Implementation of a School Escorting Model in the Houston-Galveston Region: Implications for Activity-Based Model Chain

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ABSTRACT

Escorting children to school is a particularly important type of joint travel as the outbound leg of a school tour typically occurs during the AM peak period. Nonetheless, research into how to incorporate school escorting in the activity-based model (ABM) framework is limited. The ABM in development for the Houston-Galveston Area Council (H-GAC) will incorporate a distinct school escorting component. This has led the modeling team to address several practical issues that arise within the ABM model chain. These include dealing with stops on joint school tour legs, certain daily activity pattern model features, and framework for tour mode choice models. This paper discusses the school escorting model to be estimated for the H-GAC region in detail and focuses on the implications for the ABM model chain.
INTRODUCTION

One of the key advantages of activity-based models (ABMs) is that they can be developed to forecast complex travel patterns at the household level; specifically, certain types of joint travel behavior can be forecast. Household-level joint tours for non-mandatory activities such as shopping or “personal business” have been developed and implemented in non-academic settings, notably several regional travel demand models in the United States (Gliebe and Koppelman 2002; Vovsha et al. 2003; Srinivasan and Bhat 2004).

However, escorting children to school (arguably even more important as these tours are concentrated in peak periods) is at an earlier stage of development. In particular, children’s school mode choice decisions carry an important role in determining travel patterns of other household members. Several studies have examined school mode choice from different perspectives (see, e.g., Ewing et al. 2004, McMillan 2007, Yarlagadda and Srinivasan 2008, Yoon et al. 2011). An increasingly important issue in transport modeling is how to model school escorting decisions. However, there appears to be little evidence of school escorting activities being incorporated in the activity-based model process.

In the United States, the only ABM that currently considers school escorting explicitly is SimAGENT, which has been initially developed for the Los Angeles area and draws on the CEMDAP model, which had been previously developed by the University of Texas (Pinjari et al. 2008). In CEMDAP, escorted children (as predicted by a mode choice model) are linked to one of the child’s parents in the model system. However, the model is not truly a school escorting model. For the Atlanta region, Vovsha and Petersen (2005) developed a framework for the explicit modeling of escort decisions within an ABM construct. Escort decisions included ride-sharing (where escorting occurs as part of a work journey), pure escorting, or no escorting for journeys to and from school, and the model allocated escorting duties to one of a potential three household adults. Ultimately, however, the school escorting models were not integrated into the final model design. For the Phoenix region ABM, a very similar framework is being employed (Vovsha et al. 2011), but the ABM is still under development and final model specifications are not available.

Due to the prevalence of school escorting behaviors in the region, the ABM in development for the Houston-Galveston Area Council (H-GAC) will incorporate school escorting as a distinct component. This has compelled the modeling team to address a number of practical issues, for both the school escorting model itself, but also for several other key ABM components. This paper focuses on these issues and how they will be resolved for the H-GAC ABM in development.

ACTIVITY-BASED MODEL DESIGN

The ABM was designed in a similar manner to many earlier ABMs developed in the U.S. Figure 1 shows a rough outline of key model components.
There are some very distinct and important features of the model design that warrant further explanation here. First, the daily activity pattern (DAP) model, which is a standard feature of most ABMs in practice today, predicts the number of mandatory tours for each individual and presence of stops on these tours. Mandatory tours encompass work, school, and university tours. If no mandatory tours are predicted for a particular individual, three additional alternatives are available: non-mandatory travel only, stay-at-home, and out-of-area, with individuals choosing the last two outcomes removed from further processing.

Mandatory tour destination and time-of-day choices are modeled prior to school escorting, fully joint travel generation, and individual non-mandatory travel generation. This sequencing is important as destination and particularly time-of-day choices have important implications for these other models. In the case of the school escorting model, the mandatory tour time-of-day model outputs generate the time period overlaps between an adult’s work tours and a child’s school tours.
Finally, further information about tour stops is generated prior to predicting tour mode choice, since it is expected that the presence of stops will affect mode choice more than mode choice will determine stop making. Most of the other model features and sequencing are relatively common in many ABMs in practice. The next section discusses the school escorting model component in more detail.

SCHOOL ESCORTING MODEL

As noted in the literature, escorting children to school commonly involves parents or other adult household members. While it is possible for older children to walk with younger children (essentially escorting them), it is very difficult to distinguish this behavior from older children simply making their own school tours. Therefore, such escorting behavior is not considered in this model. For the purposes of the discussion, children riding to school on school buses or escorted by non-household members are considered “not escorted.”

The Houston-Galveston region is characterized by fairly high levels of school escorting. Preschool aged children (age 0-4) are escorted about 85% of the time on the outbound journey and about 75% of the time on the inbound journey.1 The prevalence of school escorting drops for children aged 5 to 15 to 45% and 35% for outbound and inbound journeys respectively. For driving age children (age 16+), school escorting on each journey is only about 20%. School escorting is always more common on the outbound journey (home-to-school), and the prevalence of school escorting decreases with child age.

The fact that the school escorting decision is so clearly different for outbound and inbound legs has both practical and theoretical implications. In practical terms, all modeling (and analysis) must be carried out at the half-tour level, which complicates modeling efforts. Just because a child is escorted on the journey to school does not require that child be escorted on the return journey.

With this in mind, the school escorting model’s choice set structure was formulated as a joint choice of outbound and inbound half-tour escort decisions. That is, each choice alternative represents the paired choice of outbound escorting decision and inbound escorting decision. For each half-tour, alternatives will include each of a possible three working adults, three non-working adults, and a no escort alternative (seven total alternatives). In the case of working adults, the school child will be linked with a previously simulated adult mandatory tour. In the case of non-working adults, the school escorting activity serves as the primary tour purpose for the adult (pure escorting tour), though other stops may be simulated on either the linked or unlinked portion of the tour. The school escort model has not yet been estimated or calibrated, so further model details are not currently available.

Moving from model estimation to model application, a more pressing issue quickly emerges for multiple children households. Through examination of the household survey, it was determined that there are many instances where children from the same household attend the same school, or

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1 Note that the remaining non-escorted children in this age group are most often being escorted by a non-household member or taking a school bus.
adjacent schools in the same zone and arrive at the same time. More importantly, it was found that when two children share these attributes, they almost always share the same escorting choice. Table 1 shows the frequency that two children are escorted by the same adult when the children share the same school location and arrival or return time and at least one of the children is escorted to school.

Table 1: Shared escorting outcomes when school pattern is identical and (at least) one child is escorted

<table>
<thead>
<tr>
<th>Age Range for Younger Child</th>
<th>Age Range for Older Child</th>
<th>Half-Tour Outbound</th>
<th></th>
<th></th>
<th>Half-Tour Inbound</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Same</td>
<td>Not Same</td>
<td>Same</td>
<td>Not Same</td>
<td>Same</td>
<td>Not Same</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>11,358</td>
<td>206</td>
<td>98%</td>
<td>2%</td>
<td>11,042</td>
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<tr>
<td>2</td>
<td>2</td>
<td>48,824</td>
<td>560</td>
<td>99%</td>
<td>1%</td>
<td>47,968</td>
<td>789</td>
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<tr>
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<td>4,605</td>
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<td>100%</td>
<td>0%</td>
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<td>301</td>
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<tr>
<td>4</td>
<td>4</td>
<td>1,875</td>
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<td>0%</td>
<td>1,912</td>
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<td>5</td>
<td>5</td>
<td>2,732</td>
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<td>17%</td>
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<tr>
<td>1</td>
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<td>11,500</td>
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<td>12%</td>
<td>13,646</td>
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<td>0</td>
<td>100%</td>
<td>0%</td>
<td>136</td>
<td>210</td>
</tr>
</tbody>
</table>

Source: H-GAC 2010 Household travel survey (values are expanded)

This finding led to the notion of grouping children with identical school half-tour patterns (where school half-tour patterns are defined by the time and location of the half-tour). In this way, children sharing identical patterns would be modeled as a unit and be ensured to share escorting outcomes. However, because these patterns are defined at the half-tour level, rather than the tour level, a number of issues emerged across other model components in the ABM model chain.
IMPLICATIONS FOR ACTIVITY-BASED MODEL

The school escorting model has implications for several of the ABM components. Not only must an escorted child be linked with the corresponding adult, but additional considerations are needed when school children with identical patterns are also linked.

The first issue arises in how to model stops on a linked half-tour. A fairly simple solution emerges for pure school escorting tours. Since the adult’s primary activity is school escorting, the linked half-tour is fully shared between adult and child. Therefore, any stops on the linked half-tour are also fully shared. In this case, the adult’s stop-making could be modeled and the child would simply be linked with the adult for any stops.

Things are less straightforward when school escorting activity occurs as part of an adult’s mandatory tour. When this occurs, the adult’s primary activity is the mandatory activity, not school escorting. Since an adult could make a stop on either the linked or unlinked portion of his or her half-tour, a different solution is needed. The most practical solution involves modeling stops solely at the adult level. The stop time-of-day choice model would determine whether the stop occurs on the linked or unlinked portion of the adult’s tour.

Linking work and school tours impacts the daily activity pattern (DAP) model as well. As noted above, the DAP predicts the number of mandatory tours for each individual and presence of stops on each. Thus, it would be difficult to allow for the presence of stops on school tours and still allow for school escorting, since modeling children’s stop making might undermine the appropriate “bundling” of school tours.

Another key feature of the school escorting model is the linkage across children with identical school patterns. There are trade-offs associated with establishing similarity at the entire tour level or the half-tour level. There are many cases where children share a school tour pattern on one half-tour, but not the other. For instance, two children may be dropped at school by an adult, and one engages in an after-school activity, while the other goes straight home. In such cases, treating these children as a unit could be problematic for both the school escorting model itself, but also tour mode choice. Alternatively, the school escort and school tour mode choices could be conducted at the half-tour level, rather than the entire tour. This is also not ideal.

The most promising option appears to be handling shared school tour patterns within the school escorting model only. Following school destination and time-of-day choices, school tours with shared half-tour patterns would be identified. Only the youngest child in that unit would truly be modeled. Subsequent (older) children in that unit would be marked as sharing an identical escort decision as the first. After modeling the school escort decision, the linkage between children would be dropped. If the choice was an escorting alternative, both children would be linked with the adult, but otherwise, the children would be modeled independently.

As evidenced by the discussion above, there are many important implications that a school escorting model has on an ABM model chain, but few academic studies and little practical experience in looking specifically at school escorting decisions.
CONCLUSION

Given the volume of school escorting that occurs in the Houston-Galveston, combined with the fact that much of it occurs in the AM peak and nearly 1/3 of outbound school escorting involves full-time workers, the issue of school escorting is critical for understanding regional travel. Treating school travel as completely independent from adult travel behavior is clearly incorrect, particularly given the auto-dominance of school escort tours. As H-GAC prepares to incorporate an explicit school escorting model component into the ABM being developed for the region, the modeling team is working through the complex issues that arise throughout the ABM model chain. The shared nature of school escort choices for children sharing identical school tour patterns was one important behavioral school escorting feature identified. Future work will include a more detailed examination of these specific issues, estimation of a school escorting model, and measuring the impact that school escorting behavior has on other model components.

REFERENCES


