TECHSUMMARY April 2021

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ITE Trip Generation Modification Factors for Louisiana

INTRODUCTION

The *Trip Generation Manual* published by the Institute of Traffic Engineers (ITE) is widely used to estimate trip generation of individual land uses. However, the ITE trip rates are based on data collected over six decades and predominantly from sites in suburban areas. The result has been that vehicle trips tend to be overestimated in dense urban areas where transit is prevalent and pedestrian trips more frequent due to shorter trip lengths. Overall, it has been hypothesized that the "built environment" surrounding a site has a significant impact on vehicle trip rates. From the literature, some of the most influential aspects of the built environment influencing trip rates are surrounding population density, land use diversity, and traffic intensity.

Figure 1. Strip mall

OBJECTIVE

The first objective of this study was to identify to what extent population density, land use diversity, and traffic intensity add to the accurate estimation of trip generation at strip malls in Louisiana. The impact of these factors must be expressed as a modification factor to the trip rate obtained from the ITE *Trip Generation Manual.*

The second objective was to determine whether the observation of trip generation at a site could be automated, thereby relieving the labor-intensive activity of data collection of trip generation of individual land uses.

SCOPE

The scope of this project was limited to determining trip rate modification factors to the ITE trip generation rates for strip malls in Louisiana. A single land use was chosen because of the amount of work involved in observing trip generation at sufficient sites to get reliable local estimates. DOTD suspected ITE strip mall trip rates were inflated relative to those observed in Louisiana, hence their choice of strip malls for further analysis. Factors describing the built environment were limited to population density, land use diversity, and road network density within a half-mile radius of a strip mall.

METHODOLOGY

The general approach adopted in this research was to describe the three chosen expressions of the built environment in terms of variables available in secondary databases, load these databases in a GIS, use the GIS to identify built environment values for a site, and use these values to calculate modification factors to ITE trip generation rates for the site.

Population density was measured in terms of the population within a half-mile radius of the strip mall. Census data was loaded into the GIS to estimate population density at any location. Land use diversity was measured in terms of the jobs to resident workers ratio (JWR). It is a proxy for the level of mixed land use since areas with significant commercial,

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office, and industrial land use have large JWRs; areas that are predominantly residential will have a low JWR. Data to estimate JWR was also obtained from the census and loaded into the GIS. Traffic intensity was measured as the length of local connecting roads within a half-mile radius of the strip mall. Network shapefiles from DOTD were uploaded to the GIS to calculate this measure.

To identify the impact these factors have on trip generation, a sample of strip malls in southern Louisiana that varied on those dimensions were surveyed to determine their trip generation. Forty strip malls were randomly selected from the parishes of Lafayette, West Baton Rouge, East Baton Rouge, Livingston, Ascension, and Tangipahoa, and trip rates observed over two days at each site for this purpose. Observation was done both by video camera and by devices that record the presence of electronic devices that emit Bluetooth and Wi-Fi signals. Video footage was then reviewed in the office and vehicles visiting the site counted manually. Repeat counts were conducted on the video footage at a random sample of sites to estimate any error in the manual couting. It was found to be approximately 1 percent and almost entirely undercounting due to poor visibility, high speed, or vehicle occlusion (when vehicles closer to the camera obscure the view of a vehicle in the next lane). Manual counts were taken as ground truth values when developing modification factors or in assessing the accuracy of automated counting.

Modification factors were developed for whole day trip rates, and for afternoon peak hour trip rates. Modification factor values must be subtracted from the ITE estimate in order to get more accurate estimates of trip rates in Louisiana. Generally, their application results in a reduction of the ITE estimate. The modification factor for the whole day trip rates is:

$$MF_{day} = 30.11 - 32.53x_1 + 33.78x_2 + 9.21x_3 + 115.25x_4$$

where,

MF_{day} = Modification factor for whole day trip estimates from ITE

x_1 = gross floor area (in units of 1,000 square feet of the site)

x_2 = combined worker and residential density (in 1000s of population within 0.5-mile radius of the site)

x_3 = JWR ratio (ratio of number of jobs to number of resident workers within 0.5-mile radius of the site)

x_4 = local connecting road density (measured as miles of road within 0.5-mile radius of the site)

This study also investigated the automation of trip counting. Two technologies were investigated: image processing of video camera footage and detection of Bluetooth and Wi-Fi signals as a proxy for the presence of vehicles. The idea is if there is a close correlation between trip ends and Wi-Fi and Bluetooth detections, then trip ends can be inferred from the number of Wi-Fi and Bluetooth detections.

Analyzing Wi-Fi and Bluetooth data in six strip malls showed correlations of combined Wi-Fi and Bluetooth counts with manual vehicle counts, which varied from 0.92 to 0.97 in areas with low land use diversity to 0.62 to 0.76 in highly diverse areas. The main reason for the decline in correlation in highly diverse areas is expected to be the detection of devices visiting adjoining land uses.

The investigation of image processing of video footage produced promising results. Overall, the processing of video imagery to estimate the entry and exits of vehicles at land use sites produces estimates that are roughly 90 percent of the actual vehicle counts. Of great significance in this finding, however, is that this error is exclusively the result of undercounting. In fact, among all the observations of daily trip generation estimates at the 40 sites over two days, the range of estimates from video image detections ranged from 78.8 to 95.4 percent of the ground counts. Undercounting is due to poor quality images (e.g., adverse weather or poor light), vehicles passing through the observation area too quickly, or a vehicle in the closer lane obscuring the presence of a vehicle in the next lane. If observations in bad weather or poor light are excluded and an effort is made to limit the source of undercounting, much better accuracy could be achieved.

CONCLUSIONS

By using the manual counts as ground truth values, it was found that the modification factors reduce the error in the ITE daily trip rates by 36 percent. While this is good news, it shows there is still a lot of error that remains uncaptured.

Processing video imagery to estimate the entry and exits of vehicles at land use sites produces estimates that are roughly 90 percent of the actual vehicle counts. This technology can replace the manual counting portion of data collection, but the fieldwork portion is still required and it can form a considerable portion of the entire survey.

RECOMMENDATIONS

- Use video camera footage and image detection technology developed in this study to estimate trip generation rates of land uses.
- Investigate whether secondary data sources exist that can serve as input data to a process that can be used to estimate trip production at any individual land use.

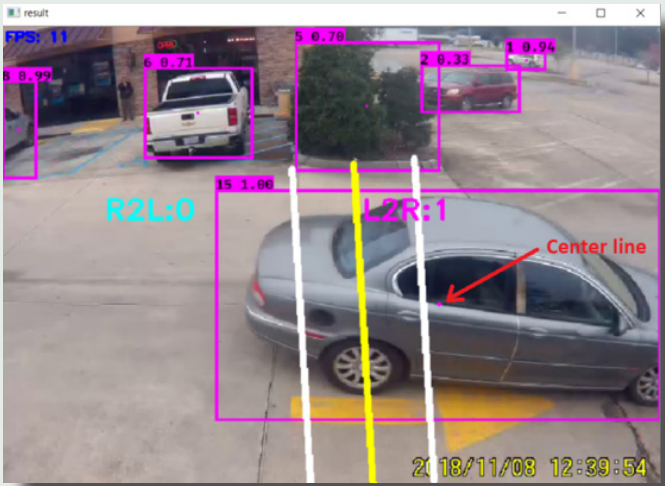

Figure2. Video image detection