Stakeholder Perception of the Intangible Value of a Public Lighting Solution in an Ecological Zone

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Introduction

New lighting technologies are going to create a revolution in the lighting industry. According to Aarts (2011), the lighting industry will go through an evolution similar to the developments in computing since the invention of the first transistor. In the next 12 years, 80 billion light bulbs will be replaced by leds. Led technology offers many advantages, such as chromaticity control, better light quality and higher efficiency (Shur & Zukauskas, 2005).

One of the application areas for new lighting solutions is public lighting. With the extended possibilities that led offers, and integration with smart sensor networks, new opportunities arise to further reduce energy use and light pollution, and, at the same time, increase people’s sense of perceived personal safety and comfort. Municipalities aim to implement such solutions, but little is known yet about their acceptance by the general public, nor the effects on the perceived safety and comfort.

The municipality of Veldhoven, The Netherlands asked THE LUX LAB to design a smart lighting solution for a bicycle path that runs through an ecological zone. The proposed solution aimed to use different lighting settings (varying in color and intensity) at different times to accommodate different stakeholders (see: Figure 1) The proposed solution offers the following settings:

In the early evening the path is intensely used by commuters, particularly children heading home. This is why lighting was placed in that zone in the first place. Cyclists’ feelings of comfort and safety are increased with more light, as people need more light when dusk is setting. Thus white, 5 lux light is proposed for this time of day (setting A).

Later in the evening as traffic ceases the light dims to a light that is less disturbing for animals and plants but still provides good visibility for cyclists (setting B: yellow-greenish, 3,5 lux). The yellow-greenish light offers good visibility at significant lower energy use caused by led efficiency in such color range combined with high sensitivity of people’s eyes to these wavelengths.

During the night as there is hardly any traffic the wild life becomes the most important stakeholder. Therefore, the light is
dimmed to the equivalent of ‘full moonlight’
(setting C: cool white, less than 1 lux), which
does not disturb animals and at the same time
requires significantly less energy while stays
aesthetically pleasing. In the case of an
emergency the system automatically gears up
to increased lighting levels to ensure
maximum safety for the incidental cyclists.

In the morning bright cool white lighting
setting (setting D: cool white, 7 lux) is used
to increase alertness of the cyclists.

The proposed solution differs from
traditional lighting installations as it aims not
just to reduce the energy use but at the same
time to increase life quality in the ecological
zone while not sacrificing safety of the road
users. The role of the designer is to
understand the needs and requirements from
the various stakeholders, and to integrate
seemingly opposing needs into a solution that
is attractive, or at least acceptable, to them.
The difficulty in these kinds of projects is
that the solution is very different from what
is currently available, so for the stakeholders
to be able to judge the concept they will have
to be able to imagine it. Moreover, to address
issues like perceived safety and comfort
means that potential users should be able to
assess the intangible values of the concept.

Testing traditional lighting for public
spaces involves comparison of different lamp
types or lighting settings for a similar
purpose (Boyce & Bruno, 1999). In this case,
as the different light settings were part of
the same concept we knew that some conditions,
like night setting, would be perceived as less
safe due to its low luminance (Boyce et al,
2000). So, the question was not which of
these settings would be preferred but whether
using different settings over the course of the
night is acceptable for different stakeholders.
Furthermore, we wanted to know if such
people knowing that such lighting aims to
accommodate flora and fauna in the
ecological zone would influence their
acceptance. The research program ‘Brilliant
Streets’ of the Intelligent Lighting Institute at
TU/e was invited to support the concept
evaluation in line with the reflective
transformative design process (Hummels &
Frens, 2008).

**Study design**

For the first iteration in the reflective
transformative design process, a
demonstrator was created which was then
shown during the ‘Liberation of Light’
exhibition. For setting A a less bright setting
with a high color rendering was chosen, to
avoid a longer accommodation times to the
less bright settings in B and C. In the
demonstrator the settings A (1.32 lx Ra 90.2
K 2507), B (3.44 lx Ra 61.8 K 4283), and C
(0.21 lx Ra 81.9 K 3966) were presented in
darkened corridors. This allowed people to
experience the lighting levels and assess the
concept. Due to restrictions in available
space setting D was left out.

The demonstrator was used to collect
feedback from relevant stakeholders using
two methods. First, an interactive
questionnaire was used to measure light
setting preference and perceived level of
safety for the general public. Visitors of the
exhibition were asked to complete a short
questionnaire after exiting the experiment
area. After answering a set of questions
regarding the preference for each separate
light setting, participants were asked to rate
the light settings with relation to their
feelings of safety by using VERO tool
(Szostek & Karapanos, 2011). In short,
participants were asked to drag each light
setting onto a circle. The closer a given
lighting design was placed to the center of
the circle the higher was the level of
perceived safety. Additional measurements
for age, gender and frequency of bicycle
usage were used.

Secondly, workshops with different
stakeholders were conducted. The goal of
these workshops was to collect feedback
from multiple points of view and to facilitate
an elaborate discussion on the validity of the
lighting solutions in the surroundings of an
ecological zone. These stakeholders included
the municipality, people living in the
neighborhood, local police, an environmental
organization and also other users: school
children, athletes who use the path for their
weekly running exercise and elderly. A
workshop consisted of the following steps:
1. Visit to the demonstrator
2. Reflection on the concept
3. Concept presentation using video material
4. Reflection on the concept
5. Evaluation of the importance of the key parameters of the concept for further development

‘Stakeholder types’ were not mixed in the workshops and at least two individuals participated representing each ‘stakeholder type’. An independent facilitator was invited to facilitate the discussion on the value of the concept.

Results

Firstly, the results of the questionnaire are discussed and then the qualitative insights regarding most important outcomes from the workshops are presented.

A total of 966 persons volunteered to fill in the questionnaire. However, due to incompleteness of records, 602 answers were used for the analysis. Among the participants 283 were male (47%) and 391 female (53%). The majority (60%) rode a bicycle daily. Among those, 13.5% of people rode a bicycle daily after dark.

The majority of participants either preferred setting A (46.3%) or had no preference regarding the light for bicycle paths (36.3%). Setting B has been chosen as the preferred one by 14% and setting C by 3.3% of people. There was no difference with respect to the light preferences by people of different age (X²=0.026, d.f.=21), gender (X²=0.101, d.f.=3) and frequency of riding a bike after dark (X²=0.735, d.f.=12). Significant difference was detected that depended on the overall frequency of riding a bike (X²=0.044, p<0.05, d.f.=12). The study showed that participants who either never or about once a year rode a bicycle had no preference for one of the light settings. If they showed preference they would most often select B and then A as preferred settings. Participants riding bicycles more frequently (once a month, once a week and daily) showed strong preference for A, then none and then B.

Similarly, the results of the repertory grid technique showed that setting A was perceived as the safest (mean distance from the center = 85.41, median = 71.72, dominant = 50), then B (mean = 95.25, median = 94.59, dominant = 50) and finally C (mean = 141.51, median = 141.51, dominant = 150).

Furthermore, the analysis showed that gender, the overall frequency of cycling or frequency of cycling after dark) did not differentiate the perception of the tested light conditions as more or less safe. With respect to age, significant correlation (.002, P < .001) was detected in the case of setting B, which was perceived as the least safe among the youngest and the oldest participants. The group who considered setting B as relatively safe was between 41 and 70 years old.

A and B settings were considered as the most similar in terms of safety (mean = 62.96; median = 61.2), while B and C were seen as the least similar (mean = 105.68, median = 108.94). Based on the t-test for two dependent samples with normal distributions can be concluded that the perceived similarity between A and B is significantly different from the perception of similarity between B and C (t = 19.96, p < .000).

The results gathered during the 7 workshop sessions are summarized in Table 1. The first important observation is that although all stakeholders were at least fairly positive towards the concept as a whole, the ranking of key parameters for its further development differed significantly. Interestingly, the road users indicated energy efficiency to be the most important parameter, whereas municipality marked it as the least important one. This seems to indicate that citizens expect from municipalities to find a balance between energy efficiency on the one hand and social safety and ecology on the other. Furthermore, during the workshops multiple questions arose that mostly related to the perception of safety. Example are: can we control light intensity in the case of emergencies; would green and yellow lighting result in unwanted changes in color perception; does car and urban lighting in the surroundings change the atmosphere?
Conclusions and discussion

This research aimed to generate insights regarding the perception of intangible value of light settings as experienced by different stakeholders. One of the most prominent difficulties in testing such radical innovations is to ensure that the participants understand the concept properly. For the concept presented in this article, two problems arose during concept evaluation: 1) despite using a demonstrator the lighting concept and its associated values were still intangible; 2) the concept itself is dynamic for which people have no previous reference.

In line with the previous research, the quantitative results confirmed that settings with higher light levels were preferred. But the results also suggest that a lower light level with a high color rendering is perceived as similar to a higher level with lower color rendering. This is an aspect for further study.

Although the experimental set-up was not similar to a realistic outdoor situation, the fact that people could experience the light settings give rise to interesting discussions on the different stakeholder perspectives. This confirmed the usefulness of this co-reflection session in an early phase of the project to elicit stakeholders’ needs. Moreover, the results of the co-reflection proved to be a strong element in building commitment from a supplier to invest in the production of specific prototypes for a next iteration.

This study had some limitations. For people participating in the survey it may not have been clear enough that the three settings were to be used over the course of the night, so they might not be triggered to reflect on the settings in relation to the probability of them using the path at the respective time blocks.

Further research aims to address these limitations and will include new moments of reflection when a limited set of prototypes is placed on the real-life situations (2012) and longitudinal studies when the complete installation is placed (2013). It will also further study the perception of different combinations of light and color rendering levels.

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References