

# Examination of the LED Source in Traffic Lights and the Effect of Airborne Dirt on its Performance

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**Abstract** – The performed evaluation consisted of two phases: measurement of the illumination levels of (new) LED system and carrying out the public opinion poll on the subjective visual performance of LED in traffic lights. The results of the measured levels of illumination show that deposition of dirt considerably affects its values. The survey results confirm an overall positive impression on LED performances in traffic lights.

**Keywords** – LED Traffic Lights, deposition of dirt, public opinion poll.

## 1. Introduction

Development and specification improvement of light emitting diodes (LED) over the last few years [1],[2] made possible the use of this light source as an alternative in traffic application, primarily traffic lights. LED characteristics [3],[4] imply a possible improvement of traffic safety due to their better visibility, with reduced use of energy and longer life.


In the year of 2012 the city of Tuzla replaced 71 incandescent traffic lights with new LED lights on the main city streets. This included replacement of 950 light bulbs with new LED light sources.

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The primary aim of the performed research was to collect and examine practical results and experience on the transition from conventional lamp technology to LEDs while taking into consideration the added environmental factor, such as deposition of dirt, dust, and moisture on the optically active components of LEDs in traffic light applications.

## 2. Methods and Experimental set-up

The general course of the performed evaluation was divided into the following two phases: measurement of the illumination levels of (new) LED system and carrying out the public opinion poll. The acceptance of a new lighting system has a decisive influence on the success of the replacement project, thus it makes sense to involve the users and the population early and survey their opinion. The questionnaires were sent to the residents to ask them to complete the questionnaires online. Thirty (30) participants were included in the survey.

The created questionnaire took into consideration the following: lighting, psychological and architectural aspects which are factors important for the traffic safety; visibility directly in front and further away from the lights, observation of fatigue (caused by looking at the light source); perception of glare, as well as their optional open comment on general impression and choice between LED or classic (incandescent) light source. Inquired performance characteristics were ranked with values between 1 and 5, where 1 is considered bad, 3 good, and 5 great.

In general, the degradation of the luminaries' performances depends on the nature and density of airborne dirt around the light sources, luminaries' design and lamp type [5]. Since deposition of dirt, dust, and moisture on the optically active

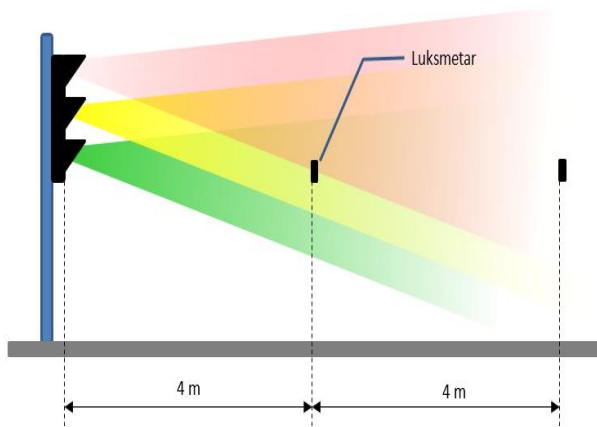


Figure 1. Illustration of the performed measurements

components of a lights source causes the most serious loss of light [6], the other part of the evaluation of LED visual performances included measuring of the levels of illumination of LED traffic lights before and after cleaning of their refractive surfaces. The measurements were performed at night time at two fixed distances, 4 m and 8 m from the lights (Figure 1.).

### 3. Results and Discussion

The results of the measured levels of the illumination of LED traffic lights before and after cleaning are shown in Table 1. It is apparent that by cleaning the refractive surfaces illumination values were increased between 13% and 25%. This implies that, even though LED light sources are considered “a low maintenance” light sources with lower maintenance needs compared to the incandescent lights, it is still necessary to perform its periodical cleaning in order to maintain the levels of illumination (Figure 2.).



Figure 2. LED traffic lights before and after cleaning

Frequency of cleaning most likely depends on the pollution category of the location. According to the average levels of pollutants measured in December 2016, Tuzla can be categorized as a medium pollution category [7], with moderate to heavy

traffic, moderate smoke or dust generating activities nearby and the ambient particulate level higher than  $150 \mu\text{g}/\text{m}^3$  and no more than  $600 \mu\text{g}/\text{m}^3$ . Measured daily average concentrations of  $\text{SO}_3$  levels were  $244,7 \mu\text{g}/\text{m}^3$  and  $309,5$  for other suspended particles [8].

The results of the performed survey are given in Figure 3. From the graphs of visibility at 4 and 8 meters from the traffic light, it is evident that this characteristic of a LED traffic light was ranked mostly as great (25 out of 30 participants).

Table 1. Illumination levels at 4 m and 8 m from the LED traffic light

	4 m			
	before cleaning		after cleaning	
	E (lx)	E' (lx)	E (lx)	E' (lx)
green	16,9	16,9	21,3	21,2
	16,8		21,5	
	17,1		21,6	
			21,4	
			20,9	
yellow	8,9	8,7	11,7	11,6
	8,6		11,4	
	8,5		11,7	
			11,6	
red	7,9	7,8	9,7	9,6
	7,8		9,6	
	7,8		9,6	
			9,6	
			9,6	

	8 m			
	before cleaning		after cleaning	
	E (lx)	E' (lx)	E (lx)	E' (lx)
green	6,0	6,1	6,9	6,9
	6,1		6,7	
	6,1		7,1	
			6,8	
			7,1	
yellow	4,8	4,8	5,9	5,9
	4,8		5,8	
	4,8		5,8	
			5,9	
red	6,8	6,7	8,4	8,3
	6,7		8,5	
	6,7		8,3	
			8,1	
			8,2	
			8,1	

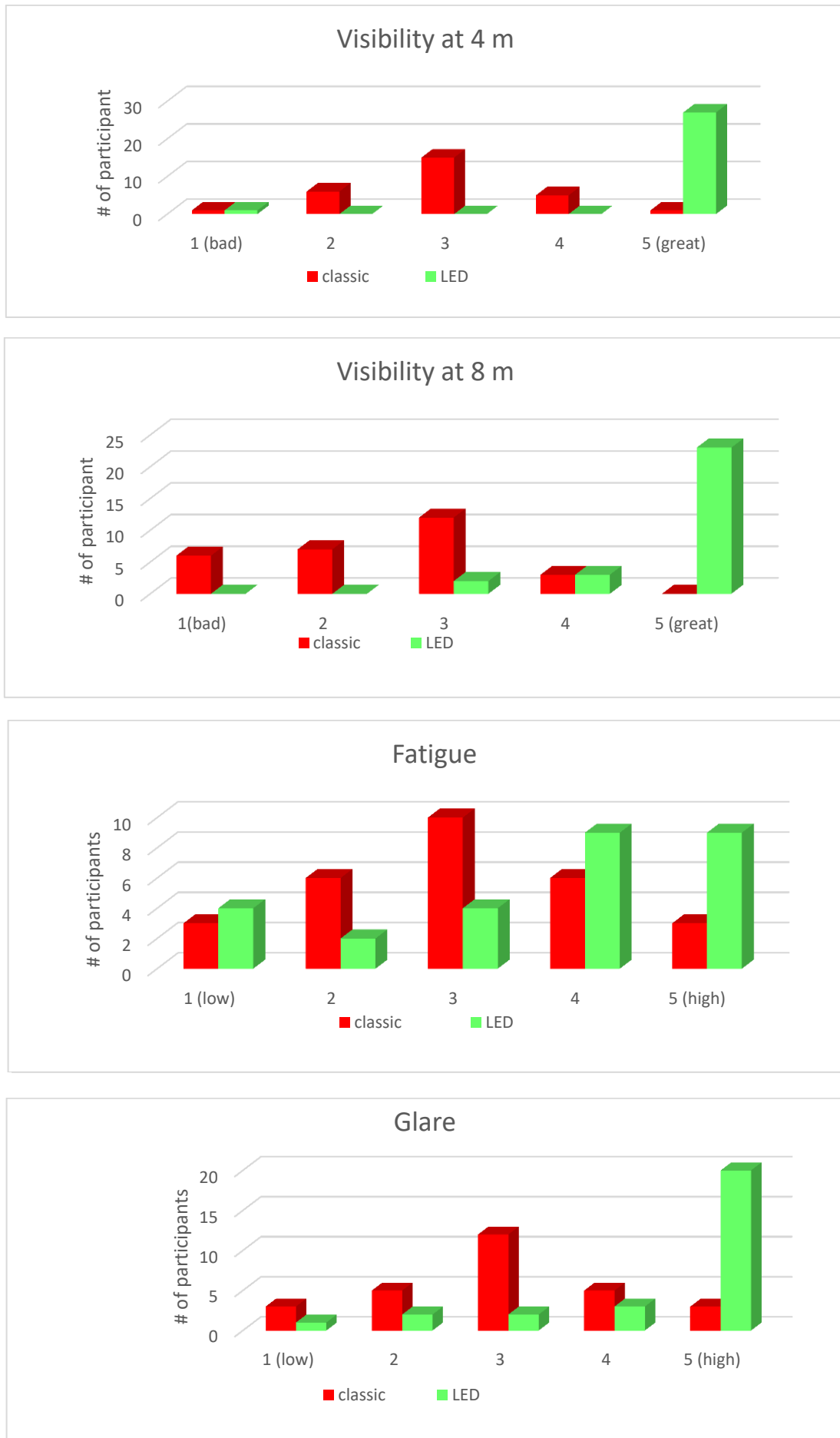


Figure 3. The survey results

The graphic representation of the poll results for glare and fatigue show that the participants find it to be medium to high. However, the poll participant still commented that they would choose LED over incandescent traffic light because of a lot better visibility and notable energy saving. This implies a general positive impression on LED performances.

#### 4. Conclusion

In our previous work we confirmed the evident reduced use of energy and longer life [9],[10]. Additionally, this evaluation included measurement of the illumination levels of (new) LED system and carrying out the public opinion poll. From an engineering and scientific perspective, when planning new LED installations, the evaluation of an old installation with conventional light sources in comparison with a recently installed LED lighting system should be taken into consideration. This evaluation should also include the users and the population survey opinions regarding the tested lighting, with psychological and architectural aspects of the project.

Implementation of the LED traffic light replacement project showed the benefits for the all traffic participants through better visibility than the incandescent light, which will have impact on traffic safety.

Even though LED light sources are considered light sources with lower maintenance needs compared to the incandescent lights [11], the performed evaluation showed that it is still necessary to perform its periodical cleaning in order to maintain the levels of illumination, which is in accordance with research findings of [12].

The last stage of any LED luminaire's implementation is recording and processing all relevant measurement data regarding communication with the citizens and documentation of public opinion poll. The poll results show that the participants find a certain concern regarding glare and fatigue, which can be characterized as medium to high. Nevertheless, the poll participants still commented that they would choose LED over incandescent traffic light because of its noticeably better visibility and evident energy saving potential. This implies an overall positive impression on LED performances.

The results of the completed questionnaires serve as a conformation for the selected replacement solutions. At the same time, they also provide information that serves as a decision aid for future projects.

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