Roadway Lighting As Countermeasure For Nightitme Collisions: Case Study Of Quebec's Highways And Arthabaska Roads

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Abstract

Compliance with roadway lighting regulations is not sufficient to warrant effective reductions in night-time collisions, lighting levels are disconnected from the crash history. A method to estimate effective lighting levels from locally observed crash history is presented. It uses statistical analyses to estimate the explanatory power of illuminance, luminance, and uniformity ratios. Findings: from Arthabaska region illuminance was not useful on road segments, luminance levels should be increased and uniformity variations reduced. For highways in Quebec, luminance should be increased up to 1.5cd/m2 and illuminance-uniformity reduced to one in order to reduce collision's severity.

Introduction

Worldwide practices in roadway lighting give preference to luminance as a design criterion for highways instead of illuminance (Wanvik 2009). The Japanese guidelines (JAS 1988), the European code (CEN 2004) and the Austroads manual (AS/NZS. 2010), they all recommend the use of luminance from the perspective of the driver. Whenever the design involves high speeds or deals with the driver's ability to perceive objects and dangerous circumstances, luminance seems more adequate (Jackett and Firth 2013).

Methodology

Values recommended by IESNA (2005) are used as initial point (Figure 1). The approach is repeated for average values of illuminance, luminance and uniformities. The first step consist in the selection of a trial level for each lighting explanatory variable, then the data is categorized according to this level and the explanatory capability of the factor is learned from the statistical analysis. If decreasing the lighting variable helps to explain a lower number of collisions then the procedure is repeated by setting up a new trial level. If the variable does not help explain a reduction in the frequency/severity of collisions then the procedure is terminated and the previous level of the lighting variable is set as recommended minimum value (Figure 1). The method must go in this way and do not follow a continuous variable approach, because of the need to identify the minimum or maximum levels for each lighting parameters in their capability to explain less collisions.

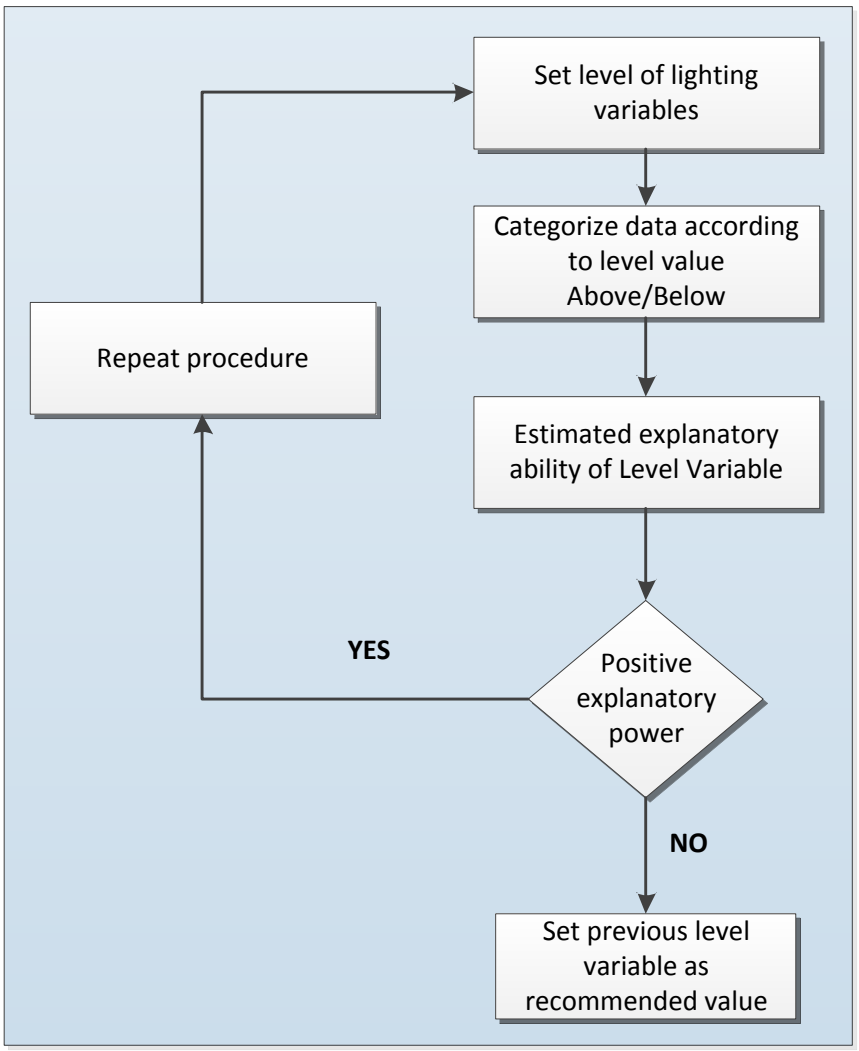

Figure 1 Method for the estimation of recommended level

Case study of the province of Quebec

For example Table 3 shows the results of the statistical analysis for luminance, similar analysis were made for other variables. As seen values of 1.5 (and above) resulted in statistically significant reductions of severity and frequency of night time motorized collisions.

Table 1 Identification of Recommended Levels for Luminance

Luminance-levels analysis of severity								
	Level of Lighting Indicator on Dummy variable							
	0.6 cd/m2		**1.5 cd/m2***		**1.7 cd/m2**		**1.9 cd/m2**	
Variable	**coeff**	**p-value**	**Coeff**	**p-value**	**coeff**	**p-value**	**Coeff**	**p-value**
nd_ratio_one	0.29	0.00	0.25	0.00	0.27	0.00	0.27	0.00
number_lanes	-0.52	0.11	-0.26	0.43	-0.32	0.34	-0.36	0.27
intersections	1.12	0.03	1.74	0.00	1.63	0.00	1.57	0.00
shoulder_width	-0.55	0.00	-0.61	0.00	-0.59	0.00	-0.59	0.00
lnaadt_night	0.78	0.00	0.70	0.00	0.75	0.00	0.76	0.00
speed	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
radius	0.00	0.24	0.00	0.33	0.00	0.28	0.00	0.27
DUMMY Var	**0.40**	0.05	**-3.39**	0.01	-4.74	0.18	-15.02	0.98
effect	*negative*	*significant*	*positive*	*significant*	*positive*	*80% CI*	*positive*	*insignificant*
No. of Obs.	450		121		74		67	
Luminance-levels analysis of frequency								
	Level of Lighting Indicator on Dummy variable							
	0.6 cd/m2		**1.5 cd/m2***		**1.7 cd/m2**		**1.9 cd/m2**	
Variable	**coeff**	**p-value**	**Coeff**	**p-value**	**coeff**	**p-value**	**Coeff**	**p-value**
nd_ratio_one	0.67	0.00	0.48	0.00	0.49	0.00	0.48	0.00
number_lanes	-0.33	0.10	-0.09	0.63	-0.01	0.96	-0.18	0.35
intersections	1.65	0.00	2.69	0.00	2.90	0.00	2.57	0.00
shoulder_width	-0.21	0.00	-0.29	0.00	-0.28	0.00	-0.28	0.00
lnaadt_night	0.50	0.00	0.48	0.00	0.52	0.00	0.49	0.00
speed	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
radius	0.00	0.00	0.00	0.05	0.00	0.04	0.00	0.02
DUMMY Var	**1.14**	0.00	**-2.08**	0.00	-3.85	0.00	-699.79	Not converge
effect	*negative*	*significant*	*positive*	*significant*	*positive*	*80% CI*	*positive*	*insignificant*
No. of Obs.	450		121		74		67	

Note: * denotes the recommended minimum level of luminance

Conclusions

Luminance for highways in Quebec should be increased to at least 1.5cd/m2. Variation of illuminance-based uniformity (average to minimum) showed that more consistent lighting is beneficial. Non-illuminated roads are preferable than those with significant variations of light on the surface of the road (illuminance uniformity variation). From the perspective of uniformity of luminance the design can tolerate up to 8 times between the brightest and darkest spots. Variations larger than 8 times should be avoided as they will likely result in negative effects from a safety perspective and could represent the fact that one is now under the presence of some degree of glare.

References

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