Converting Four lane roadways into Five lane roadways on Urban Structure: Study on Safety Effectiveness

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Abstract

- In urban or suburban areas with large number of access points, four-lane undivided highways are prone to crashes due to left-turning and through movements in a single lane.
- Expensive countermeasures like conversion from undivided to divided road are recommended by many studies. **One inexpensive alternative is reconfiguring the existing roadways by either increasing or decreasing the number of lanes.**
- This study investigated the safety impact of **converting four lane undivided roadways (4U) to five lane undivided roadways (5T) with a two-way left-turn lane (TWLTL).** This study used Empirical Bayes method to determine the safety impact of this inexpensive countermeasure.
- The findings of the current study indicated a positive safety impact. The benefit-cost ratio of this conversion ranges from 97 to 379. The current findings indicate that conversion of 4U to 5T is a feasible inexpensive solution for urban structure.

Methodology

- This study selected eight sites from Louisiana. This countermeasure requires adding of a TWLTL by restriping (see **Figure 1**).
- The observational before-after method used in this study is empirical Bayes (EB) Method.
- This method accounts for the effect of regression-to-the-mean, changes in traffic volume (**Table 1**), and other potential changes in the roadway features during the before and after time periods.
- In accounting for regression-to-the-mean, the number of crashes expected in the before period without the treatment ($N_{predicted,\,t,\,b}$) is a weighted average of information from two sources:
  - The number of crashes observed in the before period at the treated sites ($N_{observed,\,t,\,b}$).
  - The number of crashes predicted at the treated sites based on reference sites with similar traffic and physical characteristics ($N_{predicted,\,t,\,b}$).

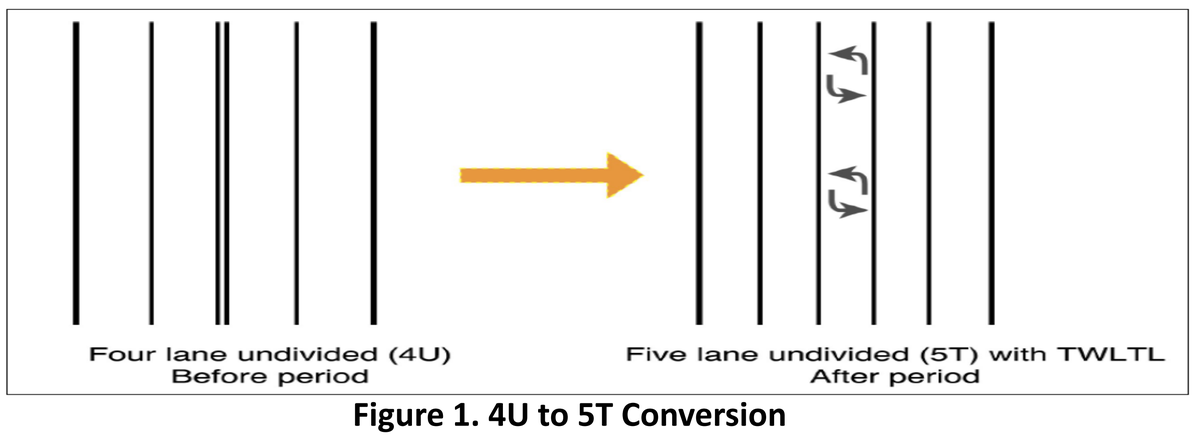

Figure 1. 4U to 5T Conversion

Table 1. AADT and Overserved Crashes in Before-After Years

Sites	Before Period			After Period		
	Years	AADT (vpd)	Total Crashes	Years	AADT (vpd)	Total Crashes
Site 1	2004-2006	19,867	21	2008-2010	19,767	9
Site 2	2004-2006	19,867	118	2008-2010	19,767	47
Site 3	2008-2010	6,833	39	2012-2014	7,900	20
Site 4	2008-2010	19,200	126	2012-2014	21,000	114
Site 5	2000-2002	23,888	358	2004-2006	26,580	148
Site 6	2004-2006	21,367	65	2008-2010	21,100	51
Site 7	2002-2004	27,467	116	2006-2008	27,000	75
Site 8	1996-1998	14,693	115	2000-2002	14,967	79

Safety Effectiveness

- The EB estimate of the expected number of crashes without treatment, $N_{expected,\,t,\,b}$, is computed from the following equation:

$$N_{expected,\ t,\,b} = w \times N_{predicted,\ t,\,b} + (1 - w) \times N_{observed,\ t,\,b}$$

$$w = \frac{1}{1 + k \times \sum_{\substack{all\ study \\ years}} N_{predicted}}$$

where,

- w = weighted adjustment to be placed on the predictive model estimate; and
- k = over-dispersion parameter of the associated SPF used to estimate $N_{predicted}$.

- **Table 2** enlists the values of site specific Crash Modification Factor (CMF), standard deviations, and 95% confidence interval (CI).
- The CMF values range from 0.35 to 0.84 (except site 6; in which CMF is greater than 1).

Table 2. CMF values and their Variances

Sites	CMF	$Var(CMF)$	$sd(CMF)$	95% $CI\ of\ CMF$
Site 1	0.48	0.03	0.18	(0.13, 0.84)
Site 2	0.42	0.01	0.07	(0.28, 0.56)
Site 3	0.62	0.03	0.17	(0.3, 0.95)
Site 4	0.84	0.01	0.11	(0.63, 1.05)
Site 5	0.35	0.00	0.03	(0.28, 0.42)
Site 6	1.18	0.05	0.22	(0.76, 1.6)
Site 7	0.65	0.01	0.10	(0.47, 0.84)
Site 8	0.64	0.01	0.09	(0.46, 0.82)

Benefit-Cost Analysis

The benefit cost ratio for the treatment sites range from 97 to 379. The benefit-cost ratio for all eight segments is shown in **Table 3**.

Table 3. Benefit-Cost Ratios

Site	Total Benefits ($)	Total Cost ($)	B/C Ratio
Site 1	278,951	2,863	97
Site 2	1,387,818	4,809	289
Site 3	810,675	5,382	151
Site 4	1,142,767	7,672	149
Site 5	3,039,771	14,084	216
Site 6	651,252	1,718	379
Site 7	630,598	4,580	138
Site 8	1,076,223	9,046	119
PDO crash cost($)	6,623		
Injury Crash cost ($)	46,518		
Cost per mile ($)	11,450		

Conclusion

- This study suggests that inserting a two way left turn lane on four lane undivided urban highways can have significant benefit.
- It is also important to note that one-size-fits-all solutions do not usually work in highway safety issues. Caution must be taken when applying this crash countermeasure in other locations.

Acknowledgments

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