Understanding stakeholders' perspectives on the intangible and tangible impacts of public projects

By

Mourad Lagsir

in fulfillment of the requirements for the degree of

Master of Science
in Management of Technology

at the Delft University of Technology,
to be defended publicly on 21 - 12 - 2023

Student number: 5651476

Project duration: May - 2023 – December 2023

Thesis committee Management of Technology

1st supervisor:	Dr. A.C. (Sander) Smit	TU Delft, Economics of Technology and Innovation
Chairman:	Prof. dr. ir. Genserik Reniers	TU Delft, Safety Security and Science

Preface

The journey of completing my master thesis has been a transformative experience, filled with challenges, learning curves, and personal growth. I find myself filled with gratitude as I reflect upon the invaluable support and guidance I have received from various quarters. First and foremost, I extend my thanks to my supervisor, Dr. S. Smit. Your guidance has been invaluable, and your patience even more so. I particularly appreciate your support during the times when I struggled with structuring the thesis paper, feeling overwhelmed by the sheer amount of information and ideas in my head. You were there to help me organize it all, providing clarity and direction when I needed it the most. I would also like to extend my thanks to Prof.dr.ir. G. Reniers who not only served as the chair of my thesis committee but also invested his time to proofread my work. Furthermore, I am thankful to all the participants who generously shared their time and insights for this research. Your contributions have been invaluable, and they have significantly enriched the findings of this study. Finally, thank you to my family and friends, who have provided encouragement and motivation throughout this academic journey.

Executive Summary

Public projects play a crucial role in societal development yet managing them effectively requires a nuanced understanding of the expectations and concerns of different stakeholders. This paper explores the complex landscape of public projects, with a particular focus on understanding the diverse perspectives of various stakeholder groups and their perceptions of the tangible and intangible impacts of these initiatives. The existing literature has provided valuable insights into specific stakeholder perspectives and regional nuances, but it remains fragmented, leading to a piecemeal understanding of the broader landscape. Addressing this gap, the research introduces a structured model that combines the RACI model for stakeholder identification and the Triple Bottom Line (TBL) approach for categorizing impact factors. This model aims to bring clarity and consistency to the assessment of stakeholder priorities in public projects. The research question guiding this study is: How do distinct stakeholder groups perceive the intangible and tangible impacts of public projects? To assess the validity of the proposed model, we explored the practical application within the context of smart street lighting projects. utilizing semi-structured interviews with 16 stakeholders across the four RACI categories. The findings reveal shared concerns across stakeholder groups, particularly regarding privacy and security issues associated with smart lighting. However, notable differences also emerged, such as manufacturers' willingness to compromise social responsibility for economic gains and citizens' feelings of exclusion from decision-making processes. Based on these findings, several suggestions were made: 1) Establish a regular dialogue mechanism with stakeholders, ensuring that each group, especially citizens, is included in the decision-making process; 2) Address privacy and security concerns by incorporating robust data protection and cybersecurity measures into the smart street lighting systems; 3) Encourage manufacturers and other profit-driven stakeholders to align more closely with social and environmental responsibilities; 4) Use the Triple Bottom Line (TBL) approach to regularly measure and (publicly) report the economic, social, and environmental impacts of the smart street lighting project to maintain transparency. This study contributes to the existing body of knowledge by providing a nuanced understanding of stakeholder perspectives in public projects, offering a structured model for future studies, and paving the way for more informed and inclusive decision-making processes. The limitations of the study, primarily related to its regional focus and potential biases in participant selection, are acknowledged, underscoring the need for further research to validate and refine the proposed model.

Table of contents

Introduction

Public projects represent a unique intersection of governance, development, and public interest. At their core, public projects are initiatives undertaken by governmental bodies, often in partnership with the private sector, non-governmental organizations (NGOs), or international bodies, to serve or improve the public's well-being. They span a diverse range of sectors, from transportation and infrastructure to healthcare, education, and environmental conservation. Public projects play a pivotal role in shaping the urban environment and influencing the quality of life for citizens (Leite et al., 2022). This can mean addressing specific needs within a community, such as constructing a hospital in an underserved area, or responding to broader societal challenges, like building transportation networks to connect remote regions and stimulate economic growth (Pokharel et al., 2023). However, the goals of public projects are not singular or strictly utilitarian. Public projects like parks, museums, or community centers can provide spaces for cultural exchange, fostering community ties and promoting inclusivity (Patrick & McKinnon, 2022) . Furthermore, infrastructure projects, for example, can pave the way for commerce, attract investors, and create jobs (Veretennikov et al., 2021). Finally, with global attention pivoting towards environmental preservation, many public projects now also prioritize ecological conservation, such as urban green spaces or renewable energy initiatives (Semeraro et al., 2021).

Managing public projects is not without challenges. In today's digital age, public projects are no longer confined to traditional brick-and-mortar infrastructures. The integration of technology, such as the Internet of Things (IoT), artificial intelligence (AI), and big data analytics, into public initiatives has exponentially increased their complexity as these technological elements demand specialized expertise, intricate planning, and agile execution, ensuring that projects are not only completed but also remain relevant and adaptable to future technological shifts (Verhoef et al., 2021). Furthermore, the stakeholder landscape for public projects is expanding. Beyond the conventional government bodies and contractors, there's a growing involvement of civil society, local communities, international organizations, and even the general public facilitated by digital platforms (Council of Europe, 2021). Managing and aligning the expectations of this diverse stakeholder group adds layers of complexity. Each stakeholder brings their own vision, concerns, and priorities, necessitating a more intricate negotiation and decision-making process. Third, the global push towards sustainability has introduced a new dimension of complexity. Public projects are now expected to be environmentally friendly, socially inclusive, and economically viable (Yip et al., 2023). This triple bottom line approach requires a delicate balance of priorities. Projects need to assess and mitigate environmental impact, ensure social inclusivity, and remain economically feasible. This often means navigating a labyrinth of environmental regulations, socio-cultural sensitivities, and economic constraints. Finally, the rapid pace of urbanization presents its own set of challenges. As cities swell and urban landscapes evolve, there's a pressing need for adaptive and forward-thinking public projects (Zhang, 2015). These projects must address the immediate challenges of overcrowded cities, such as transportation and housing, while also future

proofing for demographic shifts, technological advancements, and potential climate change impacts.

In this research, we will delve deeper into the second aspect highlighted above, focusing on the varying priorities stakeholders have in public projects. The significance of understanding and addressing stakeholder interests has been underscored by recent events that have made headlines. For instance, in the Netherlands there have been a series of protest marches against asylum seeker centers in various locations such as Middelburg in October 2023 (Sep, 2023), Ter Apel in May 2023 (ANP, 2023), Heerenveen in September 2023 (Brinkman, 2023), and Albergen in August 2023 (van den Berg, 2023). In many of these cases the main complaint is regarding the lack of community involvement and transparency about the project (Brinkman, 2023; van den Berg, 2023). These protests are indicative of the complexities involved in managing stakeholder expectations and interests. Furthermore, the push for sustainable energy solutions has also seen its share of public resistance. Protests against offshore wind energy plants have been reported in places like Zandvoort in February 2023 and Noordwijk in April 2016. These events serve as a stark reminder that while the objectives of public projects may be noble and well-intentioned, their successful implementation hinges on the ability to navigate the web of stakeholder interests. Research further supports that a clear understanding of stakeholder interests is crucial for the successful implementation of public projects (Wang et al, 2023; Laird et al., 2020).

Considering the importance of aligning stakeholder interests, it becomes intriguing to delve into how various stakeholders perceive "success" in public projects, often referred to as "feasibility." The term "feasibility" is multifaceted, and its interpretation can vary significantly depending on the stakeholder in question. Research has noted differing views on success criteria among clients, contractors, and consultants (Lai & Lam, 2010). Whereas clients tend to focus on stakeholder satisfaction, budget adherence, quality, resource efficiency and profitability, contractors and design consultants prioritize minimizing cost, duration of the project and safety (Lai & Lam, 2010; Bryde & Robinson, 2005; Frödell et al., 2008; Toor & Ogunlana, 2010). In other words, a government body might view feasibility primarily in terms of policy alignment, budgetary constraints, and long-term societal benefits. On the other hand, a private contractor might prioritize project timelines, profitability, and technical execution. Local communities, in contrast, might emphasize the project's immediate impact on their daily lives, such as potential disruptions, benefits like job creation, or concerns about environmental degradation. In literature, the word "feasibility" in the context of public projects is often described as a set of technical (Schwender et al., 2015), economic (Bridgwater et al., 1995; Mukherjee et al., 2017), legal (Abdollahbeigi et al., 2017; Brodley et al., 1975), operational (Pollock et al., 2013; Roy et al., 2017), and scheduling considerations (Aiken et al., 1997). One study noted that in Arab countries it is common practice in feasibility study procedures to also include a social study (Abu-Zeid et al,, 2007).

While individual studies, such as those by Lai & Lam (2010), Bryde & Robinson (2005), and Abu-Zeid et al. (2007), provide valuable insights into specific stakeholder perspectives or regional nuances, they also inadvertently highlight the fragmented nature of current research. Each study tends to focus on a particular set of stakeholders, a specific region, or a distinct aspect of feasibility, leading to a piecemeal understanding of the broader landscape. This fragmented approach can result in significant blind spots when trying to holistically understand or manage stakeholder perspectives in public projects. Moreover, the lack of standardization in what aspects are studied or how they are defined further complicates matters. For instance, while one study might delve into the economic impacts, it might not define or measure these in the same way as another study. This lack of consistency makes it challenging to compare, contrast, or aggregate findings across different studies, thereby limiting the development of a comprehensive model or methodology.

In this research, we aim to address the aforementioned challenges of assessing stakeholder priorities in public projects by introducing a structured model. Our proposed model integrates the RACI model (Responsible, Accountable, Consulted, Informed) for stakeholder identification and the Triple Bottom Line (TBL) for assessing impact factors. To validate our model, we will apply it to smart street lighting projects, which offer a unique combination of technological, environmental, and societal factors, thus serving as an ideal testbed to demonstrate the model's ability to capture a comprehensive view of stakeholder perspectives. Our **research design** will adopt a qualitative approach, utilizing structured interviews to gather insights from 16 diverse stakeholders. Here we investigate:

How do distinct stakeholder groups perceive the intangible and tangible impacts of public projects?

The sub-questions guiding our research include: 1) What are effective methods to map stakeholders in public projects? 2) What are ways of mapping the intangible and tangible impacts of these projects? 3) What are the ways to measure and interpret stakeholders' perceptions of these impacts? By addressing these questions, our research aims to contribute significantly to the existing literature. It seeks to bridge the gap in standardized methodologies for stakeholder assessment and impact measurement in public projects. Ultimately, the findings could potentially offer a replicable and scalable approach, leading to more effective stakeholder engagement and project outcomes in various contexts.

Theory

2.1 Proposed model

As mentioned in the introduction, our proposed model is built upon two well-established methodologies: the RACI model for stakeholder identification and the Triple Bottom Line (TBL) for categorizing impact factors. A visual representation of the proposed model can be found in Table 1.

Stakeholder group (RACI)	**Social (TBL)**	**Economic (TBL)**	**Environmental (TBL)**
Responsible (R)			
Accountable (A)			
Consulted (C)			
Informed (I)			

Table 1: visual representation of the proposed model, with stakeholder groups as defined by the RACI model on the rows and impact factors as categorized by the Triple Bottom Line (TBL) approach on the columns.

2.1.1 Utilizing RACI stakeholder model

Mapping stakeholders is a multifaceted process, crucial to the success of any public project. There are several approaches to stakeholder mapping: the Power/Interest grid, which categorizes stakeholders based on their level of authority and concern regarding the project's outcomes (Pandi-Perumal, 2015); the Salience model, which considers stakeholders' power, legitimacy, and urgency (Mitchell et al., 1997), and finally the RACI model which accounts for the different roles stakeholders have in a project (Responsible, Accountable, Consulted and Informed) (Suhanda & Pratami, 2021).

The challenges of each of these tools are familiar. The Power/Interest grid is a straightforward tool that helps in prioritizing stakeholders but may oversimplify the complexity of stakeholder interactions. The salience model has neither of these downsides but might become cumbersome in projects with a large number of stakeholders, due to the intricate analysis required for each stakeholder. Additionally, it lacks a direct link to the execution phase of project management. Finally, the RACI model might struggle to provide clear differentiation in scenarios where multiple stakeholders share equal responsibility and accountability, Furthermore, in projects where roles

and responsibilities are constantly evolving or are intentionally kept fluid, the rigid structure of RACI might not capture the dynamism effectively.

The eventual decision to utilize the RACI model for the rows of the proposed model has several reasons. Public projects (the context of this research), by their very nature, are often governed by established institutional models and protocols. These governance structures typically outline clear roles and responsibilities for various stakeholders, reducing the potential for ambiguity or overlap of roles. Furthermore, given that public projects utilize taxpayer funds and impact the broader community, there's a heightened emphasis on transparency and accountability. This public scrutiny often necessitates clear role definitions to ensure that stakeholders know who to hold accountable for specific project outcomes. Additionally, While RACI may seem rigid, it can be adapted to the changing environment of a project. Roles can be redefined as the project progresses, which is often the case in public projects that can span across multiple years and political climates. Finally, by clearly identifying those who need to be consulted, the RACI model ensures that all the necessary stakeholders are engaged appropriately. This is particularly important in public projects that often require buy-in from multiple parties. In short, the RACI model's structured, comprehensive, and adaptable nature made it an ideal choice for the rows of the proposed model, ensuring that the matrix captures the diverse and multifaceted stakeholder landscape in many public projects.

2.1.2 Utilizing the Triple Bottom Line (TBL) approach

Public projects, by their very nature, have a wide range of impacts on the communities they serve. These impacts can be broadly categorized into two types: tangible and intangible impacts. However, these terms, due to their broad and general nature, lack specificity and can lead to ambiguity. Relying on such vague classifications can potentially introduce inconsistencies and hinder the process of qualitatively assessing the priorities of different stakeholder groups. That is why the TBL approach, which emphasizes the three pillars of economic, environmental, and social considerations, is particularly apt for the columns of the proposed model. Other assessment tools, such as Cost-Benefit Analysis (CBA), Social Return on Investment (SROI), and Environmental Impact Assessments (EIA), tend to focus on one or two of these domains. For instance, CBA primarily evaluates the economic aspects, SROI extends this to include social values, and EIA specifically looks at environmental impacts. These tools, while valuable, do not provide the same breadth of analysis as the TBL. As public projects often have long-term impacts and legacies, the TBL approach ensures that the model captures not just the immediate economic benefits of a project but also its long-term environmental and social impacts, ensuring that projects are sustainable and beneficial in the long run (Romano et al., 2021; Kuchta and Mrzygocka-Chojnacka, 2020). Furthermore, research has repeatedly underscored the equal importance of understanding the intangible as well as the tangible impacts of public projects. For instance, research on the Public Health Practice Evaluation Scheme in the UK has found that its objectives were too narrowly focused on (cost-)effectiveness of interventions. suggests that more funded time to develop a protocol and ensure feasibility of the intervention prior to application could increase intervention delivery success rates (van der Graaf et al., 2021). Second, Hudson and Poussin (2019) studied the impacts of flooding and found that the intangible impacts, such as mental stress, were larger

than the tangible impacts, such as property damage. Considering these findings, it becomes evident that a comprehensive model like the TBL, which encapsulates both tangible and intangible impacts across economic, environmental, and social dimensions, is a well-grounded choice for accurately assessing stakeholder priorities in public projects.

2.2 The tangible and intangible impacts of public projects

Given the importance of understanding both tangible and intangible impacts, it becomes interesting to explore the themes presented in literature in the context of public project impacts. This understanding will give us a firm basis for the interview question that are later to be asked to validate the model. A first tangible theme often studied in literature is infrastructure developments. These include the physical improvements of roads (Ahmed et al., 2022), bridges (Castelblanco and Guevara, 2022), buildings (Abolfazl et al., 2022), and public transportation systems (Simranjeet et al., 2022). A second tangible theme in literature describes the tangible environmental changes such as the alteration of landscapes (Royall, 2013; Grossman 2008), deforestation (Silva et al., 2017; Deacon et al., 1995), or the creation of parks and green spaces (Semeraro, 2021; Ugolini et al., 2022). A third, perhaps most obvious, tangible impact is the impact on economic growth due to e.g. direct job creation (Girma et al., 2008; Ivanov et al., 2020), and stimulation of local businesses due to project-related activities (Walker & Preuss., 2008; Bleda & Chicot, 2020). Finally, literature covers several tangible impacts on public health such as improvements or detriments due to factors like pollution control (Speight, 2020; Tulchinsky et al., 2023), sanitation facilities (Ngwenya et al., 2018; Moreira et al., 2021), and healthcare infrastructure (Bayer et al., 2007; Barlow et al., 2014).

On the intangible side, literature has also presented several themes. A first intangible theme often present in literature is social cohesion, which is broadly defined as the combined reasons to stay in a particular community (Clarke et al., 2023; Mouratidis & Poortinga, 2020). A second intangible impact theme is the impact on public environmental awareness. Projects can raise awareness about environmental issues or lead to complacency, depending on their nature and execution (Rustam et al., 2020; Agrawal et al., 2023). Third, literature covers several intangible impacts on feelings of safety or vulnerability, due to improved lighting in public spaces (Herbert et al., 1994; Markvica et al., 2019) or the introduction of surveillance systems (Fontes et al., 2022; Elharrouss et al., 2021). Finally, there is an intangible impact on cultural preservation. Projects can either help preserve cultural heritage or lead to its erosion, especially if they alter historically significant sites (Bleibleh & Awad, 2020; Zhou et al., 2022).

2.3 Stakeholder perspectives in public projects

Given the presence and importance of these tangible and intangible impacts and the importance of stakeholder inclusion in the decision-making process (Wang et al., 2023), it becomes interesting to explore the themes presented in literature regarding stakeholders' perceptions of

these impacts in public projects. This understanding will give us an idea of what to expect in the interviews which facilitates a discussion after the findings have been captured and presented. A first recurrent theme is that there is a notable difference in client versus contractor perspectives on project success criteria. Whereas contractors put more emphasis on minimizing project cost and duration, clients claim to put more emphasis on satisfying the needs of other stakeholders (Bryde & Robinson, 2005; Lai & Lam, 2010). However, in their actual project management practice clients show no stronger focus on meeting stakeholder needs than contractor organisations (Bryde & Robinson, 2005). Furthermore, all stakeholders seem to agree that effective risk management is the most critical success criterion (Robert & Chan, 2017), however there is a difference between the academic sector and the private & public sector on the second most critical criteria. The public and private sectors consider meeting output specifications as the second most critical criteria, whereas the academic sector considers satisfying the need for public facility/service as second most critical criteria (Robert & Chan, 2017). Finally, research has shown that potential complex interrelationships among stakeholders are the important factors affecting social stability risk (Wang et al.., 2023). For instance, within the context of water management, these are risks such as unequal access to water, exacerbating social inequalities and environmental degradation, impacting ecosystems and dependent communities (Wang et al.., 2023). Mandiriza and colleagues add there is a high pursuit of self-interest by various stakeholders impacting the pace of PPP adoption of municipal water projects in South Africa (Mandiriza, & Fourie, 2023).

Whereas current studies tend to focus on a particular set of stakeholders, a specific region, or a distinct aspect of feasibility, this proposed model offers a novel systematic and inclusive approach to analysing stakeholders in public projects. The model can be adapted to various project contexts, making it a versatile tool for different types of public projects, from infrastructure to community development. Second, the model acknowledges the importance of intangible impacts such as social cohesion, public environmental awareness, and cultural preservation, which are often overlooked in traditional stakeholder analysis. Finally, the model places stakeholders at the core of the analysis, recognizing that their perspectives and needs are most critical to the project's success.

In the subsequent chapters, we will delve into the empirical validation of the proposed model within the specific context of smart street lighting projects. This empirical research context serves as a critical testing ground to explore and understand the perceptions of distinct stakeholder groups regarding the tangible and intangible impacts of public projects. By conducting a significant number of interviews, with four representatives from each stakeholder group identified in the RACI model, the research aims to gather a breadth of insights that can transcend individual experiences and biases. This approach is designed to capture a more generalized understanding of stakeholder perceptions, which is crucial for answering the research question: "How do distinct stakeholder groups perceive the intangible and tangible impacts of public projects?"

Methodology

To validate and test the viability of the earlier proposed model, a contextual examination of "smart street lighting projects" will be undertaken. This examination is not just a test of the model's robustness and applicability, but it is also a demonstration of how the model can be applied in real-world scenarios. In this chapter we will first introduce the empirical context of smart street lighting projects, then methods of data collection will be explained and finally the chosen process of data analysis will be discussed.

3.1 Empirical Research Context

Smart street lighting (SSL) projects refer to the initiatives that involve the installation and management of street lighting systems that use sensors, connectivity, and data analytics to optimize energy consumption, enhance public safety, and provide various other services (Mahoor et al., 2020). These streetlights automatically adjust brightness based on real-time environmental conditions, such as pedestrian or vehicular traffic, time of day, and weather (Yang et al., 2020). Or, integrated with IoT (Internet of Things) technology, smart streetlights might also serve as hubs for a range of urban services, including monitoring air quality, providing public Wi-Fi, and assisting with traffic management (Kazmi et al., 2020).

Street lighting has undergone a significant evolution since its inception. Initially, streetlights were simple oil lamps or candles, often manually lit at dusk and extinguished at dawn (Stone, 2022). As cities grew and industrialization took hold, gas lamps became prevalent, offering a brighter and more reliable source of light. The late 19th and early 20th centuries saw the advent of electric streetlights, which further transformed urban landscapes, allowing for extended nighttime activities and improved public safety (Stone, 2022). However, the real revolution began in the 21st century with the integration of digital technologies. The convergence of LED lighting, sensors, connectivity, and data analytics gave birth to smart street lighting (SSL) systems (Mahoor et al., 2020). These modern systems not only optimize energy consumption by adjusting brightness based on real-time environmental conditions but also were aimed to enhance public safety and offer a plethora of urban services (Mahoor et al., 2020). Integrated with IoT technology, today's smart streetlights serve multifunctional roles, from monitoring air quality and providing public Wi-Fi to assisting with traffic management, marking a transformative shift from mere illumination to dynamic urban infrastructure (Kazmi et al., 2020; Mahoor et al., 2020; Balachandran et al., 2015).

Smart street lighting harnesses a combination of advanced technologies to create an interconnected and responsive urban illumination system. At the heart of this system are sensors that detect various environmental conditions, such as ambient light levels, pedestrian movement, and vehicular traffic. These sensors communicate with IoT devices embedded within the streetlights, enabling them to transmit data in real-time to centralized control systems (Mahoor et al., 2020). Using this data, the control systems can make informed decisions, such as adjusting

the brightness of individual or groups of lights. The integration of LED technology allows for this adaptive brightness, ensuring energy efficiency by providing optimal light levels based on real-time needs (Yang et al., 2020). Furthermore, these streetlights can be equipped with additional IoT devices to offer extended services, such as monitoring air quality or providing public Wi-Fi (Kazmi et al., 2020). The seamless interplay between sensors, IoT devices, and control systems transforms traditional streetlights into dynamic and intelligent urban assets that respond adaptively to the ever-changing needs of the cityscape (Kazmi et al., 2020).

In the deployment of smart street lighting projects, a diverse array of primary stakeholders play pivotal roles, each bringing their unique perspectives and contributions. Local governments, often the initiators and primary financiers of such projects, are responsible for setting the vision, ensuring public interests are met, and overseeing the project's implementation and integration into the existing urban infrastructure (Ricardo et al., 2022). Technology providers bring the necessary software and hardware solutions, ensuring that the systems are cutting-edge, reliable, and scalable (Ricardo et al., 2022). Their expertise is crucial in ensuring the seamless integration of sensors, IoT devices, and control systems. Citizens, as the end-users and beneficiaries of the enhanced lighting and additional urban services, provide valuable feedback, ensuring that the systems meet their needs and enhance their quality of life. Manufacturers and installation companies are the backbone of the physical deployment, producing the required components and ensuring their proper installation and functionality (Ricardo et al., 2022). Their expertise ensures that the streetlights are not only technologically advanced but also durable and suited to the specific environmental conditions of the area. Together, these stakeholders collaborate to transform traditional street lighting into dynamic, responsive, and multifunctional urban assets.

3.2 Data Collection

3.2.1 RACI delineation of stakeholders

In the realm of smart street lighting projects, the RACI model provides clarity on stakeholder roles. Manufacturers and installation companies, are designated as 'Responsible.' These entities are primarily responsible for the hands-on tasks related to the streetlights. This includes the manufacturing of the components, ensuring quality, and the physical installation of the streetlights. They ensure the work is done according to specifications and within the desired timelines. Asset managers, often synonymous with local governments, are 'Accountable' for the overall project ensuring that the objectives are met and that all stakeholders perform their roles efficiently. 'Consulted' are the tech companies, which, while supplying the hardware and software solutions, also play an advisory role in the technical aspects of the projects, ensuring state-of-the-art systems. Lastly, as the end-users of the smart street lighting system, citizens are kept informed about the project's progress, benefits, and potential disruptions. Their feedback is vital for continuous improvement and ensuring that the systems align with their needs. However, they are not directly involved in decision-making or implementation; thus, their primary role is to be informed and provide feedback when necessary.

3.2.2 Participant selection procedure

In qualitative research, the concept of saturation is a key factor in determining the adequacy of participant selection and data collection. Saturation is reached when additional interviews no longer produce new information or insights relevant to the research questions; essentially, it's the point at which further data collection becomes redundant. In our research, saturation was reached after four interviews for each of the four RACI stakeholder groups.

The 16 stakeholders were initially approached through email. This preliminary email introduced the research context and its overarching goals and inquired if the recipients were amenable to participating in a 45-minute interview via Microsoft Teams. If a positive response was received, a follow-up email containing a consent form was dispatched. At the start of the interview, participants were given the option to verbally consent to the terms outlined in the form. In situations where there was no email response, stakeholders were directly contacted by phone to gauge their interest. The approach differed slightly for citizens, given their unique stakeholder position. Here, the researcher personally visited Helmond, a city renowned for its smart streetlights. Four residents were approached and requested to be more observant of the smart streetlights over the upcoming week. A week post this interaction, these residents were contacted for an interview. Communication with them was maintained through a combination of WhatsApp and email, ensuring ease of coordination.

3.2.3 Interview Questions

The interview design chosen for this research was "semi-structured," providing a blend of flexibility and structure to capture the depth and diversity of stakeholder perspectives. The semi-structured interview was divided into two principal phases: the open-ended phase and the structured phase.

In the open-ended phase, the goal was to create an environment where interviewees felt encouraged to share candidly about their experiences, observations, and feelings related to smart street lighting. This phase was crucial in capturing the spontaneous and genuine reflections of the participants, often leading to insights that might not have been anticipated in a strictly structured interview. Example questions from the open-ended phase included:

- "Can you describe your initial impressions when you first encountered smart street lighting in your city?"
- "How has the introduction of smart street lighting impacted your daily life or routines?"
- "Are there specific features or aspects of smart street lighting that stood out to you?"
- "Can you share any positive or negative experiences you've had as a result of these streetlights?"
- "How do you perceive the role of smart street lighting in the future development of urban areas?"

Following this, the interview transitioned to the structured phase. Here, the questioning became more directed, focusing on specifics related to the Triple Bottom Line (TBL) domains, which encompass social, environmental, and economic factors. When focusing on the social domain of the Triple Bottom Line (TBL), questions were tailored to address pivotal social considerations, namely privacy, safety, and community impact. In this domain, example questions were:

- "How do you feel about the data collection capabilities of smart street lighting, especially concerning personal privacy? Do you have any concerns about how this data might be used or who has access to it?"
- "In your opinion, has the implementation of smart street lighting affected the overall safety of the area? Do you feel safer during nighttime activities or perceive a change in neighborhood security?"
- "Have you noticed any changes in community interactions or the general ambiance of the neighborhood since the introduction of smart street lighting? Do you think it has fostered a sense of community or altered the way people engage with public spaces?".

When moving to the economic domain of the Triple Bottom Line (TBL), questions were crafted to pinpoint key economic facets such as maintenance costs, energy bill reductions, and indirect economic benefits. Example questions were:

- Have you observed or are you aware of any changes in maintenance costs since the implementation of smart street lighting? Do you believe that these lighting systems are more cost-efficient in the long run compared to traditional streetlights?
- One of the touted benefits of smart street lighting is the potential reduction in energy bills for the city. Have you noticed or heard about any significant energy savings or bill reductions since their introduction?
- Beyond the direct savings, are you aware of any indirect economic benefits brought about by smart street lighting, such as increased business activities during nighttime hours or positive impacts on property values?

Finally, with respect to the environmental domain in TBL, questions were framed to probe the ecological and environmental aspects associated with smart street lighting. Here are four example questions focusing on ecological impact on wildlife, carbon footprint, light pollution, and electronic waste. Example questions were:

- Have you noticed or are you aware of any changes in local wildlife behavior or patterns since the introduction of smart street lighting? Do you have concerns about the lights' impact on nocturnal animals or local ecosystems?
- Smart street lighting is often presented as an eco-friendlier option due to its potential energy efficiency. Do you believe these lights have positively affected the city's carbon footprint, or have there been other unforeseen environmental trade-offs?
- Light pollution is a growing concern in urban areas, affecting both humans and the environment. Have you observed a decrease or increase in light pollution since the implementation of smart street lighting? How do you feel about its intensity and coverage?
- As technology continually evolves, electronic waste becomes an environmental concern. How do you perceive the potential e-waste implications of smart street lighting, especially when it comes to replacing or upgrading components?

3.3 Data Analyse

In the methodology chapter, we explore the detailed procedures and methods used for analyzing the data from the interviews conducted. The process began with transcribing the interviews using Whisper AI in Google Colab, followed by a comprehensive three-stage coding process. The initial stage, first-order coding, utilized GPT-4's advanced capabilities to assign preliminary codes to the transcribed data, followed by a manual review to ensure accuracy and relevance. The second-order coding process then grouped these initial codes into broader categories, creating a structured and navigable data landscape. The final stage, third-order coding, transitioned from categorized codes to overarching themes using MAXQDA, a qualitative data analysis software known for its visual and analytical prowess.

The eventual themes were analysed to find patterns and commonalities across stakeholder groups, leading to the creation of a codebook that highlights the top three themes in each group, ensuring a focused and representative analysis. This codebook allowed us to fill in the model as proposed in the theory section of this paper.

3.3.1 Transcribing the interviews

The transcription of the interviews was conducted using Whisper AI, an automatic speech recognition (ASR) system, in conjunction with the cloud computing power of Google. Before starting the transcription process, all the audio files from the interviews were gathered in Microsoft Teams files and prepared. This involved ensuring that the audio quality was good (volume), the removal of background noise through Apple's Logic Pro X software and exporting the files to .mp3 format.

Then a google Collaboratory notebook was created, the interview files were loaded in, and Whisper AI was accessed to start the transcription process. One of the significant advantages of using Google Colab, especially for sensitive tasks such as transcribing interviews, is its approach to data security. When you start a session in Google Colab, it allocates a virtual machine (VM) for you to run your code. This VM provides a temporary runtime environment for your session. Once your session ends or after a period of inactivity, Google Colab automatically terminates the VM, and all the files stored in the VM's local environment are deleted. This ensures that no residual data is left behind, providing an additional layer of security. Furthermore, all interactions with Google Colab occur over a secure HTTPS connection.

The python code that was used look as follows:

```
!pip install git+https://github.com/openai/whisper.git
!sudo apt update && sudo apt install ffmpeg
!whisper "Interview(X).mp3" --model large --language nl
```

This code produced .txt files of the transcribed data. After the transcription was completed, a quality assurance process was conducted to check the accuracy of the transcribed text. Any errors or inaccuracies were corrected manually to ensure the integrity of the data. Additionally, personal

identifiable data got replaced by an [X] manually, ensuring data privacy and adhering to data protection standards.

3.3.2 First-order Coding - using GPT-4

The first-order coding process was a meticulous task of dissecting the transcribed data into distinct segments, subsequently assigning relevant labels or codes to each segment based on its content. For this stage, we utilized the advanced capabilities of GPT-4. However, it is crucial to note that GPT-4 operates without prior knowledge of our specific research questions or objectives. To mitigate this and ensure alignment with our research impact domains—social, economic, and environmental—a manual filtering step was imperative. This additional layer of scrutiny ensured that only the codes pertinent to these impact domains were retained, enhancing the relevance and precision of our data analysis.

First, the transcribed text was inputted into a local system that utilizes GPT-4's natural language processing capabilities to automatically generate codes or labels based on the content of the data. The advantage of using a local system was that the transcribed data and generated codes remained on self-managed hardware which ensuring that it is not exposed to third-party servers or external networks. An illustrative set of first-order codes together with an illustrative example from the interview text can be found in Table 2**:**

First-Order code	**Example from text**
The approach of the company towards smart street lighting from a manufacturing perspective.	Wij benaderen slimme straatverlichting vooral vanuit een productie hoek...
Ensuring the company is qualified to integrate smart lighting modules.	We zorgen dat wij gecertificeerd zijn om het in te bouwen...
The ability to adapt and integrate various smart lighting modules based on customer needs.	Als de klant zegt wij willen met smart producent nummer A in zee, maar we willen jullie armaturen….
The advantages of smart street lighting in busy city environments.	Amsterdam is een hele drukke, volle binnenstad waar je eigenlijk zo min mogelijk wilt zijn als onderhoudspartij.

Table 2: Four illustrative examples of how First-Order codes were found.

Here a total of 330 (all unique) first-order codes were identified. The complete set of codes can be found in **Appendix A.**

Second, a quality check was conducted to check the accuracy of the first order codes. During this manual filtering step, particular attention was given to the relevance of the codes in relation to the empirical context of our study. Codes that were related to the respondent's role, general company activities, or other aspects not directly tied to the social, economic, or environmental impact domains were deemed not relevant. These were codes such as: "The respondent's

appreciation for the research topic" ; "Greetings by the respondent" "The respondent's experience in the public domain, especially in large infrastructure projects like tunnels, bridges, and sluices" ; "Mentions the distinction between the company's products and other companies focusing on motion sensors"

By excluding codes that did not align with the empirical context, we were able to streamline the dataset, enhance its relevance.

3.3.3 Second-order coding - manually

The second-order coding process was a crucial step in refining the data analysis, building upon the extensive set of first-order codes generated by GPT-4. we manually grouped the filtered first-order codes into broader categories, effectively reducing the number to 87 second-order codes. This not only made the data more manageable but also facilitated the creation of a comprehensive and standardized codebook, ensuring consistency and uniformity across all interviews.

An illustrative example of this process can be found in Table 3:

First-Order Code	Second-Order Code
Discusses the difference between actual safety measures and measures that only provide a feeling of safety, using tunnel projects as an example.	The potential of smart lighting to create a false sense of security.
Mentions the potential disconnect between technological solutions and genuine societal safety.	
Mentions the high costs associated with creating detailed proposals for public projects.	High financial initial costs influencing decisions on smart city projects.
Mentions the market's reluctance to pay for certain societal benefits.	

Table 3: Four illustrative examples of how First-Order codes were converted to second-order categories.

A complete list of second-order codes can be found in **Appendix B**. With the standardized codebook in hand, these second-order codes served as the foundational building blocks for the identification of overarching themes in the data.

3.3.4 Third-order coding – using MAXQDA

The transition from second-order codes to overarching themes was facilitated using MAXQDA, a qualitative data analysis software renowned for its advanced visual capabilities. Opting for MAXQDA over GPT-4 was a strategic choice, driven by the software's ability to provide clear and intuitive visual representations of the data. In this phase, second-order codes were imported into MAXQDA. This process culminated in the identification of overarching themes. The relationships between the themes and their underlying second-order codes were presented by MAXQDA as illustrated in diagram 1.

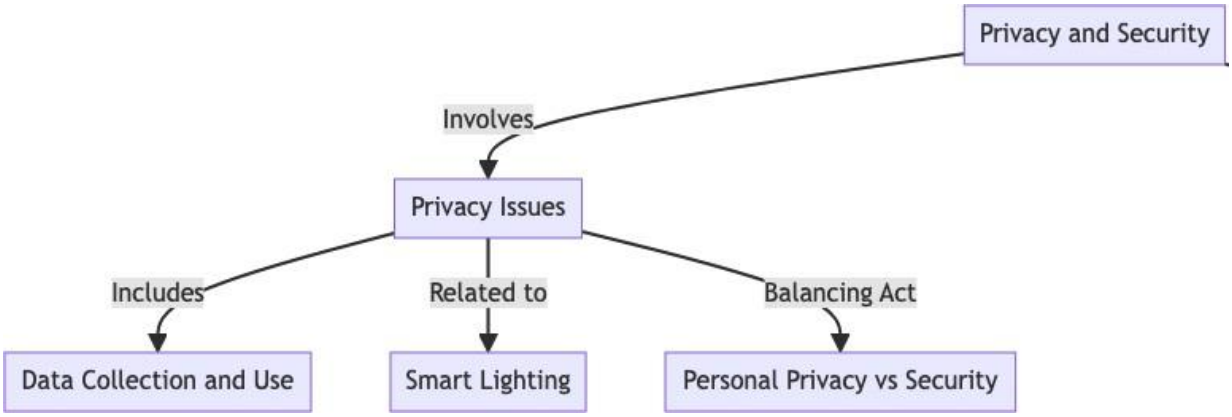

Diagram 1: visual representation of 1 overarching theme and its relationship to several second-order codes

In **Appendix C** a full list of themes and their underlying second order codes can be found. Additionally, Table 4 presents a comprehensive codebook generated from these themes, serving as a valuable resource for further analysis and interpretation.

Domain	Theme	Frequency in stakeholder group (R, A, C, I)	Example from text
Social	Privacy and Security:	(10, 3, 4, 4)	"Maar je kan ook denken we gaan er bewegingsmelders op zetten zodat we kunnen monitoren hoeveel mensen er in de stad lopen."
	Community and Public Perception:	(2, 2, 1, 8)	"Nee. Er was totaal geen betrokkenheid. Nee, geen brief, niks."
	Safety and Accessibility:	(2, 3, 3, 4)	"Sensoren die wegen verlichten als iemand passeert kunnen schijnveiligheid creëren"
	Cultural and Social Impact:	(1, 1, 2, 2)	"Ja stel als je een lantaarnpaal voor je slaapkamer aan hebt, is dat wel minder intens dan een witte, denk ik"
	Governance and Accountability:	(4, 0, 5, 0)	"In principe leggen wij de verantwoordelijkheid van de evaluatie bij de opdrachtgever."

	Communication and Transparency:	(4, 2, 1, 1)	"Het is duidelijk dat er een gebrek is aan inzicht en transparantie over welke apparaten waar hangen"
Environmental	Energy Efficiency and Sustainability:	(9, 8, 7, 3)	"Bijvoorbeeld, voor lantaarnpalen die slechts 14 watt verbruiken, levert het terugdimmen met 80% een besparing van slechts ongeveer 10 watt op"
	Product Lifecycle and Waste Management:	(3, 1, 3, 1)	"Neem bijvoorbeeld Rijkswaterstaat: voor een recent project hebben ze bedacht om armaturen niet meer individueel in plastic te verpakken"
Economic	Cost-Benefit Analysis and Financial Implications:	(12, 3, 7, 0)	"Onze primaire focus met slimme verlichting is economische winst voor onze klanten"
	Market Trends and Industry Dynamics:	(6, 1, 5, 1)	"No and that is because whilst in the Netherlands, Belgium, France this might be up and coming, unfortunately, this is not the case in many other countries around the world."
	Infrastructure and Technological Integration:	(9, 5, 8, 0)	"Bijvoorbeeld, lampen met Signify technologie kunnen beheerd worden met Luminizer, onze software. Maar het Interact-systeem van Signify kan enkel hun eigen lampen aansturen."
	Future-Readiness and Innovation:	(2, 2, 2, 0)	"Vaak kiezen onze klanten voor een Smart Ready armatuur zonder het direct te gebruiken"

	Policy and Strategy:	(0, 2, 1, 0)	"Deze uitdagingen moeten niet op projectbasis worden aangepakt, maar vanuit een beleidsoogpunt."

Table 4: codebook of third-order themes

Results

In this chapter, we'll showcase and analyse the results of our study, integrating the identified themes into the final model to highlight key outcomes and explore differences and similarities across various stakeholder groups. To ensure the model's relevance, we've selectively included themes linked to the top three second-order codes from each stakeholder group, based on how frequently they occurred in the codebook mentioned earlier. Filling in the model with the (relevant) themes we get the following result as shown in Table 5:

Stakeholder group (RACI)	Social (TBL)	Economic (TBL)	Environmental (TBL)
Responsible (R)	1) Privacy and Security:	1) Cost-Benefit Analysis and Financial Implications 2) Infrastructure and Technological Integration 3) Market Trends and Industry Dynamics	1) Energy Efficiency and Sustainability: 2) Product Lifecycle and Waste Management:
Accountable (A)	1) Privacy and Security 1) Safety and Accessibility 2) Communication and Transparency 3) Cultural and Social Impact	1) Infrastructure and Technological Integration 2) Cost-Benefit Analysis and Financial Implications 3) Future-Readiness and Innovation: 3) Policy and Strategy	1) Energy Efficiency and Sustainability: 2) Product Lifecycle and Waste Management:
Consulted (C)	1) Governance and Accountability: 2) Privacy and Security 3) Safety and Accessibility 4) Community and Public Perception: 5) Cultural and Social Impact	1) Infrastructure and Technological Integration 2) Cost-Benefit Analysis and Financial Implications 3) Market Trends and Industry Dynamics	1) Energy Efficiency and Sustainability: 2) Product Lifecycle and Waste Management:
Informed (I)	1) Community and Public Perception 2) Privacy and Security 2) Safety and Accessibility 3) Cultural and Social Impact	1) Market Trends and Industry Dynamics	1) Energy Efficiency and Sustainability: 2) Product Lifecycle and Waste Management:

Table 5: filled in model, showing the relevant themes per stakeholder group per TBL domain, in hierarchy based on frequency.

Due to the sensitive nature of the interview data, we've ensured strict confidentiality and adherence to privacy and ethical standards, thus keeping the full transcriptions available upon request.

4.1 Quick analysis of the model

If we look at the filled-in model above several things catch the attention:

- Infrastructure and technological integration emerged as a primary theme among Asset Managers (Accountable) and Tech Providers (Consulted), indicating a focus on integrating new technologies within existing infrastructures.
- Manufacturers (Responsible) predominantly focused on cost-benefit Analysis and financial Implications, suggesting a prioritization of financial metrics and economic outcomes in their decision-making.
- Asset Managers (Accountable) did not prioritize market trends and industry dynamics, potentially indicating a lesser focus on the market-driven shift towards sustainability.
- The Informed group differed by not emphasizing cost-benefit analysis and financial implications as the other stakeholder groups did, hinting at a different perspective on economic evaluation.
- The Responsible and Accountable groups showed a heightened concern for privacy and security issues, reflecting a priority on safeguarding stakeholder information and system integrity.
- Tech providers (Consulted) uniquely emphasized governance and accountability, which may reflect challenges in identifying clear lines of regulatory responsibility and outcome ownership.
- The informed group notably prioritized community and public perception more than other groups, suggesting an awareness of the social impact and the importance of public engagement.
- There was no marked difference in the prominence of the themes of energy efficiency and sustainability versus product lifecycle and waste management, although the latter was less mentioned by the Accountable and Informed groups, which may indicate varying degrees of engagement with environmental stewardship practices.
- Energy efficiency was uniformly important across all stakeholder groups, albeit slightly less so for the Informed group, indicating a general but not universal recognition of its importance in sustainability efforts.

This analysis reveals differentiated priorities and perceptions across the RACI stakeholder groups, which can inform targeted engagement strategies and project management decisions to align with the varied interests and areas of focus. The implications will be described in the discussion chapter.

4.2 Extensive Analysis per stakeholder group

4.2.1 Stakeholder group 1 | Responsible

Looking at the first stakeholder group, the **Responsible** manufacturers and installation companies several things were noteworthy. The most frequently mentioned theme was "Privacy and Security". The manufacturers seem to worry about potential privacy risks related to the collection and use of data. Examples from the interviews were:

> "Maar je kan ook denken we gaan er bewegingsmelders op zetten zodat we kunnen monitoren hoeveel mensen er in de stad lopen. Je kan er zelfs camera's aan ophangen. Wie lopen er? Dan wordt er wel heel veel data door gemeenten ineens verzameld. En ja, hoe gaat de gemeente daar mee om….?"
>
> – Respondent 1

> "Ik denk dat het gewoon van deze tijd is. Kijk zodra je op persoonsniveau dingen kan volgen, of mensen herkenbaar kan volgen inderdaad, ja dat moet je gewoon voorkomen. Dat wil niemand."
>
> - Respondent 2

Yet, when asked about it, none of the manufacturers mentioned they would reject potential parties to sell to based solely on their data privacy policies. This potentially highlights a complex balancing act that manufacturers find themselves in, navigating between safeguarding privacy and security while also pursuing profitable opportunities and partnerships.

The second dominant theme was "Cost-Benefit Analysis and Financial Implications". The manufacturers state that while smart lighting entails higher upfront costs, it brings along a plethora of indirect benefits that can lead to significant cost savings in the long run. Such as maintenance costs savings:

> "Wat volgens mij belangrijker is, waar geld op bespaard kan worden, is dat je je verlichting op afstand kan monitoren. Vroeger moest je simpelweg met een auto door de stad gaan rijden en kijken welke zijn een stuk. Of je besloot nou, we gaan gewoon om de vijf jaar vervangen we alle lampen, of ze nou stuk zijn of niet. Ja, en nu geeft de computer dat aan."
>
> – Respondent 1

> "Met slimme, verbonden verlichting worden storingen automatisch gemeld, waardoor deze inspectierondes overbodig zijn."
>
> – Respondent 3

And economic benefits derived from the possibility to do better urban planning due to data insights:

"De grootste winst zit in het hebben van inzicht in wat er staat en de grip hebben op gegenereerde informatie voor toekomstig gebruik. Hoewel smart lighting slechts een deel is van de smart city, kan het bijdragen aan inzicht in mobiliteit en hoe mensen zich door de stad bewegen."

– Respondent 4

However, they also highlight their relative lack of influence in the final decision-making process, which can impede the deployment of smart streetlights.

Two other themes share a third place together in terms of relevance. These include challenges related to infrastructure and technological integration such as interoperability and electricity grid concerns:

Er is nog een uitdaging trouwens. Er zijn nu meerdere aanbieders van slimme verlichting. Die zijn allemaal gekoppeld aan programma's. Die moeten ook allemaal beheerd worden door gemeentes. Er is nog niet een eenduidig protocol daarvoor. Dus je ziet ook wel eens projecten dat jee denkt er is een hele mooie slimme verlichting aangekocht en twee jaar later is de betreffende ambtenaar vertrokken en niemand weet meer hoe je het licht moet dimmen.

– Respondent 1

Met een verlichtingsinfrastructuur heb je al een grid door de stad. Het huidige nadeel in Nederland is dat dit grid alleen 's avonds beschikbaar is vanwege de spanningsloosheid overdag. Met een 24/7 beschikbaar grid en meerdere sensoren kun je veel meer data verkrijgen en dit kan leiden tot nieuwe inzichten en mogelijkheden, hoewel dit nu nog toekomstmuziek is

– Respondent 4

and the theme "Energy Efficiency and Sustainability" in which the manufacturers pointed out their commitment to sustainable and eco-friendly practices as well as the increasing market emphasis on energy conservation:

Onze hoofdbestanddelen van onze armaturen zijn koper en brons. Ja, dat is allebei gerecycled koper en gerecycled brons.

– Respondent 1

Sustainability is absolutely one of our core values.

– Respondent 3

Wanneer we gemeenten als eindklanten bezoeken, bespreken we thema's zoals diervriendelijke verlichting, circulariteit en duurzaamheid, omdat deze punten van groot belang zijn voor hen maar ze zijn ontzettend lastig uit te drukken in geld dus dat doen we niet.

– Respondent 4

In short, while these stakeholders possess a robust understanding of the potential implications of smart street lighting, their relative lack of influence in the final decision-making process hinders

the potential growth and improvement of these projects. In essence, this group, equipped with valuable insights and expertise, finds itself in a challenging position. They are well-aware of the benefits and pitfalls of smart lighting but face obstacles in articulating and impressing these perspectives upon the primary decision-makers: the accountable group.

4.2.2 Stakeholder group 2 | Accountable

Looking at the second stakeholder group, the **Accountable** asset managers several things were noteworthy. Throughout the interviews, four themes were equally dominant over the others namely:

1. "Infrastructure and Technological Integration",
2. "Energy Efficiency and Sustainability"
3. "Cost-Benefit Analysis and Financial Implications".
4. "Privacy and Security"

Regarding the first theme, the asset managers seem to acknowledge the ability of the lighting system to serve multiple functions such as providing lighting to assist tasks:

> Wat betreft het voorbeeld van integratie tussen laadpalen en slimme verlichting, het enige scenario dat ik me kan voorstellen, is wanneer iemand 's nachts de stekker uit een laadpaal haalt, dat dan het licht, dat op dat moment op een zeer laag niveau is gedimd, iets oplicht ter ondersteuning van die actie.
>
> – Respondent 1

, serve as an internet spot:

> Als ik het me goed herinner, was de telecomprovider KPN geïnteresseerd. Dat is ook logisch, aangezien ze een direct voordeel zouden hebben als er 5G connectiviteit in de lichtmasten zou zitten.
>
> – Respondent 1

, detect crimes:

> Deze sensoren waren zo ontworpen dat ze lokaal konden bepalen welk type incident plaatsvond, zonder real-time te luisteren
>
> – Respondent 3

Or event-based lighting to improve the ambience:

> In de binnenstad kan verlichting dynamisch worden aangepast aan sociale evenementen om de sfeer prettiger te maken.
>
> – Respondent 2

Next, while discussing the second theme "Energy Efficiency and Sustainability," asset managers predominantly highlighted the positive effects of improved lighting on the natural environment.

De keuze voor adaptieve verlichting in het park was ecologisch gemotiveerd, niet voor de veiligheid van de fietsers.

– Respondent 2

Bij ons ligt de focus, vooral vanuit het oogpunt van metingen, meer op ecologie en flora en fauna dan op sociale aspecten.

– Respondent 3

It is worth noting that the topic of energy reduction, which might seem like the most direct and apparent benefit of energy efficiency, was not brought up as frequently as the impacts on the natural environment. This observation suggests a nuanced understanding and prioritization of sustainability among asset managers, emphasizing broader environmental benefits over the more immediate and tangible gains from energy savings.

Regarding the third theme, "Cost-Benefit Analysis and Financial Implications," asset managers expressed significant concern about the high initial investment costs associated with implementing new technologies. These upfront costs play a crucial role in the final decision-making process, often serving as the determining factor for whether to proceed with the adoption of relatively new technologies. One asset manager provided a clear example of this, stating:

"Het opzetten van dergelijke infrastructuur, inclusief een open urban data platform, zou miljoenen kosten, wat ons te risicovol leek."

– Respondent 4

This respondent later showed her/his willingness to test the technology if it wasn't for the high initial investment costs:

Mocht het om een lager bedrag zijn gegaan, dan had ik overwogen om op kleinere schaal een pilotproject te starten in een specieke wijk.

– Respondent 4

Lastly, the theme of "Privacy and Security" was prominently highlighted by the asset managers, indicating a strong awareness of potential privacy issues and risks associated with the collection and use of data. The respondents acknowledged the importance of safeguarding privacy while utilizing technology for various purposes.

Respondent 2 shared their experience in Nijmegen, stating:

"In Nijmegen hebben we diverse sensoren geïnstalleerd, waaronder ook camera's voor bepaalde tellingen. Echter, deze camera's slaan expres niets op."

– Respondent 2

Reflecting a conscious effort to mitigate privacy risks by ensuring that the cameras do not retain any recorded data.

Similarly, Respondent 4 emphasized the gravity with which privacy is treated in their municipality, stating:

> "In de gemeente Amersfoort nemen we privacy uiterst serieus..."
>
> – Respondent 4

In conclusion, the accountable asset managers have demonstrated a comprehensive understanding and consideration of various themes crucial to the implementation of advanced lighting systems. They have acknowledged the multifunctionality of lighting infrastructure, recognizing its potential to enhance task visibility, provide internet connectivity, deter crime, and improve ambiance during social events. Their discussions on energy efficiency and sustainability have underscored a strong commitment to environmental stewardship, with a notable emphasis on the positive impacts of lighting on natural ecosystems, rather than focusing solely on energy reduction. Financial implications, particularly the high initial investment costs, have been identified as the most significant factors influencing decision-making processes, highlighting the need for careful cost-benefit analysis in the adoption of new technologies. The asset managers have also shown a keen awareness of privacy and security concerns, ensuring that data collection and usage are conducted responsibly to protect individual privacy. Overall, this stakeholder group has exhibited a balanced and thoughtful approach, weighing the multifaceted benefits and challenges of advanced lighting systems to make informed decisions that align with broader sustainability and ethical considerations.

4.2.3 Stakeholder group 3 | Consulted

Looking at the third stakeholder group, the **Consulted** tech companies, four themes were equally dominant over the others namely:

1. "Infrastructure and Technological Integration"
2. "Energy Efficiency and Sustainability"
3. "Policy and strategy"
4. "Safety and accessibility"

In discussing the first theme of "Infrastructure and Technological Integration," technology companies, aligning with the previous group of asset managers, recognize the multifunctional capabilities of smart lighting systems. They see these systems as more than just sources of illumination; they are platforms for a variety of technological integrations.

For instance, Respondent 4 highlighted the integration of diverse functionalities into the lighting infrastructure, just like what one might find in a smartphone or a smart refrigerator. They mentioned,

> "We integreren functies zoals temperatuurregistratie, detectie van scheefstand van de mast, GPS en andere sensoren vergelijkbaar met wat een smartphone of slimme koelkast heeft."
>
> – Respondent 4

, underscoring the potential of smart lighting systems to serve as comprehensive data collection hubs, capturing a wide array of environmental and operational information.

Furthermore, the technology companies envision smart street lighting as a foundational platform that can support and enhance other smart city initiatives. Respondent 4 further elaborated on this vision, stating,

> "Secundair zien we onze armaturen als een platform waarop andere technologieaanbieders kunnen inhaken."
>
> – Respondent 4

This perspective reflects a forward-thinking approach, where smart lighting is not seen in isolation but as an integral part of a broader, interconnected urban ecosystem.

When it comes to the second theme of "Energy Efficiency and Sustainability," technology companies are keen to highlight their dedication to adopting sustainable and environmentally friendly practices. They emphasize that their commitment goes beyond just meeting customer demands; it is a core part of their organizational culture and values.

Respondent 1 from the technology companies expressed this sentiment clearly, stating,

> "We doen het niet alleen omdat klanten het eisen; het is inmiddels een integraal onderdeel van onze bedrijfscultuur geworden."
>
> – Respondent 1

, indicating that their eco-friendly practices are not just a response to market demands but are deeply ingrained in the company's ethos.

On the other hand, Respondent 2 brought attention to the global scale of the issue, particularly focusing on the use of materials in lighting infrastructure. They pointed out,

> "Wereldwijd zijn er veel lichtmasten, en hoewel aluminium een duurzaam materiaal is, heeft het grootschalig gebruik ervan invloed op onze beperkte grondstoffen."
>
> – Respondent 4

The comment highlights a critical awareness of the environmental impact of their products, acknowledging the need for responsible material usage given the vast number of light poles worldwide.

In the discussions surrounding the third theme of "Policy and Strategy," technology companies highlighted the need to strike a balance between ensuring safety and promoting environmental sustainability. They recognize that while smart street lighting has the potential to contribute to various urban goals, the primary focus for municipalities tends to be on safety and traffic-related objectives.

Respondent 1 pointed out that municipalities are fundamentally driven by the desire to enhance safety, traffic flow, and road safety, rather than a direct pursuit of smart street lighting. They stated,

"Een gemeente streeft in de kern niet naar slimme straatverlichting, maar naar aspecten zoals veiligheid, doorstroming en verkeersveiligheid."

– Respondent 1

Respondent 2 echoed this sentiment, emphasizing the critical role of lighting in providing safety and maintaining safe traffic conditions. They remarked,

"In mijn ogen is de primaire functie van verlichting veiligheid te bieden en het verkeer veilig te houden..."

– Respondent 2

However, Respondent 4 brought attention to a potential challenge associated with smart lighting, noting that motion-activated systems can sometimes make people feel uneasy or "caught" when they trigger the lights. They shared,

"Gebaseerd op de onderzoeken die we hebben laten uitvoeren, merken we dat mensen, net zoals bij de bewegingssensor bij een garage, zich betrapt kunnen voelen wanneer ze in beweging zijn."

– Respondent 4

This insight suggests that while pursuing safety and environmental goals, technology companies also need to be mindful of the user experience and potential psychological impacts of their systems.

In addressing the final theme of "Safety and Accessibility," technology companies underscored the potential of smart street lighting to enhance public safety and adapt to various situations. They highlighted the flexibility of these systems to adjust lighting levels in response to different circumstances, ranging from emergencies to public events.

Respondent 2 illustrated the adaptability of smart lighting, explaining how it can be dimmed during quiet periods for energy efficiency, while being brightened during times of unrest or during events to enhance safety. They stated,

"Zo kan in rustige tijden de verlichting gedimd worden, terwijl deze bij onrust of tijdens evenementen feller kan worden gezet."

– Respondent 2

This showcases the dual benefits of energy savings and improved public safety. Further emphasizing the safety aspect, Respondent 2 provided a practical example of how smart lighting can be used proactively in areas with high crime rates. They mentioned,

"Een praktisch voorbeeld is een wijk met veel inbraken; hier kan de verlichting tijdelijk verhoogd worden voor extra veiligheid, tot vreugde van de bewoners."

– Respondent 2

This highlights how smart street lighting can be a responsive tool for community safety, directly addressing residents' concerns. Respondent 4 brought a unique perspective to the discussion,

pointing out the potential of using specific colors in lighting to contribute to national events. They said,

> "Ja, we geloven zeker dat specifieke kleuren, zoals oranje of rood, een bijdrage kunnen leveren tijdens nationale evenementen."
>
> – Respondent 4

, thus introducing an additional layer to how smart street lighting can be utilized, not just for safety and efficiency, but also for community engagement and celebration.

In conclusion, the Consulted Tech Companies have provided a comprehensive and insightful perspective on the role of smart street lighting within urban environments, touching upon crucial themes such as "Infrastructure and Technological Integration," "Energy Efficiency and Sustainability," "Policy and Strategy," and "Safety and Accessibility. These companies have showcased a strong commitment to sustainability, embedding eco-friendly practices within their organizational culture, and acknowledging the global implications of material usage in lighting infrastructure. They have also highlighted the necessity of balancing safety and environmental sustainability, emphasizing the primary role of lighting in ensuring public safety, while also being mindful of the potential psychological impacts on individuals. The adaptability of smart lighting systems in enhancing public safety and responding to various situational needs has been underscored, demonstrating the technology's capability to provide tangible benefits to communities, from increasing safety in high-crime areas to contributing to the celebratory atmosphere during national events.

4.2.4 Stakeholder group 4 | Informed

The final stakeholder group, the **Informed** Citizens, expressed a unanimous concern within the theme of Energy Efficiency and Sustainability, particularly highlighting the adverse environmental and social impacts of smart street lighting. Their responses indicate a sense of discontent and a longing for a more balanced and considerate implementation of these technologies.

Respondent 1 pointed out that in some locations, the addition of smart lighting seems redundant, suggesting a lack of strategic planning in the placement and necessity of these lights:

> Ja op sommige locaties lijkt de toevoeging van deze slimme verlichting overbodig.
>
> – Respondent 1

Respondent 2 brought special attention to areas like Dierdonk in Helmond, where the intensity of street lighting is so high that it creates a perpetual daylight scenario, disrupting the natural day-night cycle which could have ecological impacts and affect human well-being.

> In Dierdonk, Helmond lijkt het altijd dag door de verlichting – Respondent 2

Respondent 3 highlighted the issue of excessive brightness, even when the lights are dimmed, indicating a need for better calibration to ensure that the lighting is comfortable and not overwhelming for the residents.

> zelfs wanneer de verlichting gedimd is, komt het nog behoorlijk fel over. Een iets zachtere instelling zou welkom zijn.
>
> – Respondent 3

Finally, Respondent 4 expressed a sense of loss, noting that the introduction of smart lighting has diminished the city's ambiance. They reminisced about the previous lighting setup, which included overhead lights and additional festive lights during winter, creating a warm and inviting atmosphere. This change has not only affected the visual appeal of the city but also its sociocultural fabric, as the lights once played a role in encouraging people to visit and spend time in the city.

> Sinds de introductie van de slimme verlichting is de sfeer in de stad naar mijn mening alleen maar minder geworden. Voorheen hingen er lampen boven de hele weg in het centrum, en in de winter voegden ze kerstverlichting toe. Dat gaf de stad een gezellige, feestelijke sfeer. Die sfeer mis ik nu, want het nodigde eerder uit om de stad in te gaan.
>
> – Respondent 4

Three themes have emerged as second to most dominant: Transparency, Community and Public Perception, and Cultural and Social Impact.

Regarding the first, the citizens have shown a noticeable lack of concern about potential misinterpretations of smart devices being mistaken for cameras, indicating a level of trust or perhaps unawareness of the devices' capabilities.

> Dat het een bewegingssensor is merk je wel aan het blauwe lampje dat gaat branden zodra je gedetecteerd wordt.
>
> – Respondent 1

> In de meeste delen van Helmond zie je wel dat de straatverlichting aangaat als je aan komt rijden.
>
> – Respondent 4

However, there is a clear absence of communication from the government or responsible authorities about the functioning of these devices, resulting in low transparency. This is evident from their observations about motion sensors activating street lighting, yet there is no mention of any governmental effort to educate or inform the public about these systems.

This leads us to the second theme. The responses in general indicate a stark lack of community involvement in the decision-making processes related to smart lighting. The citizens feel left out and uninformed, as highlighted by their statements about the absence of communication.

> Nee, Totaal geen betrokkenheid. Ook geen brief, niks.
>
> – Respondent 1

> Sterker nog, het was in feite gewoon de monteur die de installatie deed. Hij legde een beetje uit wat het was en hoe het functioneerde toen ik er naar vroeg.
>
> – Respondent 3

However, this lack of engagement has not led to a notable negative perception of the smart lighting initiative.

Regarding the final theme, while the overall impact on daily activities appears to be low:

> "Toen ik voor het eerst de kastjes zag hangen, heb ik er niet echt veel aandacht aan besteed."
>
> – Respondent 1

> "Wel, ik moet eerlijk zeggen dat het me niet echt opviel tot je erover begon."
>
> – Respondent 2

, one citizen specifically pointed out the significant effects of lighting on nighttime ambiance, as well as potential implications for sleep and relaxation.

> Ik ben van mening dat gedimd of uitgeschakeld straatlicht mensen op een instinctief niveau laat voelen dat het tijd is om te ontspannen.
>
> – Respondent 3

> Ik krijg het gevoel dat een minder verlichte woonwijk 's nachts rustiger is en dat mensen daarom minder lawaai maken of minder snel overlast veroorzaken.
>
> – Respondent 3

The change in lighting has altered the city's atmosphere, affecting the way citizens interact with the urban space during the night. This shift has both subtle and pronounced effects on the social fabric of the community, as lighting plays a crucial role in shaping the nighttime environment.

In conclusion, while the Informed Citizens have not expressed overwhelming concerns, there is a clear need for improved transparency, increased community involvement, and a careful consideration of the cultural and social impacts of smart lighting systems. Addressing these issues is crucial for the successful integration and acceptance of smart lighting systems in urban spaces.

4.3 Analysis per TBL domain

In this section, we delve into an in-depth analysis of the impacts of smart street lighting, following the Triple Bottom Line (TBL) method as proposed in our model.

With respect to the social domain there were differences and similarities between stakeholder groups. Across all stakeholder groups, there was a consistent emphasis on the importance of addressing privacy and security concerns associated with smart lighting and the collection of data. Manufacturers, asset managers, and tech companies all highlighted the potential risks and the

need to safeguard individuals' privacy. Second, each group demonstrated an awareness of the social impacts of smart lighting, whether it was the potential for improved public safety highlighted by tech companies, the disruption of natural day-night cycles mentioned by citizens, or the balancing act between privacy and security discussed by manufacturers. When it comes to the differences there were a few. First, while manufacturers expressed concerns about privacy and security, they did not indicate a willingness to reject potential buyers based on their data privacy policies, showcasing a potential compromise in social responsibility for economic gains. In contrast, asset managers and tech companies demonstrated a more cautious approach, emphasizing the importance of safeguarding privacy. Second, citizens expressed a sense of exclusion from the decision-making processes, indicating a lack of community engagement and involvement. This contrasts with the other stakeholder groups, which, despite their awareness of social impacts, did not explicitly highlight the need for community involvement in their discussions. Third, Tech companies and asset managers viewed smart lighting as a tool for enhancing public safety and contributing to various urban goals, whereas citizens focused more on the negative social impacts, such as disruption to the ambiance of the city and potential adverse effects on well-being. Finally, there was a noticeable lack of transparency and communication from the responsible authorities about the functioning of smart lighting systems, as highlighted by the citizens. This issue was not explicitly addressed by the other stakeholder groups, suggesting a potential area for improvement in terms of open communication and public education.

Continuing with the economic domain, all stakeholder groups consistently emphasized the importance of conducting thorough cost-benefit analyses when considering the implementation of smart lighting systems. Manufacturers highlighted potential long-term savings, asset managers focused on the inhibiting factor of high initial costs, and tech companies brought attention to the global economic implications of material usage in lighting infrastructure. This shared focus underscores a universal acknowledgment of the need to balance financial costs against the anticipated benefits of smart lighting. However, there were notable differences as well. Manufacturers appeared more willing to engage in profitable opportunities, even when potential privacy risks were involved, showcasing a readiness to navigate the complex balance between privacy, security, and profitability. On the other hand, asset managers exhibited a more cautious approach, with financial constraints serving as a significant barrier to adoption. This difference highlights varying levels of risk tolerance and prioritization of economic gains across the stakeholder groups. Additionally, Tech companies placed a strong emphasis on sustainability, considering the long-term global economic impacts of material usage in smart lighting. This perspective was less pronounced in the other stakeholder groups, highlighting a unique focus on the broader economic implications of smart lighting adoption. Finally, the citizens' concerns about redundancy and excessive brightness of smart lighting in certain areas point to a need for more strategic economic planning in the implementation of these technologies. This perspective was not explicitly mentioned by the other stakeholder groups, suggesting a potential area for improvement in aligning economic planning with community needs and environmental considerations.

Finally, with respect to the environmental domain, all stakeholder groups acknowledged the importance of energy efficiency and sustainability in the context of smart lighting. There was a universal recognition of the environmental impacts associated with smart lighting, whether it was the potential for reduced maintenance and operational costs mentioned by manufacturers, the positive effects on natural ecosystems highlighted by asset managers, or the global implications of material usage discussed by tech companies. However, there were also differences. Manufacturers emphasized the indirect benefits and cost savings associated with smart lighting, potentially showcasing a more economically driven approach to sustainability. In contrast, asset managers and tech companies demonstrated a more direct commitment to environmental stewardship, emphasizing the positive impacts on natural ecosystems and the importance of responsible material usage. Second, Citizens expressed concerns about the adverse environmental and social impacts of smart lighting, highlighting issues such as disruption to the natural day-night cycle and the loss of nighttime ambiance. This perspective contrasts with the other stakeholder groups, which focused more on the potential benefits and positive impacts of smart lighting. Finally, the citizens' concerns about redundancy and excessive brightness of smart lighting in certain areas point to a need for more strategic environmental planning in the implementation of these technologies. This perspective was not explicitly mentioned by the other stakeholder groups, suggesting a potential area for improvement in aligning environmental strategies with community needs and expectations.

Discussion

This study has systematically examined stakeholder perspectives within the context of public projects, with a particular emphasis on smart street lighting initiatives. By employing a structured model that integrates the RACI model for stakeholder identification and the Triple Bottom Line (TBL) approach for categorizing impact factors, this research aimed to elucidate the varied ways in which different stakeholder groups perceive the tangible and intangible impacts of these projects.

Our empirical investigation has yielded a comprehensive set of data, derived from a diverse range of stakeholders including manufacturers, asset managers, tech companies, and citizens. Through semi-structured interviews, we have captured a breadth of opinions and concerns, providing a rich qualitative dataset for analysis.

The results of this study have highlighted both commonalities and disparities in stakeholder perceptions across the social, economic, and environmental domains of the TBL. While there was a unanimous recognition of the need to address privacy and security concerns associated with smart lighting, differences emerged in terms of the willingness to compromise social responsibility for economic benefits, as well as in the levels of community engagement and transparency.

As we proceed to the discussion chapter, our objective is to critically analyse these findings, situating them within the broader scholarly discourse and theoretical models that underpin this field. We will explore the implications of our results for both theoretical understanding and practical application, scrutinize the limitations of our study, and propose directions for future research in this crucial domain of public project management. This chapter aims to contribute to the scholarly dialogue on stakeholder engagement and provide practical insights for the effective implementation of smart street lighting projects and public initiatives more broadly.

5.1 Reflection on research question

The central research question of this study, "How do distinct stakeholder groups perceive the intangible and tangible impacts of public projects?" has been addressed through the empirical findings. The analysis of stakeholders' perceptions in smart street lighting projects reveals distinct priorities within the RACI framework, offering nuanced insights for enhancing project outcomes. In the **economic domain,** Asset Managers and Tech Providers focus on integrating technologies, indicating the need for strategic alignment of tech advancements with infrastructure. Manufacturers prioritize cost-benefit analysis, highlighting the importance of clear financial justification for project decisions. Notably, Asset Managers' disregard for market trends suggests a gap in sustainability considerations. In the **social domain,** Responsible and Accountable stakeholders' emphasis on privacy and security necessitates robust data protection measures. Consulted Tech Providers' focus on governance and accountability signals the need for transparent regulatory structures. The Informed group's heightened concern for public perception points to

the importance of proactive community engagement strategies. **Environmentally,** a uniform acknowledgment of energy efficiency across groups, with slight variations, calls for reinforced communication strategies, especially with the Informed group. The Accountable and Informed groups' lesser mention of lifecycle and waste management highlights the opportunity for greater environmental stewardship education.

Based on these findings, practical suggestions for smart street lighting projects could include:

- **Economic:**
  Develop educational programs to inform all stakeholders about economic evaluations and the long-term benefits of technological integration, while also ensuring Asset Managers are updated on market sustainability trends.
  - Organize workshops and seminars tailored for each RACI group to discuss the economic benefits and challenges associated with public projects.
  - Develop case studies that illustrate successful integration of technology within existing infrastructure and share them across stakeholder groups.
  - Establish a digital platform for continuous learning where stakeholders can access resources, economic models, and cost-benefit analysis examples.
  - Conduct quarterly briefings for Asset Managers to provide updates on industry dynamics and sustainability trends.
  - Facilitate roundtable discussions with Asset Managers and industry experts to explore market developments and potential implications for public projects.
  - Integrate sustainability as a key performance indicator in project reviews to ensure it remains a strategic focus.

- **Social:**
  Strengthen data protection protocols and increase public involvement through community engagement initiatives to ensure that all groups are heard and considered in decision-making.
  - Update or establish comprehensive data protection policies and conduct training sessions for Responsible and Accountable stakeholders on these protocols.
  - Create a series of public forums where citizens can provide input on project proposals, with specific sessions dedicated to discussing social impacts.
  - Develop communication materials in multiple languages and formats to ensure inclusivity in public consultations.
  - Use social media and other digital platforms to reach a broader audience and gather feedback from the Informed group.

- **Environmental:**
  Create targeted communication on energy efficiency and environmental impacts, and integrate lifecycle analysis in project planning to emphasize sustainability.
  - Launch an awareness campaign highlighting the importance of energy efficiency in public projects, emphasizing the tangible benefits such as cost savings and environmental impact.
  - Organize knowledge-sharing sessions with external experts on best practices in environmental stewardship related to public projects.
  - Incorporate lifecycle and waste management considerations into the initial planning stages of public projects.

5.2 Discussion of the proposed model

By integrating the RACI model and the Triple Bottom Line approach, this study has provided a novel lens through which to view and categorize stakeholder perspectives across social, economic, and environmental dimensions. The application of this model to smart street lighting projects has demonstrated its utility in capturing a wide array of stakeholder view. The semi-structured interviews conducted with various stakeholder groups have yielded rich qualitative data, affirming the model's capacity to elicit nuanced insights into stakeholder perceptions. The diversity of opinions and concerns captured through this process attests to the model's robustness and its potential applicability to other public project contexts.

The generalizability of this integrated model largely depends on the nature of the public project and the stakeholder environment. The RACI-TBL model is particularly useful for complex projects involving a diverse range of stakeholders. By clearly defining roles (RACI) and addressing the full spectrum of project impacts (TBL), the model can help manage and communicate with various groups effectively, however for smaller projects with fewer stakeholders or less complexity, the full deployment of RACI and TBL may not be necessary and could overcomplicate project management. Second, the generalizability of the model also depends on the nature of the project. For projects that inherently have broad economic, social, and environmental implications (e.g. Urban Development Projects, Large-Scale Infrastructure Projects, Renewable Energy Installations) this combined approach can ensure that all aspects are considered, avoiding siloed decision-making. However, if a project primarily impacts one domain (e.g. a local social awareness campaign about public health issues) with minimal economic or environmental consequences, the TBL aspect may not be as critical, though RACI might still provide valuable role clarification. Finally, this model would be most applicable in slower paced projects. In fast-paced projects where roles and impacts are constantly changing, the static nature of the RACI model and the comprehensive analysis required by TBL might not keep pace with project needs.

5.3 Alignment with existing literature

The introduction of our study set the stage by emphasizing the multifaceted nature of public projects and the inherent complexities in managing the diverse expectations of stakeholders. This complexity is reflected in our findings, which reveal a spectrum of stakeholder perceptions, aligning with the literature that underscores the critical role of stakeholder management in public projects (Wang et al., 2023)

Our research findings resonate with the existing literature on the varied nature of "feasibility" in public projects, where different stakeholders prioritize different success criteria (Bryde & Robinson, 2005; Lai & Lam, 2010). Manufacturers, akin to contractors, prioritize economic gains and exhibit a willingness to balance privacy risks against profitability. This reflects a traditional contractor's perspective focused on minimizing costs and maximizing profitability. In contrast, asset managers, mirroring clients, adopt

a cautious stance, prioritizing safety and being mindful of high initial costs, which aligns with the client's perspective of ensuring stakeholder satisfaction and budget adherence.

However, our findings diverge from the literature in the emphasis all stakeholder groups place on privacy and security, particularly within the context of smart street lighting. This marks a significant departure from the traditional focus on cost and timeline metrics, indicating a growing prioritization of data security and personal privacy in public projects—which is not fully captured in existing research.

Furthermore, the citizens' concerns about the social and environmental impacts, such as the disruption to the natural day-night cycle and the ambiance of the city, extend the conversation on the intangible impacts of public projects beyond the economic factors like mental stress highlighted by Hudson and Poussin (2019). This suggests a shift in stakeholder priorities, with environmental and social considerations becoming increasingly influential in shaping the acceptance and perceived success of public projects.

Third, the literature often describes the economic impacts of public projects in terms of direct job creation and stimulation of local businesses (Girma et al., 2008; Walker & Preuss., 2008). Our research findings complement these tangible economic benefits by bringing to light the stakeholders' concerns about the long-term sustainability and material usage in smart street lighting. This reflects a broader understanding of economic success that incorporates sustainability and resource efficiency, which may not have been as pronounced in earlier literature.

Finally, while existing studies like those by Robert & Chan (2017) identify effective risk management as a critical success criterion across stakeholder groups, our research findings present a more nuanced perspective. The stakeholders in our research findings mentioned both the tangible and intangible impacts of public projects, particularly those related to privacy, security, community engagement, environmental sustainability, and social implications. These concerns suggest a shift in the landscape of what constitutes project success. For example, the emphasis on long-term sustainability and environmental stewardship, particularly by asset managers and tech companies, points to a redefinition of success criteria to include the responsible use of resources and the minimization of ecological footprints. These considerations may supersede the conventional focus on managing risks related to project timelines, costs, and scope.

5.3 Limitations of the study

First, while this research has provided valuable insights into stakeholder perspectives on the impacts of public projects, particularly in the context of smart street lighting, it is important to acknowledge the methodological limitations that may have influenced the findings.

Second, the research relied on a relatively small sample size, with a limited number of participants from each stakeholder group. This may not fully capture the diversity of

perspectives and experiences that exist within each category. Additionally, the selection of participants was based on their availability and willingness to participate, which could introduce a selection bias, as those who chose to participate may have had stronger opinions or more interest in the topic than those who did not.

Finally, the proposed model, while comprehensive, may not capture all possible dimensions of stakeholder perspectives and impacts. The RACI and Triple Bottom Line models provide a structured approach to categorizing stakeholders and impacts, but they did not fully account for the complexity and dynamism of stakeholder relationships and the multifaceted nature of public project impacts. During the research, findings such as "technological challenges" and "legal challenges" emerged, which presented difficulties in fitting neatly into one of the three TBL domains. Technological challenges, for instance, could have implications across economic, environmental, and social domains, depending on the specific nature of the challenge and its broader impacts on the project and stakeholders. Similarly, legal challenges could influence the economic viability of a project, have social implications in terms of public trust and acceptance, and even affect environmental outcomes depending on the legal issue at hand.

5.4 General Recommendations

To mitigate the sense of exclusion felt by citizens, it is imperative to adopt inclusive decision-making processes and transparent communication strategies, ensuring that community concerns are acknowledged and addressed. This could involve public forums, surveys, and consultations, fostering a sense of trust and inclusion. Second, addressing economic and environmental concerns necessitates strategic economic planning and a commitment to environmental stewardship. Authorities should conduct comprehensive cost-benefit analyses, considering long-term impacts across economic, environmental, and social dimensions, and prioritize sustainable practices in both the development and operational phases of public projects. In this endeavor, they should actively involve and seek the expertise of manufacturers or technology providing companies. By doing so, authorities can leverage the technical knowledge and industry insights to ensure a holistic and well-informed evaluation.

Second, to overcome the limitations of the theoretical model, an expansion of the model and its domains is recommended. While the TBL approach provides a valuable lens through which to view the economic, social, and environmental dimensions of public projects, it may not fully account for the interconnectedness of these domains and the way in which challenges in one area can have ripple effects across others. In light of these findings, future research could consider integrating additional theoretical perspectives or developing more nuanced models that can better capture the complexity of stakeholder relationships and the multifaceted nature of public project impacts. This could involve exploring additional dimensions beyond the TBL domains, or incorporating dynamic models that can account for the evolving nature of stakeholder relationships and project impacts over time.

Finally, to enhance the generalizability of the findings, future research should aim to validate and apply the proposed model across diverse settings and regions, ensuring its relevance and applicability to a broad spectrum of public projects. Through the implementation of these recommendations, authorities, project planners, and managers can contribute to more inclusive, sustainable, and successful public projects, ultimately fostering community well-being and prosperity.

References

Abdollahbeigi, B., Salehi, F., & Jayashree, S.(2017). The Effect of Recruitment, Selection and Development on Talent Management in IKCO Company in Iran. 2(3), 69-77.

Abolfazl, S., Hossein, A., & Ibrahim, 0. (2022).Municipal Greenhouse Gas Emission ReductionTargets: The Role of Building Energy Regulations and Laws. Journal of Legal Affairs and Dispute Resolution in Engineering and Construction, 14(2), 04522001. doi:10.1061/(ASCE)LA.1943-4170.0000532

Agrawal, M., Kalia, P., Nema, P., Zia, A., Kaur,K., & John, H. B. (2023). Evaluating the influence of government initiatives and social platforms on green practices of Gen Z: The mediating role of environmental awareness and consciousness. Cleaner and Responsible Consumption, 8, 100109. doi:10.1016/j.clrc.2023.100109

Ahmed Muaz O., Assaad Rayan H., El-adaway Islam H., Echele Emily, Govro Kyle, & WatsonJohn. (2022). Administering Change Orders in Highway Projects. Journal of Legal Affairs andDispute Resolution in Engineering and Construction, 14(2), 05021010. doi:10.1061/(ASCE)LA.1943-4170.0000528

Aiken, L. H., Sochalski, J., & Lake, E. T. (1997). Studying outcomes of organizational change in health services. Medical care, 35(11),NS6-NS18

ANP (2023) 'tentprotest' bij ter apel in Nacht van Woensdag OP DONDERDAG, Dagblad vanhet Noorden. Available at: https://dvhn.nl/groningen/Tentprotest-bij-Ter- Apel-in-nacht-van-woensdag-op-donderdag-28429878.html (Accessed: 23 October 2023).

Balachandran, Akshay & Siva, Murali & Parthasarathi, V. & Surya, Meganathan & Vasudevan, Shriram. (2015). An Innovation in the Field of Street Lighting System with Cost andEnergy Efficiency. Indian Journal of Science andTechnology. 8. 10.17485/ijst/2015/v8i17/61261.

Barlow, J., Roehrich, J. & Wright, S. (2014). Delivering European healthcare infrastructure through public-private partnerships: The theoryand practice of contracting and bundling.

Bayer, S., Köberle-Gaiser, M., Barlow, J. (2007).Planning for adaptability in healthcare infrastructure.

Bleda, M., & Chicot, J. (2020). The role of publicprocurement in the formation of markets for innovation. Journal of Business Research, 107, 186–196. doi:10.1016/j.jbusres.2018.11.032

Bleibleh, S., & Awad, J. (2020). Preserving cultural heritage: Shifting paradigms in the faceof war, occupation, and identity. Journal of Cultural Heritage, 44, 196–203. doi:10.1016/j.culher.2020.02.013

Bridgwater, A. V. (1995). The technical andeconomic feasibility of biomass gasification for power generation. Fuel, 74(5), 631-653

Brinkman, J. (2023) Protestborden, flyers en petities in aanloop Naar inloopavond over Mogelijk Azc bij Rottum, Omrop Fryslân. Available at: https://www.omropfryslan.nl/nl/nieuws/1222075/protestborden-flyers-en-petities-in-aanloop-naar- inloopavond-over-mogelijk-azc-bij-rottum (Accessed: 23 October 2023).

Brodley, J. F. (1975). Industrial Deconcentration and Legal Feasibility: TheEfficiencies Defense. Journal of Economic Issues, 9(2), 365-380.

Bryde, D. J., & Robinson, L. (2005). Client versus contractor perspectives on project successcriteria. International Journal of Project Management, 23 (8), 622–629. doi:https://doi. org/10. 1016/j. ijproman.2005.05.003

Castelblanco, G., & Guevara, J. (2022). Buildingbridges: Unraveling the missing links between Public-Private Partnerships and sustainable development. Project Leadership and Society, 3, 100059. doi:10.1016/j.plas.2022.100059

Clarke, M., Cadaval, S., Wallace, C., Anderson, E., Egerer, M., Dinkins, L., & Platero, R. (2023).Factors that enhance or hinder social cohesion inurban greenspaces: A literature review. Urban Forestry & Urban Greening, 84, 127936. doi:10.1016/j.ufug.2023.127936

Council of Europe (2021) CDDG releases a studyon the impact of digital transformation on democracy and good governance - good governance - www.coe.int, Good Governance.
Available at: https://www.coe.int/en/web/good-governance/-/cddg-releases-a-study-on-the- impact-of-digital-

transformation-on-democracy-and-good-governance (Accessed: 23 October 2023).

Deacon, R. T. (1995). Assessing the Relationshipbetween Government Policy and Deforestation. Journal of Environmental Economics and Management, 28(1), 1–18. doi:10.1006/jeem.1995.1001

Elharrouss, O., Almaadeed, N., & Al-Maadeed,
S. (2021). A review of video surveillance systems. Journal of Visual Communication andImage Representation, 77, 103116. doi:10.1016/j.jvcir.2021.103116

Fontes, C., Hohma, E., Corrigan, C. C., & Lütge,
C. (2022). AI-powered public surveillance systems: why we (might) need them and how wewant them. Technology in Society, 71, 102137. doi:10.1016/j.techsoc.2022.102137

Frödell, M., Josephson, P.-E., & Lindahl, G. (2008). Swedish construction clients' views onproject success and measuring performance.
Journal of Engineering, Design and Technology,6 (1), 21–32. doi:10.1108/17260530810863316

Girma, S., Görg, H., Strobl, E., & Walsh, F. (2008). Creating jobs through public subsidies: An empirical analysis. Labour Economics, 15(6),1179–1199. doi:10.1016/j.labeco.2007.11.002

Grossman, J. W. (2008). HUMAN– LANDSCAPE INTERACTIONS. In D. M.
Pearsall (Ed.), Encyclopedia of Archaeology (pp.1458–1476). doi:10.1016/B978-012373962-9.00153-9

Herbert, D., & Davidson, N. (1994). Modifyingthe built environment: the impact of improved street lighting. Geoforum, 25(3), 339–350. doi:10.1016/0016-7185(94)90035-3

International. 54. 10.1016/j.habitatint.2015.11.018.

Ivanov, B., Pfeiffer, F., & Pohlan, L. (2020). Dojob creation schemes improve the social integration and well-being of the long-term unemployed? Labour Economics, 64, 101836. doi:10.1016/j.labeco.2020.101836

Kazmi, Syed Najeeb Ali & Ulasyar, Abasin & Nadeem, Faisal. (2020). IoT based Energy Efficient Smart Street Lighting Technique with Air Quality Monitoring. 1-6. 10.1109/ICOSST51357.2020.9332982.

Lai, I. K., & Lam, F. K. (2010). Perception of various performance criteria by stakeholders inthe construction sector in hong kong.
Construction Management and Economics, 28 (4), 377–391. doi:10.1080/01446190903521515.
eprint: https://doi.org/10.1080/01446190903521515

Laird, Y., Manner, J., Baldwin, L. et al. Stakeholders′ experiences of the public health research process: time to change the system?. Health Res Policy Sys 18, 83 (2020). https://doi.org/10.1186/s12961-020-00599-5
F
Leite, C. E., Granemann, S. R., Mariano, A. M., & de Oliveira, L. K. (2022). Opinion of Residents about the Freight Transport and Its Influence on the Quality of Life: An Analysis for Brasília (Brazil). Sustainability, 14(9), 5255. MDPI AG. Retrieved from http://dx.doi.org/10.3390/su14095255

Mahoor, Mohsen & Hosseini, Zohreh & Khodaei, Amin & Paaso, Aleksi & Kushner, Daniel. (2020). State-Of-The-Art in Smart Streetlight Systems: A Review. IET Smart Cities.2. 10.1049/iet-smc.2019.0029.

Mahoor, Mohsen & Hosseini, Zohreh & Khodaei, Amin & Paaso, Aleksi & Kushner, Daniel. (2020). State-Of-The-Art in Smart Streetlight Systems: A Review. IET Smart Cities.2. 10.1049/iet-smc.2019.0029.

Mandiriza, T., & Fourie, D. J. (2023). The Roleof Stakeholders in the Adoption of Public– Private Partnerships (PPPs) in Municipal WaterInfrastructure Projects: A Stakeholder Theory Perspective. World, 4(3), 416–430. MDPI AG. Retrieved from http://dx.doi.org/10.3390/world4030026

Markvica, K., Richter, G., & Lenz, G. (2019). Impact of urban street lighting on road users' perception of public space and mobility behavior.Building and Environment, 154, 32–43. doi:10.1016/j.buildenv.2019.03.009

Moreira, F. D., Rezende, S., & Passos, F. (2021).On-street toilets for sanitation access in urban public spaces: A systematic review. Utilities Policy, 70, 101186. doi:10.1016/j.jup.2021.101186

Mouratidis, K., & Poortinga, W. (2020). Built environment, urban vitality and social cohesion:Do vibrant

neighborhoods foster strong communities? Landscape and Urban Planning, 204, 103951. doi:10.1016/j.landurbplan.2020.103951

Mukherjee, M. (2017). Entrepreneurial Judgment and Analysis for Successful StrategyImplementation. International Journal of Advanced Engineering and Management, 2(1),1- 8

Ngwenya, B. N., Thakadu, O. T., Phaladze, N. A., & Bolaane, B. (2018). Access to water and sanitation facilities in primary schools: A neglected educational crisis in Ngamiland districtin Botswana. Physics and Chemistry of the Earth,Parts A/B/C, 105, 231–238. doi:10.1016/j.pce.2018.03.006

Pandi-Perumal, Seithikurippu R. & Akhter, Sohel& Zizi, Ferdinand & Jean-Louis, Girardin & Ramasubramanian, Chellamuthu & Freeman, R. & Narasimhan, Meera. (2015). Project Stakeholder Management in the Clinical Research Environment: How to Do it Right. Front. Psychiatry. 6. 71. 10.3389/fpsyt.2015.00071.

Patrick, M. and McKinnon, I. (2022) "Co-creating Inclusive Public Spaces: Learnings from Four Global Case Studies on inclusive Cities", The Journal of Public Space, 7(2), 93-116. DOI 10.32891/jps.v7i2.1500

PMI, A Guide to the Project Management Bodyof Knowledge, 6th ed. Project Management Institute, 2017.

Pokharel, R., Bertolini, L., & te Brömmelstroet, M. (2023). How does transportation facilitateregional economic development? A heuristicmapping of the literature. Transportation Research Interdisciplinary Perspectives, 19, 100817. doi:10.1016/j.trip.2023.100817

Pollock, J., Ho, S. V., & Farid, S. S. (2013).Fed-batch and perfusion culture processes: Economic, environmental, and operational feasibility under uncertainty. Biotechnology and bioengineering, 110(1), 206-219

Reuters. (2019). Switzerland switches off nuclearplant as it begins exit from atomic power. Thomson Reuters. Retrieved from https://www.reuters.com/article/us- swiss- nuclearpower/switzerland-switches-off-nuclear-plant-as-it-begins-exit-from-atomic-power- idUSKBN1YO19J

Ricardo Alvarez, Fabio Duarte, Dennis Frenchman & Carlo Ratti (2022) Sensing Lights: The Challenges of Transforming Street Lights into an Urban Intelligence Platform, Journal of Urban Technology, 29:4, 25-40, DOI: 10.1080/10630732.2022.2082825

Robert, Osei-Kyei & Chan, Albert. (2017). Stakeholders' Perspectives on the Success Criteria for Public-Private Partnership Projects.International Journal of Strategic Property Management. 22. 10.3846/ijspm.2018.444.

Roy, A., & Mukherjee, K. (2017).Entrepreneurial Education in India.

International Journal of Advanced Engineering and Management, 2(1), 15-20

Royall, D. (2013). 13.3 Land-Use Impacts on theHydrogeomorphology of Small Watersheds. In J. F. Shroder (Ed.), Treatise on Geomorphology(pp. 28–47). doi:10.1016/B978-0-12-374739-6.00341-9

Rustam, A., Wang, Y., & Zameer, H. (2020).Environmental awareness, firm sustainabilityexposure and green consumption behaviors. Journal of Cleaner Production, 268, 122016. doi:10.1016/j.jclepro.2020.122016

Semeraro, T., Scarano, A., Buccolieri, R., Santino, A., & Aarrevaara, E. (2021). Planning ofUrban Green Spaces: An Ecological Perspective on Human Benefits. Land, 10(2), 105. MDPI AG. Retrieved from http://dx.doi.org/10.3390/land10020105

Schwender, J. D., Holly, L. T., Rouben, D. P.,& Foley, K. T. (2005). Minimally invasive transforaminal lumbar interbody fusion (TLIF): technical feasibility and initial results.Clinical Spine Surgery, 18, S1-S6

Sep, M. (2023) DPG Media Privacy Gate. Available at: https://www.ad.nl/middelburg/uitstel-definitief-besluit-over-locatie-nieuw-azc- middelburg~a52e90a7/?referrer=https%3A%2F%2Fwww.google.com%2F (Accessed: 23 October 2023).

Silva, J. M. C. da, Prasad, S., & Diniz-Filho, J. A. F. (2017). The impact of deforestation, urbanization, public investments, and agricultureon human welfare in the Brazilian Amazonia. Land Use Policy, 65, 135–142. doi:10.1016/j.landusepol.2017.04.003

Simranjeet, S., Sparsh, J., Abid, H. & Neeraj,
J.K. (2022). Risk Factors in Dedicated Freight Corridor and Mass Rapid-Transit Metro Rail Infrastructure Projects. Journal of Legal Affairsand Dispute Resolution in Engineering and Construction, 14(2), 04521050. doi:10.1061/(ASCE)LA.1943-4170.0000531

Speight, J. G. (2020). 9 - Pollution prevention. In
J. G. Speight (Ed.), Natural Water Remediation (pp. 305–336). doi:10.1016/B978-0-12-803810-9.00009-7

Stone, T. (2022). The streetlights are watchingyou: A historical perspective on value change and public lighting. Prometheus, 38(1), 45–56.https://www.jstor.org/stable/48676465

Suhanda, Rahmad & Pratami, Devi. (2021). RACI Matrix Design for Managing Stakeholdersin Project Case Study of PT. XYZ. International Journal of Innovation in Enterprise System. 5.
122-133. 10.25124/ijies.v5i02.134.

Toor, S.-R., & Ogunlana, S. O. (2010). Beyond the 'iron triangle': Stakeholder perception of keyperformance indicators (kpis) for large-scale public sector development projects. InternationalJournal of Project Management, 28 (3), 228–236.Retrieved from https://www.sciencedirect.com/science/article/pii/S0263786309000623

Tulchinsky, T. H., Varavikova, E. A., & Cohen,
M. J. (2023). Chapter 9 - Environmental and occupational health. In T. H. Tulchinsky, E. A.Varavikova, & M. J. Cohen (Eds.), The New Public Health (Fourth Edition) (pp. 681–750). doi:10.1016/B978-0-12-822957-6.00016-8

Ugolini, F., Massetti, L., Calaza-Martínez, P., Cariñanos, P., Dobbs, C., Krajter Ostoić, S., … Sanesi, G. (2022). Understanding the benefits of public urban green space: How do perceptions vary between professionals and users? Landscapeand Urban Planning, 228, 104575. doi:10.1016/j.landurbplan.2022.104575

van den Berg, T. (2023) Eerste asielzoekers nemen in maart 2024 intrek in azc in Albergen, DPG Media Privacy Gate. Available at: https://www.tubantia.nl/home/eerste- asielzoekers-nemen-in-maart-2024-intrek-in-azc-in- albergen~af73806aa/?referrer=https%3A%2F%2Fwww.google.com%2F (Accessed: 23 October 2023).

Veretennikov, Nikolay & Voronina, Lyudmila & Grigorishchin, Aleksei. (2021). IMPACT OF DEMOGRAPHIC AND ECONOMIC FACTORS ON THE DEVELOPMENT OF ARCTIC MUNICIPALITIES HEALTHCARE INFRASTRUCTURE OF NORTHERN MACROREGION.. Север и рынок: формирование экономического порядка. 71. 55-69. 10.37614/2220-802X.1.2021.71.005.

Verhoef, P. C., Broekhuizen, T., Bart, Y., Bhattacharya, A., Qi Dong, J., Fabian, N., & Haenlein, M. (2021). Digital transformation: A multidisciplinary reflection and research agenda.Journal of Business Research, 122, 889–901. doi:10.1016/j.jbusres.2019.09.022

Walker, H., & Preuss, L. (2008). Fostering sustainability through sourcing from small businesses: public sector perspectives. Journal of Cleaner Production, 16(15), 1600–1609.doi:10.1016/j.jclepro.2008.04.014

Wang W, Guo X, Cao Q and Tang A (2023) A stakeholder perspective on social stability risk ofpublic–private partnerships project for water environmental governance in China: A social network analysis. Front. Ecol. Evol. 10:1022383.doi: 10.3389/fevo.2022.1022383

Wright, M. (2023) The business case for Smart Street Lighting as the Smart City Network, Tondo Smart. Available at: https://tondo- iot.com/articles/the-business-case-for-tondo- smart-street-lighting-and-smart-city-network/#h-reducing-street-light-maintenance-costs-with- smart-lighting (Accessed: 07 October 2023).

Yang, Yu-Sheng & Lee, Shih-Hsiung & Chen, Guan-Sheng & Yang, Chu-Sing & Huang, Yueh-Min & Hou, T.-W. (2020). An Implementation ofHigh Efficient Smart Street Light Management System for Smart City. IEEE Access. PP. 1-1.
10.1109/ACCESS.2020.2975708.

Yip, W.S., Zhou, H. & To, S. A critical analysison the triple bottom line of sustainable manufacturing: key findings and
implications. Environ Sci Pollut Res 30, 41388–41404 (2023). https://doi.org/10.1007/s11356-022-25122-x

Zhang, Xing Quan. (2015). The Trends, Promisesand Challenges of Urbanisation in the World.

Zhou, W., Song, S., & Feng, K. (2022). The sustainability cycle of historic houses and cultural memory: Controversy between historic preservation and heritage conservation. Frontiersof Architectural Research, 11(6), 1030–1046. doi:10.1016/j.foar.2022.04.006

Appendix A – First-order codes

The approach of the company towards smart street lighting from a manufacturing perspective.
Ensuring the company is qualified to integrate smart lighting modules.
The ability to adapt and integrate various smart lighting modules based on customer needs.
The advantages of smart street lighting in busy city environments.
The ability to adjust lighting levels during emergencies or specific events.
The potential risks associated with collecting too much data from smart lighting systems.
The importance of ensuring the privacy of individuals in the context of smart lighting.
The challenge of ensuring different smart lighting systems can work together.
The ability to adjust lighting to fit cultural or festive events.
The potential of smart lighting to enhance safety in urban areas.
The influence of smart lighting on activities during the night.
The long-term challenges of maintaining and managing smart lighting systems.
The potential for financial gain or business growth.
Reduction in energy consumption due to smart lighting.
Cost savings from efficient monitoring and maintenance of lighting.
The company's commitment to sustainable and eco-friendly practices.
The impact of lighting on the natural environment.
The challenge residents face in adjusting to changes in lighting.
The lifespan and sustainability of the manufactured products.
The logistical issues related to delivering products in certain areas.
The environmental impact of lighting in certain areas.
The feedback or concerns raised by residents regarding lighting.
The respondent's position and responsibilities in relation to the project.
The assistance provided in terms of technical details and guidance.
Potential obstacles related to the city's existing infrastructure.
The ability of the lighting system to serve multiple functions.
The gathering of information through the lighting system.
Potential issues related to the collection and use of data.
The duty to handle and protect collected data.
Key features or benefits used to promote the product.
The involvement of the community in the project.
The potential financial effects of the project on the city.
A comparison of the costs and benefits of the project.
The potential effect of the project on property values in the city.
Reference to broader smart city projects and their economic considerations.
The financial factors influencing decisions on smart city projects.
Evaluation of the environmental impacts of a product over its entire life cycle.
The practice of adding new technology or features to existing systems.
The practice of reducing energy consumption.
Issues related to the movement of goods, especially over long distances.
The importance and practice of sustainability within an organization.
Excessive or misdirected artificial light.
Lighting designed to minimize disruption to wildlife.
Variations in market trends and demands across countries.
The process and location of creating new technologies.
Issues related to the compatibility and functionality of combined technologies.

A perceived gap in understanding within the industry.
Mandatory tendering process for public projects.
Evaluation based on best economic offer.
Emphasis on energy conservation.
Financial implications of implementing smart lighting.
Using city features for promotional purposes.
Economic advantages derived from social factors.
False sense of security.
Applications for public feedback on lighting.
Worries related to data collection and personal privacy.
Ensuring privacy is integral to system design.
Opposition from the public to certain technologies.
Weighing the importance of personal privacy against security measures.
Rules governing the use of cameras in public spaces.
Determining who is accountable for regulations and outcomes.
Rules and guidelines set by European entities.
Bringing in technology from other countries.
Changes in maintenance due to smart lighting.
The extended lifespan of LED lights compared to conventional ones.
The cost considerations of implementing smart lighting.
The position and influence of lighting companies in decision-making.
The ecological consequences of implementing smart lighting.
The challenges and restrictions of using solar energy for street lighting.
Concerns about waste generated from electronic components.
The potential benefits of smart lighting in terms of efficiency and adaptability.
Balancing the goals of safety and environmental friendliness.
The potential for smart lighting to create a false sense of security.
Variability in how different entities view the benefits and drawbacks of smart lighting.
Clarifying the scope and meaning of smart lighting.
Describing the company's position in the smart lighting ecosystem.
Mention of standards or common practices in the industry.
The idea of being ready for future technological shifts.
The benefits of having data-driven insights from smart lighting.
Recognizing a lack of understanding or awareness in the market.
The broader implications of smart lighting in urban development.
The financial barriers to implementing smart lighting.
The emphasis on environmental considerations in lighting.
The value of receiving feedback post-implementation.
Issues related to data collection and personal privacy.
Differences in privacy concerns based on geographical or cultural factors.
Variations in privacy concerns based on age groups.
Emphasis on energy conservation as a primary economic benefit.
The relationship between increased technological features and potential maintenance costs.
How the size of a municipality influences their choices in smart lighting.
The unique value proposition of the manufacturer in the market.
The limitations posed by outdated or inadequate infrastructure.
The idea that light poles can serve multiple purposes beyond just lighting.
Issues related to who owns and is responsible for the infrastructure.
How sustainability is considered in project tenders.
How the company's production practices contribute to sustainability.
The lack of a standardized approach to sustainability.
The environmental impact of excessive or misdirected artificial light.

Mentions the respondent's experience in the public domain, especially in large infrastructure projects like tunnels, bridges, and sluices.
Mentions the company's origin as a family business and its evolution over the years.
Mentions the wide range of electrical components the company offers and their applications in various industries.
Mentions the company's approach to entering and developing new markets and integrating their components into new solutions.
Compares the company's product strategy to that of a supermarket, emphasizing the breadth of their product range and the challenges of catering to niche markets.
Mentions how the company's components reach the end customer through intermediaries and the challenges of stimulating demand for their products.
Mentions past regulations and practices, such as companies advising public entities to specify their products in project specifications.
Shares the respondent's perspective on the current state of street lighting in the Netherlands and the potential benefits of transitioning from AC to DC.
Mentions the basic functionality of streetlights and the potential for adding more features like cameras and motion detection systems.
Expresses concerns about the potential for smart street lighting to be used for excessive government surveillance and the implications for personal freedoms.
Discusses the difference between actual safety measures and measures that only provide a feeling of safety, using tunnel projects as an example.
Mentions the company's commitment to societal impact, especially in the context of public projects.
Mentions the company's stance on data privacy, influenced by global political shifts and their operational decisions in various countries.
Describes how public entities approach new projects and how the company is involved in the evaluation process.
Mentions the initial vision and responsibilities of public entities like Rijkswaterstaat when starting a new project.
Mentions the process of determining financing for a project, including cost estimation and involving engineering firms.
Mentions the public tendering process and potential outcomes based on market price estimations.
Mentions the Economisch Meest Voordelige Inschrijving (EMVI) method and its implications for detailed proposal submissions.
Mentions the high costs associated with creating detailed proposals for public projects.
Mentions the compensation provided to companies for valid but unsuccessful project proposals.
Mentions the difference in complexity and expertise required for municipal projects versus larger projects.
Mentions the importance of utilizing market knowledge in public projects.
Mentions the inherent risks associated with innovative project solutions and the challenges of determining responsibility.
Mentions the government's potential role in managing risks associated with innovative projects.
Mentions the primary goals of municipalities regarding street lighting, emphasizing safety and traffic flow.
Mentions the potential ecological benefits of specific lighting solutions, such as reducing animal collisions.
Mentions efforts to minimize packaging waste in product delivery.
Mentions the company's commitment to environmental responsibility beyond customer demands.
Mentions the challenges of quantifying ecological impact compared to economic impact.
Mentions the potential disconnect between technological solutions and genuine societal safety.

Mentions the potential positive and negative impacts of technology on societal connections.
Mentions the market's reluctance to pay for certain societal benefits.
Mentions the respondent's role as the general director of [NAAM] and involvement in various aspects of the company.
Mentions the provision of extensive smart lighting systems for public lighting in the Netherlands.
Mentions the software platform that manages both smart and non-smart lighting.
Mentions the limited adoption of smart lighting in cities like Amsterdam.
Mentions that the company provides the controller for the lighting but not the actual fixture.
Mentions the ability of their software platform to manage lights regardless of the controller's manufacturer.
Mentions how competitors' systems differ from theirs in terms of management capabilities.
Mentions the importance of cities adopting a policy-driven approach rather than a project-based approach.
Mentions how cities like Amsterdam and Rotterdam have made different policy decisions regarding smart lighting.
Mentions the value of smart street lighting as part of modern asset management.
Mentions the ability to adjust lighting levels based on time and need.
Mentions the potential and challenges of integrating sensors and data collection into lighting systems.
Mentions the importance of collecting energy consumption data directly from the lighting installation.
Mentions skepticism about the effectiveness of adding sensors to lampposts for monitoring purposes.
Mentions the advantage of existing infrastructure for adding additional functionalities to lampposts.
Mentions the different types of data connections needed for various functionalities.
Mentions the primary role of lighting in ensuring safety and how smart lighting can enhance this.
Mentions the ability of smart lighting to adjust intensity based on situations or events.
Mentions the potential for improved resident satisfaction through smart lighting adjustments.
Mentions concerns related to monitoring and data collection in public spaces.
Mentions the need for clear communication and transparency about the technology and its purpose.
Mentions the approach of considering the total cost of ownership for assets.
Mentions the efforts to promote the benefits of the technology to potential clients or stakeholders.
Mentions the environmental considerations of smart lighting, including production, operation, and disposal.
Mentions the ethical considerations in the production and sourcing of technology components.
Mentions the specific lighting needs or preferences of certain locations or regions.
Mentions the company's specialization in solar technology and their main products.
Mentions the respondent's role, background, and experience within the company.
Mentions the company's ability to customize products based on client needs.
Mentions the company's data management system and its connectivity features.
Mentions concerns and measures related to data privacy and system security.
Mentions the distinction between the company's products and other companies focusing on motion sensors.
Mentions the company's primary focus on solar technology and its benefits.
Mentions the potential impact of the company's lighting solutions on city safety.
Mentions the economic benefits and considerations of smart street lighting compared to traditional lighting.
Mentions both tangible and intangible economic benefits of the company's products.

Mentions the evaluation of the environmental impact of the company's products over their lifecycle.
Mentions the challenges faced in daily operations, especially in evaluating environmental impact.
Mentions the company's perspective on what constitutes smart street lighting.
Mentions the integration of various functions and sensors in the lighting system.
Mentions the company's role in public lighting projects.
Mentions the changing needs and preferences in public lighting.
Mentions the potential benefits of bidirectional communication in lighting.
Mentions the economic benefits of integrating multiple systems.
Mentions the challenges of disrupting existing systems and the need for organizational adaptability.
Mentions the potential social benefits of smart lighting in terms of ambiance and safety.
Mentions the potential of smart lighting to enhance the livability and attractiveness of a city.
Mentions the potential of smart lighting to deter criminal activities.
Mentions the importance of addressing privacy concerns related to sensor technology.
Mentions the company's commitment to complying with European privacy regulations.
Mentions the company's responsibility when supplying technology to countries with potentially lax privacy regulations.
Mentions the potential of using colored lighting during national events to enhance community experience.
Mentions the company's primary focus on ecological conservation in their lighting solutions.
Mentions the economic benefits of smart lighting, including energy savings and the creation of new economic opportunities.
Mentions the potential of their lighting systems as platforms for other technology providers to integrate their solutions.
Mentions the potential commercial value of data gathered from smart lighting systems.
Mentions the benefits of smart lighting in terms of efficient maintenance and proactive malfunction detection.
Mentions the importance of sustainable material use and the exploration of biodegradable materials.
Mentions the environmental impact of smart lighting systems when considering the entire life cycle.
Mentions the company's approach to recycling and refurbishing components of their lighting systems.
Mentions the respondent's appreciation for the interviewer's research topic and approach.
Mentions initial reactions or feelings upon encountering smart street lighting.
Mentions the perception or misunderstanding of the sensors as cameras.
Mentions the relationship between movement and the activation of the lights.
Mentions feelings of safety or comfort related to the smart lighting.
Mentions the conditions or state of lighting before the introduction of smart lighting.
Mentions concerns or feelings related to privacy due to the sensors.
Mentions concerns about the potential sharing of data collected by the sensors.
Mentions the level of involvement or communication residents had in the decision-making or feedback process.
Mentions concerns related to the environmental impact of the lighting systems.
Mentions the concept of light pollution and its relation to smart lighting.
Mentions potential recommendations or suggestions for the municipality regarding the lighting systems.
Mentions not noticing the smart street lighting until it was pointed out.
Mentions the energy-saving benefits of the dimming lights.
Mentions feelings of safety or discomfort related to the dimming of the lights, especially in riskier areas.

Mentions the ability or inability to see figures in the distance due to lighting conditions.
Mentions the potential false sense of safety when other people are around.
Mentions recognizing the motion sensors and differentiating them from cameras.
Mentions concerns or lack thereof about privacy related to the motion sensors.
Mentions the comparison between data collection by smartphones and street sensors.
Mentions the impact of lighting on nighttime activities and feelings of safety.
Mentions the potential impact of lighting on the atmosphere during nightlife or events.
Mentions the known or unknown channels to provide feedback on street lighting.
Mentions the ecological impact, including light pollution, of street lighting.
Mentions the potential economic impact of dimming lights in commercial areas during business hours.
Mentions the use of colored lighting for ecological reasons, such as not disturbing certain animal species.
Mentions the potential use of colored lighting for emergencies or events.
Mentions the potential impact of light intensity on sleep or relaxation when near residential windows.
Mentions the feeling of safety provided by the new smart street lighting.
Mentions valuing the clear explanation given by the installer about the smart lighting.
Mentions the perception of light intensity, especially when dimmed, and its effect on comfort.
Mentions the lighting serving as a warning system indicating movement or presence in the street.
Mentions a preference for lighting that focuses on specific areas of activity rather than constant illumination.
Mentions a personal interaction with the installer and the value of direct explanation over written communication.
Mentions curiosity about the purpose and functionality of the new lighting system.
Mentions confusion or lack of understanding about certain lights emitting blue light.
Mentions the absence of initial privacy concerns regarding the lighting system.
Mentions a preference for dimmed lighting to reduce light pollution and create a calmer nighttime atmosphere.
Mentions the city's decisions regarding where and how to implement the smart lighting.
Mentions the importance of city investments in climate initiatives and personal willingness to support financially.
Mentions the impact of lighting on nighttime ambiance and its potential effects on sleep and relaxation.
Mentions appreciation for the absence of direct, intense light shining into personal spaces.
Mentions areas where lighting remains constant due to continuous activity.
Mentions noticing adaptive lighting in less busy parts of the city.
Mentions feeling safe due to adequate lighting.
Mentions initial confusion about the purpose of the sensors.
Mentions the assumption that sensors were for monitoring and combating crime.
Mentions feelings about data collection and its potential uses.
Mentions the potential acceptance of cameras if they increase safety.
Mentions community involvement in decisions related to smart lighting.
Mentions the perception that the city's ambiance has decreased with the introduction of smart lighting.
Mentions the importance of supporting climate initiatives.
Mentions reluctance to pay additional taxes for certain initiatives.
Mentions personal efforts to conserve energy at home.
Mentions the responsibilities and tasks of a lighting programmer, including planning, monitoring, and implementing smart lighting.
Mentions the responsibilities and tasks of an asset manager, including overseeing team functions, maintaining an overview, and reporting to higher authorities.

Mentions the need for smart lighting projects to be pragmatic and aligned with administrative goals.
Mentions the importance of considering non-monetary benefits, such as health and societal values, when evaluating smart lighting.
Mentions the need to weigh the costs of implementing smart lighting against its long-term benefits, including CO2 reduction.
Mentions skepticism towards fully adaptive lighting systems and a preference for simpler solutions.
Mentions potential integration between smart lighting and electric vehicle charging stations.
Mentions the historical context of human activity patterns in relation to light and darkness.
Mentions the potential safety implications of street lighting, both positive and negative.
Mentions concerns related to privacy when integrating cameras with street lighting.
Mentions the potential role of smart lighting in enhancing cultural events and festivities in the city.
Mentions the use of smart lighting to monitor pedestrian routes and identify deviations that might indicate criminal activity.
Mentions the importance of ensuring that technological developments in street lighting add value to residents' lives.
Mentions the need to ensure that the implementation of technology is cost-effective and meets specific needs.
Mentions the economic considerations of dimming streetlights based on wattage and the associated savings.
Mentions the non-financial benefits of dimming, including ecological value, biodiversity, and light reduction.
Mentions the direct operational savings from dimming, including reduced energy bills and potential extended lifespan of fixtures.
Mentions the uncertainty surrounding the extended lifespan of dimmed LEDs and the need for concrete data.
Mentions the economic benefits of collecting and using sensor data in street lighting.
Mentions the specific methods Amsterdam uses to collect data, such as traffic density measurement.
Mentions the potential of combining multiple functions in a single streetlight and the challenges associated with it.
Mentions unique challenges in data collection, such as measuring dog waste.
Mentions the involvement of telecom companies in smart street lighting projects and the potential benefits of 5G connectivity.
Mentions the city's commitment to sustainability, green energy contracts, and efforts to reduce light pollution.
Mentions the city's interest in promoting biodiversity even in urban settings.
Mentions the lifecycle of smart streetlights, including installation and maintenance processes.
Mentions the use of automated systems, such as cars with cameras, to monitor the functionality of streetlights.
Mentions the challenges and reliability issues associated with solely relying on sensor notifications for streetlight functionality.
Mentions the role and responsibilities of the respondent in the context of public lighting.
Mentions the collaboration with a tech company for the smart street lighting project.
Mentions the idea of adjusting lighting levels based on traffic or activity.
Mentions the ecological reasons for implementing adaptive lighting in parks.
Mentions the relationship between lighting and perceived safety.
Mentions the adjustment of lighting levels based on social events or activities in the city.
Mentions the use of intuitive lighting to influence traffic routes.
Mentions the use of different colors in lighting to distinguish types of areas.
Mentions the economic advantages and disadvantages of implementing smart lighting.
Mentions the lifespan of smart lighting components.
Mentions the use of sensors and cameras in smart lighting.

Mentions concerns and measures related to privacy in the context of smart lighting.
Mentions the broader vision of developing a smart city.
Mentions the criteria or indicators used to evaluate the impact of a project on various fronts.
Mentions the ecological considerations and impact of lighting.
Mentions the potential indirect economic benefits of specific lighting choices.
Mentions the importance of involving the public in lighting projects.
Mentions the respondent's role and involvement in a specific project.
Mentions the involvement of various stakeholders in the project.
Mentions specific use cases or applications of the technology.
Mentions measures to ensure privacy when using certain technologies.
Mentions the criteria or factors considered when evaluating the feasibility or success of a use case.
Mentions efforts to measure the impact of lighting on ecology.
Mentions the collection and consideration of feedback from the public.
Mentions the approach to introducing and testing new technologies.
Mentions challenges faced when trying to scale up the technology.
Mentions the main goals or motivations behind the project.
Mentions a proactive strategy or method for planning and evaluation.
Mentions the financial assessment or economic considerations of the project.
Mentions the visual or aesthetic impact of lighting on the city's appearance.
Mentions the broader economic implications of lighting interventions.
Mentions the shift from traditional to innovative lighting solutions.
Mentions the assessment of the environmental effects of lighting interventions.
Mentions the process of receiving, evaluating, and acting upon feedback.
Mentions conducting a market consultation regarding smart street lighting.
Mentions the idea of collecting data through sensors in lampposts.
Mentions making data available to commercial parties through an open data platform.
Mentions concerns about high costs and uncertain returns.
Mentions considerations about the technical feasibility of the project.
Mentions challenges within the organization, especially between different departments.
Mentions financial risks associated with the project.
Mentions the concept of active dimming based on motion sensors.
Mentions the idea of replacing older lampposts with energy-efficient LED lighting.
Mentions the role and perspective of asset managers in the decision-making process.
Mentions the challenges of managing and processing sensor data.
Mentions the importance of technological innovations having a positive societal impact.
Mentions the challenge of quantifying intangible benefits such as safety, attractiveness, and sustainability.
Mentions the idea of starting a pilot project in a specific neighborhood.
Mentions the use of dimming street lights in areas with wildlife to give animals rest.
Mentions how political parties and their priorities can influence the decision to implement smart street lighting.
Mentions concerns about the privacy of residents when implementing smart street lighting.
Mentions the avoidance of collecting personal data and the strict adherence to privacy guidelines.
Mentions the ecological advantages of smart street lighting, including energy savings and reduced light pollution.
Mentions the perspective of asset managers and their primary responsibilities within the municipality.

Mentions the financial challenges and high costs associated with implementing smart street lighting.
Mentions the difference between an idealistic perspective focused on intangible benefits and a practical perspective focused on costs and tangible outcomes.
Mentions the challenges of collaboration between different departments within the municipality.
Mentions where smart street lighting fits best within municipal policy models, such as 'smart city', safety, or sustainability.
Mentions the challenges faced by different departments when trying to collaborate on interdisciplinary projects.

Appendix B – Second-order codes

The approach of the company towards smart street lighting
Ensuring the company is qualified and able to integrate smart lighting modules.
The potential for financial gain due to cost savings from efficient monitoring and maintenance of lighting.
The ability to adjust lighting levels during emergencies or events.
Potential privacy issues/risks related to the collection and use of data.
The importance of ensuring the privacy of individuals in smart lighting.
Issues related to the compatibility and functionality of combined technologies.
The ability of the lighting system to serve multiple functions.
Balancing the goals of safety and environmental friendliness.
The broader implications of smart lighting in urban development.
The relationship between increased technological features and potential maintenance costs.
Reduction in energy consumption due to smart lighting.
The commitment to sustainable and eco-friendly practices.
The positive impact of lighting on the natural environment.
The feedback or concerns raised by residents regarding lighting.
Attention towards the lifespan and sustainability of the manufactured products.
The logistical issues related to delivering products in certain areas.
Importance of evaluation of the environmental impacts
The need for clear communication and transparency about technology.
The assistance provided in terms of technical details and guidance.
The limitations posed by outdated or inadequate infrastructure.
The benefits of having data-driven insights from smart lighting.
The unique value proposition of their company in the market.
The importance of involvement of the community in the project.
Economic advantages derived from social factors.
Doing a comparison of the costs and benefits of the project.
The potential indirect effect of the project on property values in the city.
Reference to broader smart city projects and their economic considerations.
High financial initial costs influencing decisions on smart city projects.
The idea of being ready for future technological shifts.
The negative environmental impact of excessive or misdirected artificial light.
Variations in market trends and demands across countries.
Mandatory tendering process for public projects.
Evaluation based on best economic offer.
Increasing market emphasis on energy conservation.
The potential of smart lighting to create a false sense of security.
The value of receiving feedback post-implementation.
Opposition from the public to certain technologies.
Weighing the importance of personal privacy against security measures.
Rules set by European entities governing the use of cameras in public spaces.
Hard to determine who is accountable for regulations and outcomes.
The responsibility when supplying or bringing in technology to countries with lax privacy regulations.
The extended lifespan of LED lights compared to conventional ones.
The position and influence of lighting companies in decision-making.
The challenges and restrictions of using solar energy for street lighting.

Concerns about waste generated from electronic components.
Mention of standards or common practices in the industry.
A perceived gap in knowledge within the industry between companies and governments.
Variability in how different stakeholders view the benefits and drawbacks of smart lighting.
Differences in privacy concerns based on cultural and demographical factors.
How the size of a municipality influences their choices in smart lighting.
Issues related to who owns and is responsible for the infrastructure.
The lack of a standardized approach to sustainability in project tenders.
The environmental negative impact of excessive or misdirected artificial light.
The respondent's position and responsibilities in relation to the project.
Mentions the ability of their software platform to manage lights regardless of the controller's manufacturer.
The need for a policy-driven approach instead of project-driven
The economic benefits of combining multiple smart systems.
Importance of evaluation of the environmental impacts.
The approach of the company towards smart street lighting.
Low concern about smart lighting in general
Initial perception or misunderstanding of sensors as cameras.
Understanding of the relationship between movement and activation of lights.
Feelings of safety or comfort related to due to adequate smart lighting.
Low community involvement in decisions related to smart lighting.
Use of colored lighting for ecological reasons or emergencies.
Feelings of discomfort due to the dimmed lights
Low concern about privacy related issues and its potential uses.
Low impact on daily activities
Impact of lighting on nighttime ambiance and potential effects on sleep and relaxation.
Lighting serving as a warning system indicating movement or presence.
City investments in climate initiatives and personal willingness to support financially.
The negative environmental impact of excessive or misdirected artificial light
Economic advantages derived from social factors
Preference for normal LED lights
Low impact of street lights on safety
Importance of ensuring technological developments add value to residents' lives.
Importance of evaluation of the environmental impacts of a product
Mentions specific use cases or applications of the technology.
Scalability challenges
Proactive strategy or method for planning and evaluation.
Technical feasibility challenges
Challenges of collaboration between different departments within the municipality.
Challenges of managing and processing sensor data.
Political ideas influencing the decisions to swift to smart street lighting

Appendix C – Third order themes and their underlying second-order codes

Privacy and Security:

- Potential privacy issues/risks related to the collection and use of data.
- The importance of ensuring the privacy of individuals in smart lighting.
- The need for clear communication and transparency about technology.
- Weighing the importance of personal privacy against security measures.
- Rules set by European entities governing the use of cameras in public spaces.
- Potential privacy issues/risks related to the collection and use of data.
- The importance of ensuring the privacy of individuals in smart lighting.
- The responsibility when supplying or bringing in technology to countries with lax privacy regulations.
- Differences in privacy concerns based on cultural and demographical factors.
- Initial perception or misunderstanding of sensors as cameras.
- Low concern about privacy-related issues and its potential uses.

Community and Public Perception:

- The feedback or concerns raised by residents regarding lighting.
- The importance of involvement of the community in the project.
- The value of receiving feedback post-implementation.
- Opposition from the public to certain technologies.
- The feedback or concerns raised by residents regarding lighting.
- The importance of involvement of the community in the project.
- Low community involvement in decisions related to smart lighting.
- Feelings of safety or comfort related to due to adequate smart lighting.
- Use of colored lighting for ecological reasons or emergencies.
- Feelings of discomfort due to the dimmed lights.
- Impact of lighting on nighttime ambiance and potential effects on sleep and relaxation.
- Low impact on daily activities.
- Preference for normal LED lights.
- Importance of ensuring technological developments add value to residents' lives.

Safety and Accessibility:

- The ability to adjust lighting levels during emergencies or events.
- Balancing the goals of safety and environmental friendliness.
- The potential of smart lighting to create a false sense of security.
- Lighting serving as a warning system indicating movement or presence.
- Low impact of street lights on safety.

Cultural and Social Impact:

- The broader implications of smart lighting in urban development.
- Variability in how different stakeholders view the benefits and drawbacks of smart lighting.

Governance and Accountability:

- Ensuring the company is qualified and able to integrate smart lighting modules.
- Mandatory tendering process for public projects.

- Evaluation based on the best economic offer.
- Hard to determine who is accountable for regulations and outcomes.
- The position and influence of lighting companies in decision-making.
- Issues related to who owns and is responsible for the infrastructure.
- The need for a policy-driven approach instead of project-driven.
- The respondent's position and responsibilities in relation to the project.
- Challenges of collaboration between different departments within the municipality.
- Challenges of managing and processing sensor data.
- Political ideas influencing the decisions to switch to smart street lighting.

Energy Efficiency and Sustainability:

- Reduction in energy consumption due to smart lighting.
- The commitment to sustainable and eco-friendly practices.
- The positive impact of lighting on the natural environment.
- Increasing market emphasis on energy conservation.
- The negative environmental impact of excessive or misdirected artificial light.
- Importance of evaluation of the environmental impacts.

Product Lifecycle and Waste Management:

- Attention towards the lifespan and sustainability of the manufactured products.
- The limitations posed by outdated or inadequate infrastructure.

Cost-Benefit Analysis and Financial Implications:

- The potential for financial gain due to cost savings from efficient monitoring and maintenance of lighting.
- Doing a comparison of the costs and benefits of the project.
- The potential indirect effect of the project on property values in the city.
- Reference to broader smart city projects and their economic considerations.
- High financial initial costs influencing decisions on smart city projects.
- The economic benefits of combining multiple smart systems.
- Economic advantages derived from social factors.
- The relationship between increased technological features and potential maintenance costs.

Market Trends and Industry Dynamics:

- The approach of the company towards smart street lighting.
- The relationship between increased technological features and potential maintenance costs.
- The unique value proposition of their company in the market.
- Variations in market trends and demands across countries.
- The assistance provided in terms of technical details and guidance.
- The idea of being ready for future technological shifts.
- The logistical issues related to delivering products in certain areas.
- The benefits of having data-driven insights from smart lighting.
- Issues related to the compatibility and functionality of combined technologies.
- The ability of the lighting system to serve multiple functions.
- Mention of standards or common practices in the industry.
- A perceived gap in knowledge within the industry between companies and governments.

- How the size of a municipality influences their choices in smart lighting.
- The lack of a standardized approach to sustainability in project tenders.
- Low concern about smart lighting in general.
- Mentions the ability of their software platform to manage lights regardless of the controller's manufacturer.