TECHSUMMARY February 2023

State Project No. DOTLT1000373 | LTRC Project No. 20-3SA

Minimum Intersection Illumination

INTRODUCTION

In Louisiana, a total of 2,275 crashes were recorded at nighttime between 2010 – 2020 as reported by the National Highway Traffic Safety Administration (NHTSA). Some of those crashes may be attributed to unlit roadway conditions. However, according to Louisiana Department of Transportation and Development's (DOTD's) current manual, lighting is not mandatory for intersections (*DOTD's Roadway Design Procedures and Details, 2020*).

OBJECTIVE

The primary objective of this study was to examine whether Louisiana has a traffic safety problem due to lack of lighting at its intersections, particularly at roundabouts and stop-controlled intersections at rural and suburban areas. Underlying this objective, this study also aimed to:

1. Investigate if an intersection's lighting has significant impact on drivers' behavior and their ability to safely perform the driving task at unsignalized intersections.
2. Determine which states have adopted a partial/full lighting policy, guidelines, or other potentially low-cost countermeasures for lighting their intersections.
3. Explore how do such states construct and maintain the lighting equipment at their intersections.
4. Assess the benefits from providing full lighting at stop-controlled intersections and roundabouts considering the costs required to provide this countermeasure and the expected savings due to the anticipated reduction of the number and/or severity of nighttime traffic crashes.
5. Provide recommendations regarding whether DOTD should adopt a partial or full lighting policy considering the results of all previous tasks.

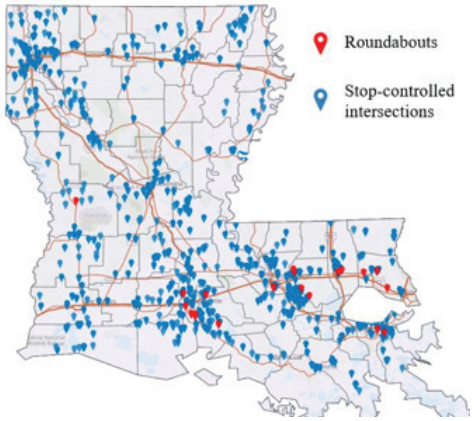

Figure 1. GIS map of stop-controlled intersections (blue) and roundabouts (red) studied in this project

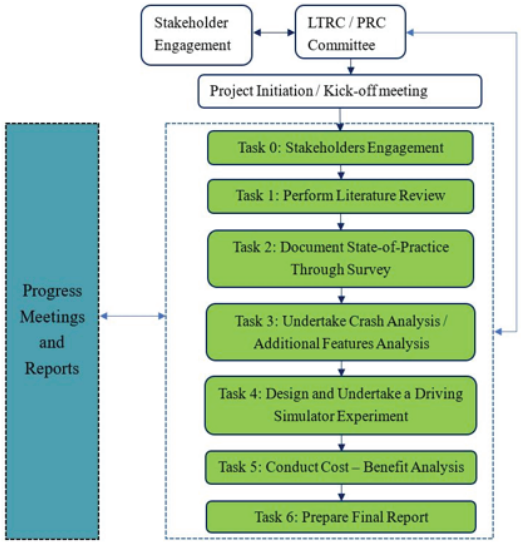

Figure 2. Overall methodology

SCOPE

The project's scope included stop-controlled intersections and roundabouts located at rural and suburban areas in Louisiana. As shown in Figure 1, the study area included a total of 577 stop-controlled intersections and 19 roundabouts in rural and suburban areas in Louisiana.

METHODOLOGY

The overall methodology used in this project is shown in Figure 2. This methodology includes:

Task1: Conduct literature review.

Task 2: Document of practice through a national survey study among professionals working at US DOTs. A total of 32 state DOTs responded to the survey (64% response rate).

Task 3: Undertake crash data analysis. A total of 705 crashes at 19 roundabouts and 4,270 crashes at 577 stop-controlled intersections were analyzed. Several statistical techniques were employed including descriptive summary statistics, cross sectional analysis, poisson, and negative binomial regression.

LTRC Report 677

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Task 4: Design and undertake a driving simulator experiment. LSU's driving simulation lab (as shown in Figure 3) was used. Two scenarios were developed: the first scenario consisted of eight stop-controlled intersections and the second scenario consisted of four roundabouts. Driving behaviors to different lighting conditions were examined (e.g., during daytime, nighttime without lighting, nighttime with partial lighting, and nighttime with full intersection's lighting).

Task 5: Conduct cost-benefit analysis to evaluate the feasibility of providing street lighting as a countermeasure to improve traffic safety at roundabouts and stop-controlled intersections.

Task 6: Prepare a final report.

Figure 3. A photo of the driving simulator while an experiment is ongoing

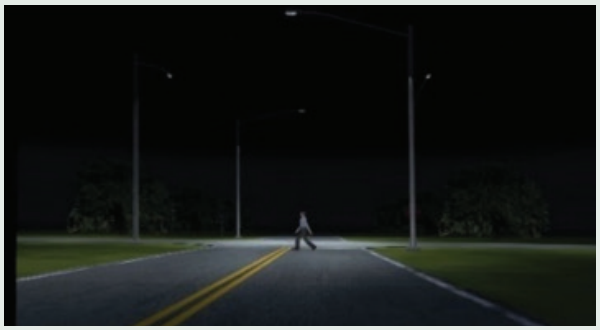

Figure 4. A screenshot of participants' view during the driving simulator experiment

CONCLUSIONS

The main findings from each of the tasks conducted to achieve the project's objectives are presented below:

1. Considering the literature review task, numerous prior studies indicated that street lighting has a positive impact on the overall traffic safety at nighttime. State DOTs' guidelines mandate that signalized intersections should be lighted while unsignalized intersections (e.g., roundabouts and stop-controlled intersections) are assessed based on traffic safety analysis. However, some state DOTs mandate that roundabouts should be lighted due to changing road geometry while approaching the intersection and to enhance visual perception of drivers during nighttime.
2. Regarding the national survey study, it was found that *AASHTO Roadway Lighting Guideline* is the most frequently used lighting manual by states that participated in this study (72% for stop-controlled intersections and 71% for roundabouts). Furthermore, lighting at stop-controlled intersections is not mandatory for almost 72% of the responding states. However, lighting is mandatory for roundabouts according to two-thirds of the participating states (67%) in the survey.
3. With respect to crash data analysis, the results of the cross-sectional and multivariate analysis indicated that Louisiana doesn't seem to have a traffic safety issue due to lack of street lighting at its roundabouts and stop-controlled intersections in rural and suburban areas. The negative binomial regression models did not show that street lighting is among the significant factors that impacted crash occurrence at nighttime.
4. Considering the driving simulator experiment, the result for stop-controlled intersections scenario shown in Figure 4 indicated that providing street lighting improved nighttime traffic safety as the time to collision (TTC) increased when street lighting is available. TTC for nighttime without lighting was 5.05s while TTC for nighttime with partial lighting was 5.38s. Furthermore, TTC for nighttime with full lighting was not calculated as the visibility from the full lighting allowed participants to notice the intersection way in advance thus giving them sufficient time to reduce their speed gradually before reaching the intersections.
5. Regarding the cost-benefits analysis, the results showed that since there was not a single crash due to lack of street lighting at roundabouts, then providing street lighting at rural and suburban roundabouts in Louisiana would not be feasible as the benefits-to-cost ratio (BCR) would be zero. However, it is feasible to provide street lighting at stop-controlled intersections in rural and suburban areas as the BCR would be 4.6. The analysis was conducted assuming the expected benefit of preventing one crash that occurred due to lack of lighting. Therefore, if more crashes were prevented by providing street lighting then the benefit to cost ratio would increase accordingly.

RECOMMENDATIONS

Based on the findings of all project's tasks, the research team recommends the following:

- Monitor traffic safety performance at intersections where lighting is installed (e.g., evaluate frequencies of crashes before and after lighting installation);
- Providing lighting at stop-controlled intersections and roundabouts in rural and suburban areas in Louisiana should not be mandatory based on the project's results. However, it may be warranted based on traffic safety analysis (e.g., where the intersection has on average at least one nighttime fatal or injury crash per year over a three-year period);
- If lighting is warranted but lighting installation is not feasible due to lack of funding or site constrains, it is recommended then to install other low-cost countermeasures such as reflective pavement markings, reflective pavement markers, larger traffic signs, double signs, blinker signs, and advanced warning;
- Deliver awareness campaign to drivers to obey traffic rules as the primary cause of nighttime crashes was traffic violations (speeding and driving under the influence), and
- Future studies are recommended to continue evaluating the impact of lack of street lighting at unsignalized intersections in Louisiana on traffic safety once missing information become available (e.g., availability of lighting at each intersection, date of lighting installation, etc.) to further validate the results of this study.