Objects in mirror are more than would appear.
MIXED-USE DEVELOPMENT (MXD) TRIP GENERATION

Current methods of traffic impact analysis, which rely on rates and adjustments from the Institute of Transportation Engineers, are believed to underestimate the traffic benefits of mixed-use developments (MXDs), leading to exaggerated roadway impacts, higher impact fees, exactions, and negotiated payments than should be the case and discouraging development of otherwise desirable projects.

A national study for the US EPA, performed by a team composed of both Fehr & Peers and academic researchers, developed a new methodology to more accurately predict the traffic impacts of MXDs.

The study evaluated household travel surveys from 239 mixed-use developments in Seattle, Portland, Sacramento, Houston, Atlanta and Boston and found statistical relationships between site characteristics and the amount of vehicle travel generated in and out of the site. MXDs were found to reduce traffic impacts relative to single-use suburban development, due to the following key factors such as diverse on-site activities that capture a large share of trips internally, placement within walkable areas with good transit access that generate high shares of walk and transit trips, and central locations that reduce trip lengths.

The MXD model has been adopted by the San Diego Association of Governments (SANDAG) as a recommended resource for Trip Generation of Smart Growth developments. It is available as a spreadsheet tool on their website, at www.sandag.org/index.asp?projectid=378&fuseaction=projects.detail.

Who needs MXD Trip Generation?

- Land Use Planners: to assess the benefits of different densities and mixes of residential, retail, office and industrial spaces
- Economists: for trade-off analysis of different combinations of land use
- Developers: to optimize the ability to respond to policies on development related to number of trips and/or climate change elements such as VMT.
- Local Jurisdictions: to assess traffic, air pollution, or greenhouse gas impacts resulting from proposed development.

Framework

In travel research, urban development patterns have come to be characterized by “D” variables. The original “three Ds,” coined by Cervero and Kockelman (1997), are density, diversity, and design. Additional Ds have been labeled since then, destination accessibility, distance to transit, and demographics (Ewing and Cervero 2001). An additional D variable is relevant to this analysis: development scale.

In the MXD model, travel to/from MXDs is conceived as a series of choices, which depend on the D variables. The choices relate directly to the methodology to adjust ITE trip generation rates downward.

The adjustments to ITE rates influence three types of trips.
- Trips that remain within the MXD
- Trips that enter or leave the MXD via walk or bike modes
- Trips that enter or leave the MXD via transit mode
The table below compares the average model error and other statistical measures for three methods:

- "Raw" vehicle trips computed with ITE (or San Diego) trip generation rates and no adjustments
- "Net" vehicle trips computed with the current ITE method of trip reduction as presented in the Trip Generation Handbook
- Vehicle trips computed with the MXD model.

<table>
<thead>
<tr>
<th></th>
<th>Raw ITE or San Diego</th>
<th>Current Methods</th>
<th>MXD Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Model</td>
<td>27%</td>
<td>15%</td>
<td>9%</td>
</tr>
<tr>
<td>Average Absolute Model Error</td>
<td>33%</td>
<td>23%</td>
<td>19%</td>
</tr>
<tr>
<td>%RMSE</td>
<td>44%</td>
<td>32%</td>
<td>24%</td>
</tr>
<tr>
<td>R Squared</td>
<td>0.65</td>
<td>0.81</td>
<td>0.90</td>
</tr>
</tbody>
</table>

The statistical validation measures indicate that the MXD model performed better than the other methods and had the smallest level of error.

The scatterplot below compares the predicted trips from the MXD model to actual observed trips at each of the 22 sites, with the dashed line representing a perfect prediction. The relatively small level of scatter indicates that the MXD model does an accurate job of predicting the net external vehicle trips by accounting for the "D" characteristics of the sites and their surrounding built environment.

**Required Data**

The data needed to perform the above adjustments can be collected in less than a day. This data includes:

**Site-Specific Information:**
- Land Area (of project site in acres)
- # of Intersections
- Number of Dwelling Units or Population (separated by single family, multi-family)
- Retail KSF or Employment (separated as specifically as possible)
- Office KSF or Employment (light industrial, manufacturing, or warehouse if possible)
- Hotel, Motel, Movie Theater (rooms, rooms, and screens)
- School (by number of students for University, High School, Middle School, or Elementary)
- Miscellaneous Trips (any special generators or anticipated trips not captured above)

**Surrounding Area Variables** (assumptions can be developed via a GIS database or Travel Demand Model if necessary):
- Is the site in a CBD or TOD? (Central Business District or Transit-Oriented Development)
- Employment: Local (within one mile of the project, but not including the project)
- Employment: Regional (within a 30 minute transit trip including the project)
- Transit: Percent of households within 1/4 mile of transit

**Information Attainable From Census or Other National Data Sources** (but site-specific is always better if available):
- Average Vehicles Owned Per Dwelling Unit
- Average Household Size (by dwelling type is best)
- Jobs per KSF (retail, office, light industrial, manufacturing, warehousing, misc. uses)
- Jobs per Unit (hotel room, movie screen, student)
- Trip Purpose Splits (home-based work, home-based other and non-home-based splits per land use type and time period)
- Average Trip Lengths (external trips from home-based work, home-based other, and non-home-based trips. Not needed to compute vehicle trip reduction, but can be used to estimate VMT as a secondary result.)

These variables are all examples of one or more of the "Ds" that are known to influence travel behavior.

**Model Results**

After developing the models with 239 nationwide MXDs, the models were initially applied to 16 MXDs for which traffic counts of external vehicle trips were available. Six of those 16 sites are in South Florida and are presented in Appendix C of the Trip Generation Handbook. A seventh site is located in Central Florida, and another site is located in Atlanta, Georgia. Six of the remaining sites are located in California, and two are in Texas. In the spring of 2009, traffic counts were collected for six additional sites in the San Diego region as part of a smart growth trip generation study, bringing the total to 22 sites. The sites represent a wide range of densities, land use mixes, and development scales.

**Acknowledgements**

The studies described here were commissioned by the US EPA, and San Diego Association of Governments (SANDAG).

The development of the MXD trip generation equation was led by Reid Ewing at the University of Utah and Jerry Walters at Fehr & Peers. Special thanks to Michael Greenwald, Ming Zhang, Mark Feldman, Robert Cervero, Lawrence Frank, and John Thomas for their guidance and contributions to the development efforts.

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