Interreg
CENTRAL EUROPE

Dynamic Light

European Union
European Regional
Development Fund

DYNAMIC LIGHT
Report on User Acceptance

DYNAMIC LIGHT—TOWARDS DYNAMIC, INTELLIGENT AND ENERGY EFFICIENT PUBLIC LIGHTING

This document has been prepared as part of the “Dynamic Light” Research project.
The “Dynamic Light” research project is supported by the Interreg CENTRAL EUROPE Programme funded under the European Regional Development Fund

Dynamic Light: Light: Report on User Acceptance has been prepared as part of the
DELIVERABLE D.T1.3.1
WP T1 – Report on Joint evaluation of user acceptance
01/2019

ISBN: 978-3-947929-05-4
Dynamic Light: Report on User Acceptance

Every care has been taken to cite and credit the original authors, articles, research papers and other scientific works in the preparation of this document. This document has been produced for a Research project without any intentions of profit or monetary gain. This is for research and academic purposes only. In case of an oversight or mistake in crediting and citation, please bring it to the notice of the author for immediate action

Author: Dynamic Light Project, Lead Partner Hochschule Wismar, Prof. Dr. Thomas Römhild, Fakultät Gestaltung
thomas.roemhild@hs-wismar.de

DYNAMIC LIGHT

REPORT ON USER ACCEPTANCE

Report on Joint evaluation of user acceptance

Chapter – 1: Acceptance of public lighting

1.1. Definition of acceptance 02

1.2. Risks and barriers to acceptance 04

1.3 Drivers of acceptance 05

1.4 The Importance of Communication 05

1.5 Role of Healthy, Liveable & Sustainable Cities 06

Chapter – 2: Factors influencing acceptance of public lighting

2.1. Overview of the Scientific Studies 08

2.2. Summary of the studies 37

Chapter – 3: Public survey and studies

3.1 Demand Analysis- Sušice 38

3.2 Survey Results- Rostock 42

Chapter – 4: Summary of the Report

4.1 Participants and Stakeholders in Integrated Planning and Design 44

4.2 Integrated Planning Processes — Approaches 44

4.3 A Policy Science Framework on Social Acceptance 45

4.4 Conclusions 46

References

Chapter – 1: Acceptance of Public lighting

Users and stakeholders restructure the space according to their representations of it. The forms of appropriation and acceptance of urban development correspond largely to the very features of urbanism (that is, its nature and social coherence because people relate to it through their past experiences and accumulated knowledge). Taking these aspects into account it seems that a change in attitude on the part of professionals of urban development and planning is called for: they must necessarily take into account the usages of the inhabitants. This would enable them to see strictly the social impact of urban projects.

The gap between the lived space and the conceived space shed lights on "blind spot" in the operational view of institutional decision-makers that reflects their relative blindness to social organisation and the effects produced of their interventions on space.

Despite the increased recognition of the importance of public and community perceptions, relatively little research has been conducted on the topic. Much of the social research in the public lighting has focussed on planned or intended behaviour, rather than focussing on actual behaviour; community acceptance etc. the issue of social acceptance has remained largely neglected.

1.1 DEFINITION OF ACCEPTANCE

Acceptance is described as an agreeable demeanour towards a concept, position, individual, or group [1].

Instead of mere consent to an infrastructure project, a public lighting project requires active acceptance by the various stakeholders, whereby individual stakeholders become part of the design process. Acceptance may therefore be expressed in various forms: attitudes, behaviour and—most importantly—investments.

Acceptance is an often-used term in practical policy literature, but clear definitions are rarely given. According to Wüstenhagen, Wolsink and Bürer [73] there are three dimensions of social acceptance, namely

- socio-political,
- community and
- market acceptance

Factors influencing socio-political and community acceptance are increasingly recognized as being important for understanding the apparent contradictions between general public support for renewable energy innovation and the difficult realization of specific projects. The third dimension, market acceptance, has received less attention so far and provides opportunities for further research, particularly from management scholars.

Socio-Political acceptance

Socio-political acceptance is social acceptance on the broadest, most general level. Many of the barriers for achieving successful projects at the implementation level can be considered as a manifestation of lack of social acceptance. At the general level of socio-political acceptance this also concerns the acceptance by key stakeholders and policy actors of effective policies.

Those policies require the institutionalization of frameworks that effectively foster and enhance market and community acceptance, for example establishment of reliable financial procurement systems that create options for new investors, and spatial planning systems that stimulate collaborative decision making.

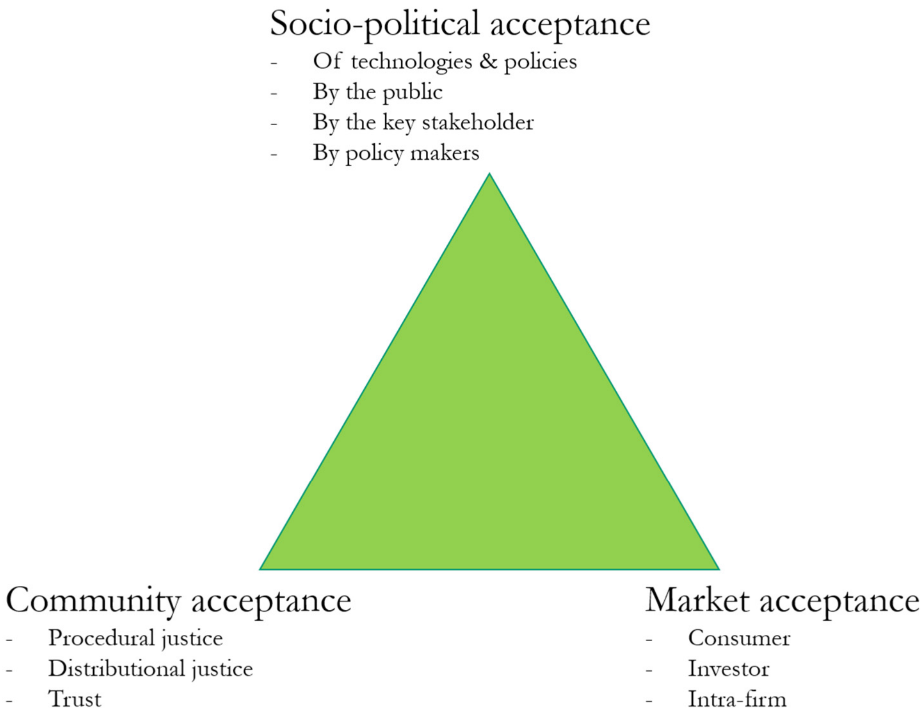


Fig.1.1: The aspects of social acceptance [58]

Community acceptance

Community acceptance refers to the specific acceptance of projects by local stakeholders, particularly residents and local authorities. A particular feature of community acceptance is that it has a time dimension. As Wolsink (2007) [55] in this issue demonstrates, the typical pattern of local acceptance before, during, and after a project follows a U-curve, going from high acceptance to (relatively) low acceptance during the siting phase (usually still positive on average) and back up to a higher level of acceptance once a project is up and running.

Market acceptance

Social acceptance can also be interpreted as market acceptance, or the process of market adoption of an innovation. In this perspective, we can learn from the literature on diffusion of innovation (Rogers, 1995) [56], which explains the adoption of innovative products by consumers through a communication process between individual adopters and their environment.

In a wider understanding of market acceptance, the focus is not just on consumers, but also on investors.

Last but not least, there is also an issue of intra-firm acceptance of sustainable strategies. Moreover, there is a link with socio-political acceptance, because these firms are influential stakeholders in the development of energy policies, and they can use their influence in the crucial political decisions about the design of financial procurement systems.

1.2 RISKS AND BARRIERS TO ACCEPTANCE

From literature eight broad themes emerge that shed a light on the barriers to acceptance of an urban design project:

a. Governance, regulations and guidelines
b. community acceptance and social impacts
c. skills & knowledge
d. public health
e. system evaluation, performance and monitoring
f. financial incentives
g. system operation & maintenance
h. sustainability and broader system impacts.

From the point of view of the community, a number of these themes are inter-related.

Not in My Background Phenomenon (NIMBY)

A colloquialism signifying one's opposition to the locating of something considered undesirable in one's neighbourhood.

The phrase "not in my backyard" has two distinct usages and categories of users. In some circumstances, it connotes the unwillingness of individuals to accept projects by corporations or governmental entities nearby, which might affect their quality of life and the value of their property.

The phrase is also used by social service and environmental justice advocates to imply an absence of social conscience expressed by a class-, race-, or disability-based opposition to the location of social-service facilities in neighbourhoods.

The NIMBY idea suggests that people have positive attitudes towards something (e.g. dynamic light) until they are actually confronted with it, at which point they oppose it for selfish reasons (O'Hare, 1977)[57].

1.3 DRIVERS OF ACCEPTANCE

Community acceptance and broad scale social support for public lighting strategies is fundamental, not only, for enhanced rate of implementation, but also, for aiding the growth of the community and social structure in complex urban environments.

There are a range of intrinsic benefits associated with public lighting projects, which make them attractive to the community such as; improved aesthetics; increased liveability and improved health of communities; adding a distinct character and identity to the area; sustainability; expression of heritage values; and more opportunities for the community to engage in public life.

Positive community attitude areas with active local environmental groups and a long history of civic environmentalism.

Success can be the result of a complex and sophisticated interplay between key champions and local contextual variables such as the rise of environmentalism, strategic external funding and the development of industry focused co-operative research schemes

Many communities reached their objectives through good design development, community and stakeholder consultation, project management and innovative public lighting system. Local governments, therefore, are in a prime position to involve local communities, which is important for understanding dynamic lighting strategies and a necessary driver of acceptance.

Economic drivers must also be considered.

There is now market demand for a new green aesthetic development

Healthy cities rely on healthy public lighting.

1.4 THE IMPORTANCE OF COMMUNICATION

Gaps between actual risk and perceptions of risk suggest the need for community education. It is evident that public understanding of dynamic lighting systems may be limited or inaccurate.

poor stakeholder engagement and management of community expectations are the main barriers to the successful implementation of dynamic lighting developments. Issues included a lack of familiarity, low awareness of operations.

Demonstration sites and utilising the media effectively to increase public awareness and reduce any

Scepticism for dynamic lighting.

Community engagement, transparency and two-way communication, creating a focus on light literacy amongst citizens.

1.5 ROLE OF HEALTHY, LIVEABLE & SUSTAINABLE CITIES

1.5.1 Institutional and Industry Issues

Despite rapid development of technology and infrastructure, change to dynamic public lighting strategies remains slow and cities continue to invest in conventional approaches to public lighting. There are a number of reasons for the inertia.

First, barriers arise from institutional arrangements. Authorities, local governments, government departments and private industries have evolved to deliver conventional public lighting solutions. Therefore, a re-evaluation of roles and responsibilities within organisations is needed to deliver innovative solutions.

A lack of co-ordination of policies, fragmented administrative frameworks, lack of trust, and inappropriate risk transfers between stakeholder organisations, impedes change. Further, conflict between design and authoritarian processes can hinder innovation and change and reinforce existing historical administrative, political and economic values.

Second, there is a general lack of information on the performance of dynamic lighting projects over their life cycle, which inhibits change to non-conventional approaches to public lighting.

This includes a lack of data on maintenance and operating costs and lack of knowledge about construction and maintenance practices. To help overcome this barrier knowledge about light quality and quantity monitoring, operation and maintenance requirements need to be published in the public domain, along with more pilot installations and research.

The third barrier to change is economic. Although sustainable public lighting is becoming more prominent, developers may still hold reservations due to perceived barriers such as increased cost.

1.5.2 Social and Design Theories Underpinning Community Acceptance of Dynamic Lighting Solutions

Two social theories that are able to provide an understanding for community acceptance of change to dynamic lighting systems are **place attachment theory** and **social capital theory**.

Both frameworks are not independent or competing, rather they are interconnected and can potentially be applied in unison as drivers of change. They provide the fullest explanation of acceptance in this context when applied in collaboration with relevant theories of urban design, such as green urbanism, so that the social and physical components are integrated into the overall shaping of a community.

1.5.3 Place attachment theory

Attachment to place refers to a dependence on or an emotional bond with biophysical aspects of the landscape; such as the natural resources or the recreational and open spaces that support social activities. There are a number of related terms used in the literature such as sense of place, place identity and place satisfaction (see Deutsch and Goulias, 2009)[60]. The strongest connection to place is reflected in the term place identity which refers to a state whereby behaviours and self-identity (their sense of themselves), or their collective group belonging, become equated with a particular locale through process, project and performance. Devine Wright and Howes (2010) [59] argue that interpreting attachment to a place is as much a social as a psychological process.

In a context of change, individuals adopt specific beliefs and attitudes contingent upon levels of trust which position them among influential groups or institutions (such as energy companies, government agencies or local opposition groups) which are actively seeking to influence ways of thinking (Devine Wright, 2010) [61].

Given that many dynamic lighting strategies define concepts such as a neighbourhood, place identity and attachment, they could be important drivers for the support for dynamic lighting systems especially where the dynamic lighting system improves the area through better light quality, ambience, safety etc. However, there are likely to be variations in the degree of attachment from just enjoying the pleasant ambiance to a strong personal identification. Such variations in attachment are likely to influence people's engagement and general support for dynamic public lighting schemes.

1.5.4 Social capital

Public lighting can be recognised as "common pool resources" either in the narrow sense that a

neighbourhood may share the maintenance and benefits of an installation or in the broader sense that the public lighting needs to be shared across the city. In the broadest sense the environment is a common pool resource for everyone on the planet.

Ostrom (1990) [62] argued that management of common pool resources is widespread and only becomes a problem when "participants may simply have no capacity to communicate with each other, no way to develop trust or no sense that they must share a common future" (1990 p21). Since Ostrom formed her argument, Putnam [Putnam (2000) [63]; Putnam, Leonardi, and Nanetti (1993) [64] has popularised the concept of social capital and the literature has grown exponentially (Halpern, 2005) [65]. The definitions of social capital are now many and varied but the common thread is social networks and the resources that can accrue from them (Rostila, 2010) [66].

The concepts of trust and a sense of shared resources are also common themes. (eg Putnam 2000 [63]; Leonard and Onyx, 2004) [67]. Thus, the issue of the management of common pool resources can be understood as only problematic in the absence of social capital.

There have been a number of studies that have identified a positive relationship between social capital and environmental action primarily in rural communities in developing countries (Adger, 2003[68]; Anderson, Locker, & Nugent, 2002 [69]; Pretty & Ward, 2001 [70]). In Australia, Onyx, Osburn, and Bullen (2004), found a strong relationship between social capital and concern for the environment in a remote mining town. Also, Morrison, Oczkowski, and Greig (2011) [71] found social capital was a better predictor of landholders' participation in environmental programs than psychological theories which focused on attitudes. Some of the most powerful evidence however comes from Portney and Berry (2010) [72] who examined 27 US cities using the Social Capital Benchmark Survey. They found that those cities most committed to pursuing sustainability policies did tend to be more participatory places with respect to signing petitions, participating in demonstrations, belonging to local reform groups, and joining neighbourhood associations, even controlling for personal income and other factors related to social capital.

Chapter – 2: Factors influencing acceptance of public lighting

This chapter summarises the findings from the various scientific studies on the topic of acceptance in public lighting. Factors influencing acceptance are established.

2.1 OVERVIEW OF STUDIES

All of the following material, photographs, tables and graphs have been sourced from the studies directly and have been assembled here for academic purposes only. Please refer to the individual studies for details.

2.1.1 Kungsholms Strand, Advanced Individual control of outdoor lighting, Stockholm Sweden [A]

The project was proposed at the Energy Agency and aimed to develop ways towards energy-efficient lighting. As a part of this proposal, technology for advanced control of outdoor lighting was intended to be tested and evaluated along a pedestrian and bicycle path in Stockholm (Kungsholms strand).

The experimental site was chosen along a stretch of 750 metres constituting of a total of 34 street

light poles housed with new LED fixtures and were installed with modern lighting control systems. Technical assessment (energy savings, reliability etc.) was aimed to be related as to how users perceive visual quality, safety and security in the space with these lights. The idea was to develop different management and control strategies for individual lighting control (per fixture), test and evaluate them.

The project is carried out in collaboration with Municipality of Stockholm city- Stockholms Stad (property owner), Fagerhult (lighting solutions), Tritech (control technology specialist), Sustainable Innovation – Sust (project management team) and the Lighting Laboratory from Kungliga Tekniska högskolan- KTH University.

PROJECT GOALS:

- A presence control system in combination with LED makes it possible to reduce energy consumption considerably by control of lighting levels. While there is a risk that controlling the environment in itself defeats the purpose of creating a secure and transparent environment, project will examine how governance should be designed so as not to jeopardize the safety of users comfort.
- Technology assessment (energy savings, reliability, etc.) will be related to how users perceive visual quality, safety and security.
- For the pilot project involving lighting control, the idea is to provide a saving potential between 40-60% of energy use, compared with the old traditional system (high- pressure sodium lamps). By installing an intelligent lighting control that reduces lighting levels at night, is estimated to reduce more than 30% for the remaining energy. All of this is aimed without compromising on the road users' perceived comfort. Such comparative analysis is carried out via interviews with the users in the space.
- The evaluation/outcome of the project will be used as a basis for opting among sustainable options for energy efficiency.

Fig.2.1: Kungsholms Strand, Satellite image.

- The evaluation will lead to strategies (possibly multiple) for illumination of the path that meets the balanced energy-efficiency, economy and comfort of road users (security, safety, visual quality). This would be done in two parts – by technical evaluation in terms of comparisons of energy consumption calculations and visual evaluation – by interviews from the people and processing their responses regarding vision, safety and security in the environment.

SITE ANAYLSIS:

The site is located at Kungsholms strand, Stockholm. Kungsholms strand is a street in the district of Kungsholmen in Stockholm. It stretches till Kungsholmen on the northern side, along Barnhus Bay and Karlberg Sea.

Stockholm Central is at a very close proximity to the site, and the installation stretch is in the central area of Stockholm. The site under analysis is a pathway along the water side for pedestrians and bicyclists. The length is marked with bold red colour in the (Fig 2.1) and (Fig 2.2). The major junctions are the intersections on the main road of St.Eriksgatan and that on the Kungsbronplan main road. The junctions are marked on the adjacent map with blue colour in the (Fig 2.2).

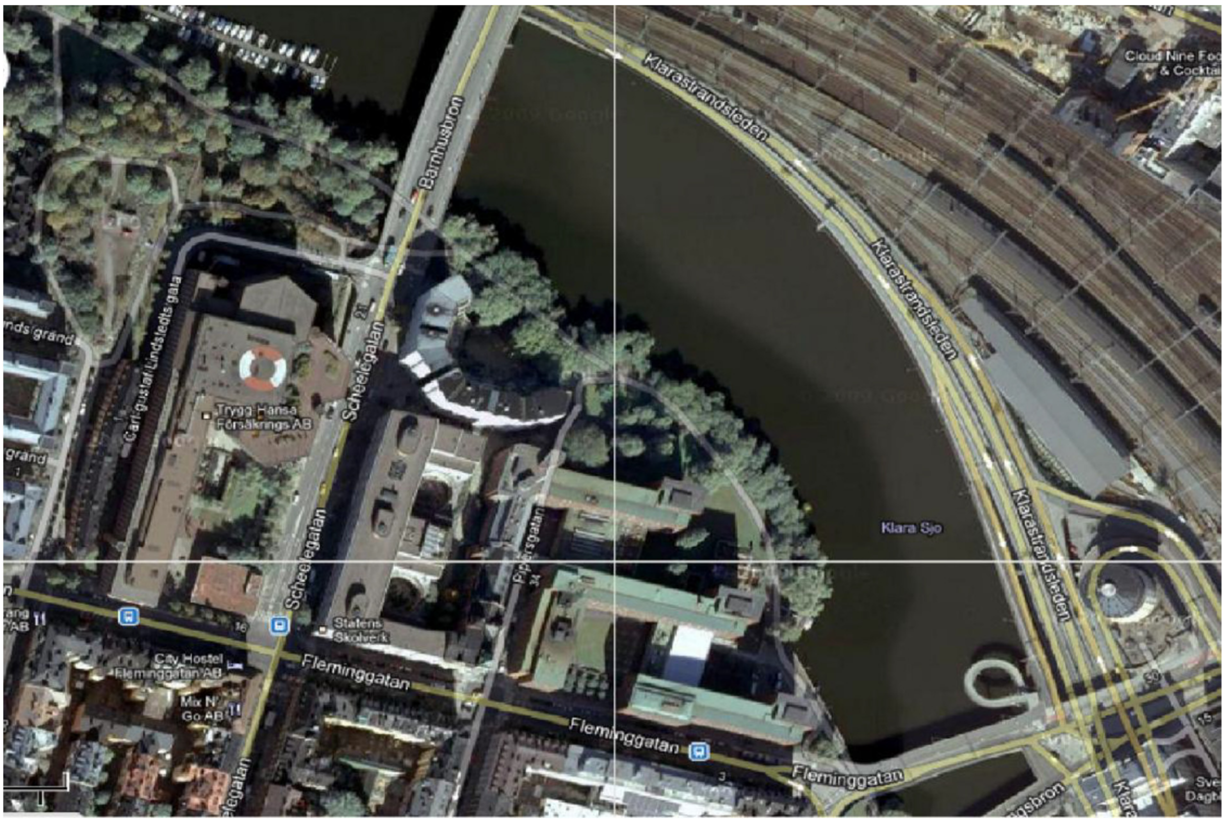


Fig.2.2: Kungsholms Strand, Installation stretch

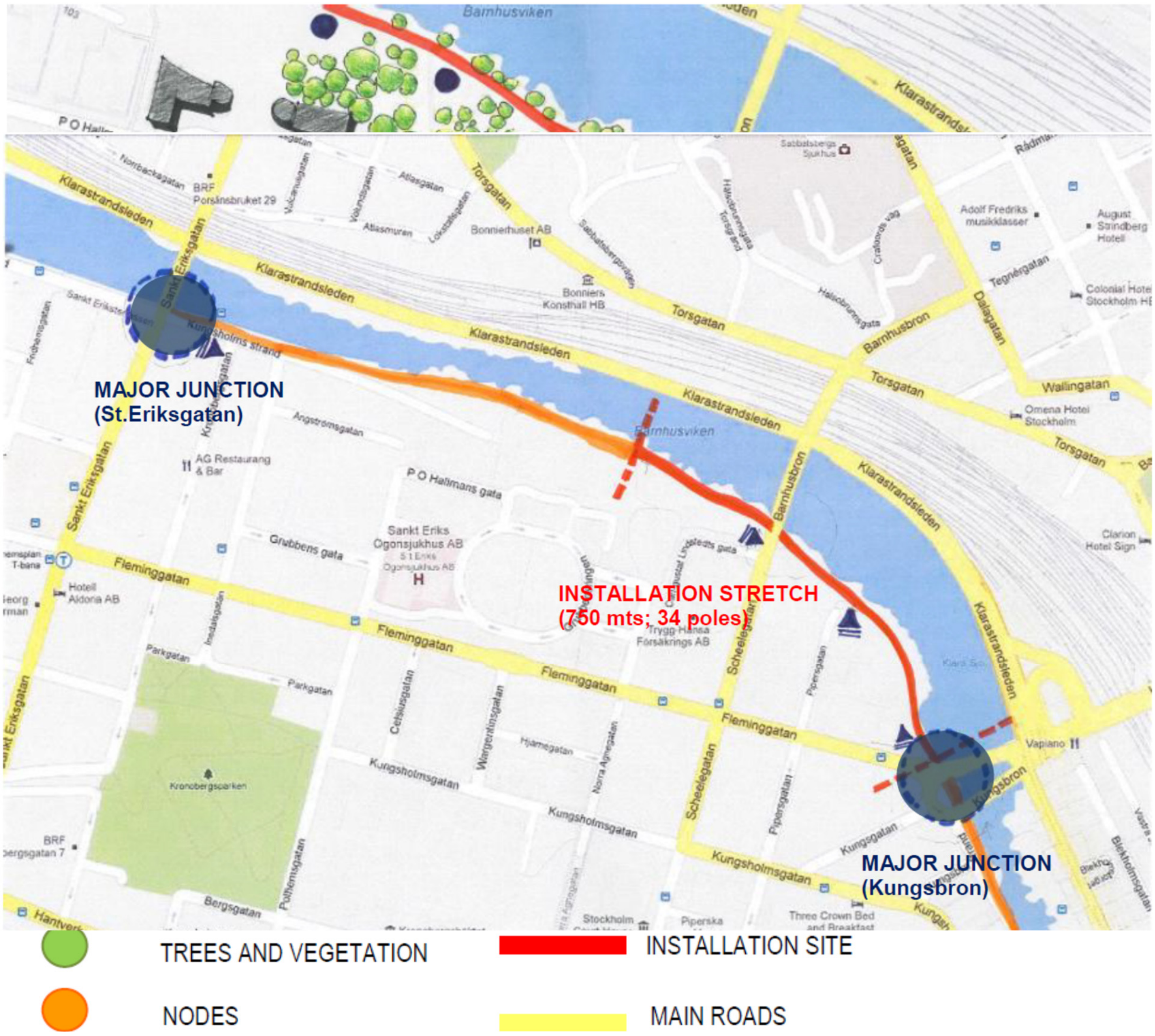


Fig.2.3: Kungsholms Strand, Site features

USERS:

Pedestrians and bicyclists are the broadly classified categories when based on the frequent type of users on the road. Otherwise, considering various activities, the users of the space are pedestrians, walkers, joggers, dog-walkers, bicyclists and parents with their babies in the prams. Mostly, the pathway is used as a link between the users' source and destination places. Mostly, the purpose of taking the route is:

a. Commute to/from work

b. Exercise in the form of jogging, brisk walking, taking the dog for a walk

c. Casual strolls, recreation and relaxation.

MOVEMENT & PEAK HOURS OF TRAFFIC:

The movement along the side is considered mostly linear, with clearly distinguished tracks for pedestrians and bicyclists. There is just one Y-junction along the installation, allowing people to divert their movement from the installation stretch when required.

The hours for the traffic observation are considered from the time of the lighting installation being turned on. Based on the observations at the site, the traffic is heavy from 18.00- 21.00, although it is comparatively much lesser on weekends. Friday evenings and nights were busier among the rest of the week. The traffic gradually reduces after 21.00 till midnight and is sparse after midnight.

GENERAL OBSERVATION- LIGHTING:

Apart from the light from the lighting installation, the other sources or lighting elements on the site were:

- Light reflections from the water body
- Light impression from the presence/absence of dense vegetation and tree foliage
- City lights visible on the other side of the Kungsholms strand
- Light from the public lighting from the overhead road, bridges
- Light from the surrounding buildings

TECHNICAL INFORMATION:

In the (Fig.2.4), the green dots broadly represent the installation poles with new LED light fixtures. A total number of 34 poles were installed with the new fixtures over a stretch of 750 metres.

Fig.2.4: Kungsholms Strand, New LED light fixtures

LUMINAIRE & SENSORS:

LED with 2000 Lumen output, with DALI control.

Fig.2.5: Luminaire, Sensor and Installation on the fixture

Coverage angle: 200 °, the sensor horizontally rotatable ± 90 °

Range: about 12 m at an installation height of 2.5 m

Range Adjustment: Mechanically through bending of the ball, max 80 °

Brightness: Approximately 2 to 1000 lux

Permissible ambient temperature: -25 ° C... +55 ° C

Protection: IP44 Protection class: II

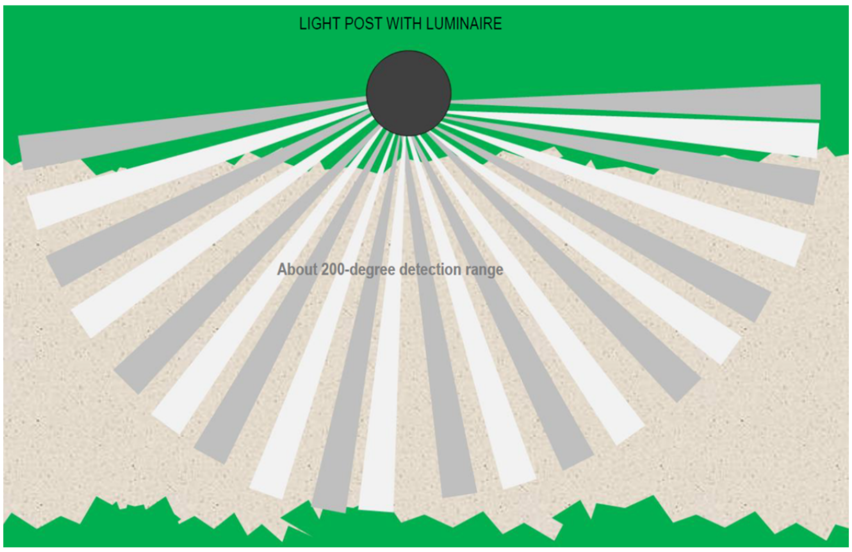
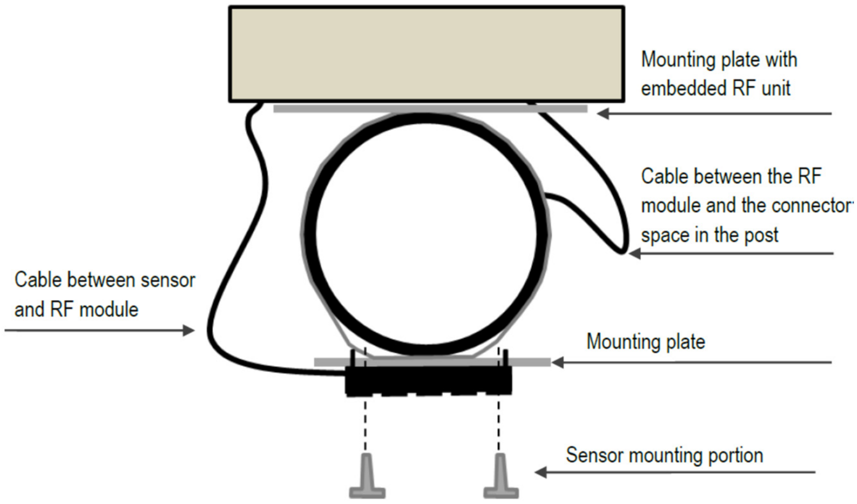


Fig.2.6: Detection range



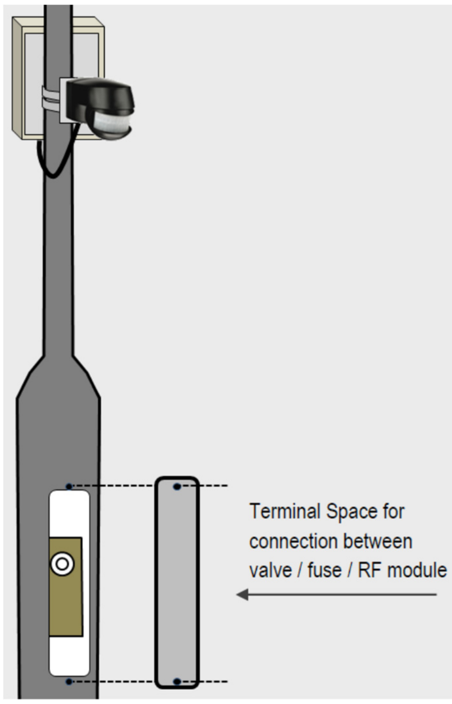


Fig.2.8: Installation detail

FUNCTIONING:

Each light point consists of the following:

- A luminaire with LED light source.
- A DALI controller
- A movement detector – (PIR) It detects the objects warmer that the surroundings and movement.
- A controller – The controller is a Meshnet radio unit from Tritech consisting of the following parts-
    1. A DALI Master – that communicates with the DALI controller.
    2. A short distance radio – that communicates with the other luminaires (light masts) and with a master node. Each radio nose has an identity (serial number) so that it can be addressed. The radio uses 869 MHz.
    3. Control Logic – It controls the installation.

WORKING PRINCIPLE:

During the night the entire installation is dimmed down. If a light mast detects the presence of a person (movement detector), it increases the light intensity and also send a radio message to a specified number of light masts in its proximity. Each of the other light masts receives the radio message but only responds if it contains its ID, accordingly that light masts increases in light intensity. The light mast stays in the state of high light intensity for a pre-set time interval before returning to lower light intensity state.

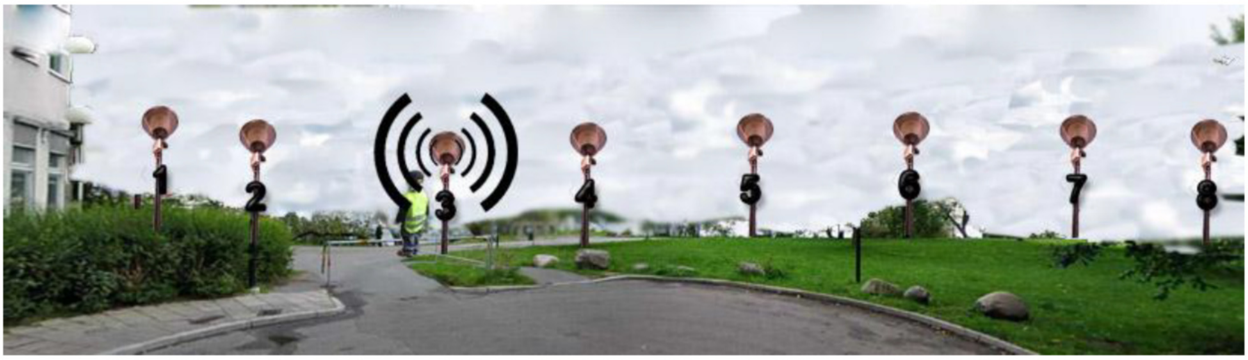


Fig.2.9: Working example

EXAMPLE:

Numbers in figure 2.9 indicate the addresses of each lightning pole.

- A person is moving close to pole 3. The PIR activates and sends a message to the control unit.
- The control unit sends a radio message saying: "Please light up pole #2, #3, and #4" (itself and the closest neighbours).
- This radio message is received by all poles (#1 - #8). Pole #1 and #5 - #8 finds that message is not for them and does nothing.
- Pole #2 - #4 finds that message is for them and lights up the pole for a preset amount of time (typically from 60 or 120 seconds). Note that pole #3, the one transmitting the message, also receives its own transmission and reacts to it.
- Each pole that detects the radio message will re-transmit it again – but only once. This extends the radio range area.
- If the person moves closer to pole #2 – it will do a similar transmission saying "Please light up pole #1, #2 (own), and #3".
- After a certain amount of time, the pole will return to low power again. This timer is restarted every time the pole receives a radio message to light up to high power.

VISUAL EVALUATION

USER RESPONSES: A questionnaire was formulated in order to gather responses from people. In total, 105 people were questioned, 41 female and 64 male, though the percentage of men using the stretch was comparatively high. The pathway was actively used during the stipulated time of the survey (20.30hrs- 23.30 hrs).

TEST AIMS:

Five scenarios were designed to be implemented over a period of 5 weeks. The idea behind the formulation of scenarios was to test the extent of the possibilities with lighting control systems; ranging from the most basic scenario (with no presence control system and maximum power level of 10) to the extreme scenario with lighting control and short timer settings- both with maximum power level of 10 and lower power levels of 8.The aim was to test how far could we go with the scenarios to save energy and compare which could be useful for the design of options for the future scenarios. The following section gives a brief idea about each of the scenarios:

Scenario #0 - All poles on at maximum level 10 with no lighting control operation.

Scenario #1 - All poles on at maximum level 10 (except for end 3 poles at level 7) with 120 seconds timer settings.

Scenario #2 - All poles on at maximum level 8 (except for end 3 poles at level 7) with 120 seconds timer settings.

Scenario #3 - 7 poles (3+1+3) on at maximum level 10 with 120 seconds timer settings. This scenario was designed specifically with respect to the movement of the user in the space, and the light following him/her. In scenario # 3 and scenario #4, only 7 poles out of the whole 34 poles were programmed to control from highest to lowest light level by presence control system depending on the position of the user, although all the poles are installed with the sensors. Hence (3+1+3) indicates three poles before the current position of the user+ current pole + three poles after the current position of the user.

Scenario #4 - 7 poles (3+1+3) on at maximum level 10 with 60 seconds timer settings. This scenario also was designed specifically with respect to the movement of the user in the space, and the light following him/her, but with much shorter timer settings in order to test the extreme limits for experimentation with the lighting control system.

Here is the summary:

Scenario	Low Power Level	High Power Level	Number of Masts	Timer settings (Sec)
#0	100%	100%	All	No
#1	50% (70% for first 3)	100%	All	120
#2	50% (70% for first 3)	80%	All	120
#3	50% (70% for first 3)	100%	7 (3+1+3)	120
#4	50% (70% for first 3)	100%	7 (3+1+3)	60

QUESTIONNAIRES:

As part of the project evaluation, a standard questionnaire was formulated keeping in mind criteria needed for evaluation of each of the scenarios. The questions concentrated on human vision, safety and perception and included range of ages, genders and the mode of transport by the users to provide comparisons in relation to the lighting situation.

The questionnaire can be found in the Appendix.

COMPARATIVE ANALYSIS:

COMPARISONS REGARDING THE SAFETY AMONG DIFFERENT SCENARIOS

From the tests the following results were derived:

- Concerning the overall safety, the scenarios can be arranged starting from the safest to the least safe scenario as follows:

SCENARIO#2 > SCENARIO #3 > SCENARIO #4 > SCENARIO #1 > SCENARIO #0

Decreasing level of safeness

- Concerning 'Safety versus Age-group' the scenarios can be arranged starting from the safest to the least safe scenario as follows:

SCENARIO# 3 □ SCENARIO #2 > SCENARIO #4 > SCENARIO #1 > SCENARIO #0

Decreasing level of safeness

- Concerning 'Safety versus Gender', the scenarios can be arranged starting from the safest to the least safe scenario as follows:

SCENARIO#3 > SCENARIO #2 > SCENARIO #4 > SCENARIO #1 > SCENARIO #0

Decreasing level of safeness

- The overall feeling of safety in all the aspects based on gender and age-group, the scenarios can be arranged starting from the safest to the least safe scenario as follows::

SCENARIO#3 > SCENARIO #2 > SCENARIO #4 > SCENARIO #1 > SCENARIO #0

Decreasing level of safeness

COMPARISONS AMONG ALL SCENARIOS (summing up all the aspects)

The table below shows the results from scenario #0 to scenario #4 and rated on a scale of 1 to 5, in order to choose the best scenario among all five of them.

SCENARIO	USER RESPONSES			ENERGY VALUES	RESULT
	SAFETY	*VISUAL COMFORT*	*PERCEPTION*	ENERGY CONSUMPTION *(Based on the average values for the common days)*	
#0	1	1	1	1	**4**
#1	2	4	5	2	**13**
#2	5	5	3	3	**16**
#3	4	3	4	4	**15**
#4	3	2	2	5	**12**

In the table above, the scenarios have been numbered by the order of preference, i.e. 5 indicating the most preferred and 1 indicating the least preferred situation. Hence the scenario which has the maximum total value in the result section is the most preferred scenario and the one with the least sum value is the least preferred scenario.

RESULTS

- Studying all the data and the comparative analysis table in the previous section, scenario #2 proves to be the most favourable among them followed closely by scenario #3.
- Scenario #0, which is a stable lighting situation without any active lighting control system, is the least preferable scenario.
- If the scenarios are to be arranged in order of preference based on both visual and technical evaluation, the order would be as follows :

SCENARIO #0 > SCENARIO #4 > SCENARIO #1 > SCENARIO #3 > SCENARIO #2

Increasing order of preference

CONCLUSIONS:

Thorough study and evaluation of the project led to the discovery of a lot of interesting aspects. These aspects include observations and analysis of the situation, suggestions and areas of improvement for further development in this field. These aspects are summarized according to the chronological order of the report as below:

1. SAFETY:

- Men, generally felt safer than women in the environment. However, majority of both men and women who felt unsafe in the space admitted that their perception of safety is irrespective of the lighting but more associated with the presence or absence of people. According to them, isolated places without people feel more unsafe. Area/locality and time of the day also make a difference in the perception of safety.
- Cultural background of the people also is an interesting factor which changes the perception of safety noticeably.
- The youngest age group (under 20 years) are the most vulnerable lot when it comes to safety, whereas majority of the oldest generation (above 60 years) feel secure in the environment.
- Few of the people associate safety with light levels. Brighter spaces make people feel safer, but this might be subjected to psychological conditioning of the mind.
- The people comprising of 20-40 and 40-60 age group have mixed responses regarding the feeling of safety in the space, although majority of them expressed to feel completely safe in the space.

2. VISUAL COMFORTABILITY:

- General conception of the people regarding the quality of light is positive. They find it good and comfortable.
- The satisfaction levels of older age groups (above 60 years and 40-60 years) are much higher than that of the youngest and middle aged groups (under 20 and 20-40 years).

3. GENERAL FEELING AND PERCEPTION OF THE SPACE:

- On the whole, based on the evaluation, people were positive about the atmosphere and the lighting situation. The only suggestion, as discussed above, was to improve the aesthetics of the space along the water side with some decorative light or lighting effects along with functional public

4. SITE CONTEXTUAL DISCUSSION:

Surroundings certainly have a vital effect on the perception of the users regarding safety and human vision in the space. The following points are of relevance in terms of the site and context which provides useful information regarding the lighting situation:

- The dark and dense foliage in the surroundings affected the human field of vision and gave the space a closed kind of impression making the people feel more vulnerable of any attack. Since the dark colour of the leaves didn't reflect much light and obstructed the view to look beyond the trees, the people felt more anxious and unsecure. This phenomenon was even prominent where the road stretch was narrow and at a closer proximity to the trees due to the lack of good, spread surrounding light compared to the road stretch where it was broader and catches more light, broadening the field of vision, thus creating an impression of safe environment.

- The colour of the leaves on the trees changed the picture of the place. The light coloured yellow leaves on the trees during late autumn reflected a good amount of light, making it appear much brighter although the light levels were much lower or the same than before. The same effect was observed on the cloudy days, where the clouds reflected light, making the sky look brighter and hence affecting the perception of brightness in the space.
- It must be kept in mind that the lighting situation on the site was not independent and isolated but was affected by the surrounding light from the other light sources, viz., the reflections from the water, the street lighting across the water body, light from the neighbouring buildings etc. This might have affected the responses from the users. This is supported by the fact that about 80% of the people didn't notice the changed lighting along the road, though most of them used the path regularly. Had the site been a lighting situation in an isolated place without any interference of external light, the people might have noticed it. Hence, the location of the site (isolated or in a bigger lit environment) affects the perception of the lighting in a sub-conscious way.
- Lighting of the vertical surfaces is equally important as the lighting on the horizontal surface of the road.

Responses and suggestions from people:

Summary of the comments

1. Lighting levels and distribution – Though the overall reaction to the lighting situation was good like in the previous cases, but two of them distinctly pointed out the problem with their point of view. Both of them suggested that the distance between two adjacent poles were not uniform everywhere, especially the poles closer to the Tekniska Namndhuset building are placed far apart giving an impression of low light levels than required. Some of them responded that the lights look 'bright and powerful' whereas one of them liked the place with dimmed light levels when there were no people walking around, avoiding unnecessary light for the residents living around. Another user expressed that during last few days, he subconsciously sensed some change in the ambience of the place and thought it was much better and brighter, although the idea of any change in the light fixtures didn't occur to him. Another person said that the transition from the low to high light levels and vice versa was gradual and was not clearly noticeable, hence making it visually comfortable.

2. Safety – Similar to the previous cases, it was only the women who expressed any comments about the safety in the place. Two of them agreed that it feels very safe in the place during the busy hours, but the situation could be completely different when there were no people in the place. There was a slight doubt in their minds about the feeling of safety during late hours. There was only one person till now among all the scenarios, who didn't like the idea of changing light levels at all was a woman in her late twenties.She admitted that it was so because she is a girl and feels extremely vulnerable. On the contrary, another woman said that it feels completely safe to walk along the stretch with the presence control systems, even if it was late in the night.

3. Overall atmosphere and feelings – Feeling good in the space was now an obvious answer although one elderly man was very content with the lighting.

4. General – The general public seem to embrace the idea of energy saving with lighting control system very positively; one of them suggested that it was a good initiative towards preventing light pollution too. The participants who had participated in the earlier scenarios also mentioned that they didn't find any difference among the scenarios and find it good. A lighting design student felt that this scenario works better with the idea of lesser timer settings, as it is probably more efficient in terms of energy without compromising on the users comfort.

2.1.2 Subjective evaluation of luminance distribution for intelligent outdoor lighting. [B]

V Viliūnas, PhD, H Vaitkevičius, HabilDr, R Stanikūnas, PhD, P Vitta, PhD, R Bliumas, PhD, A Auškalnytė, BSc, A Tuzikas, MSc, A Petrulis, BSc, L Dabašinskas, BSc, and A Žukauskas, HabilDr; Institute of Applied Research, Vilnius University, Vilnius, Lithuania & Department of General Psychology, Vilnius University, Vilnius, Lithuania

Commonly, two types of criteria are used to evaluate outdoor lighting quality. The objective criteria are based on statistical data of accidents and the subjective criteria are based on psychophysical data from laboratory or real-situation conditions. The objective criteria are the crime rate and traffic accident rate.

Researchers have investigated discrete parameters that might be affected by lighting characteristics such as perceived brightness [15], preference [16], visual acuity [17], feeling of safety [5,17], reaction-time [10,18–20], visual field [21], colour identification [22–24] and recognition threshold and small target visibility [25]. In practice, the application of such a large number of parameters to the subjective evaluation of the lighting quality of intelligently controlled installations poses a difficult problem [26–29]

This study aims at establishing the main subjective factors for the assessment of the luminance distribution of an intelligent light-emitting diode-based outdoor lighting installation for pedestrians. A psychophysical method based on questionnaires was applied. The subjective impressions were identified using the semantic-differential (SD) scale [30,31] and the Likert scale [32].

Methodology

The experiment was carried out within an intelligent LED-based outdoor lighting installation in a moderately urbanised pinewood area of the Vilnius University campus (Figure 1). Six lamp posts were illuminating a section of a street, the distance between the posts was 30 m.

Fig.2.10: Lighting installation at Vilnius University campus

Each luminaire consisted of 66 high-power white phosphor conversion LEDs (Cree model XR-E) with a correlated colour temperature of 3060K and colour-rendering index of 82. The rated photopic luminous flux of each lamp was 7180 lm.

Using a microcontroller-based control system operated by power line communication, the light sources were individually dimmed in order to simulate different lighting patterns. Each lamp was operated either at the full rated flux (100%), or dimmed to 50%, 10% or 0% (switched off) of the rated flux.

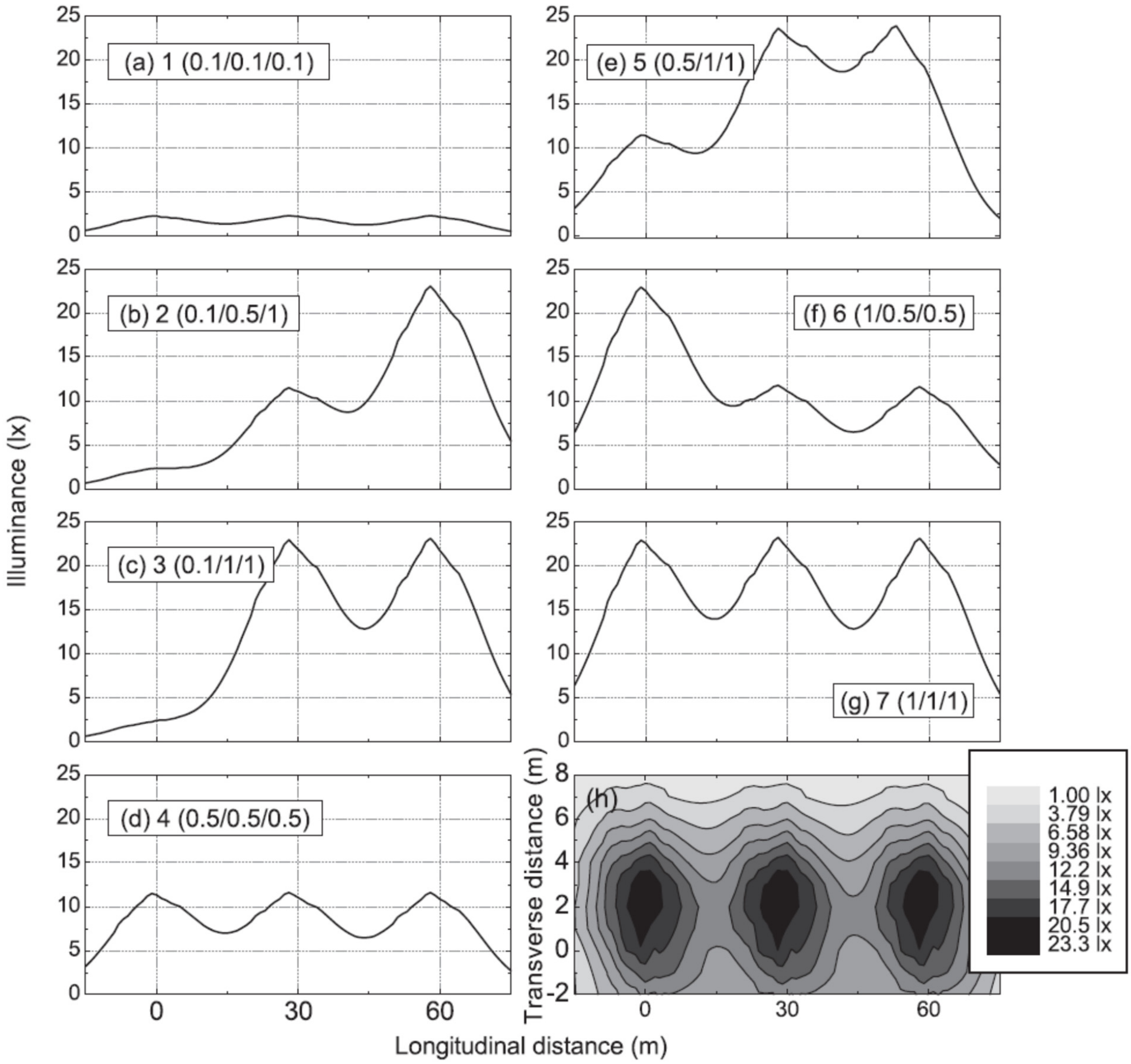


Fig.2.11: (a)–(g) Distribution of horizontal illuminance along the centre line of the street for the seven lighting patterns used in experiment and (h) the two-dimensional distribution of horizontal illuminance for pattern 7Lighting installation at Vilnius University campus

Figure 2.11 shows the distribution of horizontal illuminance along the centre line of the street. The notation ‘0.1/0.5/1’, for example, corresponds to a pattern with the light output of the light sources in the first, second and third luminaires from the subject of 10%, 50% and 100%, respectively.

Tests:

The experiment was carried out after dark and during the experiment, the street section was kept empty. A subject was standing under the first lamp post and was viewing along the street in the direction of the other posts. The subjects were not acquainted with the geographical environment. The presentation order of the light patterns for each subject was randomised.

SD scaling: The following set of SD items (polar opposite adjectives) was used:

1) Pleasant/unpleasant

2) Far/near

3) Dim/bright

4) Stimulating/suppressing

5) Valuable/cheap

6) Uneven/even

7) Calming/scary

8) Frightening/encouraging

9) Ugly/nice

10) Dangerous/safe

11) Wide/narrow

12) Exposing/hiding

Each subject received the SD scales printed in a random, spatially and temporally balanced order.

Likert scaling: The Likert scale was used for the verification of the results of the SD scaling.

Five groups of statements (refuge, prospect, safety, escape and mask) were used and each group consisted of three statements. The mean score from the preliminary experiment (across seven experimental conditions) of these three items was used in the analysis.

Item	Statement	Group
1	There are plenty of places where criminals can lurk on this street.	Refuge
2	To see stars is most important to me when walking on the street	Mask
3	It is easy to see even the smallest objects on this street	Prospect
4	I feel that even after playing tricks on this street, I would not be caught	Escape
5	I wouldn't choose to go home alone through this street	Safety

6	Streets lit in this way will only increase the number of vandals	Escape
7	I feel safe on this street	Safety
8	Street lighting will never be the same as in pictures	Mask
9	I wouldn't like to drive a car on the street lit in this way	Prospect
10	I could easily escape from an attacker on this street	Escape
11	Such unusual street lighting annoys me	Prospect
12	If needed I could easily romp throughout this street completely unnoticed	Refuge
13	In fact, I never pay attention to the street lighting	Mask
14	I love it that this street is surrounded by the darkness of the night	Refuge
15	I think one could be easily assaulted on this street	Safety

RESULTS & CONCLUSIONS:

The results are in agreement with the study of Haans and de Kort [46], where the first experiment showed that stationary pedestrians prefer having light in their own immediate surroundings over light on the more distant parts of the road and the second experiment revealed that participants valued least the lighting distribution in which their immediate surroundings were poorly lit (i.e. the dark spot condition).

The results reveal two factors that need to be considered when assessing intelligent outdoor lighting installations: a major factor that is related to the **subjective feeling of well-being** and a minor factor that is related to the **physical properties of the environment**.

The major factor 'well-being' on SD and Likert scaling was found to account for 63% and 66% of the total information about the responses to items, respectively.

2.1.3 Dynamic pedestrian lighting: Effects on walking speed, legibility and environmental perception. [C]

E Pedersen PhD and M Johansson PhD, Faculty of Technology LTH, Department of Architecture and Built Environment, Lund University, Sweden

Dynamic LED lighting technology offers new opportunities to design energy-efficient installations that provide high-quality lighting for pedestrians based on variation in demand over time, typically controlled by the presence or absence of people. Still it is unclear how dynamic lighting will affect pedestrians.

Generally, lighting level acceptability and perceived safety seem to decrease with decreased overall illuminance when lighting levels are medium or low [38].

Studies that specifically have addressed the effects on pedestrians of dimming and increasing illuminance controlled by motion-detection sensors indicate that perceived social safety and visual comfort also depend on qualities of the ambient light [39,40] and the light distribution on the pathway [41,42].

These studies discuss pedestrian lighting in relation to the perceived environmental quality and perceived social safety of the pedestrian environment rather than the users' experience of the light per se, and none of them considers the effect of the dimming of the light as such. Moreover, these studies primarily rely on self-reports, limiting the conclusions that can be drawn regarding potential effects on pedestrians [43,44]

The aim of this study is to describe human response to dimming while walking. The study explores the effects of dimmed lighting that increases in illuminance with pedestrian proximity on walking in terms of walking time, legibility in terms of reading performance, perceived lighting quality and visibility, and evaluative appraisal of increased illuminance.

The objective was to disentangle the effects of the dimming per se from other context-dependent effects of the lighting.

METHOD:

The study took place in a full-scale laboratory at the Department of Architecture and Built Environment, Lund University. The pathway was 19m long and 2.5m wide. Two lamp masts with luminaires were placed 1.5m (luminaire I) and 17.5m (luminaire II) from the start of the pathway and 0.30m from the right edge.

The system consisted of a control unit, two Passive Infrared (PIR) motion-detection sensors, and two energy meters (for the luminaire and control system). Motion detection sensor A (for returning the illuminance to 100%) was placed 7.5m after the starting point, i.e. 10m before the far-end luminaire (luminaire II). Motion-detection sensor B (used to stop the timer) was placed 19.0m after the starting point, i.e. 1.5m after luminaire II.

A standardized DALI protocol was used for the dimming. The luminaire was set to 100% illuminance, or to three dimming alternatives: approximately 60% of maximum illuminance), approximately 40% of maximum illuminance or approximately 20% of maximum illuminance. The illuminance distribution in the lab differed between the four conditions as seen in (Figure XX).

PARTICIPANTS:

In total, 61 persons participated: 33 in the 20–35-year age group (mean 23 years, SD 2.9 years; 18 females and 15 males) and 28 in 60–75-year age group (mean 69 years, SD 7.7 years; 15 females and 13 males). The session lasted for approximately 2 hours.

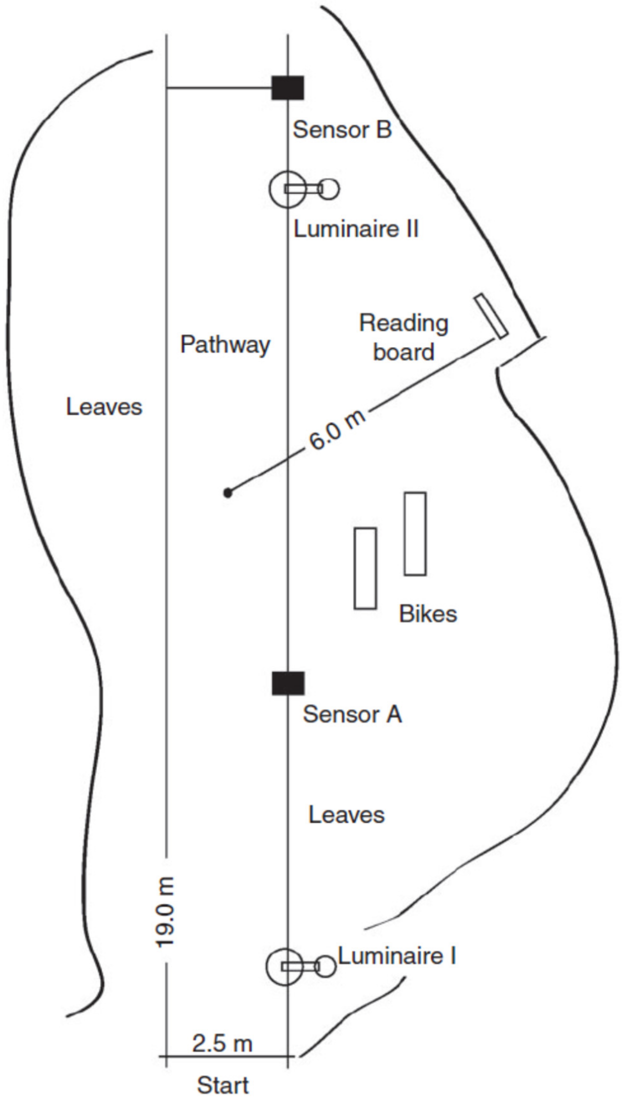


Fig.2.12: The laboratory setting

Fig.2.13: Pathway and luminaire II in the laboratory

Scene	Predicted lighting level (%)	Horizontal illuminance (lx)	Relative illuminance (%)	Luminaire Power (W)	Relative Power (%)	Power control system (W)
1	100	84.8	100	36.8	100.0	3.65
2	60	51.4	60	23.6	64.2	3.65
3	40	35.5	42.4	17.6	47.7	3.65
4	20	18.7	22.4	11.3	30.6	3.65

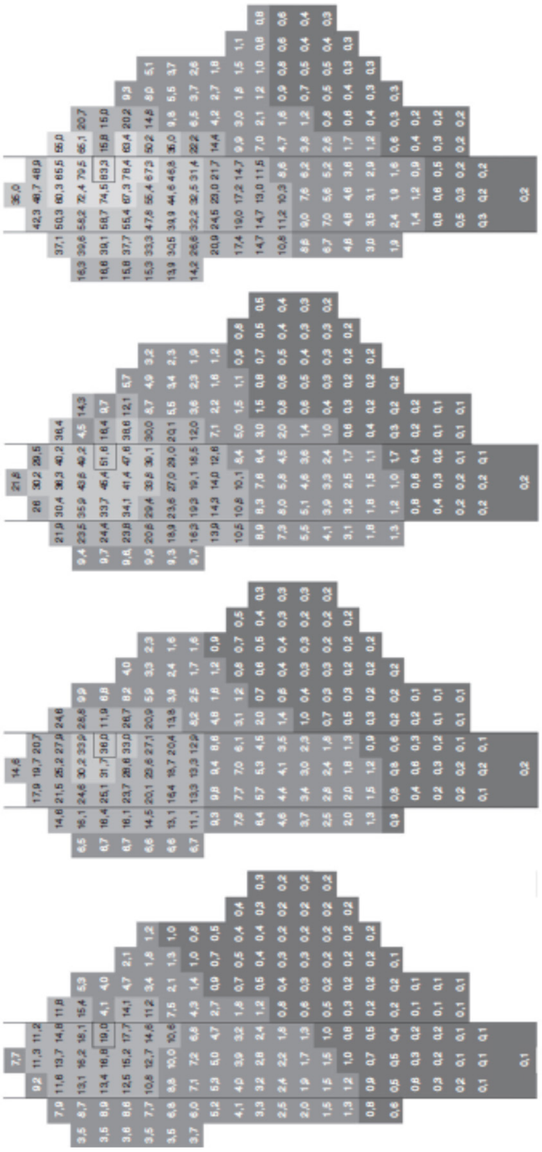


Fig.2.14: Illuminance (lx) distribution on the ground, on the pathway, and in the surroundings measured in a 1x1 m grid; left to right: 20%, 40%, 60% and 100% condition

MEASUREMENTS & PROCEDURE

Walking was electronically measured as walking time in seconds (s). Legibility was measured as correctly read number of optotypes (0–5). Perceived lighting quality during the walk was measured as brightness ('dark' to 'bright') and comfort ('pleasant' to 'unpleasant'; reversed in the analyses). Perceived visibility of the pathway and surroundings was measured as ranging from 'very good' to 'very bad' (reversed in the analyses). Evaluative appraisal of the change in illuminance from dimmed condition to full light was measured as perceived reaction ('not at all' to 'strong'), environmental appraisal ('pleasant' to 'unpleasant'), and affective appraisal ('positive' to 'negative'). All scales were seven-point semantic differentials.

In the first part of the experiment, one participant at a time walked along the pathway. In the second part of the experiment, the participant stood in the middle of the pathway, 6m in front of the luminaire, and looked towards a board placed 6m away, perpendicular to the participant's line of sight.

RESULTS:

Walking: On average, it took the participants longer (m¼14.67–14.92 s) to walk the pathway if the lighting was dimmed, even though light levels increased to 100% when they passed sensor. The dimming affected the walking time both from the start to the first motion detection sensor (A) and from this sensor to the end of the pathway (motion-detection sensor B).

Legibility: The average number of correctly read optotypes under dimmed conditions varied significantly with the dimming level.

Perceived lighting quality and visibility during the walk: The light was perceived as brighter the less the dimming. There was no difference in how pleasant the lighting was perceived between the three dimming conditions regardless of the presentation order. However, the dimmed conditions were perceived as significantly more pleasant than the first undimmed condition.

DISCUSSIONS:

The results indicate that dimming affects pedestrians' walking time; the larger differences between the dimmed lighting levels and the full lighting, the longer walking time. The effect was seen both before and after the increase to full light. A reasonable explanation is that participants hesitated at the start of the pathway due to the relative darkness, and this also seems to have affected walking time after the light increase.

It may also be that the actual moment when the illuminance increased surprised the participants, so that they did not increase their walking speed as much as expected.

The increased walking time under dimmed conditions is contrary to the finding of Donker et al.40 who, in a field study, found that pedestrians walked faster along dark than well-lit pathways. These walks were carried out in different urban places and the result was interpreted as an effect of increased fear in relatively darker places. The present study was conducted in a controlled indoor laboratory environment using exactly the same setting for all lighting conditions. It is therefore unlikely that the feelings of fear said to be caused by other environmental characteristics would interact with the studied perceptions.

The result of the legibility test indicates that the actual change in illuminance is of little importance for the ability to read. There was no difference in legibility between lighting conditions during the seconds when the light was increasing or immediately afterwards, regardless of the original level of illuminance.

The results of the present study imply that planners and lighting designers must balance the reduced energy use obtained by dimming with the walking conditions provided by artificial outdoor lighting of the urban environment, also taking account of different age groups.

2.1.4 Individual factors influencing the assessment of the outdoor lighting of an urban footpath [D]

M Johansson DSc[a], M Rosèn MSc[b] and R Küller DSc[a] [a]Environmental Psychology, Department of Architecture and Built Environment Lund University, Sweden [b]SWECO, Traffic Planning, Örebro, Sweden

There is a continuing interaction between people and their physical environment, where properties of the environment, such as lighting, may impede or support certain behaviours [47]. This interaction is mediated by characteristics of the individual person such as perceptions, attitudes and personality [48]. One and the same environment may therefore affect people differently. This implies that environmental design should be evaluated not only according to objective criteria but also according to peoples' perceptions.

This study investigates the perceived sufficiency of one lighting installation among groups that are extra sensitive to the lighting conditions. The study looks into the relationship between personality and the perceptions of outdoor lighting on the one hand, and the perceived danger and visual accessibility of an urban footpath on the other hand.

The aim is to investigate the relationship between the individual's level of environmental trust and subjective perceptions of the artificial lighting along an urban footpath on one hand, and the perceived visual accessibility and danger on the other hand. Three groups that are likely to be extra sensitive to the qualities of the urban environment were investigated namely: people with a reduced visual field, elderly people and young women.

METHOD:

The sample included 81 people divided into three groups: visually impaired people, elderly people and young women. The study was located on a traffic-separated foot and cycle path in the town of Orebro (129 000 inhabitants) in Sweden. The investigated section of the footpath is 170m long and connects the city centre with residential areas The path has a cemetery and a car park on one side, and a nursery school and a park on the other side. The width of the footpath is 2.5 m. The path has an asphalt surface and is separated from the adjacent grass by means of paving stones. It is elevated from the cycleway, and the path and the cycleway are separated by curb stones. The lighting consists of one row of 6m high poles placed every 30 m. The studied distance includes 7 poles.

	Visually impaired	Elderly	Young women	Total sample
N	25	33	23	81
Response rate to the invitation to participate (%)	60	45	n/a	n/a
Gender				
Women (*N*)	15	15	23	53
Men (*N*)	10	18	–	28
Age (years)				
Range	26–83	65–91	20–27	20–91
Mean age	55	76	23	54
Remaining visual field				
Mean (%)	20	100	100	60

Fig.2.15: Description of the three groups of participants. A section of the investigated footpath

RESULTS & DISCUSSIONS:

The results of the present study suggest that the perceptions of the lighting should be addressed in order to provide visually impaired people, the elderly and young women with good opportunities to participate in the urban environment after dark.

The feeling that one is able to walk out in the neighbourhood is important to people's health and well-being [47]. The perception of safety further constitutes a basic prerequisite for people to choose to walk and cycle [48].

Although exterior lighting consumes energy, the total negative environmental impact would be reduced if improved lighting could support people in substituting short car trips by walking and cycling [49].

Most of the elderly and the young women reported sufficient visual accessibility. It was however inadequate for the group of visually impaired people. The majority of the participants in this group reported that they did not see signs, could not see obstacles on the ground or recognise faces. For this group the lighting failed to support very basic functions of outdoor lighting.

The participating women in general, assessed the path as more dangerous than did the men. This gender difference has also been identified in previous studies [50,51,52]

In the analyses of perceived visual accessibility, the extent of the visual field was the major contributor, followed by environmental trust, and the perceived brightness of the lighting.

This means that the perception of the lighting as unpleasant, unnatural and monotonous was most important to the perceived danger of the footpath. Indeed, previous research suggests that the perceptions of the lighting as comfortable and pleasant are important qualities of outdoor lighting.

Wang and Taylor [53] found an inverted U-shaped relationship, where people's fear increased as they walked further into the path but decreased as they approached the end of the path. This might imply that lighting quantity and quality are more important for certain parts of footpaths, for example, where the distance to safe zones is the greatest.

This study shows that designers ought to be aware of the influence of individual characteristics including the subjective light qualities brightness and hedonic tone, and in trust in the physical environment when setting the standards of exterior lighting. People's responses to the external lighting in different groups need to be considered in parallel for perceived visual accessibility and danger.

2.1.5 Stakeholder perception of the intangible value of a public lighting solution in an ecological zone. [E]

E. den Ouden[1], J. Keijzers[2], A. Szóstek[3], & E. de Vries[4]

1 Industrial Design, Eindhoven University of Technology, Intelligent Lighting Institute, Eindhoven, The Netherlands 2 Fontys University of Applied Sciences, Eindhoven, The Netherlands 3Interdisciplinary Center for Applied Cognitive Studies, School of Social Sciences and Humanities, Warsaw, Poland 4 THE LUX LAB Lighting Design, Eindhoven, The Netherlands

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 colour and intensity) at different times to accommodate different stakeholders.

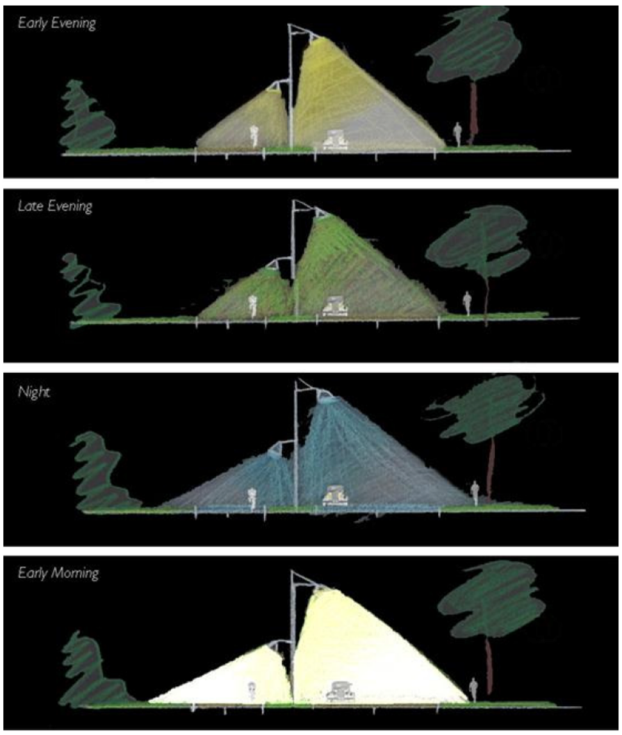


Fig.2.15: Design sketches for the lighting scenarios (THE LUX LAB, 2010)

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 colour 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 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.

METHOD:

A demonstrator and was created 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).

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 neighbourhood, 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

RESULTS:

A total of 602 answers were used for the analysis. Among the participants 283 were male (47%) and 391 females (53%). The majority (60%) rode a bicycle daily. Among those, 13.5% of people rode a bicycle daily after dark.

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. Participants riding bicycles more frequently (once a month, once a week and daily) showed strong preferences.

The results gathered during the 7 workshop sessions are summarized in Table below:

	Police	Supplier	Environmental organisation	Users	Municipality
Ecology	4	3	1	3	2
Social safety	1	2	2	2	1
Energy efficiency	6	4	3	1	6
Atmosphere	2	1	4	4	3
Promotional value	5	6	5	5	5
Purchase & maintenance costs	3	5	6	6	4

Table showing the overview of the ranking of key parameters

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 colour perception; does car and urban lighting in the surroundings change the atmosphere?

CONCLUSIONS:

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.

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.

2.1.6 Light distribution in dynamic street lighting : two experimental studies on its effects on perceived safety, prospect, concealment, and escape. [F]

Haans, A.; de Kort, Y.A.W. Journal of Environmental Psychology, TU Eindhoven

https://pure.tue.nl/en/publications/light-distribution-in-dynamic-street-lighting--two-experimental-studies-on-its-effects-on-perceived-safety-prospect-concealment-and-escape(b84b48ba-6677-4860-836e-eede5bc7ecf4).html

The researchers posed the question of how much lighting pedestrians need to feel safe and how it should be distributed. To test this, two experiments were carried out to investigate the effects of different lighting distributions on perceived safety. The assessment was done based on the appraisal of three safety-related cues – prospect, escape and refuge/ concealment.

The study was carried out in on a 150 meter long street in the campus of Eindhoven University of Technology. All the participants were students and were familiar with the surroundings and considered it fairly safe.

The experiment was divided into 1) Stationary and 2) mobile assessment of three lighting distributions (refer Fig.2.17 below)

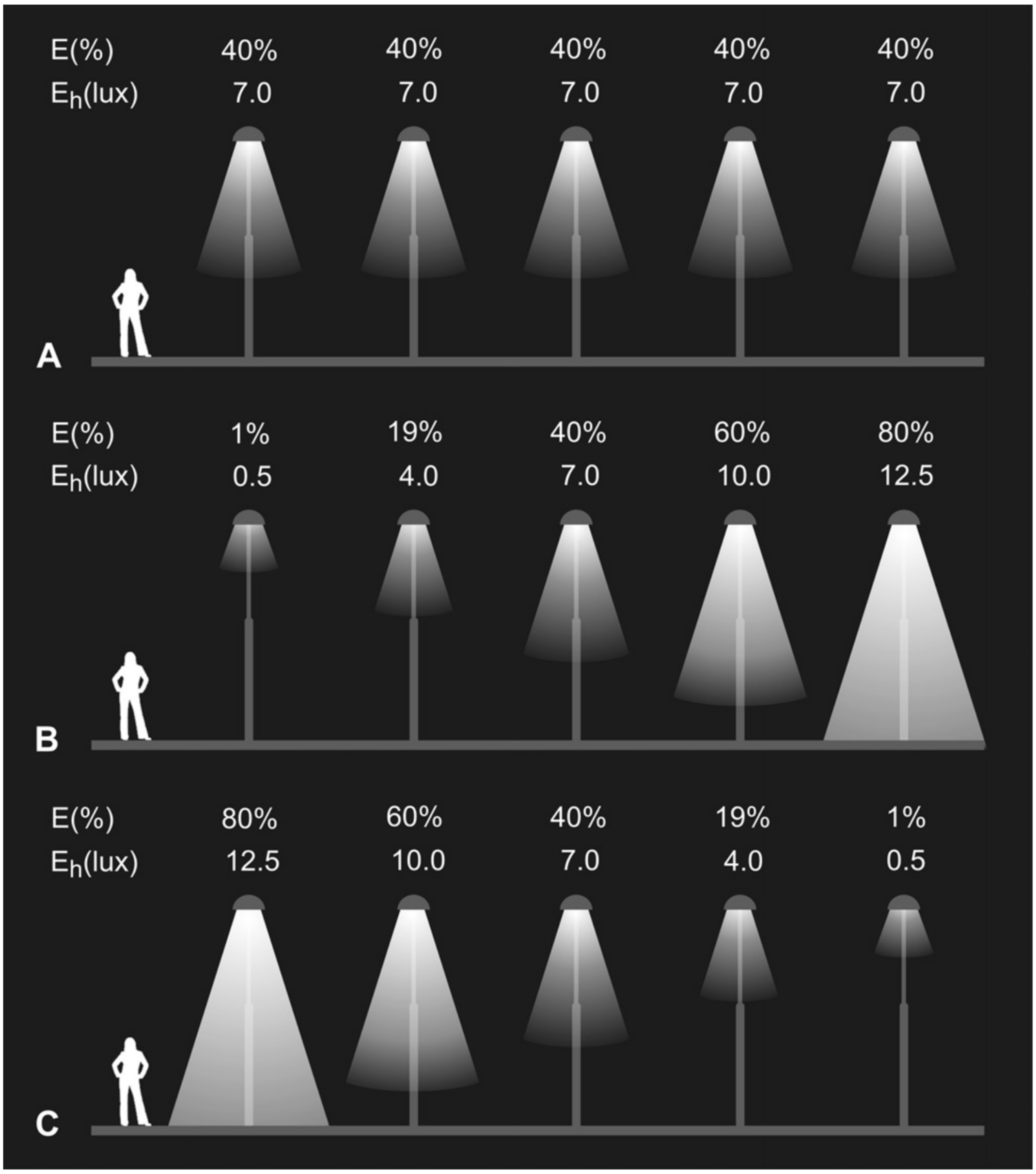


Fig.2.17: The conventional (A), ascending (B), and descending light distribution (C) in Experiment 1. E(%) is the percentage of the maximum output of a luminaire. Eh(lux) is the horizontal illuminance at street level straight underneath the lamppost. [14]

<u>Effect of light distribution on perceived safety:</u>

The results from this study demonstrate that, with respect to their perceived personal safety, the participants preferred to have more light in their own immediate surroundings, even if this meant a reduction in the illumination of the more distant parts of the road. The researchers hence concluded that illuminating pedestrians' immediate surroundings is more important than illuminating the road that lies ahead. [14]

Light distribution, proximate cues, and perceived safety:

- Prospect and escape were rated highest, and concealment lowest with the lighting distribution that was deemed most safe (i.e., the descending distribution).
- High prospect and high escape were positively related to perceived personal safety, high concealment was found to be negatively related to perceived safety.
- Results also confirm that the effect of light distribution on perceived safety is mediated by changes in people's appraisals of prospect, escape, and concealment.
- In general, offering more light in the participants' immediate surroundings, and thus less light on the more distant parts of the road, increased their appraisal of escape, but reduced concealment.
- Prospect increased when we offered more light in the participant's immediate surroundings.
- Strangely, participants indicated to have a better overview over what was happening in the street when they had less light in the distance, and thus more light in their immediate surroundings.

General Findings

- Pedestrians prefer having light in their own immediate surroundings over light on the more distant parts of the road.
- The effect of light distribution on perceived personal safety could be explained, at least partially, by changes in people's appraisals of the safety-related street characteristics prospect, escape, and concealment.
- People take additional cues into account beside prospect, concealment, and escape.
- A relatively high sense of safety was associated with high prospect and escape, but low concealment.
- Prospect was found to be the most important predictor for people's perceived personal safety.

Limitations and need for further research

- The test site as a relatively safe place and familiar to the test subjects.
- Position on the street was determined by pressing a button on a portable radio link each time passing a lamppost. By doing so, assigning a notion of control over the street lighting to the participants, which might have affected their safety perceptions.
- The street lighting adapted only to the participant, but not to an occasional other user of the test site.

2.1.7 Resolving the conflict of reduced street lighting: Two ways to increase the acceptability of reduced street lighting. [G]

Christine Boomsma, University of Groningen, Master's thesis Research Master Human Behaviour in Social Contexts, July 2009

This research proposed two routes to increase the acceptability of reduced lighting policies based on the costs and benefits related to these policies. Studies were conducted among students at the University of Groningen and employees at the municipality of Heerenveen. Both routes were confirmed. Firstly, acceptability increased when lighting levels did not threaten perceived safety. As hypothesized, lighting level had most impact on acceptability when entrapment was low. Contrary to the expectations, this effect was not found for perceived safety. Secondly, information on the environmental impact of street lighting increased acceptability of low lighting and in turn perceived safety. Surprisingly, providing information was only effective in increasing safety for females. Furthermore, the influence of information depended on values, but less than expected.

The lighting level would only be accepted when the lighting level does not pose a threat to perceived social safety. Both studies confirmed this route; perceived social safety fully (Study 1) or partly (Study 2) mediated the relationship between lighting level and acceptability of lighting levels. An increase in lighting level led to an increase in perceived social safety, which in turn led to an increase in acceptability of lighting levels.

It was expected that an increase in lighting levels would only lead to an increase in perceived social safety when entrapment was low (Hypothesis 2). Entrapment proved to be an important factor in influencing feelings of safety and acceptability of lighting levels. Low entrapment levels were perceived as safer and more acceptable. And in a low entrapment setting high lighting levels were perceived as too much, indicating that a low entrapment setting offers opportunities to reduce lighting. These findings are consistent with previous research on the impact of physical features on perceived social safety. Studies by Fisher and Nasar (1992) [74] have shown that lighting is not the only factor influencing perceived social safety, other elements in the physical surrounding, notably entrapment, play a crucial part.

Gender also proved to be an important factor with respect to perceived social safety and acceptability of lighting levels. In both studies females perceived the same situation as less safe than males, replicating findings from previous research (Blöbaum & Hunecke 2005 [75]; Loewen et al., 1993 [76]). Study 2 also indicated that overall males evaluated lighting levels as more acceptable compared to females (Hypothesis 3). We also found that females on average preferred a higher lighting level where they still felt safe and that they still found acceptable, compared to males.

Providing information on the detrimental effects of street lighting on the environment was expected to positively influence acceptability of lighting level, which in turn would influence perceived social safety. Both studies confirmed that acceptability of lighting level mediates the relationship between information and perceived social safety (Hypothesis 5). Moreover, individuals evaluated lower lighting levels as more acceptable when information was provided compared to when no information was provided. And higher lighting levels were evaluated as less acceptable when information was provided, compared to the condition where no information was provided.

Individuals with strong altruistic and biospheric values chose a lower minimal acceptable lighting level when information was provided compared to the condition where no information was provided. Previous research has shown that strong altruistic and biospheric values are generally positively related to pro-environmental beliefs and behaviour (Nilsson, Von Borgstede, & Biel, 2004; Nordlund & Garvill, 2002 [78]; Steg et al., 2005 [77]; Stern, 2000 [79]), but altruistic and biospheric values were expected to offer a unique contribution to the explanation of acceptability of lighting level in the current research.

2.2 SUMMARY

Acceptability of public lighting policies can be conceptualised as an attitude: a positive or negative evaluations of the policy. An attitude is based on weighting the costs and benefits of a particular concept. Improvement of environmental quality is a positive aspect of public lighting. However, a negative aspect of reduced light levels, cost cutting, negligence and new technology may reduce the acceptability of public lighting. Consequently, there are two ways by which acceptability public lighting policies can be increased - By reducing the negative aspect of the lighting policies and subsequently increasing perceived benefits. Or by stressing the positive aspects of public lighting policies, in particular positive effects on environmental quality, reduced costs etc.

For policy makers it is interesting to note that increasing the lighting level above the current norm of street lighting in an urban setting does not lead to any major changes in perceived social safety. Also, acceptability of lighting level does notably increase at lighting levels higher than one step below the norm, in some cases it even decreased. Increasing the lighting level above the norm is not necessary with respect to feelings of safety and acceptability.

To prevent a decrease in perceived social safety and rejection of the lighting level when lighting levels are reduced, policy makers should take physical features and individual characteristics into account. Providing information on the detrimental impact of street lighting on the environment can increase the acceptability of low lighting settings

Chapter – 3: Public survey and studies

3.1 SUŠICE

3.1.1 Overview

Following demand analysis focuses on users' lighting demand according to their civic needs in town of Sušice in the Czech Republic. The demand analysis aims to find out the extent to which the users accept energetically efficient dynamic lighting appliances and what needs to be adapted to increase their acceptance.

Park "Santos", located near the city centre by the riverside, has been selected as a pilot area. In total 36 poles were placed in two supply sites (see the red and the red/blue lines).

GPS: 49°13'34.6"N 13°30'57.4"E

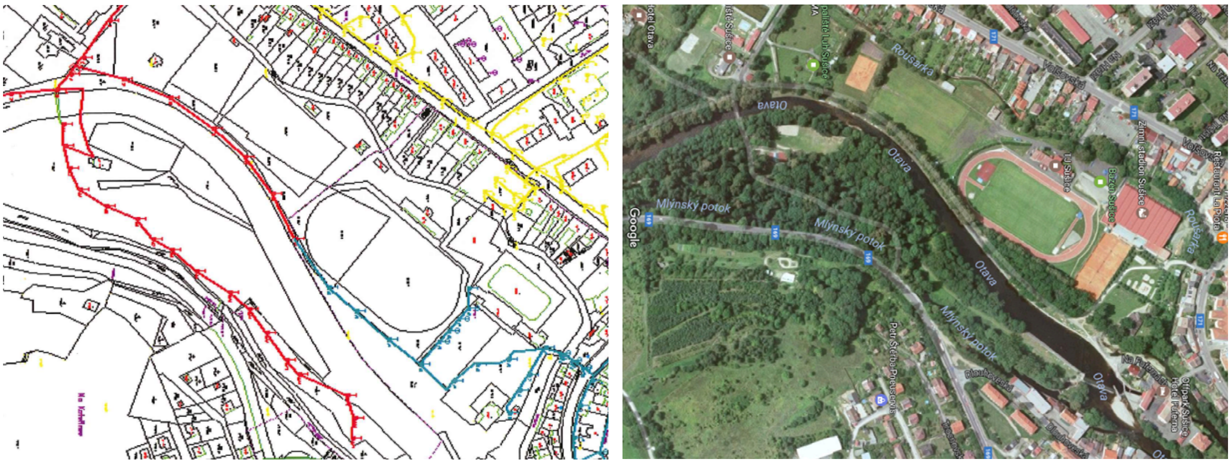


Fig. 3.1: Park Santos, the supply site, town of Sušice

An urban forest park was founded on the island of Santos before the First World War and later became the centre of social life in Sušice during the First Republic. After the war, its deterioration started due to the lack of maintenance, yet it remained a popular place for recreation. In 2013, it was partially renovated and became a sought-after area for relaxation and leisure activities. In addition, it acts as an important link for both, the pedestrians and the cyclists, connecting two parts of the city with the historic centre.

The area consists of several buildings (grounds) built right within the park in the previous century (mainly its latest 5 decades), all of which form an entertainment complex for sport and leisure activities. There is a public swimming pool, an athletic stadium, an indoor stadium, tennis courts, a hotel and a restaurant.

3.1.2 Field survey

To figure out the issues related to acceptance, knowledge and awareness about dynamic lighting strategies, as well as problems, needs, expectations and requirements different stakeholders have from public lighting, the following methods were used:

- Questionnaires aimed at the users
    - Investigations of the level of awareness, the knowledge and acceptance of dynamic lighting control systems for public lighting.
    - Investigations of the site-specific problems, the needs and expectations from different users of a specific pilot site.
- Questionnaire aimed at the municipalities

Investigations of the level of awareness, knowledge and acceptance of dynamic lighting control system for public lighting and its utility.

Field observations to investigate the use of the park during the year (Number of users, Time of use, Frequency, Activities as a function of time).

Conducted during the spring 2017. In total 7 tracked days, 5 working days, Saturday and Sunday.

In both questionnaires, the designed questions were measurable and comparable. For the same reason, the questions had a yes/no form or were very short, open-ended questions. The controlled interviews were conducted to fill in the questionnaire and to ensure proper completion of all the relevant questions/information.

Altogether 29 questionnaires have been collected (two from municipal representatives, two from restaurants and 25 from the residents visiting park Santos). All the data were collected during the spring 2017.

Gender:	
Male:	16 (64%)
Female:	9 (36%)
Age:	
0-14	1 (male 1, female 0), 4%
15-64	23 (male 14, female 9), 92%
65+	1 (male 1, female 0), 4%

The core findings on acceptance, knowledge and awareness about dynamic lighting strategies of the residents are summarized in the following chapter.

3.1.3 Findings

The overall impression of the residents about the quality of illumination in the pilot area is satisfactory. The senior population who were completely satisfied with the current lighting situation usually visit the park only during the daytime (more than 40 % of park users are not using it during the night-time). Only 24 % of the respondents are unhappy with the quality of public lighting.

At the same time, the residents have low expectation of public lighting quality. In most cases, they are happy that public lighting provides certain level of illumination (poor), no matter the quality and side effects.

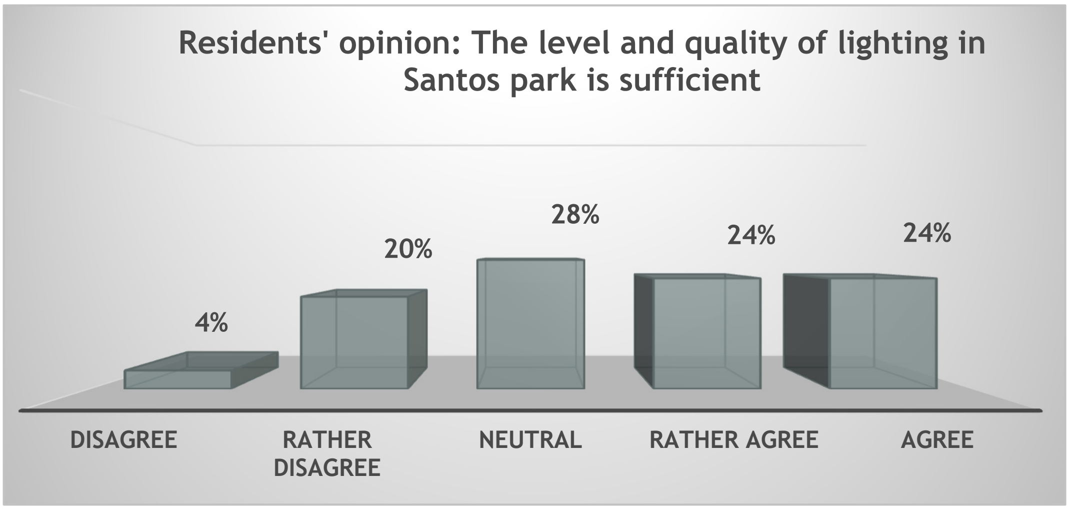


Fig. 3.2, Town of Sušice, Residents' opinion on the quality of public lighting

According to the results of the survey conducted in Santos Park, 60% of the respondents are not aware about the dynamic control of public lighting. 24% answered that they are somewhat aware, which in general meant that they have only heard something about it, in certain cases they mistook the term for something else. The conclusion is that only 1 out of 6 respondents is aware about dynamic control of public lighting (see figure below).

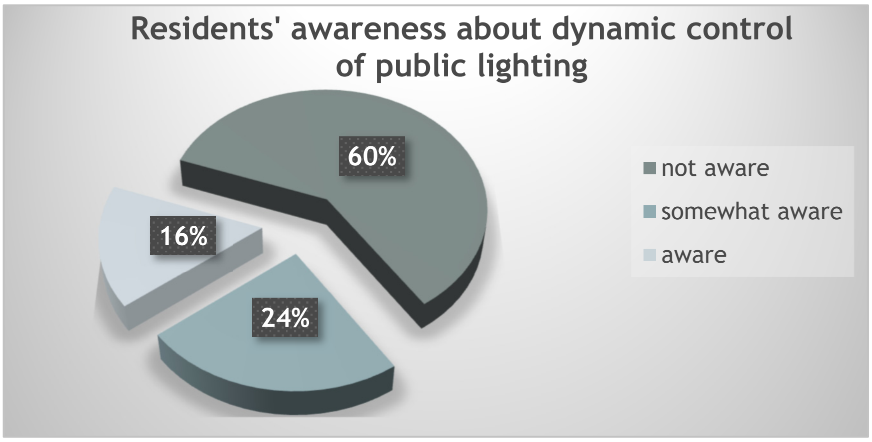


Fig. 3.3, Town of Sušice, Citizens' awareness

Few questions regarding residents' opinion about changes in public lighting were asked at the end of the survey to find out whether they consider the overall improvements to be positive or not. The respondents were divided in the following groups, those who are satisfied with current situation and are neutral to any changes (24%), those who are satisfied but agree or rather agree with improvements (52%), and those who are not satisfied and welcome changes (24%).

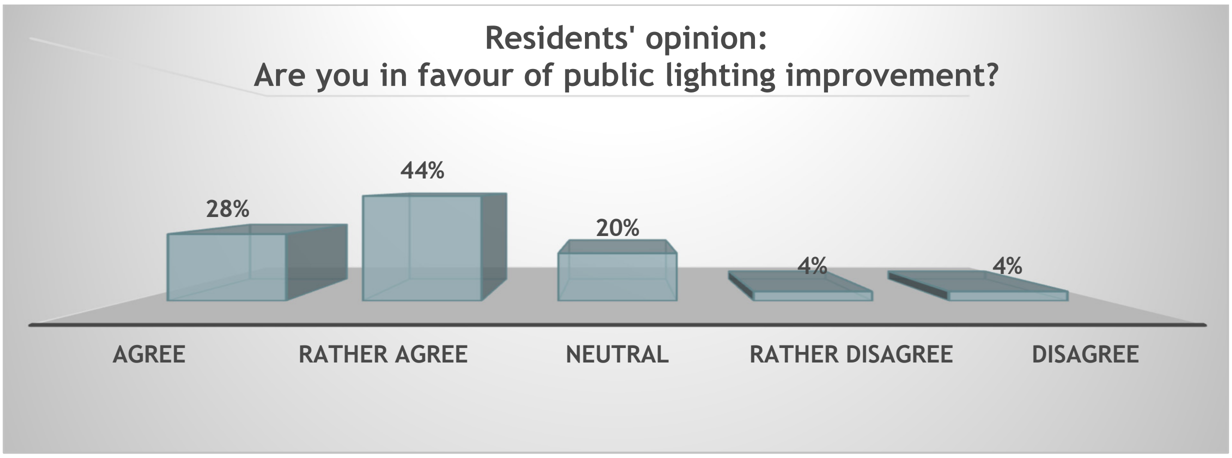


Fig. 3.4, Town of Sušice, Residents' opinion about public lighting improvements

The figure above showed that more than 70 per cent of the respondents are in favour of public lighting improvement. On the contrary, only 8 per cent of the respondents do not wish to improve the public lighting.

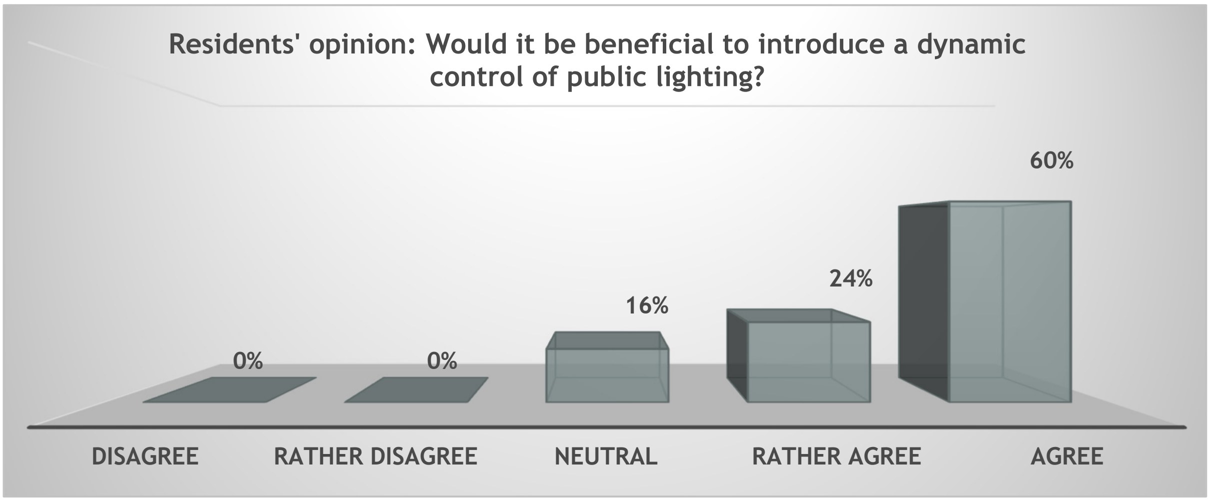


Fig. 3.5, Town of Sušice, Residents' opinion about dynamic control of public lighting

According to 84 per cent of the residents, it would be beneficial to have the dynamic system in place as the light levels could be adjusted from higher to lower or vice versa, taking in consideration factors like time of the day, frequency of use, weather conditions etc.

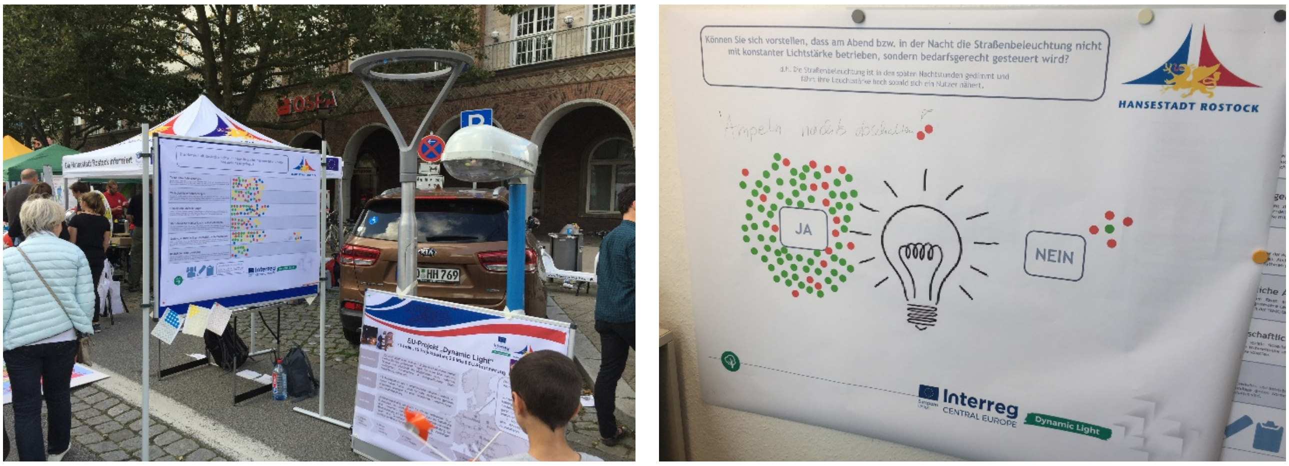
At this stage it is important to state, that 60 per cent of the respondents have never heard of dynamic control before and thus the benefits were explained to them to image it's benefits.

3.2 ROSTOCK

The Hanseatic city of Rostock is developing a holistic lighting concept for the city, which will include dynamic lighting applications. To involve the citizens as the main stakeholders into the development process, different surveys were used.

3.2.1 Public Survey on Climate Day

As a part of the climate action day in Rostock, the project "Dynamic Light" was presented and the opinion on the future lighting concept was asked. The visitors also had the chance to share their opinion by placing coloured stickers at two posters.



1. ***Figure 1:*** *Public survey on climate action day in Rostock*

The first poster was devoted to ecological, environmental, safety- related and regulatory topics. All these items were then connected to the issue of creating a new public lighting concept. The majority of the participants considered the environment as a most important aspect for a new lighting system of the city. 38 citizens posted their sticker here and showed that taking care about animals and humans has high priority.

The second poster was devoted to dynamic lighting for the city. In this case, 82 citizens of Rostock would prefer to dim the public lighting during the night. Just 5 citizens were against it, while 2 were not sure about this item.

3.2.3 Questionnaire

Technically it is not needed to have a constant lighting throughout the night. In hours with low frequency of use the light levels and brightness could be reduced, e.g. with the aim to save energy or to reduce light pollution. In connection with the development of al lighting concept it is important to involve especially the citizens. To get a more detailed collective opinion, a questionnaire for assessing acceptance for dynamic lighting was used.

The questionnaire asked for the evaluation of acceptance of dynamic lighting strategies. 80 citizens of the city of Rostock participated in the survey. About 70 % of the respondents have an idea about dynamic lighting. Nevertheless, the majority of them want more information about the topic and some best-practice examples for a demonstration of the technics. The change of light is for nearly all of the respondents acceptable, due to several advantages like reducing energy consumption, lower light pollution, improved light conditions as well as better atmosphere and ambience at night. The main advantages are seen in the reduced energy consumption as well as the improved orientation and way finding.

Opinions on adjustment of brightness level are divided. Although, 70% feel no or only a slight difference between the brightness levels, only 50% of respondents are agree with a frequent change at night depending on the type and number of users. The survey shows that too less brightness promotes a sense of insecurity, especially among woman, regardless of their age group.

More than 60 % of the respondents think that it will be advantageous in future to a system which can independently adjust the lighting level dependent on various influencing factors, such as time, frequency of use or the weather.

With the investigations of usage based illumination of park paths, foot and cycle tracks as well as the exemplification of the test implementation and the pilot action, the city of Rostock refer to the citizens' issues.

Chapter – 4: Summary

The assessment of outdoor lighting quality is based on the measurement of physical parameters, evaluation of human visual perception aspects and influence of lighting on the environment [9-11]

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 public lighting 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 [54].

4.1 PARTICIPANTS AND STAKEHOLDERS IN INTEGRATED PLANNING AND DESIGN

A strategic planning process should aim to generate visionary and long-term results. This definition calls for sustainable development of urban settlements which includes a specified degree of flexibility for local and future adaptation.

Engineering and planning disciplines, including transportation, energy supply, water and waste management, as well as environmental assessment need to be integrated into one holistic approach for resource-efficient and climate-sensitive neighbourhood planning.

Two main groups of planning process stakeholders can be identified by analysing influences on urban development:

.. The stakeholders affected by the process result, e. g. target groups, investors, administration.

.. The stakeholders who are process actors, e. g. the planning disciplines, investors, and responsible administration.

Some actors are based in both groups. For example, the local administration has, on the one hand, great interest in planning results in terms of local development while, on the other hand, it is responsible for legal regulations concerning the planning process (e. g. planning supervision, mostly installed in local/regional/national administration). Because of this, planning processes are characterized by integrative governance at both procedural (e. g. public consultation) and operational levels (e. g. integration of planning disciplines).

4.2 INTEGRATED PLANNING PROCESSES — APPROACHES

The central task for governance of any urban planning process is balancing customer and stakeholder goals at the programmatic level with the requirements of technological, economic, environmental, and social dimensions.

One central task, and benefit, of a successful integrated planning process is the consideration and balancing of interests. Early integration of all relevant stakeholders allows conflicts between programmatic and technological requirements to be more easily identified and helps avoid expensive corrections during the implementation phase. Moreover, synergies between disciplines can be identified, which increases resource efficiency.

Although there is no pre-defined optimal planning procedure, at neither regional nor international levels, international developments of recent decades show movement away from the ideal visionary "master-planning" to the process orientated "strategic planning" (UN-Habitat 2009, p. 47). The process is defined by a strategic approach with three planning phases (OBauB Bay 2010, p. 48) [80]:

... The first phase is the analysis and definition of goals, which forms the framework for further planning. Through a discussion-based process, political, administrative, and citizen stakeholders come together with various experts to define and evaluate project goals in light of the local socio-geographical background.

... The second phase is the planning process of the disciplines as they define goals for scale-specific and legally binding planning products.

... The third phase is project implementation, followed by a monitoring phase which evaluates the project results including stakeholder satisfaction.

Although this phase-model suggests a linear process, feedback and adjustment loops between the phases are a beneficial and necessary part of the process and avoid top-down light-planning. ***The integrative approach is the core of successful sustainable planning***.

Participation of all sectors from the beginning of the planning process is highly beneficial for a project. This allows stakeholders and disciplines the opportunity to weigh, and thus balance, the advantages and disadvantages of their goals, requirements, and measures community engagement and consultation is essential for successful implementation of public lighting strategies.

community values and aspirations govern public lighting design and, therefore

Participation, which is itself paradoxical, can either provide the necessary flexibility so that the representatives of the users shift the program towards the social demand, or exclude them. In the first case, the conviction of individuals to have influenced, even slightly, the destiny of their district, gives them the impression of succeeding a satisfactory compromise. Participation, therefore, contributes to the determination of conditions of acceptance of urban public lighting development.

Public participation and education could significantly change support for dynamic lighting strategies.

4.3 A POLICY SCIENCE FRAMEWORK ON SOCIAL ACCEPTANCE

In their paper Dermont et al. (2017) [81] propose a three-step approach to be considered when talking about social acceptance. We can modify this approach for dynamic public lighting approach.

Step – 1: Defining the object of interest

Step – 2: Identifying relevant stakeholders

Step – 3: Determining stakeholder's roles

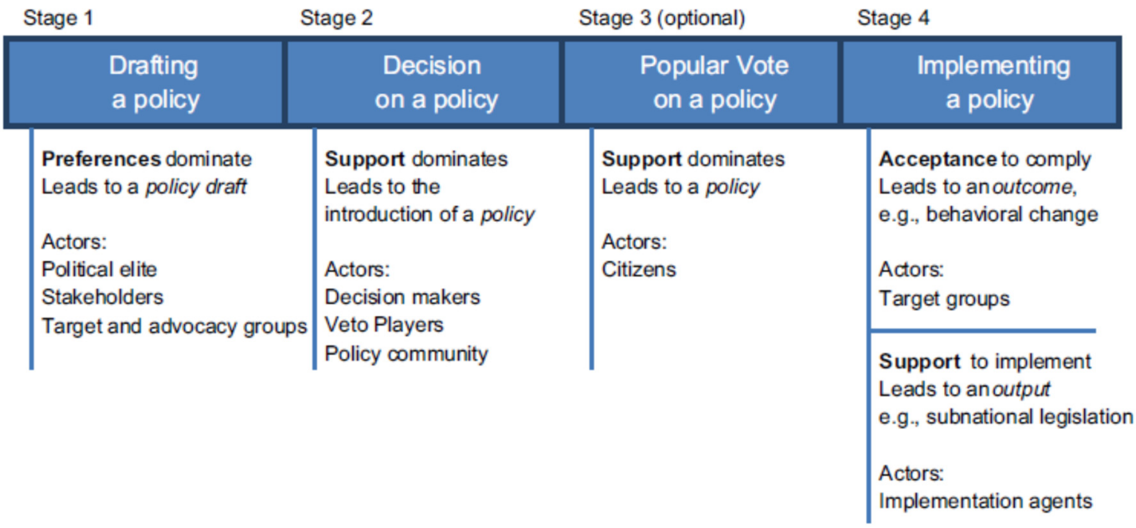


Fig.4:1. Exemplary stages of a policy from drafting to implementation including relevant actors and their roles. Dermont et al [81]

4.4 CONCLUSION

- Lack of social acceptance is an important potential barrier to the transition to dynamic public lighting solutions.
- Even though energy efficiency and low pollution are strongly preferred by citizens, support for according instruments and technologies is not self-evident.
- Many times, the question is – How can costs be compensated for?
- Uncertainty, lack of knowledge and experience: a hurdle to “social acceptance” –but also a natural characteristics of dynamic public lighting solutions.

REFERENCE

[1] Nugent, Pam M.S., "ACCEPTANCE," in PsychologyDictionary.org, April 7, 2013, https://psychologydictionary.org/acceptance/ (accessed May 23, 2018).

[9] Schreuder D. Outdoor Lighting: Physics, Vision and Perception. Berlin: Springer, 2008.

[10] Boyce PR. Lighting for Driving. Boca Raton: CRC Press, 2009.

[11] Shinar D. Traffic Safety and Human Behaviour. Bingley: Emerald, 2008.

[15] Fotios SA, Cheal C. Predicting lamp spectrum effects at mesopic levels. Part 1: Spatial brightness. Lighting Research and Technology 2011; 43: 143–157.

[16] Fotios SA, Cheal C. Predicting lamp spectrum effects at mesopic levels. Part 2: Preferred appearance and visual acuity. Lighting Research and Technology 2011; 43: 159–172.

[17] Boyce PR, Eklund NH, Hamilton BJ, Bruno LD. Perceptions of safety at night in different lighting conditions. Lighting Research and Technology 2000; 32: 79–91.

[18] Walkey H, Orrevetela¨ inen P, Barbur J, Halonen L, Goodman T, Alferdinck J, Freiding A, Szalma´ s A. Mesopic visual efficiency II: Reaction time experiments. Lighting Research and Technology 2007; 39: 335–354.

[19] Lewis AL. Visual performance as a function of spectral power distribution of light sources at luminances used for general outdoor lighting. Journal of the Illuminating Engineering Society 1999; 28: 37–42.

[20] He Y, Rea M, Bierman A, Bullough J. Evaluating light source efficacy under mesopic conditions using reaction times. Journal of the Illuminating Engineering Society 1997; 26: 125–138.

[21] Lin Y, Chen W, Chen D, Shao H. The effect of spectrum on visual field in road lighting. Building and Environment 2004; 39: 433–439.

[22] Ishida T. Color identification data obtained from photopic to mesopic illuminance levels. Color Research and Application 2002; 27: 252–259.

[23] Shin JC, Yaguchi H, Shioiri S. Change of color appearance in photopic, mesopic and scotopic vision. Optical Review 2004; 11: 265–271.

[24] Yao Q, Sun Y, Lin Y. Research on facial recognition and color identification under CMH and HPS lamps for road lighting. Leukos 2009; 6: 169–178.

[25] Mayeur A, Bre´mond R, Bastien JMC. Effects of the viewing context on target detection. Implications for road lighting design. Applied Ergonomics 2010; 41: 461–468.

[26] Houser KW, Tiller DK. Measuring the subjective response to interior lighting: paired comparisons and semantic differential scaling. Lighting Research and Technology 2003; 35:183–195.

[27] Zhou B, Yao Y. Evaluating information retrieval system performance based on user preference. Journal of Intelligent Information Systems 2010; 34: 227–248.

[28] Cox EP III. The optimal number of response alternatives for a scale: A review. Journal of Marketing Research 1980; 17: 407–422.

[29] Coombs CH. A Theory of Data. New York: John Wiley and Sons, 1964.

[38] Boomsma C, Steg L. The effect of information and values on acceptability of reduced street lighting. Journal of Environmental Psychology2014; 39: 22–31.

[39] Harita US. Project Kungsholms strand: advanced individual control of outdoor lighting. Stockholm, Sweden: KTH, 2013. Retrieved 1 September 2016, from https://www.google.se/?gfe_rd¼cr&ei¼TpZHU4TcN4PK8gevwICIAg#q¼ProjectþKungsholmsþstrand:þadvancedþindividualþcontrolþofþoutdoorþlighting.

[40] Ejhed J, Branzell P-H, Theocharaoudis D. Human related urban-lighting by advanced control

system: Proceedings of 28th CIE Session, Manchester, UK, June 28 –July 4: 2015.

[41] Haans A, de Kort YAW. Light distribution in dynamic street lighting: two experimental studies on its effects on perceived safety, prospect, concealment, and escape. Journal of Environmental Psychology 2012; 32: 342–352.

[42] Viliunas V, Vaitkevicius H, Stanikunas R, Vitta P, Bliumas R, Ausˇkalnyte A, Tuzikas A, Petrulis A, Dabasinskas L, Zukasuskas A. Subjective evaluation of luminance distribution for intelligent outdoor lighting. Lighting Research and Technology 2014; 46: 421–433.

[43] Fotios S, Unwin J, Farrall S. Road lightingand pedestrian reassurance after dark: a review. Lighting Research and Technology 2015; 47: 449–469.

[44] Rahm J, Johansson, M. Walking after dark: a systematic literature review of pedestrians' response to outdoor lighting. Environmental Psychology Monographs, No 24. Lund University, 2016.

[46] Haans A, de Kort YAW. Light distribution in dynamic street lighting: Two experimental studies on its effects on perceived safety, prospect, concealment, and escape. Journal of Environmental Psychology 2012; 32: 342–352.

[47] Balfour JL. Neighborhood environment and loss of physical function in older adults: Evidence from the Alameda County Study. American Journal of Epidemiology 2002; 15: 507–515.

[48] Andersson B, Ra¨dslans rum (The room of fear) VR-report 2001:32. Stockholm: Vinnova, 2001.

[49] Raynham P, Saskvikro¨ nning T. White light and facial recognition. Lighting Journal 2003; 1: 29–33.

[50] Listerborn C. Om Ra¨ tten att Slippa Skyddas. (About the Right not to be Protected). Licenciate thesis. Gothenburg: Chalmers University of Technology, 2000.

[51] Vrij A, Winkel FW. Characteristics of the built environment and fear of crime: A research note on interventions in unsafe locations. Deviant Behavior 1991; 12: 203–215.

[52] Painter K. The influence of street lighting improvements on crime, fear and pedestrian street use, after dark. Landscape and Urban Planning 1996; 35: 193–201.

[53] Wang K, Taylor RB. Simulated walks through dangerous alleys: Impacts of features and progress of fear. Journal of Environmental Psychology 2006; 26: 269–283.

[54] E. den Ouden, J. Keijzers, A. Szóstek, & E. de Vries, Stakeholder perception of the intangible value of a public lighting solution in an ecological zone.

[55] Wolsink, M., 2007. Planning of renewables schemes. Deliberative and fair decision-making on landscape issues instead of reproachful accusations of non-cooperation. Energy Policy 35 (5), in press. doi:10.1016/j.enpol.2006.12.002.

[56] Rogers, E.M., 1995. Diffusion of Innovations, fourth ed. The Free Press, New York.

[57] O'Hare, M., 1977. "Not on MY block you don't": facility siting and the strategic importance of compensation. Public Policy 25, 407–458.

[58] R. Wu¨ stenhagen et al. / Energy Policy 35 (2007) 2683–2691, Social acceptance of renewable energy innovation: An introduction to the concept, Energy Policy 35 (2007) 2683–2691

[59] Devine-Wright, P., 2009. Rethinking NIMBYism: the role of place attachment and place identity in explaining place-protective action. J. Community Appl. Soc. Psychol. 19 (6), 426–441.

[60] Deutsch, K. and Goulias, K. (2009). Investigating the Impact of Sense of Place on Travel Behavior Using an Intercept Survey Methodology. Paper submitted for presentation at the 88th annual Transportation Research Board Meeting. University of California Transportation Center UCTC Research Paper No. 887.

[61] Devine Wright, P. (2010). Introduciton to the special issue: Place, identity and environmental beahviour. Journal of Environmental Psychology. 30, 267-270.

[62] Ostrom, E. (1990) Governing the Commons. Cambridge, Cambridge University Press

[63] Putnam, R. D. (2000). Bowling Alone : The collapse and revival of American community. New York: Simon and Schuster.

[64] Putnam, R. D., Leonardi, R., and Nanetti, R. (1993). Making democracy work : civic traditions in modern Italy. Princeton, N.J: Princeton University Press.

[65] Halpern, D. (2005). Social Capital. Cambridge: Polity Press.

[66] Rostila, M. (2010). The facets of social capital. Journal for the Theory of Social Behaviour, 41(3), 308-326.

[67] Leonard, R., and Onyx, J. (2004). Social Capital and Community Building: Spinning straw into gold. London: Janus.

[68] Adger, W. N. (2003). Social Capital, Collective Action, and Adaptation to Climate Change. Economic Geography, 79(4), 387–404.

[69] Anderson, C. L., Locker, L., and Nugent, R. (2002). Microcredit, social capital and common pool resources. World Development, 30(1), 95-105.

[70] Pretty, J., and Ward, H. (2001). Social Capital and the Environment. World Development 29(2), 209-227. PUB, Singapore's national water agency (2008a). NEWater, viewed 8 July 2010. http://www.pub.gov.sg/newater/aboutnewater/Pages/default.aspx

[71] Morrison, M., Oczkowski, E., and Greig, J. (2011). The primacy of human capital and social capital in influencing landholders' participation in programmes designed to improve environmental

outcomes*. Australian Journal of Agricultural and Resource Economics, 55(4), 560-578. doi: 10.1111/j.1467-8489.2011.00554.x

[72] Portney, K. E., and Berry, J. M. (2010). Participation and the Pursuit of Sustainability in U.S. Cities. Urban Affairs Review, 46(1), 119-139.

[73] Wüstenhagen, R., Wolsink, M., Bürer, M.J., 2007. Social acceptance of renewable energy innovation: an introduction to the concept. Energy Policy 35 (5), 2683–2691.

[74] Fisher, B. S., & Nasar, J. L. (1992). Fear of crime in relation to three exterior site features: Prospect, refuge, and escape. Environment and Behavior, 24, 35-65.

[75] Blöbaum, A., & Hunecke, M. (2005). Perceived danger in urban public space: The impacts of physical features and personal factors. Environment and Behavior, 37, 465-486.

[76] Loewen, L. J., Steel, G. D., & Suedfeld, P. (1993). Perceived safety from crime in the urban environment. Journal of Environmental Psychology, 13, 323-331.

[77] Steg, L., Dreijerink, L., & Abrahamse, W. (2005). Factors influencing the acceptability of energy policies: Testing VBN theory. Journal of Environmental Psychology, 25, 415-425.

[78] Annika, Nordlund & Garvill, Jörgen. (2002). Value Structures Behind Proenvironmental Behavior. Environment and Behavior - ENVIRON BEHAV. 34. 740-756. 10.1177/001391602237244.

[79] C. Stern, Paul. (2000). Toward a Coherent Theory of Environmentally Significant Behavior. Journal of Social Issues. 56. 407-424. 10.1111/0022-4537.00175.

[80] OBauB Bay (Oberste Baubehörde im Bayerischen Staatsministerium des Innern) (2010): Arbeitsblätter für Bauleitplanung Nr.17, Energie und Ortsplanung. München.

[81] Dermont, Clau & Ingold, Karin & Kammermann, Lorenz & Stadelmann-Steffen, Isabelle. (2017). Bringing the policy making perspective in: A political science approach to social acceptance. Energy Policy. 108. 359-368. 10.1016/j.enpol.2017.05.062.

SCIENTIFIC STUDIES

[A] KUNGSHOLMS STRAND - Advanced individual control of outdoor lighting: The project is carried out in collaboration with Municipality of Stockholm city- Stockholms Stad (property owner), Fagerhult (lighting solutions), Tritech (control technology specialist), Sustainable Innovation – Sust (project management team) and the Lighting Laboratory from Kungliga Tekniska högskolan- KTH University.

[B] Subjective evaluation of luminance distribution for intelligent outdoor lighting; V Viliunas PhD[a], H Vaitkevicius HabilDr[b], R Stanikunas PhD[b], P Vitta PhD[a], R Bliumas PhD[b], A Auskalnyte BSc[b], A Tuzikas MSc[a], A Petrulis BSc[a], L Dabasinskas BSc[a] and A Zukauskas HabilDr[a]

[a] Institute of Applied Research, Vilnius University, Vilnius, Lithuania

[b] Department of General Psychology, Vilnius University, Vilnius, Lithuania

Lighting Res. Technol. 2014; Vol. 46: 421–433

[C] Dynamic pedestrian lighting: Effects on walking speed, legibility and environmental perception.

E Pedersen PhD and M Johansson PhD, Faculty of Technology LTH, Department of Architecture and Built Environment, Lund University, Sweden; Lighting Res. Technol. 2016; 0: 1–15

[D] Individual factors influencing the assessment of the outdoor lighting of an urban footpath.

M Johansson DSc[a], M Rosèn MSc[b] and R Küller DSc[a] [a]Environmental Psychology, Department of Architecture and Built Environment Lund University, Sweden [b]SWECO, Traffic Planning, Örebro, Sweden, Lighting Res. Technol. 2011; 43: 31–43

[E] Stakeholder perception of the intangible value of a public lighting solution in an ecological zone. E. den Ouden[1], J. Keijzers[2], A. Szóstek[3], & E. de Vries[4]

1 Industrial Design, Eindhoven University of Technology, Intelligent Lighting Institute, Eindhoven, The Netherlands 2 Fontys University of Applied Sciences, Eindhoven, The Netherlands 3Interdisciplinary Center for Applied Cognitive Studies, School of Social Sciences and Humanities, Warsaw, Poland 4 THE LUX LAB Lighting Design, Eindhoven, The Netherlands

[F] Haans, A., & Kort, de, Y. A. W. (2012). Light distribution in dynamic street lighting : two experimental studies on its effects on perceived safety, prospect, concealment, and escape. Journal of Environmental Psychology, 32(4), 342-352. DOI: 10.1016/j.jenvp.2012.05.006

[G] Resolving the conflict of reduced street lighting: Two ways to increase the acceptability of reduced street lighting, Christine Boomsma, University of Groningen, Master's thesis Research Master Human Behaviour in Social Contexts, July 2009

Authors		
	Name (organisation)	**e-mail**
WP leader	Prof. Dr. Römhild Peter Schmidt Saurabh Sachdev	peter.schmidt@hs-wismar.de saurabh.sachdev@hs-wismar.de
Contributing participants	**Chapters:** 1 + 2. University of Applied Sciences: Technology, Business and Design 3. Porsenna and Menea 3 Hansestadt Rostock	

ISBN: 978-3-947929-05-4
Dynamic Light: Report on User Acceptance

www.interreg-central.eu/dynamiclight

This project is supported by the Interreg CENTRAL EUROPE Programme funded under the European Regional Development Fund

DELIVERABLE D.T1.3.1
WP T1 – Report on Joint evaluation of user acceptance
01/2019

This project is supported by the Interreg CENTRAL EUROPE Programme funded under the European Regional Development Fund
www.interreg-central.eu/dynamiclight

Lead Partner: Hochschule Wismar

Prof. Dr. Thomas Römhild

Project Partners