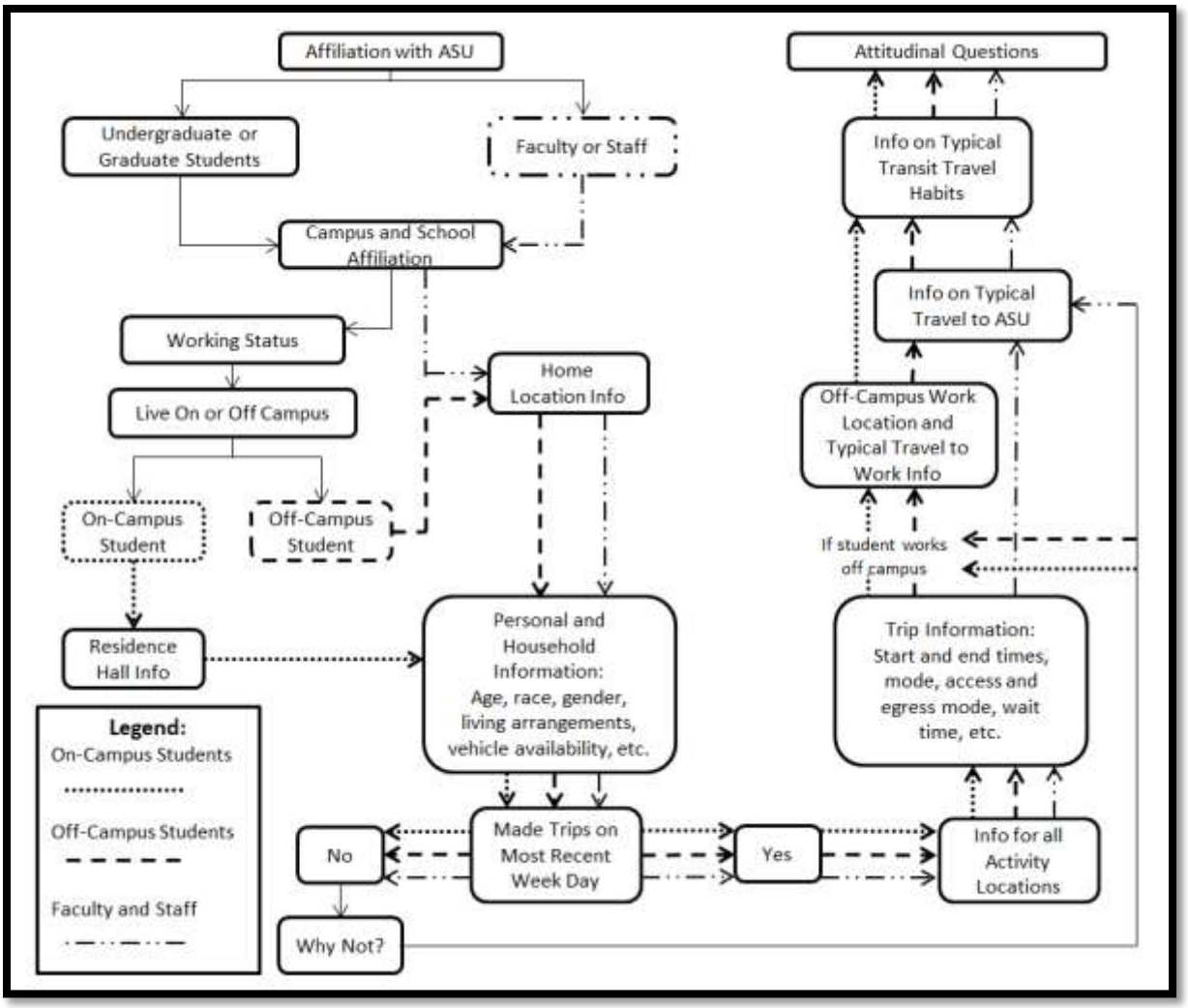

Figure 2. Schematic Depicting Flow of Survey Design Content

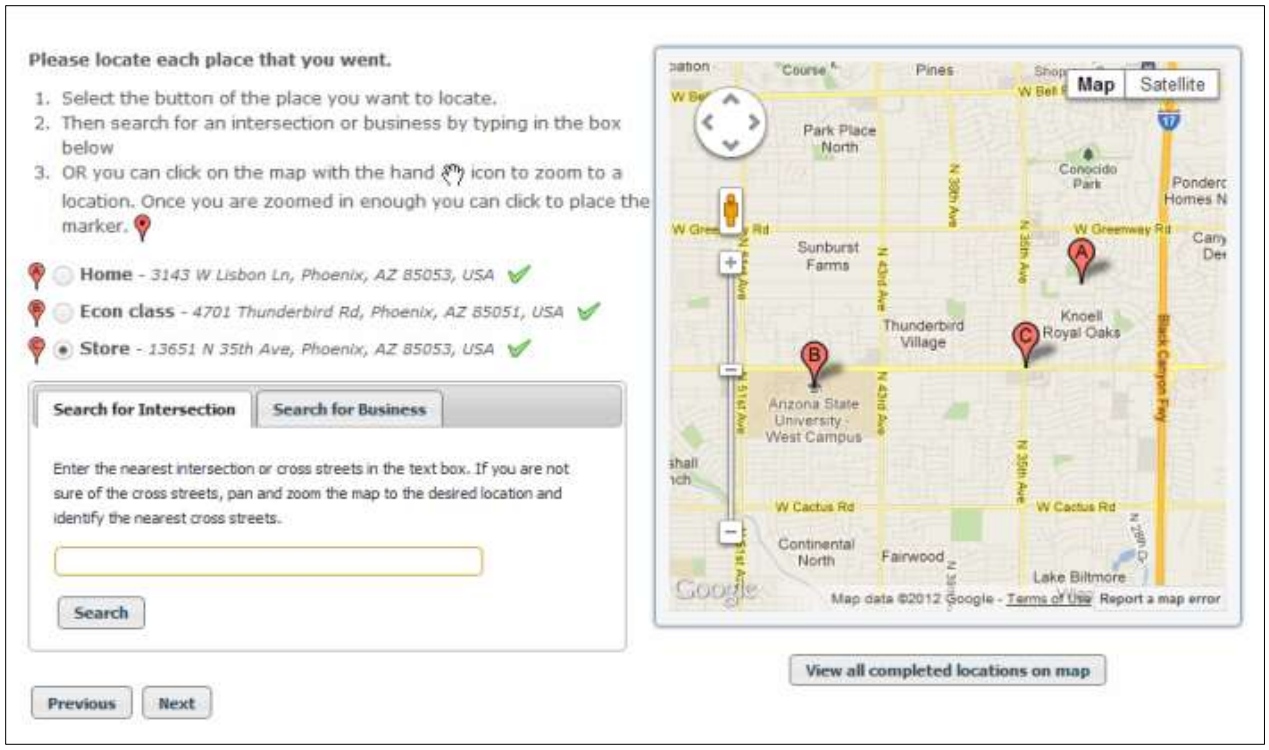

Figure 3. Survey Screen Showing Map-based Interface for Identifying Locations

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. 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 travel to and from ASU. 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 ASU-based travel, 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 attitudinal statements were presented at the end of the survey and respondents indicated the extent to which they agree or disagree with the statement on a five point scale. Examples of such statements include "I am not afraid to ride transit", and "My personal vehicle reflects who I am".

In order to encourage participation in the survey, an incentive was introduced. All respondents were informed that they could be entered into a drawing to win the latest iPAD, with one iPAD each for a student and a faculty/staff respondent, 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, indicating the incentive may have played a positive role in enhancing participation.

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 to retain greater control of the online survey system by the study team. Two simple web addresses were registered and directed such that typing in either address would redirect a user to the survey. The simple addresses registered are www.asutravelsurvey.com and www.asutravelsurvey.org (these 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 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 university population of students, faculty, and staff at 3:30 AM on Wednesday, April 4, 2012 when a vast majority of the university population are likely to be offline. As individuals are likely to access their accounts in a somewhat staggered fashion as the day progresses, sending out the announcement in the middle of the night prevented server overload. The message included a brief overview of the survey, a link to the survey instrument, a request for participation from the ASU community, assurance of the safety and privacy of all information provided, and contact information for the study's principal investigator. 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 UTO introduced a "To-Do" task in the MyASU portal account of all students, faculty, and staff. 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 the ASU travel survey and encouraging the community to respond. Second, the study team printed 10,000 flyers, which were distributed and posted throughout the four 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 in paper and printed on brightly colored sheets, were posted in all departments, centers, administrative units, libraries, student union buildings, recreational centers, dining halls, and residential dormitories which could be accessed. Third, a slightly simplified version of the flyer was published as an advertisement in the ASU daily campus newspaper called *State Press*. The ad, placed in both 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, thus lending credibility to the survey and appealing to the civic consciousness of the university community.

The ASU Parking and Transit Services office included a link and reminder to the ASU travel survey in its periodic electronic newsletters, only one of which was sent to the entire survey community in the three-week period covered by the survey. The office also advertised the survey prominently on its website. Finally, the 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 Maricopa Association of Governments project manager. All of these efforts helped raise awareness of the project and generate a sense of goodwill among the community.

The choice of a pure online web-based travel survey administration method was one that was made after careful consideration. A review of the literature supported the approach taken by the study team. Over the past decade, web-based travel surveys have become increasingly

popular in the travel data collection domain. Adler et al (2002) found that, 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 (Anderson, 2003). At 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 more. 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).

The ASU travel and mode usage survey was closed on April 26, 2012. Figure 4 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).

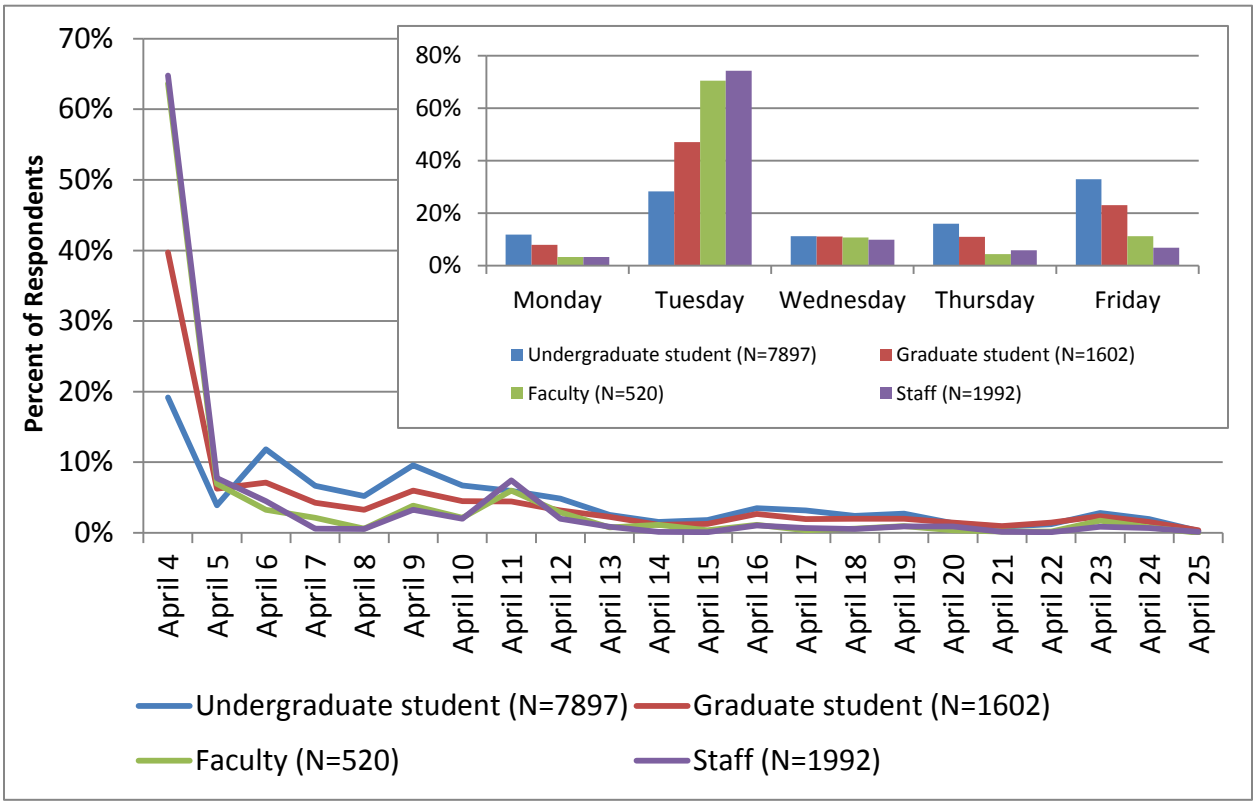

Figure 4. Date and Day of Week Profile of Respondent Completion of ASU Travel Survey

Overall, it can be seen that respondents took the survey within the first week of its deployment. In the case of faculty and staff, literally 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 travel diary responses were obtained for Tuesday with the pattern much more pronounced for faculty and staff members. 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).

DATA PREPARATION AND WEIGHTING

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, interviewers make direct contact with respondents and have the opportunity to clarify responses or ask follow-up questions to prevent under-reporting of trips (Cambridge Systematics, Inc., 1996). In the web-based survey, respondents may provide erroneous information because they genuinely misunderstand or misinterpret the question being asked; or, as noted by one respondent, they "want to simply win the iPAD" and have no real interest in the survey per se.

The study team conducted a very thorough and systematic coding and analysis of the raw data received through the online web-based survey system. 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. Several examples of quality and consistency checks can be identified:

- Do the trip distance and trip duration align with each other? If a 10 mile trip is being made in 5 minutes by walk, for example, there is clearly an error.
- Do the activity purpose descriptions and labels entered by the respondent align with the coordinates of the location chosen? For example, if a respondent says that they went to ASU to attend class, but the geo-coordinates point to a location far removed from any ASU campus, then the trip is flagged as erroneous.
- If the coordinates of the origin and destination are exactly identical to one another, then the trip is flagged as potentially erroneous.

In a number of instances, the study team 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 the study team chose 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 data sets.

Table 1 offers a summary of the final survey data set compiled after the extensive filtering and cleaning process was performed. The final cleaned data set 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% for the university population as a whole, a number that is generally consistent with response rates from similar travel surveys (Khattak, et al, 2012; Miller, 2012). The response rates for the student segments are the lowest, supporting the notion that students are likely to be less 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.

Table 1. 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 Under-graduate Students	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 Appt	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%)	100.0%		53520	4.46	100.0%	

Note: All statistics are unweighted to depict the actual survey response profile.

The table 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, inter-campus, and non-ASU-based trips. 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 travel diaries. Freshmen and sophomores tend to have higher trip rates, presumably because a higher proportion of them live on-campus. 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.

The study team had to weight and expand the data to ensure that non-response biases were corrected and the weighted survey sample could be used to draw inferences regarding university population travel characteristics. The team adopted the synthetic population generation method embedded in a software tool called PopGen to weight and expand the sample. PopGen is a synthetic population generation algorithm which is able to weight and expand any survey sample data set such that the weighted and expanded sample data exhibits traits that closely mirror those of the true population (Ye, et al, 2009).

In order to apply the weighting procedure using PopGen, marginal distributions were 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), the study team compiled 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. 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. Figure 5 offers an illustrative example of the comparison of selected marginal controls against unweighted and weighted sample distributions for a few demographic categories.

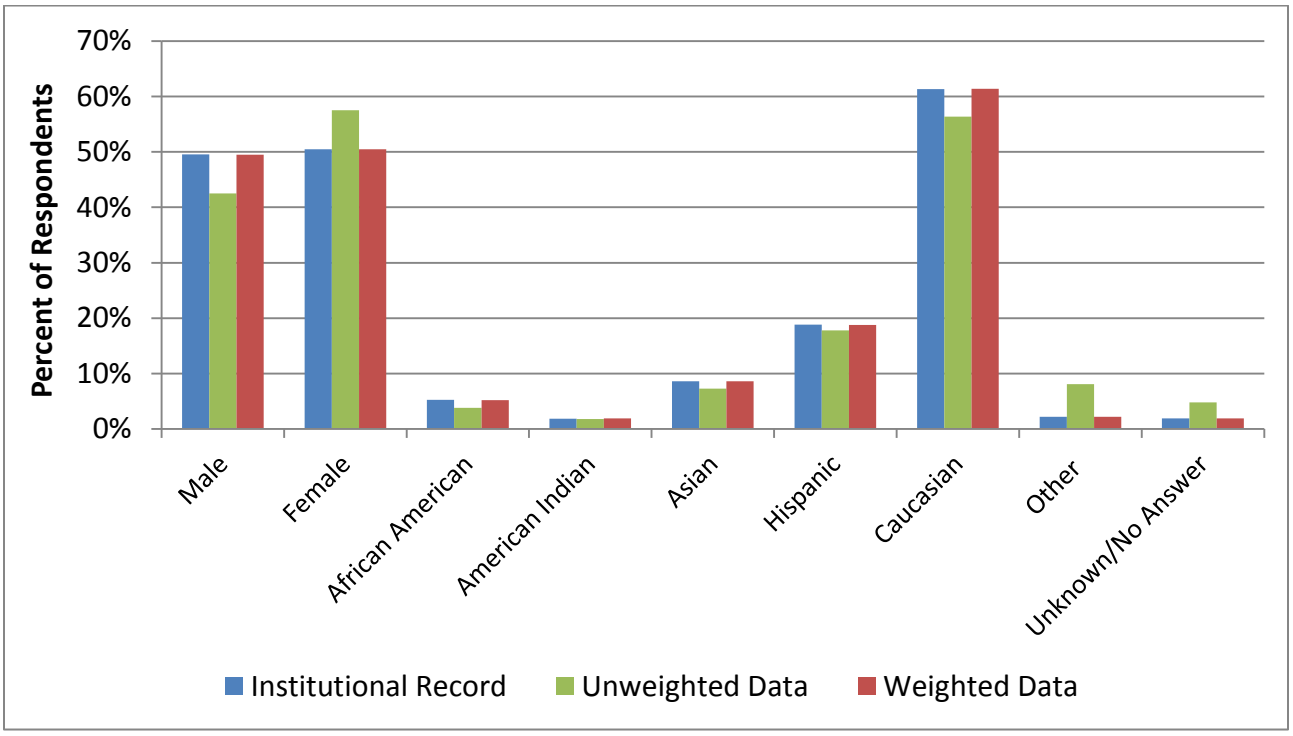

Figure 5. Comparison of Unweighted and Weighted Sample Data for Undergraduate Student Segment

In the interest of brevity, graphs for other attributes and population market segments are not presented in this paper. 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.

CONCLUSIONS AND LESSONS LEARNED

This paper presents a detailed report of the process followed and results obtained in administering a comprehensive activity-travel survey to a university population. Universities are recognized as special generators in transportation planning processes; however, university populations remain under-studied in the travel behavior analysis arena. The study reported in this paper is based on a comprehensive survey of the Arizona State University 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 paper 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 the 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, while faculty and staff members may view the survey as an attempt on the part of the university to monitor their activities during the workday. Appropriate language should be incorporated to alleviate such concerns. It should also be recognized that students will be students; while most will take the survey seriously and do a good job of providing responses, there will be 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 study 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.

- *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 the 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.

- *Resource Needs*: The development, programming, deployment, and administration of an online web-based travel survey is an intensive exercise for which appropriate resources should be allocated. The Arizona State University travel survey was developed and administered in six months (not including the development of the online survey software system and not including the data assembly and analysis tasks). It is extremely beneficial to employ a firm with specific expertise in the programming of online survey software systems and deployment of web-based travel surveys.

This study has shown that it is possible to obtain a statistically robust survey data set that can be used to analyze, understand, and model the travel characteristics of a university population, and the lessons learned may prove useful in informing future data collection efforts of this nature.

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