



**Haaga-Helia**

University of Applied Sciences Ltd.

## **SDG 11 - Sustainable Cities and Communities**

**Final report**

**Ideasquare Summer School, CERN Bootcamp 2023**

Mary Jalandoni, Emma Kaasinen, Sakari Mäkinen, Umakant Yadav, Bohyun Yoon

June 14<sup>th</sup> 2023



## Contents

<b>1</b>	<b><i>Abstract</i></b> .....	<b>1</b>
<b>2</b>	<b><i>Introduction</i></b> .....	<b>2</b>
<b>3</b>	<b><i>Development Approach</i></b> .....	<b>3</b>
3.1	<b>Discover</b> .....	<b>3</b>
3.2	<b>Define</b> .....	<b>7</b>
3.3	<b>Develop</b> .....	<b>12</b>
<b>4</b>	<b><i>Evolution of the Design</i></b> .....	<b>15</b>
4.1	<b>Application of ATTRACT technologies</b> .....	<b>16</b>
<b>5</b>	<b><i>Final Solution</i></b> .....	<b>20</b>
5.1	<b>System Level Description</b> .....	<b>20</b>
5.2	<b>Functional Description</b> .....	<b>21</b>
5.3	<b>Use case description for Tara</b> .....	<b>22</b>
5.4	<b>Scalability and societal Impact</b> .....	<b>23</b>
<b>6</b>	<b><i>Conclusion and Reflection</i></b> .....	<b>25</b>
<b>7</b>	<b><i>References</i></b> .....	<b>26</b>
<b>8</b>	<b><i>Annex</i></b> .....	<b>28</b>

## 1 Abstract

This project utilizes service design methods to investigate the impact of lighting on perceived safety. The team developed a concept to enhance the sense of safety and foster inclusivity in public space. The concept is grounded in solid theoretical framework and informed by interviews conducted with residents of certain areas in Finland, and experts in the field. By integrating research findings and insights from various stakeholders, this project aims to contribute to developing strategies that promote safer, more welcoming, and diverse urban environments. The findings highlight the potential of lighting design as a key element in enhancing public safety.

*This is part of ATTRACT that has received funding from the European Union's Horizon 2020 Research and Innovation Programme.*

## 2 Introduction

Our team is committed to advancing Sustainable Development Goal 11; Sustainable Cities and Communities. This SDG focuses on making cities and human settlements inclusive, safe, resilient, and sustainable. Within this extensive framework, our team specifically emphasizes the importance of citizens' perceived safety in urban areas, recognizing it as a pivotal factor that can significantly impact all aspects of SDG 11.

Approaching the concept of safety, we delve into the realm of lighting. Our comprehensive background research has revealed that lighting plays a crucial role in influencing both security and perceived feeling of safety. Understanding that perceived safety aligns with crime statistics, we firmly believe that shaping people's personal experiences is of paramount importance on a global scale. By implementing measures to enhance safety, we aim to bolster social control, combat gender inequality, and mitigate the potential for segregation and polarization in urban and residential areas.

Our project adopts a dual perspective in tackling this issue. Firstly, we explore avenues to improve lighting conditions in urban environments by harnessing the potential of ATTRACT technologies. These innovative solutions offer opportunities for optimizing lighting conditions to enhance safety. Additionally, we dive deep into the realm of public spaces and their diversity.

We recognize the significance of ensuring that all individuals, regardless of their background, feel secure and comfortable in urban environments. To this end, we are driven to conceive a novel concept that attracts diverse groups of people, encouraging them to engage with urban areas in multifaceted ways. By doing so, we aim to cultivate a sense of safety for women, minorities, and individuals from diverse cultural backgrounds. Furthermore, we aspire to foster positive social interactions and behaviors towards other citizens in public spaces.

Addressing this notable social challenge necessitates a gradual and concerted effort. Nonetheless, we firmly believe that through collective resolution, we can significantly enhance urban safety in every corner of the world.

### 3 Development Approach

Our team began approaching the SDG 11 topic with a very broad perspective. Following the Double Diamond process (See Figure 1 below), we started our Discovery phase by discussing *what sustainable cities mean for us as individuals*.

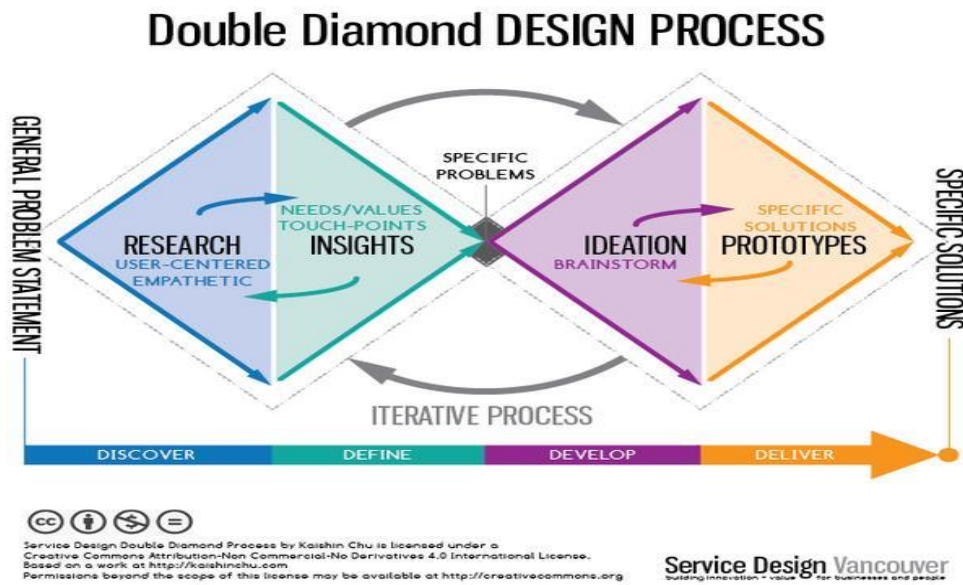


Figure 1. Double Diamond Design Process (Source: openclassrooms, 2020)

We all concluded that a sustainable city should be safe, and thus, we were able to narrow down our research question as follows:

#### **"How do we make urban environments feel safe and inclusive for the people?"**

The Double Diamond Design Process is a widely-used and reliable model often used in service design projects. There are two connected diamonds which are divided into four stages: Discover, Define, Develop, and Deliver. According to Don Norman (2013, 220-221), the Double Diamond model was first introduced by the British Design Council in 2005. Both diamonds consist of divergence and convergence phases. The first diamond is about “finding the right **problem**” and leads to concluding the problem at hand. The second diamond is about “finding the right **solution**”, and it ultimately builds up to the project’s final proposed solution. (Norman, 2013.)

#### 3.1 Discover

Research is done on the first stage: discovery. Research provides a deep understanding of the subject matter and the various stakeholders involved. There are various tools that could be used to

enable it. For this project, we conducted the research with literature review, virtual ethnography, and in-depth interviews.

We started the user-centered research with virtual ethnography. Virtual Ethnography is an approach to investigate how people interact with one another in online communities. When doing it, designers can decide to become part of a community, only observe (non-participant virtual ethnography, a “fly on the wall” approach), only document their own experiences (self-virtual ethnographic), or get in touch with specific participants to ‘shadow’ their online activities. (Haaga-Helia s.a., a.)

This was our initial tool for understanding what Safety means for the residents of Kannelmäki and Malmi districts in Helsinki – both residential areas that generally have a poor reputation as residential neighborhoods. We joined Facebook groups of residents in said areas, and asked what gives them a sense of enjoyment and safety in their area. The respondents were free to share as much input as they felt comfortable with. The message was posted by Sakari (Malmi) and Emma (Kannelmäki) using their personal accounts. Most of the answers were given in Finnish. See Annex for the message posted in the groups. Some of the participants in the Facebook groups also volunteered to take part in in-depth interviews. In this particular case the residents were asked in their individual interviews about safety: what makes them feel safe/unsafe in their living area. They gave answers in written form.

In addition to local residents in said areas, we also interviewed various stakeholders such as: users, urban designers, technology experts, security experts, and legislative experts.

In-depth interviews help designers to gather understanding and insights directly from participants. They can be conducted in a semi-structured (around key themes), or unstructured manner, and are mostly done face to face so designers can observe body language and to create a more intimate atmosphere but can also be conducted by telephone or online. (Haaga-Helia s.a., b.)

Some of the experts answered questions via email, while others were interviewed over Teams or in person. The experts interviewed for the project were:

- **Andrea Ballabio** – Technology expert for VISIR2
- **Dr. Santiago José Cartamil Bueno** – Technology expert for MEGAMORPH
- **Samu Iiskola** – Security director of Vantaa city
- **Héloïse Roman** – Equality project manager of Geneva city
- **Jalmari Sarla** – Researcher of placemaking and suburban regeneration, entrepreneur and urban activist
- **Karolina Toivettula** – Community manager at Forum Virium, the innovation company of Helsinki city

The questions for the interviews were made to be flexible according to the stakeholder or organization being interviewed. As a reference, we created a framework of questions to cover a specific theme of discussion.

Interview questions for the experts:

1. What are some consequences if an area is deemed unsafe by the residents?
2. What makes people feel safe and/or unsafe around public spaces based on your organization's previous research?
3. What according to you is considered a safe area (inside a certain city)?
4. How do we balance urban safety and inclusivity in public spaces planning?
5. What are some solutions in urban planning in improving perception of safety in public spaces?

From social media virtual ethnography and later more detailed individual interviews with residents, we identified several consistent themes that either improved or worsened the sense of safety. In both groups, residents mentioned that the condition and cleanliness of public spaces influenced their sense of safety. An interesting detail was that many spoke about lighting and how its inadequacy particularly created feelings of insecurity near train stations. Both groups also felt that the presence of youth gangs in public areas contributed to a sense of insecurity. According to many, poorly maintained train station areas attracted intoxicated individuals, and loud and disorderly groups to the area. On the other hand, proximity to nature, community engagement, and areas accessible to diverse groups of people fostered a sense of safety. Well-lit park areas, streets, and especially train station areas alleviated feelings of insecurity.

The interview with Vantaa's security expert, Samu liskola, provided a deep understanding of what promotes a sense of safety in residential areas. Firstly, he emphasized the importance of addressing various social issues at an early stage to prevent them from escalating into problem behavior and later reflecting in crime statistics. He highlighted that the city has a limited budget for various measures, although they have identified certain factors related to safety.

The key messages from liskola's interview were as follows: It would be beneficial to provide meaningful activities for children and young people after school. Additionally, urban environments should be developed in a way that public spaces are accessible to all groups of people. They recognize that a problematic aspect for safety is the gathering of groups typically composed of young men in public places, who due to a lack of meaningful activities, engage in disruptive behavior. Their presence also creates a sense of insecurity among the residents of the area, leading to other groups avoiding public spaces. This, in turn, negatively affects the reputation of the areas and perpetuates a cycle of insecurity.

Regarding the maintenance of urban areas, Iiskola specifically mentioned the importance of lighting, for which they receive feedback from residents every year. Inadequate lighting is perceived as a contributing factor to insecurity and hampers crime investigation, for example. However, he acknowledged the challenges of constructing the required infrastructure for lighting with limited resources. He believed that investing in lighting is necessary because poorly lit areas attract various forms of disruptive behavior, such as drug use.

In his interview, Jalmari Sarla, an experienced urban designer, spoke about social control, that is, how other people's presence and diversity generates a sense of safety in public spaces. Sarla referred to Jane Jacobs (1972) who argued that when a public space is visible from nearby apartments' windows and remains active throughout the day with people present, it creates a sense of safety and discourages criminal activity.

Sarla continued that when considering perceptions of unsafety, it is crucial to take into account an individual's personal position in relation to potential threats. Factors such as gender, ethnicity, and physical appearance strongly influence the extent to which individuals feel safe or unsafe in public spaces: for example, a white male may less likely be harassed or threatened in the public space than many other groups of people. Sarla mentions in his master's thesis (2021) that in urban design literature, **space** refers to anonymous locations, whereas **place** can be interpreted as affective areas with active community involvement (see e.g. Dupre, 2018). An active procedure to turn spaces into places is called **placemaking**, which is a "community-driven process that shapes urban spaces to become quality public spaces that contribute to people's health, happiness and well-being" ("What is placemaking?", s.a.).

Sarla also mentioned during the interview that implementing good infrastructure such as lighting and ensuring protection from traffic are the cornerstones of safe urban environments. Further effective approach is to encourage a mix of uses and activities within public spaces. By facilitating a diverse range of activities, such as recreation, social gatherings, and cultural events, the space becomes more vibrant and populated, which enhances safety through increased social control and urban sociality (Latham & Layton, 2019).

Same themes recurred in all expert interviews. The final expert interview took place in Geneva with Héloïse Roman, who leads the city's gender equality projects and is involved in urban planning, focusing on the safety of women and minorities. She also highlighted the role of lighting in preventing sexual crimes and violence but did not see it as the primary solution to underlying issues. She shared that research had revealed significant differences in the mobility of women and men. Men typically spend much more time in public spaces, while women more often simply pass through them. One major reason for this was the unwanted sexual attention experienced by women, particularly young



women, which they found distressing. She stated that improving women's self-confidence and simultaneously addressing attitudes towards interpersonal interactions would help address the situation. Thus, it would be crucial to take actions that enhance the diversity of public spaces.

Based on the technology expert interviews and the available content on the ATTRACT website, we've discovered important information that could help us develop ideas for the challenge.

### 3.2 Define

After gathering all the insights we needed and could accumulate, it was time to move on to the next stage of definition. Define stage is about collating the insights and identifying the overlapping themes that exist (Norman, 2013). Doing so helps the designers to narrow down the idea into a more specific challenge. This is the part where we make sense of all the information that has been shared to us.

We've combined the data from most of the interviews and virtual ethnography in an affinity diagram and grouped them accordingly. From the answers we identified two touchpoints (Sense of Safety/Unsafety) and organized them according to overlapping themes. By looking at the Figure 2 below, it can be seen that residents consider the following as tangible points for the sense of safety:

- Access to Nature
- People & Community
- Services & Activities
- Others



Figure 2. Grouping of the answers in FB groups for Malmi & Kannelmäki residents for the theme **Sense of Safety**

People who answered the questions seem to demonstrate high value for other people around them in their community. Especially having trustworthy neighbours, and "a village-like spirit" in the area,

creates a sense of belonging and safety for the residents of Malmi and Kannelmäki regions. Another significantly considerable factor in fulfilling the sense of safety were the opportunities for the children, like good schools and daycare and safe playgrounds in short distance from home. Also reliable public transportation options that provide the possibility to manage daily life without owning a car were raised more than once.

Another important factor that creates a sense of safety in both Malmi and Kannelmäki areas, is the fact that from both of them, there is easy access to beautiful nature. People go to parks and the forest to ease their minds from the hectic city life. Only seeing nature at least once a day makes people feel less stressed. In his research, Jan Gehl (2010) has pointed out a factor of “liveability”, which has become a prominent concept in urban development research. It basically means to design urban areas so that they are practical and accessible, and allow for aimless strolling, sitting and recreation, and consider aesthetic factors together with practicality, in human scale (Gehl, 2010).

Accordingly, the Figure 3 below presents the touchpoints that determine a sense of unrest. We identified the following high-level themes:

- Public decorum
- Drug & alcohol abuse
- Public spaces
- Perceived image
- School & bullying
- Persons of authority
- Robberies

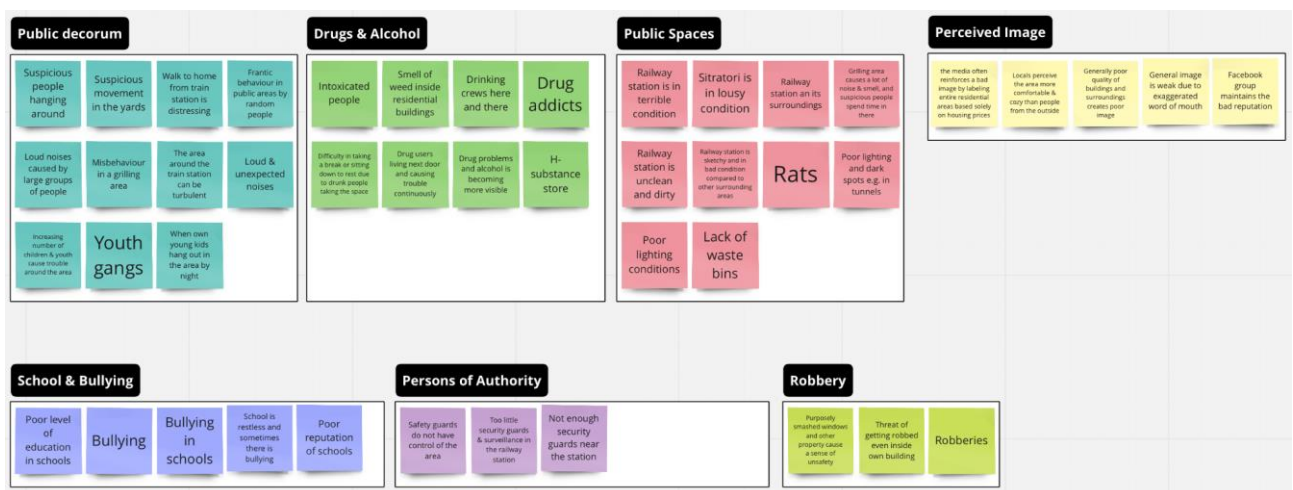


Figure 3. Grouping of the answers in FB groups for Malmi & Kannelmäki residents for the theme **Sense of Unsafety**

On the other hand, the factors that cause a sense of unsafety in the researched areas were highly focused on people as well, only in a bit of a different kind of way; intoxicated people (both from alcohol and illegal drugs) seem to cause high proportions of anxiety among the residents. There were multiple mentions of “drug gangs” or “drinking crews” taking over the best hangout areas close to the supermarkets and market squares, which made the respondents end up avoiding those areas, despite really wanting to stop for a coffee or ice cream.

Since some of the areas in both of the studied neighbourhoods are considered unsafe by the vast majority of people, there was also a high demand for more surveillance by the police or security guards.

Interestingly, the perceived and/or publicly represented image of both of our focus areas is significantly worse than in the minds of the people actually living there. According to one respondent, “the media often reinforces a bad image by labelling entire residential areas based solely on housing prices”. It is true that house and apartment prices are lower in these areas, compared to some other places e.g. closer to the city centre. However, residents still seem to have formed a strong bond and a sense of belonging to these areas, despite them getting poor coverage in the local media.

Our last interview with Héloïse Roman was conducted during the bootcamp, and so, insights gathered from this interview were not included in the diagram. However, the data remained impactful and therefore was used to compare with previous data accumulated. The interview’s greatest impact on our idea is the factor of **diversity**. Discussions about security vs. sense of safety and the application of technology was extensive but eventually the challenge was narrowed down to “**How do we improve the sense of safety and diversity in public spaces?**” and in this regard, the topic of **Lighting** was sought to be the most applicable and relevant idea to explore in this project. We then researched literature about lighting and its involvement in the sense of safety.

A value proposition canvas was created to challenge the impact of lighting on the specific pains and hopeful gains of the end-users. The Value Proposition Canvas (VPC) is a core part of the Business Model Canvas. The VPC focuses on the user and his requirements vis-à-vis the service provider service proposition. It helps designers to find out why the user needs a service (job-to-be-done), what the user can perceive as extra value (gains) and what the user finds disadvantageous (pains). (Haaga-Helia s.a., c.) See Figure 4 below for our group’s VPC for this project.

We found that lighting has a great impact on the mobility of different users throughout the city. Although it is not a direct solution to all the issues discussed, it alleviates mostly the **fear** and **sense of unsafety** in a city; it also sheds light to the discussions about **diversity in public spaces** and how this creates an environment of **social control**, the presence of general others psychologically affects a person and the sense of safety s/he experiences within him/herself.

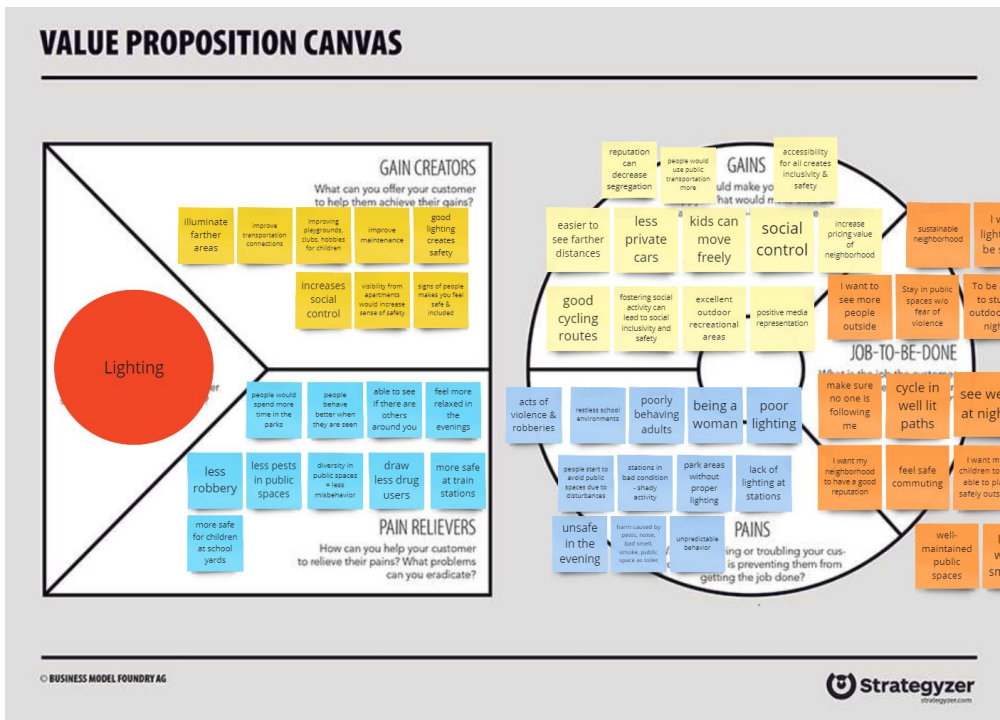


Figure 4. Value Proposition Canvas for Lighting

From the data gathered, we also created personas that represent the groups of people that have the most need for a sense of safety. A Persona Map, sometimes called Pen Portrait, is a tool that helps designers to create a representation of types of users, employees, and stakeholders. Personas answer the question, ‘Who are we designing for?’ and they help to align strategy and future solutions to specific target groups. (Haaga-Helia s.a., d.) Our Persona map for this project’s target audience is presented in Figure 5 below.

	BIO	DAILY ROUTINE	MOTIVATIONS	FRUSTRATIONS	WANTS
 <p><b>Tara</b></p>	<ul style="list-style-type: none"> <li>• 27 year old from Ghana</li> <li>• Immigrated to Finland when she was 23</li> <li>• Dating her boyfriend for 2 years</li> </ul>	<ul style="list-style-type: none"> <li>• Working 3 different shifts</li> <li>• Commuting by train</li> <li>• Going to grocery shopping on the way home from work</li> </ul>	<ul style="list-style-type: none"> <li>• I want to be a successful in my career</li> <li>• I want to travel around the world</li> <li>• I want to be able to support my family back home in Ghana financially</li> </ul>	<ul style="list-style-type: none"> <li>• There are groups of men hanging out at the square, and they are often intoxicated and catcalling</li> <li>• When I work the night shift, it feels intimidating to get home from the train station to my apartment</li> </ul>	<ul style="list-style-type: none"> <li>• I want to feel safe and relaxed when I come home from work</li> <li>• I want to get out more often to the store at any time of the day without feeling stressed</li> </ul>
 <p><b>The Singhs</b></p>	<ul style="list-style-type: none"> <li>• Relocated from India to Finland to pursue father's IT work</li> <li>• Mother is a homemaker</li> <li>• Children are going to an international school</li> </ul>	<ul style="list-style-type: none"> <li>• Father goes to work on his car early in the morning</li> <li>• Mother brings the children to school and daycare in the neighbourhood</li> <li>• Mother goes grocery shopping while children are at school</li> </ul>	<ul style="list-style-type: none"> <li>• We want to raise children in safe and happy environment</li> <li>• We want to live in a convenient location with nearby malls and nature</li> </ul>	<ul style="list-style-type: none"> <li>• The mall is not family friendly, there are too many misbehaving youngsters</li> <li>• We don't want to live in the area with a bad reputation</li> </ul>	<ul style="list-style-type: none"> <li>• We want to buy a house in the neighbourhood</li> <li>• We want a safe school and daycare for our children</li> <li>• We want to feel safe in public spaces</li> </ul>
 <p><b>Antti</b></p>	<ul style="list-style-type: none"> <li>• 65 year old man from Seinäjoki</li> <li>• Retired accountant</li> <li>• Living alone but often takes care of old parents living nearby</li> <li>• Often visited by grand children</li> </ul>	<ul style="list-style-type: none"> <li>• Likes to go for an early morning walk</li> <li>• Goes to the market square often to meet other people</li> <li>• Plays chess with his friends in the park</li> </ul>	<ul style="list-style-type: none"> <li>• I want to meet foreigners in my neighbourhood</li> <li>• I want to be in nature everyday to maintain good health</li> </ul>	<ul style="list-style-type: none"> <li>• There has been a robbery in my neighbourhood at night</li> <li>• I have safety concerns regarding my grand children playing in the playground without adult supervision</li> </ul>	<ul style="list-style-type: none"> <li>• I want the neighbourhood to be safe for my grandchildren to visit me without potential danger</li> <li>• I want this neighbourhood to have more international restaurants</li> </ul>

Figure 5. Persona mapping

Tara represents multiple groups of single young women and immigrants. She has different mobility within the city, depending on the time of day. She is concerned about her safety in certain spaces in the city especially where homogenous groups dominate said spaces. She feels unsafe even during commute and would like to be relieved of this frustration and possibly even experience joyful moments in her neighborhood.

The Singhs represent typical families in cities, both local and immigrant, who share the same goals and needs. They personify different members of a family that use services and infrastructure a little bit differently. The mom moves throughout the city in a more domesticated aspect while the father moves according to his individual needs. The children follow along the paths of their parents. Generally, they hope the city would be a friendly space for all the members of their family, especially for the safety of their children.

Antti personifies the older group of people in a city. He has experience living alone, however, still cares for the needs of his family. He also personifies the male group that is present in a city. Although he is a man and feels a greater sense of safety in his neighborhood, he still feels a small sense of unsafety, because he is old and therefore deemed vulnerable. He is open-minded and social, willing to meet new and diverse people.

To summarize, based on literature review, user research, and expert interviews, our defined challenge is to address the issue of lighting and how it affects the mobility and sense of safety of diverse groups in public spaces.

### **3.3 Develop**

This phase may also be called Ideation. This is the part where designers come up with ideas or solutions for the defined challenge. Brainstorming is the most familiar way to ideate, however, can be restrictive and therefore limits the creativity of the ideas. (Stickdorn, et.al., 2018.) Instead of sharing ideas to the group, we've decided to use How-Might-We as a guiding tool for generation of ideas and Quick Voting to select the best ideas out of all.

'How might we...?' questions are helpful for moving from conclusions or challenges to new ideas and possibilities. With a HMW question designers simply articulate what they would like to find answers or solutions to. (Haaga-Helia s.a., e.)

Quick Voting is a tool used by designers to rapidly get the majority's view. Designers use Post-it's or a marker such as a Dot to select the ideas they like or see value. This process allows every member to have an equal say in choosing from the listed ideas. (Haaga-Helia s.a., f.)

We did not utilize the tool in its fullest capacity, but we came up with ideas guided by the notion of HMW tool. We individually created ideas guided by the users' jobs-to-be-done from the value proposition canvas. Each person generated a minimum of three ideas in 15 minutes, and then shared their ideas in turn. The ideas gathered in this phase and the voting between them can be seen in Figure 6 below. The group quietly voted on three ideas (100) they thought were best and sub-votes (hearts) on ideas that have good qualities but could be ideated in another way.



Figure 6. Ideation & Voting Diagram

The three top ideas were:

1. Determine the placing of lights/screens on the areas/routes most used by women/minorities/families.
2. Use MEGAMORPH technology to create public places that address specific target groups: women, children etc (screens, sensors in the ground that light up etc).
3. V+(M.M screen = Light + screen) – Visir 2 + MEGAMORPH screen = Light/Screen Panels.

We also identified repeating themes throughout the ideas generated such as personalization, movement based, colors, and footfall. From the winning ideas and repeating themes, the group decided to combine them and come up with a system idea, rather than a product idea, that could

address multiple issues. We combated the idea of whether or not using two technologies to maximize the capabilities of the system idea and eventually agreed to use both Visir 2 and MEGAMORPH.



## 4 Evolution of the Design

In the early stages of our project, we had already observed in social media surveys conducted in Helsinki, Finland, that the impact of lighting conditions affects people's perceived sense of safety in the urban environment. In an interview with a security expert Samu Iiskola from the city of Vantaa, lighting also emerged as a significant factor having influence on the sense of safety in the city. According to Iiskola, lighting consistently appeared as a repeated concern in their security surveys, despite multiple improvements in the lighting conditions being taken.

Our group could understand this concern, as Finland can be quite dark depending on the time of year. However, since lighting was prominently highlighted in various contexts, we became interested in it as a safety factor and a potential research theme for our project. We had already identified a promising ATTRACT technology called MEGAMORPH, which could potentially offer solutions in this regard.

To build a Proof of Concept, we started to search for research on the topic. We wanted our concept to be scalable globally, so that the solution could be applied in every corner of the world as well. In a study conducted by Kate Painter already back in 1961, it was noted that lighting conditions have a significant impact on the perceived sense of safety in urban environments. The study observed the effects of lighting in three different neighborhoods in London. In this particular research it was found that improving lighting conditions led to clear improvements in both perceived safety and crime statistics. (Painter, 1961.)

A study conducted by Vogiatzaki, Zerefos and Marzia (2020) shows that lighting can affect crime indirectly through two separate mechanisms. Firstly, it enables people to recognize the intentions of others, see well, and allows for better surveillance. Secondly, it enhances community confidence and increases informal social control. By providing increased reassurance to vulnerable groups, controlling light and its parameters can enhance city life. (Vogiatzaki, et.al., 2020.)

Fear of crime is often mistaken as an indicator of criminal activity. Improved lighting can reduce fear of crime by increasing visibility, recognition of facial characteristics, and enhancing lines of sight. Offenders prefer to remain unseen, so increased visibility can deter criminal activity and allow pedestrians to identify potential threats. The distribution and qualities of light in a specific space play a crucial role. Brightly lit areas with low uniformity can create darker areas that may be used for criminal activity. Uniform lighting without surveillance can increase petty crimes, as it provides better visual information. (Vogiatzaki, et. al., 2020.)

The point stated above was also raised in an interview with an expert from the city of Geneva, H elo ise Roman. She indicated that it is not enough that we increase lighting to one spot, but instead improving lighting conditions is a much more complicated and multifaceted issue. Roman also pointed

out that providing bright lights in some of the areas and/or routes used by people who are potential victims of malicious behaviour, might highlight them as prey for other citizens with cruel intentions.

A survey by Peña-García, Hurtado and Aguilar-Luzón (2015) was conducted in Granada to evaluate the impact of public lighting on people's feelings of well-being and perceptions of safety. The study examined the relationships between subjective responses from 275 pedestrians and objective parameters such as average illuminance and color of light. The following key conclusions were drawn from the results (Peña-García, et.al., 2015):

- The average scores for all questions increased with higher average illuminance, indicating that more intense lighting contributed to increased alertness and a greater sense of well-being. Scores were generally higher when the light was yellow-sodium due to the higher spectral sensitivity of the human eye to this type of light.
- White light performed better in terms of safety perception, particularly for facial recognition, highlighting the importance of enhanced chromatic reproduction. However, the difference in stress levels between white and yellow-sodium light was relatively smaller, suggesting that the higher melatonin inhibition and cortisol release caused by white light also apply to public lighting.
- The findings from this study (Peña-García, et.al., 2015) suggest that well-illuminated streets with optimal lighting uniformity tend to make the people feel safer and better, provided that average illumination levels are higher. It is important for lighting engineers, urban planners, and city administrators to consider these findings when making decisions about lighting installations, including the choice between white or yellow light and the desired levels of illumination.

That being said, it seems evident that poor lighting conditions play a significant role in raising a feeling of unsafety. However, there is also a correlation between the perceived feeling of safety and increased crime rates. A systematic review that examined various studies on urban streetscape lighting and its impact on crime, indicated that well-designed lighting interventions, including increased illumination levels and improved visibility, can lead to decreased crime rates and increased feelings of safety. (Armitage & Monchuk, 2012.)

#### **4.1 Application of ATTRACT technologies**

As we researched the subject even further, the team became more and more invested in the potential solution associated with lighting conditions. We had learnt from the expert from MEGAMORPH, that one of the benefits of this particular ATTRACT technology is its capability of *adjusting* to the existing lighting conditions. It would mean that we could affect the lighting conditions in a more comprehensive

way. Visir 2 motion sensors can be applied to existing camera and surveillance technologies to enhance their capabilities in multiple ways.

**MEGAMORPH** – GMOD (Graphene Modulator) is an innovative display technology that utilizes graphene optical modulators as pixels. GMOD functions as a reflecting display, as opposed to conventional emissive displays, which are typically used in portable devices like smartphones and laptops and drain a lot of battery power. It allows for the modification of RGB sources to provide large colour gamuts or the tuning of sunlight to reflect natural colours. Furthermore, GMOD displays have great contrast even in bright settings, enabling ultra-high resolution while lowering average power consumption, notably in head-mounted displays (HMDs), heads-up displays (HUDs), and other portable devices.

By leveraging the capabilities of GMOD displays, sustainable cities can foster social inclusion, enhance safety measures, and create a sense of belonging among residents. The technology can be harnessed to ensure that information, services, and opportunities are accessible to all, irrespective of language barriers, disabilities, or cultural backgrounds. Ultimately, GMOD displays can contribute to building a more inclusive, cohesive, and socially sustainable urban environment.

**VISIR 2** is an innovative image sensor that combines visible and infrared capabilities in a complementary metal oxide semiconductor (CMOS) design. This sensor technology offers comprehensive coverage of both the visible and short-wave infrared (SWIR) spectral ranges using a single sensor. This unique feature enables easy discrimination between the two spectral bands. By leveraging this technology, future image sensors will have the ability to operate seamlessly across the entire visible to SWIR range within a single device.

Incorporating VISIR 2 image sensor technology into various aspects of urban planning, infrastructure, and service provision can enable an environment that prioritizes social inclusivity and safety in sustainable cities. By considering the potential applications of VISIR 2, cities can develop innovative solutions that contribute to a more inclusive, safe, and sustainable urban environment. This technology enables the optimization of resources and enhances emergency response capabilities.

Our initial idea of integrating MEGAMORPH and VISIR 2 technologies could potentially offer synergic benefits for social inclusion and safety in a sustainable city. Here are few examples on how we envision integrating these two technologies together:

- Use MEGAMORPH GMOD displays as interactive information kiosks in particular public areas, transportation hubs, or community centers to create accessible and educational displays in urban environments. These displays can offer multilingual data, real-time updates on locality, routes, and schedules for public transportation, as well as accessibility features. They can also include VISIR 2 sensors to improve visibility and safety for people with vision

problems or mobility issues. We may construct inclusive and educational displays that cater to various demographics and provide equal access to urban services by combining the two technologies.

- Smart surveillance and emergency response: Install VISIR 2-capable surveillance systems all around in recognized high-crime or emergency locations. The SWIR spectrum can be used by these cameras to improve vision in low light and aid in detecting heat signatures. Integrate MEGAMORPH GMOD displays to give real-time information visualization for managing and coordinating emergency situations in emergency response and command centers. In order to ensure the safety and security of the community, this combination offers efficient surveillance, early event identification, and quick emergency reaction.
- Utilize VISIR 2 sensors for environmental monitoring, such as air quality, temperature, and pollution detection. This will increase public awareness of environmental issues. To give real-time visualizations and alarms, combine this data with MEGAMORPH GMOD displays installed in public areas, parks, and educational facilities. This integration aids in increasing environmental awareness among the general public, encouraging sustainable lifestyles, and motivating locals to take initiative for a healthier and more environmentally friendly city.
- Accessible urban navigation and wayfinding: To develop accessible urban navigation systems, combine VISIR 2 sensors with MEGAMORPH GMOD displays. For people with mobility issues or visual impairments, we can create accessible wayfinding solutions by fusing SWIR capabilities with high-resolution images. All inhabitants will have equal access to these solutions, which can deliver audible and tactile feedback, detect impediments, and provide real-time navigation aid.
- Using MEGAMORPH GMOD displays in public areas to highlight local artwork, cultural events, and interactive installations, would promote community involvement and cultural expression. Use VISIR 2 sensors to build engaging, immersive, and visually stunning experiences for locals. This integration encourages social inclusion and fortifies links within the community by fostering cultural expression, communal interaction, and a sense of belonging.

It is possible to design a technologically cutting-edge and socially inclusive city that sets priority on safety, accessibility, and sustainability by merging MEGAMORPH GMOD displays with VISIR 2 sensors in many ways. To achieve a successful solution and optimize the benefits for the citizens, it is required to work together with relevant parties, such as urban designers, technology providers, local government, municipality authorities and community organizations.

Initially our idea for the final solution began by using Visir 2 externally attached to surveillance cameras to detect wavelengths of animate or inanimate objects that could be potential harm or instruments of crime in public spaces. It also detects movement and footfall. The data gathered from Visir2 will then be used to identify the correct placement of public lighting, as well as opportunities for personalization. MEGAMORPH will then be used to incorporate screens, HUDs, walls, sidewalks, and public lighting. Using MEGAMORPH improves public lighting technology and can be used for creative animation, interactive lights, changing colors, etc. In Figure 7, we present the interconnectivity between the chosen technologies.

This idea addresses issues on the lack of lighting or its poor quality, bringing in diverse groups to public spaces to promote social control and expanding the mobility of diverse minorities in public spaces, among others.

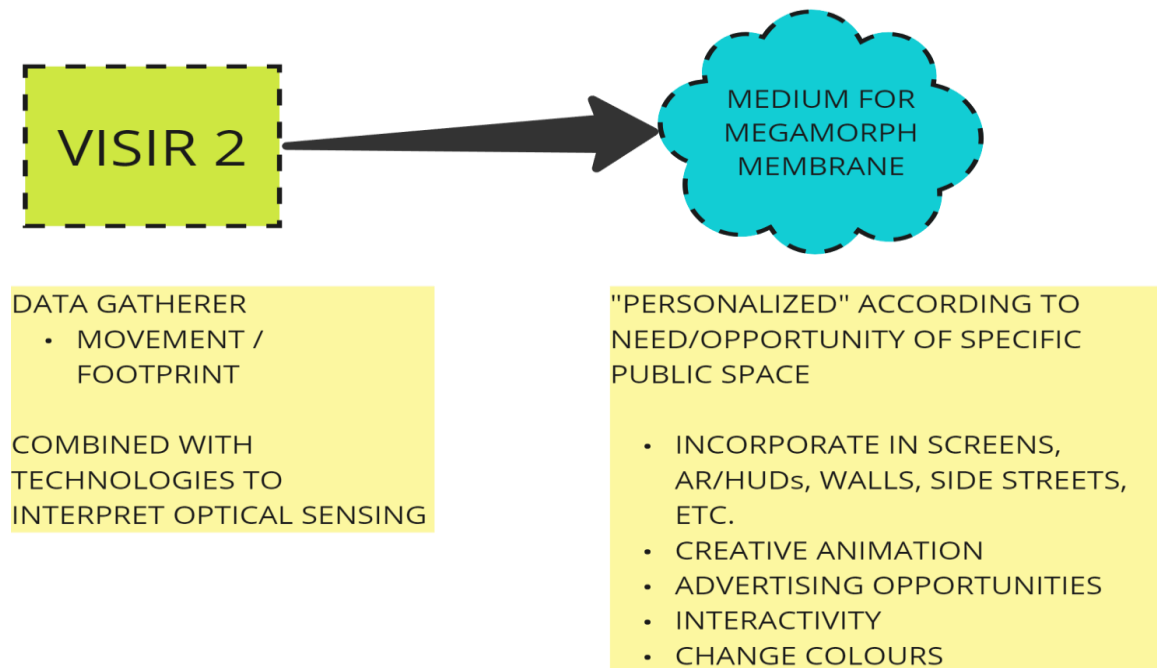


Figure 7. Attract Technology Implementation

However, after receiving feedback on this idea and questions being raised on the application of Visir 2, it posed many issues, privacy being the main one. Eventually the group decided to let go of this technology, realizing that our idea will still be as effective and more feasible in the context of Sense of safety and diversity in public spaces by only utilizing the MEGAMORPH technology.

At first, integrating both Visir 2 and MEGAMORPH into the final solution seemed like a perfect fit. Even though we as a group initially decided to pursue our solution further by integrating both of the technologies described above, after all we were forced to drop Visir 2 out of the final solution due to potential risk-factors and complications it might bring along, like already mentioned above.

This is how we eventually ended up with MEGAMORPH being the only one of the ATTRACT technologies to utilize in our solution to enhance lighting conditions and thus make cities and urban areas feel more welcoming, safe, and inclusive for a diverse group of citizens.

## 5 Final Solution

In this section we will present and discuss the final solution, which aims to tackle the issues presented in the earlier sections of this report.

### 5.1 System Level Description

People might feel a sense of unsafety in certain public spaces caused by risk of violence and harassment, poor lighting or complete lack of it, unmaintained surroundings (like buildings in bad condition or shabby train stations, etc.), and personal identities and biases. We came up with an idea that caters to the general public as end-users, however, the group that could potentially benefit the most out of it are the diverse minorities. This idea could be used by public office and urban planners or designers, incorporating it in the placement and planning of infrastructure, finally boiling down to bringing safer surroundings to all citizens.

The prototype consisted of two parts, whose core idea was formed during the team's ideation phase based on the background research conducted. MEGAMORPH technology enables the creation and enhancement of lighting conditions in places where achieving such conditions would usually be unreasonably difficult and/or expensive with existing technologies. These places include dark alleys, street turnarounds, unmaintained public parks and market squares, and road sections with relatively poor visibility due to intense lighting on main streets.

The background research revealed that the feeling of insecurity is intensified by the strong contrast between the dim lighting on the side streets and alleys, and the intense lighting of main roads. One of the significant advantages of the chosen technology is its ability to intelligently adapt to the prevailing lighting conditions, allowing the construction of a balanced lighting environment. Existing infrastructure can be updated, and additional lighting can be implemented in locations where adding infrastructure would be challenging, such as due to cost reasons.

Another key element of the suggested solution is to use the technology to create safer and more inclusive areas in the urban environment, such as downtown areas and/or suburbs. Research by Latham and Layton (2019) shows repetitive data about social control and how bringing diversity in public spaces enables this. People tend to feel a sense of safety with a diverse group of other people around them. To make this happen, we've come up with the idea to use the technology for creative, fun, cultural, and interactive displays. Local artists can be invited to digitally exhibit their work, augmented reality games, animated stories for kids, improving educational recreational spaces, are some ways in which the idea can be implemented.

By drawing diverse people to spaces that are currently being dominated by homogenous groups, a sense of community builds up and thereafter also builds a sense of safety. Using the technology for cultural purposes also creates an inclusive environment for all, which welcomes people to spend more time outside, thus bringing along strong social control in these areas as well.

## **5.2 Functional Description**

MEGAMORPH technology can be practically used in all displays due to its raw material, graphene, which is malleable (i.e., can be bent), and highly affordable. It presents a cost-effective solution for the public sector. It is also worth noting that MEGAMORPH is compatible with various sensors, allowing it to be integrated with a simple motion detector, enabling the lighting to respond to the level of activity in the street area.

Motion-responsive lighting can reduce the energy consumption and can also be used as a psychological tool to impact crime statistics. During the interview phase, it became apparent that drug use often occurs in areas with poor visibility. Acts of violence also frequently occur in places where visibility between the victim and the perpetrator is low – for example, park areas after sunset or shady alleys between low-usage buildings after office hours. Since MEGAMORPH significantly reduces the manufacturing costs of light-emitting devices, the lighting conditions in these areas can be significantly improved, which has a lowering impact on crime statistics.

During our interview with the MEGAMORPH expert, Dr. Santiago José Cartamil Bueno, we also understood that as a reflector of light, the technology can absorb and retain energy – i.e. making it function basically like a solar panel, thus enabling the construction of self-sustaining lighting. This would essentially lead to a technological revolution in various areas. It would be particularly significant in developing countries, where infrastructure is more often than not initially weak, and resources are scarce. These countries are facing multiple significant security threats, which could be significantly mitigated by a cost-effective and self-sustaining lighting system.

MEGAMORPH is suitable for use in practically any display device, making it applicable in numerous other commercial applications as well, e.g., offering a platform for advertising or marketing purposes. However, it is worth pointing out that we do not aim for deploying the presented solution primarily for capitalistic purposes, but this point of view is something to look into when considering possibilities to monetize the solution in later stages.

One major reason for the insecurity of women and minorities is the sexual harassment by men, the roots of which lie in upbringing and the culture. With the affordable MEGAMORPH technology, the construction of displays and thus various devices will undergo a revolution. The affordability of the

technology will help bridge the gap between developing countries and advanced nations. It will be easier to provide education and enlightenment abroad, which enables influencing a proper upbringing from an early stage. This, in turn, improves women's equality and safety, addressing the fundamental roots from which insecurity grows globally.

Affordable, energy-efficient, and high-definition display technology also enables the design of a more vibrant, communal, fun, and interesting urban environment. The graphene membrane is similar to the material used in heads-up displays or AR technology, which gives an opportunity to expand the usage of MEGAMORPH for socio-cultural purposes. Since the membrane is also malleable, it can bend into different forms and can be used to attach to different shapes of media. Refer to Figure 8 below, which presents the application of the technologies in our prototype.

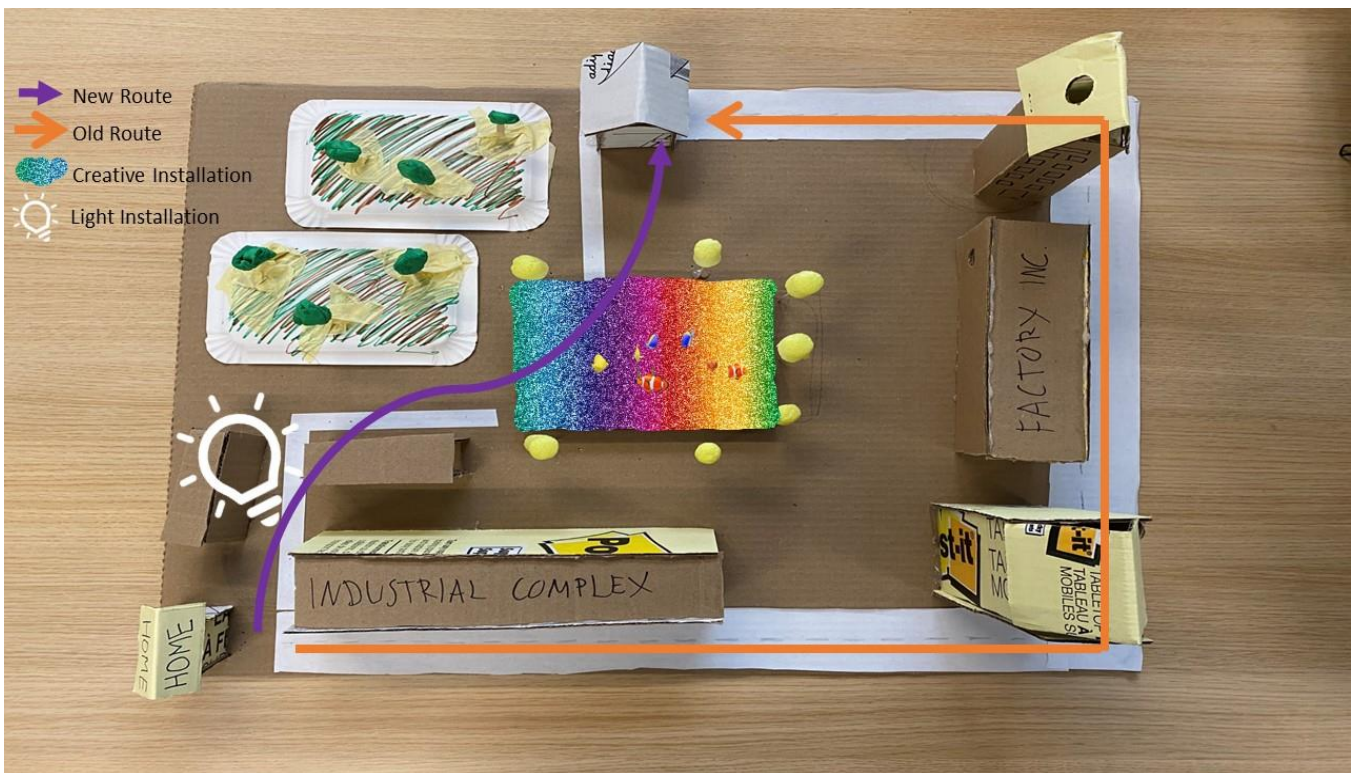


Figure 8. The Prototype

### 5.3 Use case description for Tara

Tara, 27, from Ghana, who works three different shifts as a nurse, often takes the long route around the buildings on the side of heavily trafficked roads to get to work, or to come back home, which takes a lot of time and effort and also puts her in danger around high speeding private cars. There is a shorter route which requires her to pass through an alley that has insufficient lighting in the evening. She's also heard rumors of violence and harassment happening there, which gives her a strong



feeling of unrest and anxiety. In addition, that alley leads to a market square where homogenous groups often stay which makes the space uninviting and causes her to avoid this route.

*How might we make the route through the dark alley and market square more safe, welcoming, and accessible to Tara?*

By using the MEGAMORPH technology, different types of light installations can be added to the dark alley. The technology will gather its energy during daytime and thus will consume less electricity when it is needed. The same technology will be introduced to the market square but in the form of a multimedia screen. There can be colored interactive lights or artistic displays and animations. In creating cultural, artistic, and interactive displays, we can build interest for the area and attract more people to stay for longer periods of time, instead of just passing through the space. This then creates a greater sense of safety, given the opportunity to be in the presence of diverse groups of people. Eventually, trouble-causing people will diffuse, making the area safer for many. Tara can now take the shorter route at any time of the day.

It is easy to personalize the usage of the MEGAMORPH technology according to the needs and opportunity of a specific space. Another way it can be used is to install screens with MEGAMORPH in the dark alley. The screens can be combined with thermal or optical sensors to detect movement. The screens will then display playful animated characters and numbers (that signify the number of people present in the space) when movement is detected to alleviate the sense of unsafety. Possibilities of educational AR events and the like are available too, which can be utilized in the market square.

#### **5.4 Scalability and societal Impact**

We have created a system solution that can be applied in many different ways. It is important to understand that this idea is not focused on adding more lighting infrastructure, but instead it is meant to address places and areas where lighting conditions are insufficient and/or needed. As the technology used for this solution, MEGAMORPH, is very affordable and flexible, the scalability of the idea increases. Figure 9 below shows the levels where our solution brings societal impacts.



Figure 9. Scalability and Societal Impact of the Solution Idea

The primary societal impacts of this idea are: Illumination, increased social control, visibility, inclusivity, providing better lighting for remote areas, attract more diverse crowds in public spaces, improved streetlight technology, saving energy, safe and inviting environment, sustainability, green energy, decreased acts of violence and harassment in public spaces, and accessibility. These impacts create another wave of impact that again creates another wave of impact, and therefore the positive cycle emerges. While the ideated solution remains simple, it generates multitude of opportunities and addresses many pains of urban society. Lighting itself will not solve the many problems of this world but it is definitely capable of affecting change.

## 6 Conclusion and Reflection

The project was initiated in response to a wide-ranging global social challenge: How can we promote the development of sustainable cities where everyone can live and thrive in safety, regardless of their cultural heritage or individual characteristics?

By harnessing ATTRACT technologies, we successfully developed a groundbreaking concept that has the power to influence the perception of safety, which, in turn, bolsters the self-confidence of vulnerable groups and effectively curbs criminal activities. As we embarked on this project, we recognized our deep interest in exploring the realm of soft social values, diverging away from the reliance on traditional hard statistical facts. We sought to unleash our creativity to discover a solution that could directly address security threats while simultaneously strengthening the psychological sense of safety. Our innovative solution, leveraging the cutting-edge MEGAMORPH technology, seamlessly integrates both of these aspects.

The scalability of our solution is further enhanced by the substantial cost savings it offers to cities and the public sector. It promotes sustainable development through significant energy savings, resulting in reduced carbon dioxide emissions. Moreover, it acts as a bridge, closing the gap between developed and developing countries, facilitating the export of education and knowledge transfer. Additionally, our solution strikes a chord with contemporary Western societies, as it can be easily integrated with artificial intelligence applications, enabling the creation of tailored and innovative solutions that cater to specific demographic groups.

In conclusion, the seemingly simple concept that initially sparked our interest has proven its immense potential by addressing various aspects of the challenges faced by sustainable cities. It approaches the topic holistically, combining practical and psycho-social perspectives. Furthermore, it equips us with powerful tools to influence interpersonal interactions, foster social cohesion, and establish social control within diverse urban environments. Additionally, it generates substantial cost savings for the public sector, making it an attractive solution beyond the confines of our theoretical framework. Unfortunately, the public sector faces chronic resource shortages, even in developed nations. Our solution becomes particularly critical in developing countries where infrastructural deficiencies in lighting persist. By providing a cost-effective solution, we can tangibly impact the conditions of these urban environments.

It is worth noting that while this solution primarily addresses lighting and its role in improving safety conditions, the MEGAMORPH technology's sensor capabilities open up countless possibilities for further refinement. As the technology can harness solar energy, it unlocks vast opportunities for future innovations and advancements.

## 7 References

Armitage, R., & Monchuk, L. E. 2012. Urban Streetscape Lighting and Crime: A Systematic Review. *Crime Science*, 1(4), 1-11.

openclassrooms 2020, Double Diamond Design Process URL:

<https://openclassrooms.com/en/courses/4555886-host-a-design-thinking-workshop/5071826-ideate-and-explore> Accessed June 12th, 2023.

Dupre, K., 2018. Trends and gaps in place-making in the context of urban development and tourism: 25 Years of Literature Review (2018). *J. Place Manag. Dev.*

<https://doi.org/10.1108/JPMD-07-2017-0072>

Framework for Innovation, Design Council. URL: <https://www.designcouncil.org.uk/our-resources/framework-for-innovation/> Accessed May 30th 2023.

Fiksu kaupunki 2022. Experimentation evaluation toolkit. URL: [https://fiksukaupunki.fi/wp-content/uploads/2022/12/Experimentation-evaluation-toolkit\\_fk\\_website.pdf](https://fiksukaupunki.fi/wp-content/uploads/2022/12/Experimentation-evaluation-toolkit_fk_website.pdf) Accessed May 5th 2023.

Fiksu kaupunki. 2022. Metrics for urban space. URL:

<https://fiksukaupunki.fi/toolbox/experimentation-evaluation-toolkit-metrics-for-urban-space-experiments/> Accessed May 5th 2023.

Gehl, J., 2010. *Cities for people*. Island Press, Washington, DC.

Haaga-Helia s.a., a, Virtual Ethnography. URL: <https://www.haaga-helia.fi/en/virtual-ethnography> Accessed June 12th 2023.

Haaga-Helia s.a., b, In-depth Interview. URL: <https://www.haaga-helia.fi/en/depth-interview> Accessed June 12th 2023.

Haaga-Helia s.a., c, Value Proposition Canvas. URL: <https://www.haaga-helia.fi/en/value-proposition-canvas> Accessed June 12th 2023.

Haaga-Helia s.a., d, Persona Mapping. URL: <https://www.haaga-helia.fi/en/persona-mapping> Accessed June 12th 2023.

Haaga-Helia s.a., e, How Might We..?. URL: <https://www.haaga-helia.fi/en/how-might-we> Accessed June 12th 2023.

Haaga-Helia s.a., *f*, Quick Voting. URL: <https://www.haaga-helia.fi/en/quick-voting> Accessed June 12th 2023.

Jacobs, J., 1972. The death and life of great American cities. Penguin Books, Harmondsworth, Middx., Engl.

Latham, A. & Layton, J. 2019. Social infrastructure and the public life of cities: Studying urban sociality and public spaces. *Geography Compass*, 13, pp. 1-15.

Norman, D.A. 2013. *The Design of Everyday Things*. MIT Press.

Painter, K. 1961. The Impact of Street Lighting on Crime, Fear, and Pedestrian Street Use. URL: [https://popcenter.asu.edu/sites/default/files/137-painter-the\\_impact\\_of\\_street\\_lighting\\_on\\_crime\\_fear\\_an.pdf](https://popcenter.asu.edu/sites/default/files/137-painter-the_impact_of_street_lighting_on_crime_fear_an.pdf). Accessed June 13th.

Peña-García, A., Hurtado, A., Aguilar-Luzón, M.C. 2015. Impact of public lighting on pedestrians' perception of safety and well-being. URL: [https://haaga-helia.finna.fi/PrimoRecord/pci.cdi\\_proquest\\_miscellaneous\\_1770361470?sid=2995080285](https://haaga-helia.finna.fi/PrimoRecord/pci.cdi_proquest_miscellaneous_1770361470?sid=2995080285) Accessed June 6th 2023.

Sarla, J. 2021. *Placemaking and suburban regeneration in Helsinki: ethnographic exploration into spatial and aesthetic experiences of public spaces in Malmi and Malminkartano*. University of Helsinki, Faculty of Arts.

Stickdorn, M., Hormess, M.E., Lawrence, A. & Schneider, J. 2018. *This is Service Design Doing: Applying service design thinking in the real world*. O'Reilly Media, Inc.

Vogiatzaki, M., Zerefos, S., Marzia, T. 2020. Enhancing City Sustainability through Smart Technologies: A Framework for Automatic Pre-Emptive Action to Promote Safety and Security Using Lighting and ICT-Based Surveillance. URL: [https://haaga-helia.finna.fi/PrimoRecord/pci.cdi\\_crossref\\_primary\\_10\\_3390\\_su12156142?sid=2995080285](https://haaga-helia.finna.fi/PrimoRecord/pci.cdi_crossref_primary_10_3390_su12156142?sid=2995080285) Accessed June 6th 2023.

What is Placemaking?, s.a. URL <https://www.pps.org/article/what-is-placemaking> Accessed June 12th 2023.

## 8 Annex

The message posted in the local Facebook groups of Malmi and Kannelmäki residential districts in Helsinki. Both language versions were posted in the same message:

### Finnish

Hei kaikki [Malmin/Kannelmäen] asukkaat ja alueen ystävät!

Olen osa korkeakouluopiskelijoista koostuvaa ryhmää, joka tutkii asuinalueiden houkuttelevuuteen, imagoon ja koettuun viihtyisyyteen liittyviä tekijöitä.

Olemme kiinnostuneita kuulemaan, mitkä tekijät sinun mielestäsi vaikuttavat alueen viihtyisyyteen ja turvallisuuden tunteeseen (tai niiden puutteeseen) [Malmilla/Kannelmäessä].

Arvostamme valtavasti, mikäli käytät muutaman minuutin aikaa kertoaksesi henkilökohtaisen kokemuksesi [Malmista/Kannelmäestä].

Voit jättää vastauksesi kommenttikenttään, tai halutessasi voit vastata minulle myös yksityisviestillä. Vastaaajien henkilöllisyyttä, nimeä tai mitään tunnistetietoja EI julkaista vastausten perusteella koostetussa työssä.

Kiitos jo etukäteen, että jaat meille ajatuksesi!

### English

Hi everyone,

I am a part of a group of students researching the factors related to the image, perceived attractiveness, and comfort in certain areas. We are interested in hearing what factors do you believe affect the enjoyment and sense of safety (or lack of them) in the [Malmi/Kannelmäki] area.

We highly appreciate you taking the time to leave your comments below, or if you feel like it, you can also reach me via direct message.

Respondents' names or any information related to the person will NOT be published in the final report.

Thank you already in advance for sharing your thoughts!