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Special Events Travel Surveys and Model Development

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Background

The focus of travel demand forecasting has historically been on daily weekday travel. As such, regional travel models – trip-based and tour/activity-based models – are not well equipped to handle travel to and from special events (e.g., sporting events, concerts, state fairs). Since special event patrons can constitute a substantial portion of travel demand, it is important to collect travel data and model these exclusively. The importance of such a study was further highlighted by the successful introduction of light rail transit (LRT) in the Phoenix metropolitan region. Therefore, Maricopa Association of Governments (MAG) developed a successful proposal for Federal Transit Administration (FTA) Alternatives Analysis Discretionary Program section 5339 funds.

The MAG regional model is the main tool utilized at the agency for long range planning and air quality conformity analyses. This model is a state-of-practice four-step model, and estimates travel demand for passengers and trucks for an average weekday. An activity-based model (ABM) is also under development that will eventually replace the four-step model but it also predicts typical weekday travel. It does not adequately account for planned special events travel on weekdays or weekends.

The project consultant team, led by Cambridge Systematics (CS), identified special events in the region that impact travel demand especially transit ridership, collected data related to travel associated with these events, developed and validated a stand-alone special events model (SEM), integrated with the existing four-step model, tested a few LRT scenarios, and also integrated it with FTA’s SUMMIT module. This stand-alone SEM will enable MAG and its member agencies to predict and analyze planned special events travel with an emphasis on transit applications.

This paper focuses on all aspects of data collection and model development including survey design and sampling plan, collection of special events travel data, expansion of survey data, model design plan, estimation and development of the SEM, calibration and validation, integration with the passenger model, and the impact on LRT ridership due to special event travel.

Classification of Special Events

Special events in the MAG region range from weekend festivals that attract local residents to large sporting events, which bring thousands of visitors into the region. Given the large number of special events that occur each year, it is infeasible to collect data and create models for each individual event. Therefore, the special events in the region were categorized by nine salient characteristics that aided in data collection:

- Predicted Attendance
- Event Frequency
- Regular versus Periodic Event
- Venue Type
- Event Start and End Time
- Single versus Multiple Days
- Day of Week
- Event Market Area
- Local versus Regional Attendance.
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Short Listing Special Events

The first step of the data collection effort was to compile a list of all special events in the region that attract at least 1,500 patrons. Owing to over 300 events that occur in a single calendar year, the following criteria were employed to bring the list down to 20 where data collection was necessary (and conducted):

- Importance of capturing impacts of special events on the LRT system;
- High attendance events at several large stadiums and sports complexes;
- Desire to survey events in many cities across MAG region;
- Good representation within each of the nine classifications;
- Long enough survey period (Sep’09-May’10) to reflect seasonality of special events.

Sampling Plan

The sampling frame for the special event intercept surveys was the set of attendees to the various events in the region. To use resources effectively, sample sizes specific to each shortlisted special event were calculated based on 95 percent confidence level and +/- 10 percent margin of error. The size of events was used, however, only as a professional judgment to allocate more surveys for larger events. Projected attendance numbers based on previous years’ attendance or similar events were used to calculate sample sizes for each of the events. This sampling plan yielded a target of 6,100 surveys, spread over 20 special events, including pretests.

Survey Instrument

A master survey instrument template was developed for use at all events and was customized to each event by a few event-specific add-on questions. The approach to the design of the survey instrument was driven by the need to maximize the response rate. As a result, the instrument was set up in a concise format that could be completed in a maximum of three to five minutes. MAG and CS staff identified the critical survey elements while West Group Research (WGR) staff constructed the survey instrument in a one-page, user friendly format.

Pretests

The pretest was conducted at the Fall Frenzy event, a concert where many bands performed, at the Tempe Beach Park, and a target of 100 completes was set. Interviewers were stationed at the event at different time slots to capture a variety of attendees listening to various bands. Each pretest survey took about three to five minutes to complete, and a high-cooperation rate of 33-50 percent was achieved during the daytime, but not so much in the nighttime. A total of 161 surveys were retrieved out of which 123 surveys were deemed complete. Overall, WGR staff members were able to achieve about five interviews per hour, and this estimate was used to plan for other events.

Full Surveys

In all, special event surveys were conducted at 20 special events that yielded a total of 7,264 surveys, including the pretest event. Each event database was reviewed thoroughly for surveys that did not meet completion criteria. After the first few events, the average completion rate was about 80 percent. To compensate for this completion rate, an oversampling of 20 percent was done for all subsequent events to achieve the target.
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A total of 5,943 completed and usable surveys were achieved after the cleaning process. It quickly became evident that people who arrived early to events were much more willing to respond to the surveyors. As expected, the closer to the start time the lower the response rate.

Counts for the project were also conducted at a majority of events for data expansion, and were divided into 15-minute increments to provide as much flexibility in the data analysis as possible. At a few of the events with high-volume, entry counts were tabulated every hour due to limited staff resources.

Survey Data Expansion

Several expansion techniques were explored, and it was determined that the best method was to develop event-specific expansion factors, which were stratified further by time period, entry/gateway to the event, and party size. Party size was defined as the number of people, including the respondent who traveled to the event together. An expansion factor for each survey was obtained by weighting the number of surveys collected at each gate/entry during each time period by party size and expanding the values to the total number of attendees entering the gate/entry during the time period. This was obtained by accurately counting the number of people entering the venue at every entry gate. However, owing to budget constraints, this was only possible for those events where staff could easily be positioned at all entry points. For those events where this approach could not be used, the total attendance on the day of the special event was used.

Special Events Model Design

The objective of the SEM is to forecast travel demand pertaining to different types of special events in the MAG region. The SEM should be able to predict the number of trips by location type (home based, hotel based, work/other based); origin TAZ of trips; mode choice of trips; and vehicle-miles traveled (VMT) generated as a result of special events. The collected data were used to develop a special events modeling framework, shown in Figure 1, which was used to model different types of special events. The key factors considered while developing the structure for the SEM are - size or attendance at an event; origin type of special event trips; proximity to LRT; day of week and time of day; and event market area.

Trip Generation

The objective of trip generation is to predict the number of person trips traveling to and from special events. The number of person trips is based on total anticipated attendance at the event. For the forecast year, the number of person trips can be predicted based on base year attendance, capacity at the event venue, and predicted population growth between the base and forecast year. As an alternative, the forecast year attendance to the event can be input directly, rather than relying on the model to forecast attendance.
FIGURE 1. Special Events Model Structure
Trip Distribution

The objective of trip distribution is twofold:

- Predicting probability of trips beginning or ending at home, work, hotel, or other location;
- Predicting location of these origins or probabilities of such trips occurring in every TAZ in the region.

The weighted survey results were used to calculate the percentage of trips starting from different origin types by major special event category. In the absence of data to provide alternate assumptions, these percentages are held constant for forecast years.

As the special event is always the destination TAZ, the trip distribution model predicts the origin choice of trips to the event by origin type – home, work, hotel, or other based. Separate origin choice models were estimated for trips originating from home, hotel, and work/other combined. The models are specified in the multinomial logit (MNL) form; and each model employed size and utility variables.

**Home Based Origin Choice Model** - Home based trips constitute the majority of special event trips. This model was segmented by household income level (quintiles) and household vehicle ownership (0 vehicles or 1 or more vehicles). Size variables used were number of HBNW trips produced in a zone by income category. For this model, a number of distance bias factors were added during model calibration. The distance bias factors represent the distance variable for different event segments. For instance, home based attendees were found to be attracted from a more widespread area for pro sporting events (MLB, NFL, NBA, NHL) compared to other events. Segmentation of the logsum variable across national, multi-regional, and regional events was also found to be significant.

**Hotel Based Origin Choice Model** - Hotel based trips (i.e., those originating at a hotel) represent the second largest group of trips. The hotel based model is not segmented, and hotel employment is used as the size variable. Retail employment was introduced as a utility variable to reflect that individuals may be more likely to stay at hotels near areas with shopping, which is exactly what the positive coefficient on the variable indicates.

**Work and Other Based Origin Choice Model** - As very few trips originated at either work or other locations, these two origin types were combined for estimation although the two origin types are segmented across a number of key variables. For the work based segment, HBW attractions were used as the size variable; and for the other based segment, total trip attractions were used as the size variable.

Validation targets were derived from the expanded survey data. Trip length frequency distributions (TLFD) of the observed data were plotted against modeled distributions for all three final calibrated models. In addition, coincidence ratios (CR) between actual versus modeled results were also calculated.

Mode Choice

The objective of mode choice is to develop a procedure to predict mode of travel to and from special events. This model determines the probabilities of choosing different modes at the TAZ level by major special event category and origin location type.

Two types of choice models – multinomial logit and nested logit – were tested. The major modes as derived from the survey data include drive alone, shared ride-2, shared ride-3, walk access to light rail, drive access to light rail, walk access to bus, drive access to bus, and non-motorized (walk/bike).
A multinomial logit structure was tested first to explore the basic model structure, introduce new variables incrementally, and test the quality of the data. The more complex nested logit structure was introduced later in the process. Separate models for events with access to light rail and without access to light rail, as well as one joint model, were estimated for different location types (i.e., home, work, hotel, other). Many explanatory variables were examined in the mode choice model, including alternative specific constants (ASC); level of service variables (in-vehicle time, out-of-vehicle time, and cost); socioeconomic variables including household income, household size, and number of vehicles; event characteristics such as event market area and location, time-of-day, and day of week; origin or destination zonal variables; and nesting coefficients. Different nesting structures, interaction variables, and various functional forms for the LOS variables were also examined.

During mode choice model calibration and validation, a combination of expanded survey data (for auto modes) and transit boarding/alighting data (for transit modes) was used. The ASCs were adjusted until the modeled mode share matched observed shares by mode. To obtain transit counts attributed to the special event, the counts on the special event minus the counts on non-special event days were used. There were significantly fewer transit riders to the events than the survey suggested; meaning transit riders were oversampled in survey collection. Perhaps those that use transit are more likely to be willing to take the survey. Or in some cases, particular event entrances may have been oversampled as they were located closer to transit stations.

Trip Assignment

The objective of trip assignment is to assign special event trips to the MAG highway and transit networks. The SEM trip tables from the mode choice procedure are fed into the existing highway and transit assignment model of MAG’s travel model. For weekday events, the existing weekday highway and transit skims are used, and for weekend events, the off-peak weekday skims are used. The LRT ridership by station and time period was derived from the transit assignments. Though the special events are designed for projection on a daily basis, it may be desirable to obtain yearly trip totals. This is especially important for transit revenue projections. For recurring events, instead of modeling each event separately, an annualization factor can be assigned to determine yearly passenger and vehicle trips. The annualization factor is simply the total number of annual events, or event days.

After a thorough examination of highway counts close to the special events, it was determined that it was impossible distinguish between special event trips from observed counts. Therefore, the assignment validation was performed just for LRT. The comparison of the LRT boarding data on special event and non-special event days suggested that event patrons use LRT to access special events. The LRT count data were previously used to calibrate the mode choice model for all special events near LRT. The calibrated model resulted in LRT trips that more closely match the LRT count totals, with the exception of a couple of events.

Special Event Model Application

The SEM is designed as a forecasting and scenario testing tool for current and future planned special events in the MAG region. The model is a stand-alone forecasting procedure, but it can be integrated within weekday trip-based modeling framework. One of the long-term goals includes utilization of the developed SEM approaches and collected data for the activity-based model. As the SEM is being designed to handle all types of events, the model can also be applied specific to each event type. That is, if MAG desires to analyze different future LRT alignments for a particular event, then the SEM for that event can be executed and integrated with the MAG travel model. The SEM can also be applied on different days of the week as special events occur on both weekdays and weekends. As part of this study,
the SEM was also integrated with FTA’s SUMMIT module. A no-LRT scenario was performed and its usability to test alternative scenarios was also examined.