SAFETY EVALUATION OF ALL-ELECTRONIC TOLL COLLECTION SYSTEM

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Overview

- Traditional Mainline Toll Plaza (TMTP) is considered the most high risk location on toll roads.
- There is a lack of research that quantifies the safety impacts of the new tolling systems.
- This study evaluated the safety effectiveness of conversion from TMTP or Hybrid Mainline Toll Plaza (HMTP) to All-Electronic Toll Collection (AETC) system.
- Data included all mainline toll plazas in Florida was used in the analysis. And crash data for eleven-year period (2003-2013) was investigated.
- Various observational Before-After studies including the Empirical Bayes method were applied.
- This paper provided an up-to-date safety impact of using different toll collection systems. And proved for the first time the benefits of using AETC system.

Data Preparation

- Data from one hundred sites of mainline toll plazas located on approximately 750 miles of toll roads in Florida was used. These toll plazas were classified based on the type of design (i.e. TMTP, HMTP, or AETC), and whether if the location was a reference site, treated site or the treatment was applied from the beginning.
- Multiple sources of data available online maintained by Florida Department of Transportation (FDOT) were utilized to identify:
  - Locations.
  - Traffic data.
  - Geometric and geographic data.
  - Crash Data.

Results

<table>
<thead>
<tr>
<th>Crash Category</th>
<th>Upgrade to TMTP Previous study</th>
<th>Upgrade to AETC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>'Full' SPF Standard Error</td>
<td>'Full' SPF Standard Error</td>
</tr>
<tr>
<td>Total Crashes</td>
<td>0.53 (0.05) 0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>Fatality</td>
<td>0.84 (0.07) 0.07</td>
<td>0.06</td>
</tr>
<tr>
<td>PDO</td>
<td>0.46 (0.06) 0.06</td>
<td>0.06</td>
</tr>
<tr>
<td>Rear End</td>
<td>0.47 (0.06) 0.06</td>
<td>0.06</td>
</tr>
<tr>
<td>LCRC</td>
<td>0.45 (0.06) 0.06</td>
<td>0.06</td>
</tr>
</tbody>
</table>

Safety Effectiveness of Treatments

- TMTP
- HMTP
- AETC

- Total
- Fatality
- PDO
- RE
- LCRC

Summary and Conclusion

This study evaluated the safety effectiveness of conversion from TMTP or HMTP to AETC system. An extensive data collection was conducted that included hundred mainline toll plazas located on more than 750 miles of toll roads in Florida. Various observational before-after studies including the Empirical Bayes method were applied.

The results indicated that the conversion from the TMTP to an AETC system resulted in an average crash reduction of 77, 76, and 67 percent for total, fatal-and-injury and Property Damage Only (PDO) crashes, respectively; also, for rear end and Lane Change Related (LCR) crashes the average reductions were 81 and 75 percent, respectively. The conversion from HMTP to AETC system enhanced traffic safety by reducing crashes by 23, 29 and 19 percent for total, fatal-and-injury, and PDO crashes respectively; also, for rear end and LCR crashes, the average reductions were 15 and 21 percent, respectively.

Overall, this paper provided an up-to-date safety impact of using different toll collection systems. The results proved that the AETC system significantly improved traffic safety for all crash categories; and changed toll plazas from the highest risk on Expressways to be similar to regular segments.

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Conclusion

The results of this study proved that there is a significant difference between the different designs of the HMTP. The Incident Rate Ratios (IRR) value shows that the risk of crashes at design 2 ($D_2$) of the HMTP was approximately 19 percent higher than at the design 1 ($D_1$), given that all other variables are constant. The increased crash risk at $D_2$ may be explained by the fact that more than 81 percent of the vehicles in Florida are equipped with prepaid toll transponders. Thus, the use of $D_2$ will cause more than 81 percent of the traffic to diverge and merge before and after the toll plaza.

Another finding is there is an indication that the majority of crashes occurred at diverge and merge areas before and after the HMTP. The IRR value shows that the risk of crashes at diverge areas were approximately 23 percent higher than at the merge areas, given that all other variables are constant.

Moreover, the results indicated significant relationships between the crash frequency and toll plaza types, annual average daily traffic, and driver-age. This means all of these three variables significantly affect the frequency of toll plazas-related crashes.

It was also found that the HMTP and the AETC were associated with less number of crashes than at the traditional mainline toll plaza by 44.7 and 72.6 percent, respectively. For those agencies that cannot adopt the HMTP and the AETC systems, improving traffic safety at traditional toll plazas should take a priority.

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