

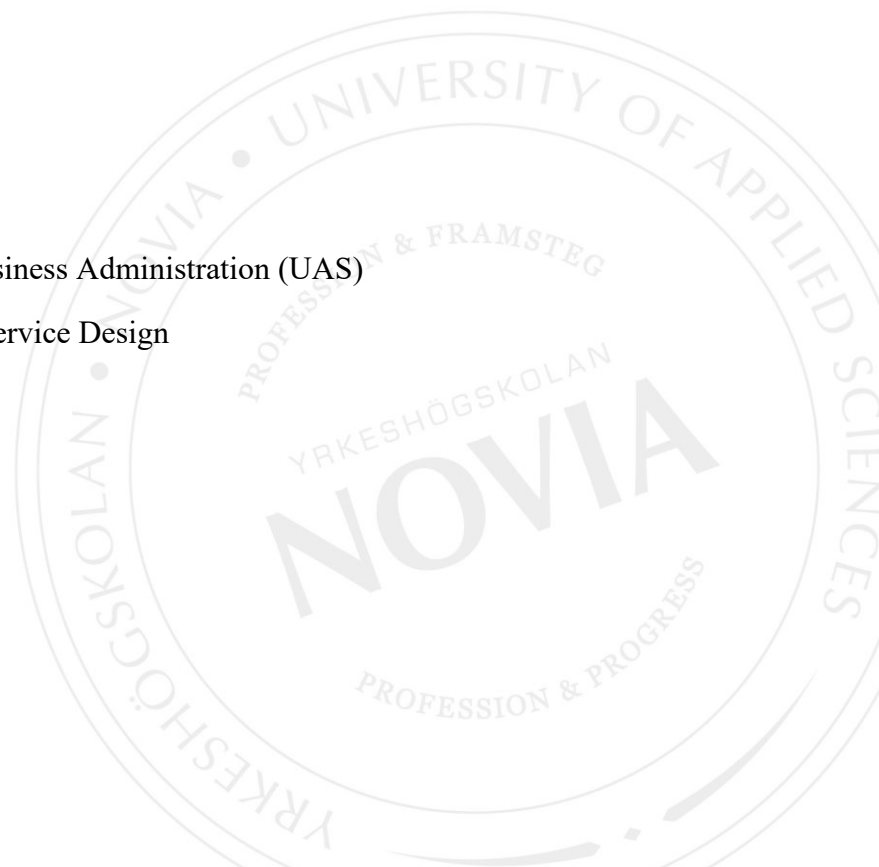
Innovative Financing Mechanisms for Upscaling EU-Funded Smart City Solutions

Shumaila Hamood

Thesis for a Master of Business Administration (UAS)

The Degree Program of Service Design

Turku, 2023



Degree Thesis report

Author: Shumaila Hamood

Degree Program: Service Design

Specialization: Masters in Business Administration

Supervisor(s): Fredrik Strandberg, Elina Vartama, Reija Anckar

Title: Innovative Financing Mechanisms for Upscaling EU-Funded Smart City Solutions

Date: 04/12/2023

Number of pages: 71

Appendices:9

Abstract

Positive energy districts, which produce more energy than they consume, are envisioned to be deployed across Europe by the European Commission by 2050. RESPONSE is one such project, a 60-month implementation plan under the Horizon 2020 funding program of the European Commission. By integrating energy-efficient heating and cooling systems, lighting solutions, smart mobility, and sustainable retrofits into existing building clusters, the project's primary objective is to establish positive energy districts.

As one of the lighthouse cities of RESPONSE, the city of Turku along with its partner organizations in the project, is actively exploring funding options to identify liquidity and investment partners. They will also lay out how to combine the available funding options of the EU Commission with new financing mechanisms to upscale the project and look for replication opportunities.

The already developed business model used in RESPONSE was examined in this thesis study to identify strengths, limitations, and areas for improvement. The emphasis was on overcoming barriers and risks to ensure the effective implementation of the business model and identify new revenue sources. Experts' opinions were considered to promote replication in other areas by identifying and addressing risk factors.

In this study, the research methodologies used to collect data were a blend of preparatory research, e-research, conversation and discourse analysis, participant observation, qualitative comparative analysis, and building a research wall to apprehend the complications and derive solutions. Additionally, tools like benchmarking and case study analysis were used. A co-creative workshop method was also used to build system mapping. A stakeholder map and service blueprint were generated during system mapping to gain profound knowledge of the research study.

In conclusion, all the research methods and tools employed to collect information were utilized to create a toolkit that culminated as a decision matrix for selecting appropriate financing options for implementing any given integrated solution as an upscaling or replication of the project.

In addition, the use case analysis of 5G lighting poles and Direct current-coupled bi-facial solar panel systems were discussed to understand the dynamics of the business model and how financing mechanisms can be introduced for the particular integrated solutions.

Language: English

Keywords: smart cities, citizen engagement, financing mechanisms, integrated solutions, replication, upscaling

Acknowledgments

I would like to extend my gratitude to the Turku Development Unit team for taking me on board and for their support and guidance throughout the thesis process.

I would also like to express my appreciation to Novia UAS for appointing a specialized advisor to help me combine aspects of Finance with Service Design. Special thanks to my advisor Fredrik Strandberg who inspired me in this process and guided me along the way.

A heartfelt thank you goes to my husband and kids for taking this path of lifelong learning with me and allowing me to explore new horizons.

Table of Contents

1	Introduction	1
1.1	Project Background.....	1
1.2	Thesis Study Background and Scope	3
1.3	Limitations of Study.....	4
1.4	Research Questions.....	5
1.5	Problem Area Framework.....	6
2	Theoretical Context and Literature Review.....	7
2.1	RESPONSE in the Context of Turku’s Climate Action Plan.....	7
2.2	Sustainability and Smart Cities.....	8
2.3	Designing Services with a Thinking Approach.....	11
3	Research Analysis Methods.....	14
3.1	Preparatory Research	14
3.2	e-Research	14
3.3	Participant Observation Method	15
3.4	Qualitative Comparative Analysis	15
3.5	Building a Research Wall	16
3.6	Co-Creative Workshop to Develop System Maps	16
3.7	Thesis Project Timeline.....	16
4	Preparatory Research Insights (Ask)	17
4.1	e-Research Insights (Compare).....	18
4.2	Participant Observation Method Insights (Understand).....	18
4.2.1	Attending Consortium Event as a Participant.....	21
4.3	QCA Combined With Research Wall Method Insights (Ideate).....	22
4.4	Co-Creative Workshop to Develop System Maps (Ideate).....	23
5	Deliverables and Tangible Outcomes (Challenge-Explore-Observe).....	25
5.1	Exploring Funding and Financing Mechanisms	25
5.2	Stakeholder Map	29
5.3	Service Blueprint of EU-Funded Project.....	31
5.4	Strategic Analysis of Business Model Canvas	33
5.5	Improvements in S2CBMC	38
6	Developing Innovative Financing Mechanisms Toolkit (Prototype)	39
6.1	Overview of Innovative Funding and Financing Mechanisms	40
6.2	Decision Matrix for Choosing Financing Mechanism.....	42
6.3	Finance Framework for Integrated Solutions of RESPONSE	46
6.4	Use Case of 5G Smart City Lighting Poles	48
6.4.1	Technical Specifications	49

6.4.2	Blended Finance With the Use of Funding/Loan and BOT Finance Mechanisms	50
6.4.3	Municipal Bonds as Financing Mechanism	52
6.5	Case Study on Direct Current (DC) – Coupled Bi-Facial Solar Panel System	55
6.5.1	Technical Specifications	55
6.5.2	Cooperative Funding	56
6.5.3	Benefits of the Mechanism	57
6.5.4	Energy Performance Contracts (EPCs).....	57
7	Risk Management.....	60
8	Future Suggestions	66
8.1	Lessons Learned.....	68
9	Conclusion.....	69
10	References	72
11	List of Figures.....	78
12	List of Tables	79
13	Appendices.....	80

Appendix A: Slides depicting five clusters of building blocks used for implementation of the RESPONSE project as PED.

Appendix B: Work Packages Roadmap

Appendix C: June 06-08, 2023, the “Consortium event Turku”. Photo courtesy Helmi Andersson

Appendix D: June 06-08, 2023, the “PED site visit Turku”. Integrated solutions

Appendix E: Research Wall

Appendix F: Case study of decision matrix models

Appendix G: Turku and RESPONSE plans

Appendix H: Co-Creating System Maps (1/2, 2/2)

Appendix I: Interview Questions for EU Advisor

List of Abbreviations

Abbreviation	Expanded Form
BM	Business Model
BOT	Build Operate Transfer
EC	European Commission
ELENA	European Local Energy Assistance
EPC	Energy Performance Contracting
EU	European Union
EV	Electric Vehicle
FC	Fellow City (project partners)
ICT	Information and Communication Technology
IoT	Internet of Things
LED	Light-Emitting Diode
LHC	Lighthouse City (project, city)
PEB	Positive Energy Block
PED	Positive Energy District
PPP	Public Private Partnership
RES	Renewable Energy Sources
ROI	Return on Investment
SC	Smart City
S2CBMC	Smart City Circular Business Model Canvas
SME	Small and Medium Enterprise
V2G	Vehicle-to-grid
WP	Work Package

1 Introduction

Integrating sustainable smart city solutions in urban development can bring value to an inhabitant's quality of life and also significantly help in achieving energy efficiency. Considering the longer life cycle of these developments, it is important to take into account the long-term risks associated with them. Cities can stay ahead of the curve by implementing strategic thinking and product positioning rooted in service design principles. By understanding the intersections between sustainability and the built environment, breakthrough ideas can be generated and purposeful solutions can be developed to address age-old problems of climate change, social exclusion, and health worldwide. This can result in a greener future for our cities and the world as a whole.

A publication by the United Nations in 1987 titled The Brundtland Report, defined the concept of sustainability by emphasizing that it is important to meet the needs of the present generation, but while achieving that, we should not jeopardize the ability of future generations to meet their own needs (World Commission on Environment and Development, 1987, p. 43). This can be a guiding principle for any resilient smart city project and RESPONSE, being one of the sustainable smart city endeavours, is one such example.

1.1 Project Background

RESPONSE became a reality under the implementation of the European Commission's Horizon 2020 funding program. The project has a 60-month execution plan with a time frame of October 2020 to September 2025. It has the overarching objective of building adaptable and smart cities that enhance the quality of life and mitigate the effects of climate change. The project's primary aim is to develop energy-positive built areas that can generate more energy than they use each year. These areas are called Positive Energy Blocks (PEBs), and when combined as clusters, they form Positive Energy Districts (PEDs). (*About – RESPONSE*, n.d.)

The lighthouse cities (LHCs) of Dijon, France, and Turku, Finland where PEDs are introduced, are the project's pilot locations. Additionally, six fellow cities (FCs) are involved, which include Brussels (Belgium), Gabrovo (Bulgaria), Zaragoza (Spain), Botosani (Romania), Severodonet (Ukraine), and Ptolemaida (Greece). The two LHCs will impart their knowledge to the FCs. (*About – RESPONSE*, n.d.)

The Turku Student Village Foundation (TYS) participated as one of the core stakeholders in this pilot project aimed at creating a climate-friendly and sustainable smart city. The five blocks of buildings namely Aitiopaikka, Ikituuri, Nummenranta, 5th Block, and Tyysija participated in the positivity measures comprising PED and are owned by TYS. (Response to Ylioppilaskylä Residents, 2020). See Appendix A for an aerial view and more details about PEDs.

By planning multi-level facilities in Turku, RESPONSE started its operation with these five building blocks in Yo-kylä (Student village) as a demonstration site in October 2020.

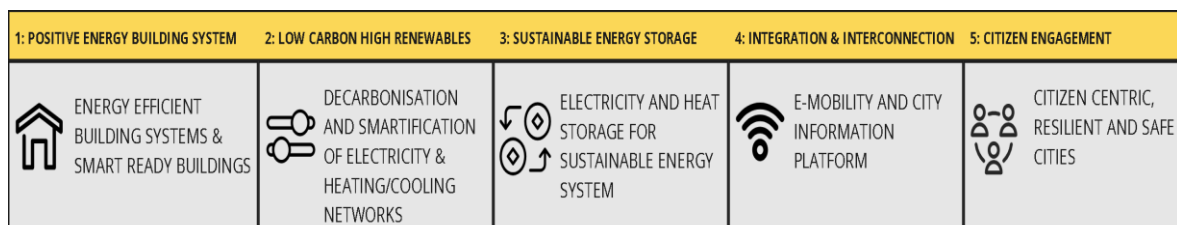


Figure 1. RESPONSE project framework comprising five pillars

Figure 1 explains the RESPONSE action plan of achieving smart city energy transmission by providing integrated solutions in five categories. The first pillar involves the demonstration of energy-efficient retrofitting to decrease energy consumption. The second pillar is about decarbonization and smartification of electricity and heating/cooling networks to increase the share of renewable energy. The third pillar consists of systems for sustainable heat storage to create flexibility in energy consumption. The fourth pillar is to use integration and interconnectivity of information and communication technologies to manage E-Mobility and governance. The fifth and last pillar is to engage citizens to share responsibility, create knowledge-sharing channels, and accomplish resilient and safe cities. (*About – RESPONSE*, n.d.)

All these pillars constitute ten integrated solutions, including electricity and heat storage, renewable energy sources (RES) generation (use of natural processes to produce energy, e.g., solar panels), energy-efficient buildings (installing EE windows), insulations, polyurethane sealing, water saving nozzles, LED lighting, smart mobility, 5G lighting poles, and city planning, including shared schemes of electrical vehicles and EV charging stations.

Mentoring approaches for outreach to build consumer awareness and citizen engagement are also important parts of the project. These solutions have already been deployed in the building cluster of PED at this stage. (*About – RESPONSE*, n.d.) (For pictures of Integrated solutions, see Appendix D)

1.2 Thesis Study Background and Scope

The researcher contacted the Project Development Unit of Turku for this thesis study project on RESPONSE. The Project Development Unit as a commissioner of this thesis study sought assistance for research on “*available funding schemes, financing mechanisms, and possible crowd equity facilitators*”. It was also intended to find potential deployment of these financing mechanisms, for replication of the RESPONSE integrated solutions in other areas of the city.

For this purpose, the researcher was engaged by the commissioner and then the scope of the research study and timeline was established. The research study focused on the demonstration site of RESPONSE in Turku.

The study was interdisciplinary, incorporating service design to look at a sustainable urban development project under the Smart City framework. One major aspect of the study was to see how service design and design thinking can help in exploring the mechanisms of finance so that the integrated solutions of smart cities can be upscaled and replicated.

RESPONSE is divided into 13 work packages referred to as WPs from here onward (please see Appendix B for all the WPs). It should be noted that some of the WPs, run parallel to each other. However, the thesis study focused mainly on WP5-Business Models for Smart City Solutions and Governance Capacity.

The project's WP5 aim is to develop sustainable and replicable business models for smart cities and their stakeholders. The WP focuses on governance issues and aims to accelerate the smart economy in Lighthouse and Fellow cities. The three main subtasks include developing the Smart City Business Model Canvas, implementing circularity concepts for sustainability, and assessing energy, social, and business flows in urban environments. This WP contributes to the financial viability of RESPONSE's ideas in smart cities by providing a foundation for future project activities. (Leroy & Sanfilippo, 2021)

The Commissioner's expectations from this thesis study were to create an informative toolkit that explains different funding options, gives insights into their primary applications, and indicates where to access them to achieve RESPONSE upscaling and replication goals. To develop the toolkit, the researcher planned to develop system maps and analyze the current business model canvas of the project. The commissioner had already developed the business model canvas (BMC) as part of the WP5 plan, and the researcher wanted to analyze it to understand the dynamics of business and suggest financing mechanisms accordingly.

As per the brief provided by the commissioner on WP5, the goal of this specific WP is to create sustainable and replicable business models (BMs) that will help cities and their stakeholders capture value from these solutions. The research study focused on the following steps, which involved several activities explained further in the report:

Assessing existing frameworks: The first step was to analyze the BMC that was already being developed as part of WP5. BMC utilized in other cities was also considered to be helpful in this study to identify potential areas for enhancement.

Identifying new revenue streams: In addition to energy-related services, potential non-energy services could also be identified to generate new revenue streams.

Analyzing investors' and citizens' perspectives: The BM was to be analyzed with the perspectives of investors and citizens in mind to promote their replication in other areas or cities.

1.3 Limitations of Study

Due to the complex nature and scale of the project, the time frame of delivering the toolkit was a major limitation. The financing mechanisms research which was a primary outcome expected by the commissioner had to be sent in July 2023 for a deliverable of RESPONSE following its timeframe. The researcher contacted the commissioner in mid-January 2023 and started the study research immediately.

During the research, another challenge was a learning curve which was to know the fundamentals of EU projects and financing mechanisms. Since the researcher is an international student and new to Finland, had to overcome this limitation by understanding these projects and also gaining a comprehensive understanding of financing mechanisms. Previous experience of being an architect coupled with the new skills and knowledge of

service design helped in following a thorough research methodology to minimize the difficulties and restrictions of circumstances discussed above.

It is important to underscore the potential obstacles and complexities encountered by the researcher throughout the research process, as these could be regarded as contextual constraints on the thesis. However, it is also to highlight the complexity and learning journey involved in conducting this research.

1.4 Research Questions

The thesis research investigated the following areas to respond to the research questions. The questions were modified as the investigation went on, but they mostly maintained the direction.

Identifying challenges: What are the challenges of the current BMC, and how is it integrating financing mechanisms into its design within PED?

Identifying critical factors: What is the prospect of potential change in BM that can bring funding streams?

Positioning strategy: How can effective financing mechanisms be developed (toolkit) so that PED becomes a blueprint for upscaling and replication?

Risk Management: What are the implications of potential obstacles in replicating smart city solutions and how to mitigate the obstacles?

The first two research questions were about identifying challenges and identifying critical factors in the business model and its canvas. The first two sets of questions aimed to understand the existing challenges within the current business model and analyzed the obstacles and difficulties in integrating financing mechanisms into the design of PEDs. These were more of a diagnostic nature questions to comprehend the ongoing scenario. The second question in particular focused on the potential for change within the BMC to attract funding streams, identify key elements, and strategies, or highlight modifications that can increase the current BM financial viability. This research area explores present state problems and barriers that may hinder the project's financial sustainability and future orientation focusing on opportunities.

The third question about positioning strategy was to present Positive Energy Districts (PED) as a model for replication and upscaling through efficient financing. It highlighted the strategic nature of the study, which is essential to the scalability and long-term success of any such project. Additionally, the fourth question highlighted risk management: The goal here was to pinpoint and deal with any possible barriers to the replication of smart city solutions. Exploring risk management is crucial to every project's resilience and success. Gaining a full understanding of how to overcome obstacles in replication can be achieved by looking at the implications of obstacles and mitigation measures.

The research questions addressed a holistic approach and provided a wide view of the RESPONSE project. This supported a more thorough and perceptive investigation, which may be beneficial for the project's long-term objectives.

1.5 Problem Area Framework

The thesis framework provided a comprehensive and clear view of how the major components of this research study interacted to generate a workable and sustainable conclusion. The report goes into more detail about each of these elements in the following chapter, offering an expanded review of how smart cities, sustainability, service design process, and financing mechanisms work together. The relationship diagram in Figure 2 outlines the main focus areas of the thesis study.



Figure 2. Relationship diagram showing problem area framework

The relationship diagram (Figure 2) illustrates that the project's main motivators are sustainability and the idea of a smart city, both of which demand ongoing support from policymakers and active public participation. The integration of a service design process, which was effectively used to manage the project's complexity, is a key component of this framework. The service design and design thinking approach played a crucial role in accomplishing the project's goals and ensuring that the archetype (toolkit) developed as a result of this study can act as a reference model for relevant initiatives, whether in the private sector or other cities. Spreading the ideas of sustainability and smart cities further requires this model's adaptability and replication.

The thesis focused on an in-depth analysis of the RESPONSE project's present business model. With the aid of a specifically created toolbox, innovative financing possibilities can be developed based on this study.

2 Theoretical Context and Literature Review

The following chapter will take a closer look at how the literature review opens up these areas, discussed in the problem area framework, and encompasses the entire process in the following chapter.

2.1 RESPONSE in the Context of Turku's Climate Action Plan

Turku is the sixth largest city in Finland and will turn 800 years old in 2029. A sustainable gift for the city to achieve is to become carbon neutral and an action plan was approved on June 11, 2018, for this vision. The objective is to collectively create a strategy for advancing sustainability and addressing the climate change challenges. Renewable energy sources will be promoted and carbon emissions from different sectors including mobility and transportation will be minimized. More focus will be given to sustainable urban development where low-carbon construction practices will be implemented. Additionally, this potential shift will be achieved by raising awareness and sharing responsibility among the citizens. (CARBON NEUTRAL TURKU - Our Climate Target, 2022)

This sustainable action plan will also have an emphasis on completing thorough life cycle assessments for newly constructed buildings. This initiative seeks to incorporate the idea of

a circular economy into all construction projects. Additionally, the city will cut greenhouse gas emissions through smart financial management, budget allocations, and operating procedures. The city also wants to make use of the climate budget in 2023. (CARBON NEUTRAL TURKU - Our Climate Target, 2022).

RESPONSE, being a part of that ambitious plan, has many key objectives to meet, but the study here focused on the result of developing a robust investment concept plan that can attract viable resources of capital blending from public funding and private financing. The goal was to ensure a participatory approach by mobilizing combined intelligence through citizen and stakeholder engagement. This will also, in the end, lead to providing a platform of guidance for other partners to adapt the solutions adjusting to their context. (Work Plan – RESPONSE, n.d.)

Another important factor to highlight here is the principle behind choosing a variety of cities (as LHCs and FCs) with unique features to participate in EU initiatives such as RESPONSE. The objective, according to David Goujon, the project manager for sustainable cities at the European Institute for Energy Research (EIFER) in Karlsruhe, Germany, is to address the particular needs and characteristics of various populations and test what works for them. Regarding RESPONSE, Turku and Dijon were selected because of their divergent qualities. Dijon, which has a large number of lower-class households with a diverse mix of cultures, is not like Turku, which places a great deal of emphasis on its large student population. The project aims to find new ways to empower different types of citizens and encourage other European cities to scale up and emulate similar examples by choosing cities with different characteristics and stages on the sustainability path. It is hoped that strategies that have been shown to work in one city's circumstances can be modified and applied in others. This approach recognizes that the success of EU projects promoting clean energy and sustainability depends on the customization of sustainability initiatives to the unique context and requirements of individual cities. (Goujon & Murshed, 2023)

RESPONSE project framework for the adoption of sustainable practices goes well with the city's proactive policies and commitment.

2.2 Sustainability and Smart Cities

In a "smart city," technological advances that are utilized for the benefit of locals and businesses enhance existing networks and services. A smart city goes beyond the use of

digital technologies that enhance resource management and reduce pollution. It consists of improved water supply and waste disposal systems, improved urban transportation networks, and more effective lighting and heating systems. In addition to this, it creates a local administration that is more responsive and engaging, ensures public safety, and meets the needs and requirements of an aging population. This comprehensive strategy for urban development focuses on the residents' overall quality of life and promotes an environment that is favourable for businesses to grow. Furthermore, it encompasses the prospect of digital innovation. (European Commission, n.d.)

A smart city is a concept that calls for the integration of human, digital, and physical systems within conventional networks and services that are applied to achieve a more effective use of energy resources. This strategy is crucial in Europe, where 75% of the population lives in urban areas. Urban areas in Europe impact the region's energy use and greenhouse gas emissions significantly, resulting in large impacts on climate change. Cities are the primary sources of economic expansion and job opportunities within the European Union. They advocate for crucial nodes that effectively stimulate economic growth and boost employment. Promoting research and innovation initiatives is essential regarding the need to tackle the problems of reducing climate change and promoting economic growth. In this context, the European Union recognizes that expanding research and innovation is vital for achieving its goals for cities' reliance on energy and ecological sustainability. As the EU moves toward a low-carbon energy system, EU member states are encouraged to make a coordinated effort to address the complex issues of climate change, energy efficiency, and sustainable urban development by introducing smart cities. (European Commission, n.d.)



Figure 3. Smart City network comprising focal activities Source (Schneider Electric, 2014 as cited in Leon-Garcia et al., 2015)

Cities are a crucial part of a country's economy and sustainability, and for cities to become smart, plans for resolving present problems and those arising from rapid urbanization in the future must be developed. The paper presented at the First EAI International Summit, Smart City 360°, discusses the importance of a Smart City and its different aspects as shown in Figure 3 above. Further to explain the concept of smart cities, it gave a list of smart city components and features which are discussed below:

Smart Government: The adoption of information and communication technologies by a city's government marks the start of a smart city. This makes it possible for the government to deliver accessible, open, and effective public services. (Leon-Garcia et al., 2015)

Safety and Security: For smart cities, ensuring safety and security is of utmost importance. This calls for the widespread deployment of intelligent monitoring systems, CCTV cameras, and preventive emergency response systems. (Leon-Garcia et al., 2015)

Citizen Participation: Promoting proactive citizen participation is essential. Governments are utilizing web platforms and mobile apps more frequently to let people use the newest technology to solve problems and even transform elections. (Leon-Garcia et al., 2015)

Smart Utility: Smart cities employ innovative approaches to tackle the problem of utility management. This covers the use of smart grids, energy meters that are connected to the internet, renewable energy sources, and cutting-edge waste disposal technologies. (Leon-Garcia et al., 2015)

Smart Economy: The foundation of a smart city is a strong, safe economy. Strong collaborations between the public and commercial sectors are frequently needed to promote innovation, raise GDP, and create new job possibilities. (Leon-Garcia et al., 2015)

Smart Mobility: Real-time data and Internet of Things (IoT) technology is essential to smart cities' efficient traffic management. Urban transportation is improved by the use of data from sensors, social media, and video cameras to avoid traffic bottlenecks and blockages. (Leon-Garcia et al., 2015)

Smart Environment: One of the top priorities is to build an eco-friendly metropolis. This involves using most of the available public transportation, reducing the use of private vehicles, switching to electric or hybrid technology, and implementing recycling programs with tracking provided by the IoT. (Leon-Garcia et al., 2015)

Smart Living: Intelligent modern homes are becoming more prevalent. The Internet of Things (IoT) enables communication across different automation systems and gadgets in homes, giving residents more convenience and control. Through mobile apps, appliances such as refrigerators and heating systems can be remotely controlled. (Leon-Garcia et al., 2015)

It is important to highlight that making a city smart doesn't always require adding entirely new infrastructure; instead, it often involves enhancing the existing technology with big data gathered from connected devices and sensors and data analytics that support smart city applications. The success of such initiatives, however, depends on the adoption and usage of smart city applications by citizens, which support decision-making and encourage behavioural change. (Woetzel et al., 2018, as cited in McKinsey Global Institute, 2018)

The Smart City concept, with its interdisciplinary approach, gives a very solid theoretical background to this research. As an anchoring point, it fundamentally combines ideas of governance, urban planning, sustainability, the circular economy, technology, and digitalization. Our living spaces are changing, and to enhance urban resilience to cope with such rapid changes, we need design thinking strategies. In addition to being innovative, smart cities are also governed by regulatory bodies that collaborate closely with their citizens. While keeping data privacy and security in mind and in accordance with policy-making, social inclusion is welcomed. Generally speaking, smart cities provide a rich theoretical background that can be customized with the aid of design thinking principles to encourage resilience, integrate with future trends, and better handle the developing world.

2.3 Designing Services with a Thinking Approach

Design thinking is often an inevitable process. It not only serves the function of fulfilling the requirements of the consumer but also showcases the potential of the project, especially if paired with sustainability and the smart city revolution, bringing more value. On one hand, it fulfills a human-centric approach, which is a common touchpoint for service design, and on the other, it refines strategies and moves towards a better future.

While a smart city approach design gives you a foundation, design thinking gives you a starting point to identify the problem and create a solution. This study was more likely based on Newman's "The Design Squiggle" which represents the design process as shown here in the Figure below.

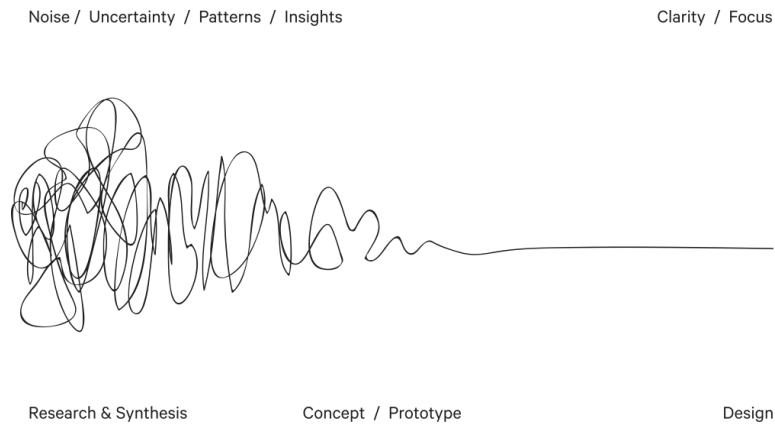


Figure 4. Damien Newman's "Squiggle" represents the design process. The Design Squiggle

The design squiggle shown in Figure 4, is a very straightforward way of showing how the design process is delivered, from the gathering of information, learning new things, coming up with creative ideas, iterating on prototypes, and finally arriving at a single designed solution. It aims to capture the feeling of the journey. Chaos and uncertainty on the left are followed by a single point of focus: the design on the right. (The Design Squiggle, n.d.) The researcher found a similarity in the design thinking models of Damien Newman and a discussion by Simon Clatworthy, as the latter also suggested the same kind of approach to a design process, shown in his article below:

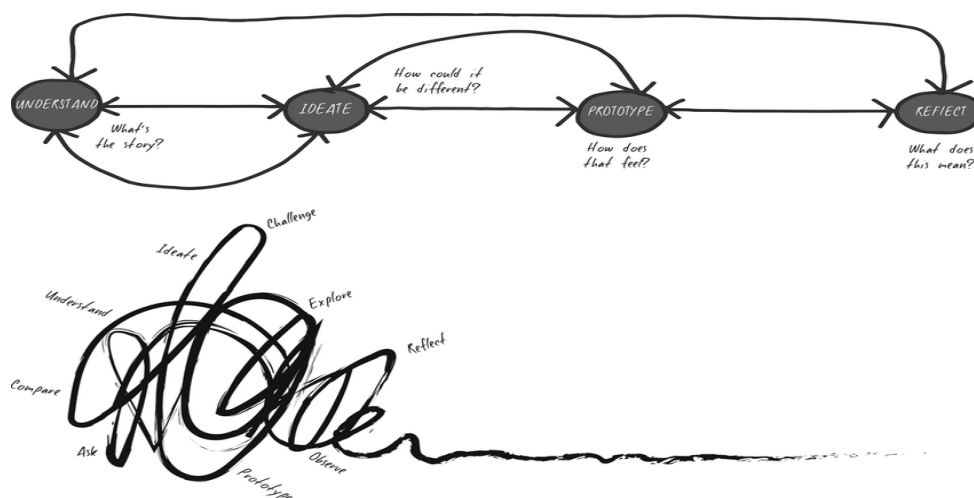


Figure 5. The design thinking approach cycles through phases. Source (Clatworthy, 2017)

Explaining his idea in Figure 5, Clatworthy says that design is not just designing products, services, and interactions but also the role that organizations play during the process. It is important to introduce design early in the project process, during the 'fuzzy front end' (Clatworthy, 2017). He also suggests that design is not always a linear process as shown above rather it's a chaotic "rapid, messy and non-linear cycling, jumping between these stages" as shown below. Design is therefore also a process as well as an outcome, and it works best when introduced at the start of a project. The front end is where the major decisions are made and where a project knows least about what will be the result. The researcher couldn't agree more with Clatworthy when he said "*There is no agreed definition of design thinking nor an agreement of its core characteristics*" (Clatworthy, 2017, p. 170).

With globalization, digitization, and a shifting information landscape, we live in a VUCA (volatile, uncertain, complex, and ambiguous) world. Strategic decisions are necessary for organizations to manage interconnected events and disruptions and to shape change. Effective leaders must be able to see the best possible future, grasp ongoing changes, and predict outcomes. The combination of strategic foresight and design offers a fresh perspective on how to perceive and handle change. Conventional forecasting is ineffective in dynamic, quickly changing environments. For adaptability and flexible decision-making in these uncertain times, a new approach is required. (Buehring & Bishop, 2020)

The research methods discussed in the upcoming chapters will show how design thinking and service design were connected to this whole research study.

3 Research Analysis Methods

The project's nature called for the use of a variety of research methods which are shown here in Figure 6 below. These methods will be briefly introduced, outlining their introduction.

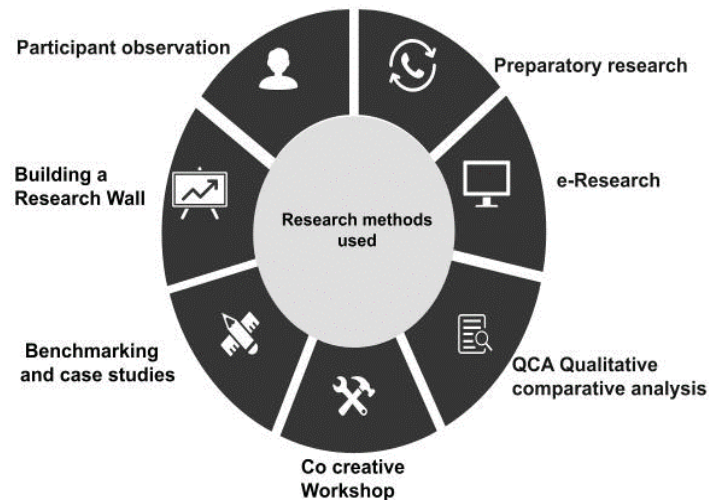


Figure 6. Methodology overview

A brief introduction to each method is given below, offering an overview of each of the methods. A detailed discussion of how the researcher employed these methods to collect data and the types of data generated through each approach will be presented in Chapter 4.

3.1 Preparatory Research

According to the #TISDD METHOD LIBRARY, preparatory research entailed exploring the research problem from the client's point of view to obtain a deeper comprehension of their background, viewpoints, internal dynamics, and any potential conflicts that might arise throughout the project. The organization's initial internal interviews yield insightful information and can serve as a starting point.(Stickdorn et al., 2018)

3.2 e-Research

Engaging in e- Research is a form of secondary research. It is also called interchangeably as desk research, which is a method that relies on pre-existing data from sources like academic research, trend studies, market research reports, and customer data. This data can come from

internal or external sources, such as reports, white papers, and academic papers. Secondary research is typically conducted using online search engines, research platforms like Google Scholar, scientific databases, publications, libraries, conferences, and expert discussions. The main goal of desk research is to identify existing research on a specific subject or research issue, hone research questions, and determine the most efficient data collection methods. It should be the first stage after primary research to avoid redundancy and improve the body of current knowledge. It is most helpful starting point simply to avoid reinventing the wheel. (Stickdorn et al., 2018)

Desk research helps gather the primary data by utilizing others' (government, universities, demographic surveys, or online search engines) research done on the same topic instead of conducting field visits yourself. The existing research may not be the same, but it can be closer to answering your questions. (Jansen, 2021)

3.3 Participant Observation Method

A research methodology called participant observation involves immersing oneself in social contexts where complex interactions between people, objects, and their physical environment take place. The initial step in this strategy is to physically enter the environment being studied, such as a community, a place of employment, or a recreational area. To monitor participants' natural behaviors and actions, building rapport with them is necessary. This requires some level of acceptability as a reliable presence. Lastly, allotting enough time for interaction, observation, and engagement to collect a variety of experiences using unstructured interviews. The informal character of this method necessitates sustained engagement, allowing for a thorough comprehension of the research context and insights into participants' behaviors and interactions. (Stickdorn et al., 2018) .

3.4 Qualitative Comparative Analysis

Qualitative comparative analysis (QCA), which is based on set theory and the language of necessary and sufficient conditions, is the best method for capturing this causal complexity. QCA, a case-based research methodology, views cases as combinations of conditions and examines each case's conditions in an organized manner to determine the criteria that are both necessary and sufficient for an outcome. (*Qualitative Comparative Analysis*, Georgetown University Press, n.d.)

3.5 Building a Research Wall

As described in the source "#TISDD METHOD LIBRARY," the "Research Wall" method is a useful strategy for combining and displaying research data. The main goal of this approach is to make data synthesis and analysis easier by organizing the data visually, much like detectives do with crime scene data. It enables academics to spot trends, communicate new findings, and draw conclusions from gathered data. A research wall gives you a platform to share your work with others as it progresses and helps you find trends in your data. Usually, the first step in data synthesis is to group the data into distinct categories or to make a basic mental map of the dataset. Make an inventory of the data. To ensure nothing is lost, create an asset catalog of your data with headings like "5 video interviews of families, 25 customer quotes on common problems, 15 photos of critical situations." Depending on your data index, this could be a straightforward list or a mind map. (Stickdorn et al., 2018)

3.6 Co-Creative Workshop to Develop System Maps

An effective way to comprehend ecosystems is through a co-creative workshop that is tailored to present a particular perspective, such as that of customers or different departments inside the company. To guarantee significant contributions, it is essential to attract people who possess a solid understanding of the selected viewpoint. It is important to clearly define the workshop's scope and take the situational context into account. Participants are better able to work together and align their understanding as a result. (Stickdorn et al., 2018)

A crucial element contributing to the effectiveness of these workshops is the preliminary qualitative research. The outcomes will be more representative of the more valuable data researchers bring to the event. Workshops with participants who merely have a cursory understanding, however, could produce biased outcomes. (Stickdorn et al., 2018)

3.7 Thesis Project Timeline

The thesis timeline is displayed here, with the first four lanes representing the research period, the lane in yellow color representing the Novia dates for the thesis seminars, and the last lane representing the timeframe of delivering the research to the commissioner. The final submission arrow, however, was the pinnacle of the process; the researcher was required to provide the commissioner with sufficient time to review the report before it was submitted for the final seminar in November 2023. The Report was thoroughly reviewed by the

commissioner for it to be factual and aligned with RESPONSE information and the researcher resolved all the comments marked on the report.

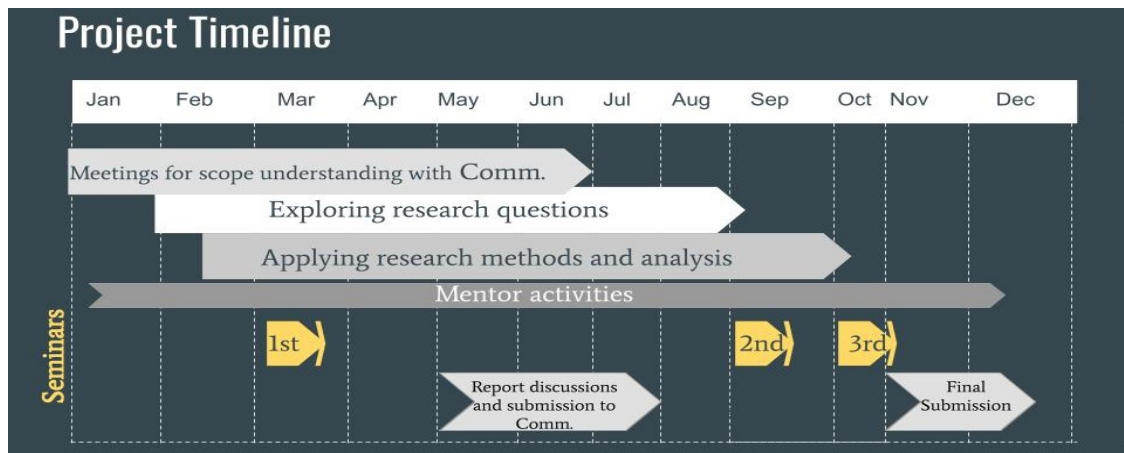


Figure 7. Project Timeline

As shown in Figure 7, applying research methods and analysis can be found in chapter 4 and mentor activities can be further reviewed in section 4.2.

4 Preparatory Research Insights (Ask)

Preparatory research as a starting point is more about finding the right questions to ask with less focus on finding answers. It also helps in formulating the research questions for any study. (Stickdorn et al., 2018). The researcher started with this approach early on thesis study because it is a fundamental and initial step to formulate research questions and broadly know the direction of the research. While research questions evolve during the process and is also an iterative process a main axis needs to be defined in the beginning. Some insightful information from early internal interviews with the commissioner was gained to grasp the study perspective. Acquired knowledge of relevant EU initiatives began to improve comprehension of the operating principles of energy efficiency and SC projects. Additionally, Turku's plans were examined via social media posts and web pages.

This preliminary research produced more key observations rather than written descriptions. It also entailed gathering visual resources based on memory and site visits. The researcher, being a resident of the PED area, witnessed a major portion of retrofitting works conducted

in the 5th Block of PED from the period of fall 2022 till spring 2023. This was also one of the reasons why the researcher got interested in the RESPONSE project which later on was taken as a thesis study. It is important to mention here that before diving in deep, this kind of extensive, open research can serve as a platform for self-education.

4.1 e-Research Insights (Compare)

This subsequent step of data collection through e-research/desk research was time to refine the initial understanding. The researcher began to broaden the knowledge by using digital databases from different search engines. A wide range of sources, including academic papers, publications released by organizations and EU projects, demographic surveys, and websites, were used to create a substantial body of knowledge on the topic. By using this approach, the researcher could establish the foundation. The study was able to concentrate more on the EU's activities, how they connect to financing for smart cities around Europe, and how it gave a comprehensive grasp of integrated solutions spanning several sectors in any smart city project. This strategy turned out to be a successful turning point, and the researcher generated useful information regarding the dynamics of integrated solutions and smart cities that are being discovered, as well as how these solutions function.

The researcher also gained knowledge about the project's implementation strategy, its funding from the EU, and its roadmap as well as the business models of such projects. Additionally, the entire life cycle of these projects was studied, including how they improve the sustainable urban fabric, incorporate technology into transportation, and use energy regeneration techniques. Later phases of the investigation and analysis of the results made use of this data. Creating research for the service blueprint, which was then improved in a co-creative workshop with the Commissioner, was one of the method's main results.

4.2 Participant Observation Method Insights (Understand)

Acting as a participant observer in the RESPONSE mentorship efforts, the researcher actively contributed to promoting energy awareness and sustainable behaviors among local PED residents and students. The responsibilities of a RESPONSE mentor included educating oneself and others about energy-related issues and imparting the knowledge and abilities required to work with citizens while effectively utilizing social media and other platforms.

Mentors held frequent meetings throughout the mentorship program every four to five weeks, actively participating in ongoing activities in the Student Village and the city of Turku. We represented Turku's perspective in the consortium meetings and provided insightful feedback on the project's objectives and results. The researcher's participation in the Energy Solutions for People-Turku RESPONSE Hackathon 2023 was one noteworthy activity in the role of a mentor. The researcher being a mentor of the RESPONSE project, offered the participating teams insightful user-centered input and feedback to help them improve their solutions. The hackathon's main aim was to look for digital solutions to encourage locals to track their energy use, change their consumption patterns, and see the effects of their choices to increase awareness of energy-related concerns. ("Hackathon Turku," n.d.). Through this experience, the researcher was able to obtain a greater understanding of how people form their opinions and view the energy trilemma. Also, it was a good example of how to understand the dynamics of citizen engagement and create awareness in the realm of smart city projects.

The mentorship program also included topics other than RESPONSE. For example, mentors took part in the Climate Fresk workshop, which was planned by a fellow mentor from France. This engaging board game gives players information on climate change and knowledge for influencing it in a positive direction. It helps identify the factors leading us towards climate change and its outcomes.

The RESPONSE project has given mentors opportunities to experience a variety of technical solutions by arranging field visits throughout the year. Our task included reaching other residents in PED through social media on energy-related topics as well as participating in physical activities. These activities included swap meets for used clothing, recycling days, and a visit to the Kakola wastewater treatment facility to learn about wastewater management and heat pump storage.

As a mentor, the researcher also took part in a walk program using the web-based application called Air Quality Journey Planner, which leads users, cyclists, and pedestrians, on routes that are greener, faster, and safer around the city. The mentor walk program included students and residents of PED to take a greener route from the Student Village to the city center to encourage a healthier lifestyle. The Air Quality Journey Planner is being developed as one of the integrated solutions for the RESPONSE project.

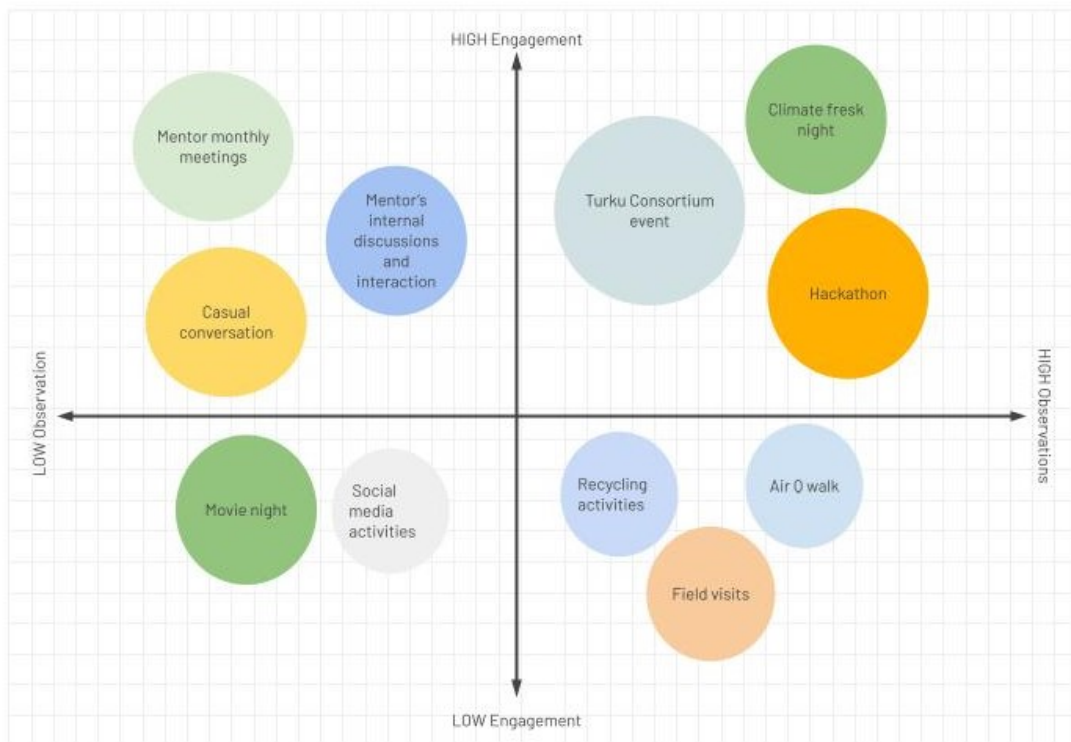


Figure 8. Participation engagement sprint

The participant observation method can be highly engaging and observant at times, but it can also be low engagement and low observational at other times, as Figure 8 illustrates. The various tasks completed during a mentoring position are divided into four sections, indicating that there are formal ways to acquire knowledge as well as more relaxed, informal ways to fully engage in a learning experience.

In conclusion, RESPONSE mentorship was an opportunity to obtain practical knowledge and understanding of the issues, and public views surrounding energy. This involvement in numerous activities deepened the comprehension of the thesis and gave the research study vital real-world context. By becoming a participant observer in the project's environment, the aim was to understand the dynamics, challenges, and activities firsthand. This approach allowed the researcher to gather insights from the stakeholders' perspectives and observe the project's operations, which, in turn, helped in informed analysis and understanding of the RESPONSE project.

4.2.1 Attending Consortium Event as a Participant

As an extension to the participant observation method, a more formal turn of events came when Turku hosted RESPONSE's consortium meeting in the summer. Over 70 participants from LHCs and FCs attended the consortium meeting that the Turku RESPONSE team organized and hosted from June 6–8, 2023.



Figure 9. Energy Mentor Consortium attendee

Over three days, all the partners engaged in a variety of workshops, presentations, discussions, and site visits to exchange expertise and lessons learned with one another. The researcher actively participated in the event as a mentor for energy and as a representative of PED residents. It's worth mentioning that the researcher finally had the opportunity to meet with representatives from several organizations and key partners in RESPONSE, gain insights into numerous aspects of the project, and put a face to each of the names of the stakeholders that had previously only existed on paper for the researcher.

The concluding day was dedicated to discussions about potential future partnerships. A workshop on climate change and its effects on our surroundings was held by Turku's climate department and the researcher took active participation as an attendee. (For pictures of the Consortium, see Appendix C)

4.3 QCA Combined With Research Wall Method Insights (Ideate)

At this stage, the researcher was able to combine two research methods to provide grounds for better financial planning by proposing mechanisms that are suitable for projects with a sustainable vision.

QCA research methodology has its foundations of a robust method in handling complex causal relationships of set conditions, for any similar topics. The decision to use this method was taken looking at the intricate world of choices in financing mechanisms. The rationale behind using the method was that while doing a desk research study similar patterns and choices of mechanisms were observed for EE and sustainable SC projects. But the data itself was too intricate and too wide to comprehend. The researcher felt the need to look at the data as a combination of conditions. In this case, it was about categorizing it sometimes into projects or initiatives from the EU and sometimes taking a more in-depth view of individual integrated solutions from the SC perspective. As established in the theoretical background chapter 2.2 about sustainability and SCs, these projects have similar frames of work and a lot of them have common geopolitical backgrounds. Mainly the criteria was to see projects from European countries as they often share a common policy framework around sustainability projects. EU has its regulations and goals which provide a consistent dataset making comparison and analysis more reliable.

EU backdrop for searching for financing mechanisms can be valuable not only within the EU but also for countries and regions worldwide interested in enhancing their sustainability efforts. The core concept of the QCA method of perceiving cases as "combinations of conditions" was also enhanced by utilizing tools like benchmarking and case studies. For creating the toolkit, the benchmarking or case studies may not have provided upfront data in this report but it was all integrated systematically into a Research wall and was accessed whenever needed throughout the research process.

The research wall, as explained earlier in the chapter, was about making an inventory of the cases and creating an asset wall but in this case, it was a digital research wall. As the research progressed the relevant set of information was bookmarked on Google Chrome with folder names (see Appendix E for understanding). Identifying and validating the information was also a part of this process. The research wall is also dependent upon how the researcher groups it and most of the time it will make sense to the researcher only. Discussing aspects and segments with the commissioner was introduced at this stage so the direction of

shortlisting the mechanisms became more cocurated and also helped in avoiding researcher confirmation bias.

The analysis was done by observing commonalities and distinctions between financing mechanisms during this phase. It was at the end of this method that synthesizing the data was done, with the help of case studies and benchmarking tools. Potential proposals for financing mechanisms of two integrated solutions 5G lighting poles and Direct Current (DC)-coupled bi-facial solar panel systems were also generated. This stage brought actionable elements to the research study.

All these methods and tools were combined to create a comprehensive toolkit for financing mechanisms. A variety of funding and financing options and possible projects were included in this toolkit. Specific application of those financing mechanisms was used for DC-coupled bi-facial solar panel systems and 5G lighting poles. This helped progress the study and the results were delivered to the commissioner in July for the upcoming deliverable report submission of the RESPONSE project. The commissioner used the baseline data while keeping in mind the RESPONSE project's timeline, but the researcher carried out a thesis study and advanced the investigation to determine how more value could be added to the project. Following this phase, the researcher began analyzing the project's current BMC and co-created the system maps. Initially, the researcher created system maps individually to help conduct a thorough analysis of the research questions. These maps were then refined in a co-created workshop, details of which are discussed next.

4.4 Co-Creative Workshop to Develop System Maps (Ideate)

Co-creative workshops are an effective tool for understanding complex systems from a variety of angles. Within the framework of this investigation, a two-session co-creative workshop was carried out with a focus on creating a service blueprint. The researcher actively collaborated with participants from the Development Unit of RESPONSE during the process. The main objective was to jointly develop an extensive service blueprint. The improved blueprint benefited from several crucial actions that were enhanced by thorough earlier research and active involvement of the researcher's understanding of the operational procedures of the project.

Step 1: Qualitative Research and Workshop Preparation

The basis for success in these kinds of workshops is extensive qualitative research done in advance. The co-creative process is built on the insights that are obtained during this phase. Therefore, the workshop's contributions will be more significant the more solid and thorough the preliminary data are. To guarantee that the products of the co-creative process appropriately represent the ecosystem, the researcher carried out extensive qualitative research to obtain insightful information prior to the workshop.

Step 2: Choosing Informed Participants

The selection of workshop participants with in-depth project knowledge was essential to its success. Their knowledge of the project's goals and their level of expertise were essential in ensuring that the contributions made during the workshop were sound and relevant.

Step 3: Initial Co-Creative Session

An interactive session between the researcher and the Development Unit's participants marked the first co-creative workshop session. Using Miro, a digital whiteboard platform, the team of three participants including the facilitator, worked together to refine and improve the first service blueprint. The qualitative research served as the basis for this blueprint, and the participants' insights were crucial in adding to its precision and depth. This process was iterative, which guaranteed that the finished blueprint was thorough and functional.

Step 4: Revision and Input

After the initial meeting, the participant input was carefully integrated into the blueprint. The document was sent for further refinement without the facilitator being involved because the whiteboard was interactive and digital. The blueprint was continuously improved through this iterative process, bringing it one step closer to its final form.

Step 5: Involvement of the Department of Citizen Engagement

Once the co-creation process with the Development Unit was completed successfully, the blueprint was forwarded to the Citizen Engagement Manager for feedback. The researcher gave detailed collaboration instructions for a remote workshop on the service blueprint. Unfortunately, the manager was not able to contribute but another team member from TUAS was able to go through the document and gave feedback. The document link is still active

and the Citizen Engagement Manager can contribute whenever it is convenient for them, thanks to this strategy. As a service design process, this is an ongoing work and there is always a chance of refining the outcome.

Step 6: Several Iterations of Feedback

However as mentioned in the previous steps, the service blueprint was reviewed and evaluated several times. Every round featured new participants who were closely familiar with each aspect of the project. Every feedback cycle helped the blueprint continue to be improved and refined.

The achievement of a service blueprint that reflected the goals and complexities of the project was made possible in large part by this collaborative approach. (see Appendix H for co-creation of system maps)

5 Deliverables and Tangible Outcomes (Challenge-Explore-Observe)

An extensive review of the RESPONSE project network and its complex relationships with different entities, systems, and stakeholders will be covered in this chapter as a result of the research phase overlapping with defining the tangible outcomes.

5.1 Exploring Funding and Financing Mechanisms

To understand the business model of RESPONSE, an overview of the project's interactions with various entities is important to establish. The project has diverse key actors involved such as local-level organizations, research institutes, commercial suppliers, and end-users—the citizens who will be using the project's outputs. This relationship is shown in Figure 10 for gaining an understanding of this network is essential to improving our understanding of the system map that follows.

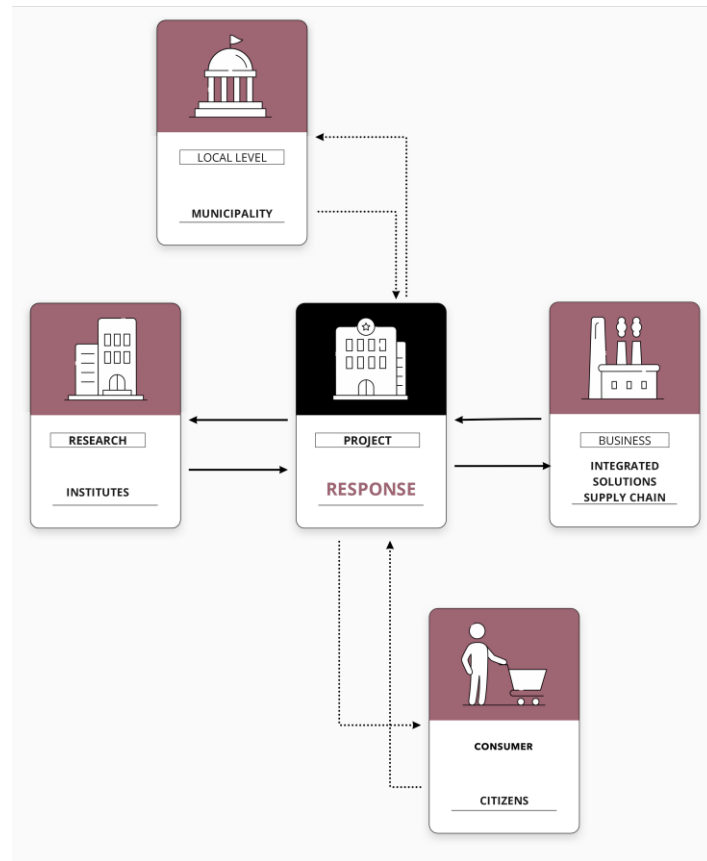


Figure 10. RESPONSE project network

As Figure 10 suggests, the RESPONSE project selected its consortium partners strategically varying from academia and technology partners to businesses. These organizations provide the project with their advanced knowledge, perceptions, and skills. They play a key role in advancing research, leading to innovation, and keeping the project at the top of urban sustainability. The project involved state-owned organizations and kept citizen engagement activities as the project cornerstone. This strategy makes sure that both these ends are involved in keeping an alliance with regional and EU policies to promote participation and uplift democratic values.

The RESPONSE project received funds from the EU, to implement the envisioned activities. The project has a funding-based business model. However, the financing mechanisms are introduced, which is a subsequent financial plan aiming for the project's activities to be replicated, upscaled, or even complement the envisioned activities.

According to the "H2020 PROSPECT Glossary of Financial Terms" (n.d.), Financing mechanisms are "the mechanisms through which financial institutions provide funds for the realization of activities, purchases, or investments of an organization. Through financing

schemes, future expected money flows are put to use for projects that start in the present." Funding sources, on the other hand, are "the budgetary resources for the development and implementation of programs and projects. Types of funding sources include grants, bonds, awards, private donations, or internal capital allocated within an organization".

A finance mechanism refers to a specific financial plan or strategy used to manage and utilize financial resources for a particular project or initiative. Finance mechanisms are usually developed by the project management team and may involve various financial tools, such as loans, bonds, equity investments, or crowdfunding, to raise and manage the necessary capital. On the other hand, funding refers to the act of receiving capital arranged by an external party, such as a government agency, a grant-making foundation, or a private investor.

Many initiatives and programs are funded by the EU. It enforces rigorous rules to maintain strict control over the use of funds and ensure that they are spent transparently and responsibly. EU funding is available in a variety of formats. Generally, applicants submit project ideas according to a "call for proposals" to be considered for funding like grants, subsidies, loans, guarantees equity, etc. (Funding, Grants, Subsidies | European Union, n.d.)

Large financial resources are usually required for infrastructure development, and the employment of the financing mechanisms can serve various purposes. Kevin Ramsay, a consulting company, in their report on Financing & Funding of Infrastructure in New Zealand, gives a list of factors that are involved when financing mechanisms are introduced in the project. The detail is discussed below:

- **Scheduling and expansion of funds:** Financing will allow for the cash to be spread out over time, easing the immediate financial stress and allowing the project to move forward.
- **Align funding with usage and life cycle:** It is possible to structure financing so that expenditures are paid by variables like predicted consumption or infrastructure lifespan. This guarantees that the expenses are reasonable, given the gains realized.
- **Ensure timely delivery:** The project can move on with deployment and replication without delay by using financing mechanisms.

- **Shifting risks among stakeholders:** Financing such as that used in PPPs can transfer risks to another organization and keep debt off the balance sheet of the municipality as part of the financial benefits.
- **Increasing the cost-paying capacity:** The financing mechanisms will make sure that the expenses spent during the project's conception and execution are all paid for.
- **Demand management:** The financing mechanism of implementing user fees or other charges can effectively control demand and ensure infrastructure is used effectively.
- **Uphold corporate value:** By devising cost responsibility, effective resource allocation, and adherence to financial goals, financing mechanisms can foster value.
- **Reallocation of growth:** By providing means to areas with limited resources or marginalized populations, certain financing mechanisms can promote equitable growth. ("Financing & Funding of Infrastructure in New Zealand," 2022)

In one of the semi-structured interviews and subsequent email exchange with a senior EU advisor on the project BM (the first goal of the study), she confirmed that:

There are several co-funding possibilities or grants available to support sustainable energy projects. These grants are supported by various programs, such as Horizon Europe and LIFE. However, the grants only co-finance a limited amount of infrastructure, mostly as depreciation costs during the project's lifetime, based on the program rules. This means that additional types of financing schemes are necessary to scale up the demonstrated solutions beyond the initial project lifetime. (EU advisor,2023)

Establishing the need for a financing mechanism in a smart city project, the following chapter will discuss how the research phase started what methods were used, and where design thinking helped in reaching research objectives. The research phase started to bring more tangible outcomes which are discussed onward.

5.2 Stakeholder Map

The purpose of developing this deliverable as a part of the research study was to provide a clear overview of the project's hierarchical system in terms of key actors and stakeholders involved.

According to Stickdorn (2011), “A stakeholder map is a visual or physical representation of the various groups involved with a particular service”. Stickdorn also states that a person “can use stakeholder mapping to understand the internal formal and informal structures”. The stakeholder map was the initial tool to identify the different tiers of collaborators involved and identify whom to address significantly and pragmatically

A stakeholder map is a graphic or tangible depiction and it supports:

- Figuring out who the collaborator in the design process.
- Recognizing the sources of influence and power in design thinking and decisions.
- Making certain that all important stakeholder groups are taken into account.
- Gaining knowledge of the viewpoints of stakeholders and how they relate to the project. (Dam and Teo, 2022)

A wide range of people can be considered stakeholders, including core user group members, high-ranking organizational officials, and regular people who might be negatively impacted by your project or positively. In addition, people with whom you interact, exchange ideas, and participate in project-related activities are also considered stakeholders. (Dam and Teo, 2022)

Creating the stakeholder map shown below, indeed helped to make all the formal and informal structures of the project. A stakeholder map was developed with three cores, including primary stakeholders as a core team, secondary as the involved team, and tertiary as an informed team of the project. The 53 partners from 13 European countries are distributed among different tiers.

Turku local ecosystem - the internal core team - consists of 19 partners among which 11 are private SMEs, 5 are city-owned organizations (Municipality itself, Turku Energia, Turku City Data, TYS, and TUAS) and 3 are state-owned organizations (UTU, VTT and FMI).

They are the primary stakeholders. There are secondary stakeholders mainly project developers and companies providing evaluation to the core team partners. The tertiary stakeholders are the LHC Dijon and six FCs and regulatory bodies.

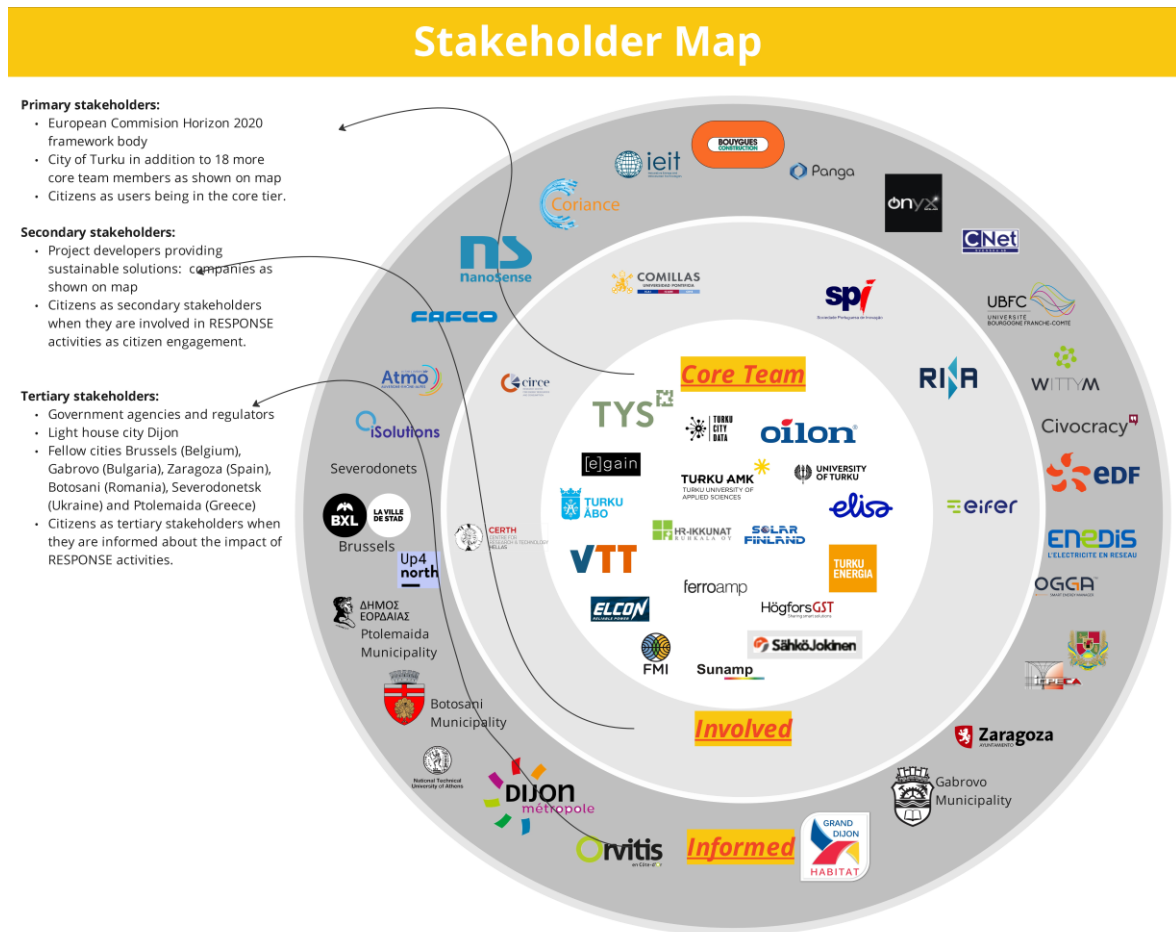


Fig 11. Stakeholder map

One important highlight of this process, for the researcher, was to be able to identify citizens in all three tiers of the map, keeping SC fundamentals in mind. Below is a brief description of why the researcher felt that citizens belonged to all three tiers.

End Users: The main end users and beneficiaries of the smart city project are the residents of PED as well as other inhabitants of Turku especially when it comes to IS like the AQJP app or advanced air quality modeling. They use the services, infrastructure, and innovations created in the context of smart cities and RESPONSE firsthand. Since they are the final users of the project's outputs, this makes them essential to the core tier.

Co-participation and Engagement: Co-creation and citizen involvement are becoming more and more important in smart city initiatives including RESPONSE. People are now viewed as active participants in the creation of solutions rather than as passive recipients. They contribute ideas, opinions, and feedback, which makes their participation essential to the secondary or involved tier of the map.

Data facilitators: As a result of their interactions with different systems and services, residents of smart cities produce enormous volumes of data. Decision-making, urban planning, and enhancing quality of life all benefit greatly from this data in the form of direct information as well as in the form of feedback mechanisms. The tertiary tier are the ones from informed group and citizens help shape more equitable solutions to cater to the needs of the community thus making them part of this tier as well.

The participation of citizens in all three tiers acknowledges their diverse roles in smart cities, including those of community members, data providers, end users, co-creators, and contributors to governance. Their active involvement supports the ideals of inclusivity and citizen-centric urban development while also increasing the efficacy of smart city initiatives. This also makes them important entities in the strategic management process.

5.3 Service Blueprint of EU-Funded Project

To understand the project execution process better, the second step was to develop a service blueprint. A stakeholder map led the researcher to develop a service blueprint that can show the entire service delivery process by outlining all the tasks that are carried out by the various roles of stakeholders involved at each stage. The resulting structure makes it possible to depict the sequence of tasks of key actors throughout the process, above and below the line of visibility. It then helped analyze a third and foremost important outcome of the research, which was the analysis of the business model used in the RESPONSE project. Below is shown the service blueprint, developed with the help of the co-creative workshop method and discussed in great detail earlier in section 3.12.



SERVICE BLUE PRINT FOR RESPONSE

EU FUNDED SMART CITY PROJECT

STAGE	1.PROJECT ACQUISITION PLAN AND BUDGETING	2. PRE-IMPLEMENTATION PLANNING	3.IMPLEMENTATION	3A.RESIDENT'S ENGAGEMENT	4.UPSCALING and/or REPLICATION (within same city)	5.KNOWLEDGE SHARING FOR REPLICATION (in other cities)	6.EVALUATION BY EU FOR COMPLIANCE
Core Team Actions	<ul style="list-style-type: none"> Set objectives Create a thorough project plan comprising selected smart city solutions. Involve stakeholders and get their feedback and commitment. Allocate own funding & resource planning. Assure compliance with objectives 	<ul style="list-style-type: none"> Part take in ensembling project consortium Apply for EU grant and formalize the agreements 	<ul style="list-style-type: none"> On-site piloting & demonstration Monitoring performance, adjusting the plans and/or mitigating any deviations by gathering data and managing process effectively. 	<ul style="list-style-type: none"> Ensure following long term goals of sustainability by engaging community and end users for awareness and effective outcomes. 	<ul style="list-style-type: none"> Monitor performance to assess feasibility of upscaling/ replicating solutions. Analyze financing mechanisms to meet the demands of expansion 	<ul style="list-style-type: none"> Data gathered and put forward the lessons learnt. Exchange best practices and research findings with stakeholders, key actors and other cities involved. 	<ul style="list-style-type: none"> EU examine impact and performance of project. Financial audits for better transparency. Identifying success or challenges and improvements.
Frontstage (Core team and involved stakeholders for the INFORMED ones)	<ul style="list-style-type: none"> Communicate goals and objectives. Create a panel of experts to validate project's intended goals 	<ul style="list-style-type: none"> Inform about received funding and intended actions 	<ul style="list-style-type: none"> Develop communication channels to monitor and give access to data to all key actors. Share transparent progress reports. 	<ul style="list-style-type: none"> Outreach bigger audience through arranging public events of knowledge sharing, fairs, hackathons and activities revolving sustainability goals. 	<ul style="list-style-type: none"> Keep evaluating and share success stories for upscaling. 	<ul style="list-style-type: none"> Sharing also knowledge on funding possibilities/financial benefits. Consult fellow cities for assistance on replication. 	<ul style="list-style-type: none"> Updating on the improvements and innovations status reports. Sharing project outcomes and knowledge with EU. Amendments on the identified shortcomings.
Backstage (Core team within itself and with the INVOLVED stakeholders)	<ul style="list-style-type: none"> The end goal defines what kind of partners are needed and then the eligibility of the partners has to be checked. Preliminary budgeting for the entire partnership according to available funds. 	<ul style="list-style-type: none"> Lock project detailed timelines and targets to meet. Carry out preliminary feasibility assessments of the project. Create an internal project consortium and human resources. 	<ul style="list-style-type: none"> Create data centres and networking.Work collaboratively with teams within ecosystem and technology providers. 	<ul style="list-style-type: none"> Making necessary arrangements for sharing the knowledge about events and collaborations with other stakeholders. 	<ul style="list-style-type: none"> Asses performance and progress of work for replication. Create risk management plans for replication based on the change of context and location. 	<ul style="list-style-type: none"> Consolidate easily readable information on implementation 	<ul style="list-style-type: none"> Internal collaboration for documentation and facilitate information transfer.
Support Processes	<ul style="list-style-type: none"> Evaluation and feedback 	<ul style="list-style-type: none"> Consultation internally and with EU 	<ul style="list-style-type: none"> Monitoring and adjustments where needed 	<ul style="list-style-type: none"> Involving peer mentors and non profit organizations 	<ul style="list-style-type: none"> EU smart cities marketplace providing technical assistance, guidance in finance, matchmaking partnerships and other support systems. 	<ul style="list-style-type: none"> Impact analysis tools, digital and IoT data, graphs and surveys. 	<ul style="list-style-type: none"> Data driven decisions. Feedback based actions.
Other thoughts / comments	<ul style="list-style-type: none"> Ensuring continuous involvement of all stakeholders. Time management at the start and during the project. 	<ul style="list-style-type: none"> Clear communication is the key for decision making. Mutual interest and trust is needed in the partnership. 	<ul style="list-style-type: none"> Encourage a responsive support system for data exchange and technical issues to resolve. 	<ul style="list-style-type: none"> Establish a feedback system to address user centric problems. Utilizing citizen engagement to increase acceptability of the upscaling processes in the city 	<ul style="list-style-type: none"> Political priorities and balancing to be taken into account. Financial mechanism tools to be in place. 	<ul style="list-style-type: none"> Maintain an open channel for partners like a web portal for incoming feedback and suggestions. 	<ul style="list-style-type: none"> Highlight the achievements to gain encouraging response from EU and collaborate for further involvement in replication. How current and future projects support the EU goals and strategies / How EU can achieve its goals by supporting the projects

Fig 12 Service Blueprint of EU-funded project (Case study RESPONSE)

(see this link for improved legibility

https://miro.com/app/board/uXjVNHnvE7k/?share_link_id=183331150288)

The service blueprint served to be a valuable tool in developing and authenticating a huge amount of information that was gathered and observed during the research. It facilitated the understanding of the project step by step. The role of involved partners and their contribution was now more clearer and this better understanding helped in the analysis of the business model which was the next step of the research study. The visual illustration of the process made it easier to identify obstacles and provided a chance to take effective steps where needed. Overall, this was a huge step in channeling the influx of information into a comprehensive result.

There are several benefits to using service blueprinting. They give businesses a comprehensive understanding of their services, including all resources and operational procedures that are not readily apparent. Businesses can gain strategic insights by concentrating on this broader comprehension in addition to usability considerations and

touchpoint design. Service blueprints are an invaluable resource for pinpointing an organization's weak points. While problems with the user interface are usually easy to identify, systemic issues can be harder to diagnose. By mapping dependencies and exposing the bigger picture, blueprinting helps organizations effectively address root causes. service blueprinting encourages departmental collaboration, it is especially helpful for coordinating complex services. When departments concentrate on their specific touchpoints, blueprinting forces companies to record the entire internal journey, highlighting dependencies and overlaps that might otherwise be missed. (Gibbons, 2017)

5.4 Strategic Analysis of Business Model Canvas

Business Model Canvas is a tool used in the business world. The nine building blocks of the Business Model Canvas, created by Strategyzer's Alex Osterwalder and Yves Pigneur, demonstrate how a company plans to create value and generate revenue. These blocks cover three primary business areas: desirability, viability, and feasibility. In essence, the canvas serves as a blueprint for implementing a strategic plan through organizational structures, processes, and systems. (Strategyzer, n.d.)



Figure 13. How BMC works? Source: (Business Model Canvas, adapted from Osterwalder & Pigneur, as presented in Vaughan Broderick, 2023)

But what is a business model? Osterwalder and Pigneur defined it effectively when they said,

“A business model describes the rationale of how an organization creates, delivers, and captures value”. (Osterwalder & Pigneur, 2010)

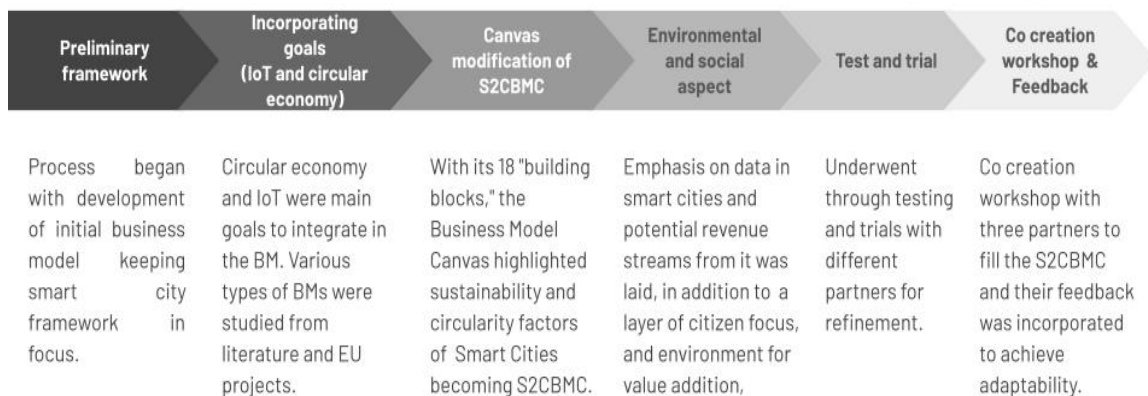
As per Vaughan Broderick, BMC has three primary goals:

1. When mapping current business models and illustrating what is happening, BMC is a handy tool. It can identify competitors and opportunities for distinction and similarity among each other. present state.
2. BMC is also used to create new business models and it can more often bring innovation as a useful strategy to gain a competitive edge.
3. The innovation strategies can be explored at the incubation phase where ideas are either “killed” or adapted for further exploitation. (Broderick, 2023)

The business model canvas analysis is important to understand the in-depth relationships among different stakeholders and what the project is delivering which in a nutshell is what the business model is. As shown in Figure 13, the three sections of a BMC, the desirability section showcase the value proposition, customer segments, and channels. The Viability section includes revenue streams and cost structure, whereas the Feasibility section includes key resources, activities, and partnerships.

RESPONSE conducted some studies before modifying a conventional business model canvas because the conventional canvas does not consider the principles of smart city

Process for development of Business Model Canvas of RESPONSE (S2CBMC)



initiatives.

Fig 14. Derived from information given in report D5.4 Turku Business Models Portfolio - V1 (Zinchuk et al., 2022).

As seen in Figure 14, there were several phases in developing the Smart City Circular Business Model Canvas (S2CBMC) as part of the RESPONSE project. The main focus was to develop a comprehensive framework in the context of smart cities.

Initially, different business model types were consulted from existing literature and several EU projects. After the initial study, the main focus shifted to the smart city framework, integrating the circular economy and IoT features. Unlike the nine building blocks of a traditional Business model, the S2CBMC has eighteen building blocks to unfold the different aspects of business. Layers of environmental and social aspects were also included to improve the project outcomes. Evolving after the testing and trials of the initial concept into a detailed business model, this tool emphasized the significance of sustainability and social implications in Smart Cities. The canvas also showcased the value of data in Smart city business models and potential revenue streams by placing a data-driven building block in the center.

A co-creation workshop was conducted by the RESPONSE team with three stakeholders, including two SMEs and one national research organization. Trials with partners improved the canvas's usability when their feedback was gathered at the end. But more importantly, it was perceived that stakeholders with different business natures will approach the S2CBMC differently as was the case with research organizations and private SMEs.

In both LHCs, Turku, and Dijon, the refined version of S2CBMC will be used for case-specific businesses. Further development is still anticipated as part of the EC criteria, and there will be a portfolio of business models with various upgraded versions throughout the project's life cycle. This gave a chance to the researcher to include this next step in the study, discussed further. Business model analysis is going to be the third outcome of ongoing research and evaluation techniques combined with project findings that were established during the process.

To understand the canvas better, below is the preview of the refined version of S2CBMC developed after the feedback session, developed by the RESPONSE team.

<p>15. Environmental Foresight & Impact What are the environmental aspects involved and how they affect the main beneficiaries before and after the implementation of the technology/solution? (for example, global warming, scarcity of specific resources, etc.). By "main beneficiaries" it is necessary to refer to individual citizens, communities, municipality, local businesses, etc. which are somehow involved or affected by the technology/solution implementation.</p>	<p>1. Need/ Issue to be addressed/ Challenge What is the main existing problem(s)/issue(s)/challenge(s) identified that the technology/solution is expected to address? With technology/solution it is meant the smart city project which is evaluated through the business model canvas The solution is addressing one or more environmental issues? Social issues? Economic issues? A combination of them? Is the issue(s) typical of the local context or it may be found also in other cities?</p>	<p>18. Social Foresight & Impacts What are the social aspects and how they affect the main users and beneficiaries of the implementation of the technology/solution? (for example, cultural barriers, knowledge, technology acceptance, etc.) Does the technology/solution bring any effect associated to the job market (creation/loss of jobs)? To workers productivity? To costs for citizens? To properties value? To comfort? To air quality? To traffic congestion? To noise? To city, district, building appearance? To city tourism? To city international image? To attractiveness for investors? To citizens education and skills (including learning opportunities)? To knowledge generation and talents creation? To digital inclusiveness? To services/information accessibility? To participation? To sense of responsibility? To positive behavioural changes? To sense of community?</p>				
	<p>5. Key Actors Who are the smart city actors involved in the technology/solution implementation? -City-Core Partner(s)-Supporting Partner(s) Here it is worth to adopt a wide perspective in terms of involved actors in order to reflect the "open" and collaborative approach that characterizes smart cities.</p>		<p>7. Key Activities Which are the key activities to be performed by the main actors to implement the value proposition? -City-End user(s) -Core Partner(s) -Supporting Partner(s)</p>	<p>3. Value Proposition Which monetary and/or non-monetary benefits (value) is expected to be delivered to each main beneficiary/user of the technology/solution? What measurable objectives / thresholds / KPIs can eventually be set to evaluate the effectiveness of the individual smart city solution/technology?</p>	<p>8. Actor Relationships Which type of relationship connects each main actor to the network associated to the technology/ solution implemented? "Actors", in this block, includes as well users and beneficiaries. Are there already existing relationships?</p>	<p>2. Network Beneficiaries / Users Which target users or beneficiaries is the value created for? Users and beneficiaries may relate to individual citizens, communities, local businesses, research organizations, governments, associations, etc. With "users" it is necessary to refer to individuals and/or entities which directly employ the smart city technology/solution. With "beneficiary" it is necessary to refer to individuals and/or entities which are affected by the smart city technology/ solution. There is no need to distinguish between the two categories when completing this block but the distinction may help identifying the entities and parties to be indicated.</p>
	<p>6. Key Actors Offerings What offerings does each actor deliver? (i.e. expertise, know-how, infrastructure, processes, etc.)</p>		<p>10. Key Resources and Infrastructure What key resources are required to implement the value proposition as well as the channels, relationships and revenue streams? In the case of smart city project resources may be physical (for example electrical equipment), intellectual (for example patents), human (for example a specific team expertise) and financial (for example funding opportunities).</p>	<p>11. Data What data is required for the functioning or exploited for the operation of the solution? What data is collected through the solution? For example, temperature, energy demand and supply at specific points in time, etc. To which entities/ users data collected can be made available?</p>	<p>4. Deployment Channels Through which channels do end users - beneficiaries want to be reached? In presence of multiple channels, which one works best / which one is the most cost efficient? How they interact with the technology/solution implemented? For example, automated processes over which they have no control, mobile/web-applications requiring active interaction, mobile/web-applications which are only meant for information-purposes, etc.)</p>	
	<p>9. Key Actors Co-creation Which key operations do the key actors perform?</p>		<p>12. Circular Business Model and Innovation What are the key aspects associated to circularity in the business model? Please, describe the circularization strategies.</p>			
<p>13. Budget Cost What are the most important costs in relation to the main actors associated with the technology/solution implementation? What cost can be covered by each actor? Which key resources are the most expensive for investors(s)? Which key activities are the most expensive for investor(s)? Is there opportunity for blending public funding with private financing? Which cost are covered by each one?</p>			<p>14. Revenue Streams What are the main revenue streams? Which actors generate revenues? For what do they currently pay and how are they currently paying (before the technology/solution implementation)? What are the non-monetary revenues?</p>			
<p>16. Environmental Impacts: Costs What is the ecological cost of the technology/solution? (i.e. greenhouse gas emission, land use, energy consumption, water consumption) Costs can be estimated in terms of percentage impact (where feasible).</p>			<p>17. Environmental Impacts: Benefits What are the ecological benefits of the technology/solution? Benefits can be estimated in terms of percentage impact (where feasible).</p>			

Fig 15. S2CBMC. Source: Report D5.4 Turku Business Models Portfolio - V1 (Zinchuk et al., 2022).

(see this link for improved legibility https://miro.com/app/board/uXjVNHnvE7k=?share_link_id=183331150288)

Cities must strike a balance between economic opportunity and population growth while enhancing the quality of life through environmental protection, public sector productivity, safety, and energy- and air-quality improvement. Smart city investment cases are different from typical business development and public sector management, requiring explicit goals and innovative business models from city leaders. (Giourka et al., 2019)

It was clear from the justification for developing this S2CBMC that the project required an inventive business model. We can evaluate how S2CBMC adds more layers for a smart city-centric outcome by comparing it with the three business areas of a traditional business model (TBM). The parallels and distinctions between the two BMs are compared in the table below.

Table 1. Parallels and distinctions between the two BMs (research analysis)

Traditional Business Model Framework			S2CBMC value addition framework
Feasibility (Problem-focused) Can we deliver it?	Desirability (Customer-Focused) Do customers want it?	Viability (Business-Focused) What is it worth?	Additional Business Area (Digitalization and Circularity)
Need/Issue/Challenge (Block 1)	Value Propositions (Block 3)	Budget Cost (Block 13)	Circular business model and innovation (Block 12)
Key Actors (Block 5)	Actor Relationships (Block 8)	Revenue Streams (Block 14)	Data (Block 11)
Key Activities (Block 7)	Network Beneficiaries (Block 2)		
	Deployment Channels (Block 4)		
Overlapping building blocks from S2CBMC			
Key actors' offerings (Block 6)		Environmental Foresight and Impact (Block 15)	
Key actors' co-creation (Block 9)	Social foresight and impact (Block 18)	Environmental Impacts: Cost (Block 16)	
Key Resources and Infrastructure (Block10)		Environmental Impacts: Benefits (Block 17)	

Circularity and IoT data are combined in the RESPONSE framework to promote innovative BMs and a holistic viewpoint on SC solutions. It emphasizes the significance of taking economic, operational, environmental, and social factors into account to make informed decisions that are useful for the city and its citizens.

5.5 Improvements in S2CBMC

Below are a few of the improvements and suggestions that the researcher concluded after analyzing the S2CBMC as part of the second research question.

- **User Friendly:** The canvas can be transferred to a more user-friendly and collaborative whiteboard program like Miro based on the basic feedback from the workshop which was conducted by the RESPONSE team. This will improve the effectiveness of the work. Teams can work more productively and with less time spent.
- **Risk Assessment:** Although there is already a detailed and thorough layering of impact assessment in terms of social and environmental aspects, the researcher felt that as a smart city project, a risk assessment building block should also be added to the canvas. This can be achieved by creating future scenarios and answering “what-if” questions. This will create a better analysis of the risk situations. Which in return can equip the key actors for better risk management from the beginning of business operations.
- **Cybersecurity:** In addition, there seemed a missing link in the cybersecurity discussion when the data building block was being added. Channels for information and data collection and presentation to other key actors for further management provide good grounds to emphasize the importance of data and technology. But cybersecurity is a major aspect of data transfer. This could also be linked to risk management building blocks for solutions especially, where more user-centric data is being gathered.
- **Replication:** When it comes to adaptability, project upscaling, and replication are crucial components of smart city projects. The canvas should include a building block for this aspect as well so that planning for assessing knowledge transfer, capacity building, and other critical elements important for the successful execution in locations other than the demonstration site can be identified. The topic of established financing mechanisms for replication can be discussed. Partnerships and networking can also be developed well in advance. There is no long-term financing plan visible on the canvas.

- **Subsidization:** Could there be any subsidization block added to the canvas where business gets to know if there is any tax bonuses or subsidies available for them. This will attract more interest from a business perspective.
- **Stakeholder Alignment:** The SC2BMC places a strong emphasis on working together amongst various stakeholders. It could be difficult to make sure that every stakeholder has the same goal and financial commitment, looking at the variety of key players. To keep it aligned, stakeholder feedback should be continuously gathered and taken into consideration. There could be some blocks eliminated by looking at the interest or commitment of stakeholders in the business model

To sum up, the SC2BMC offers a detailed framework for dealing with important elements within the framework of positive energy districts. It might, however, benefit from more information and clarification in a few areas, particularly about ownership, long-term funding, and risk assessment. Suggestions from interested parties and continuous observation are necessary to enhance and optimize the SC2BMC to ensure the project's success. This also answers the first research question of identifying the challenges of the current BMC and how is it integrating financing mechanisms into its design.

6 Developing Innovative Financing Mechanisms Toolkit (Prototype)

In conjunction with the above chapter and to find the answer to our second research question which was Identifying critical factors in the BM so that funding streams can be introduced. The researcher first explored the possibility of introducing a toolkit based on the research outcomes for sustainable smart cities. This process was done earlier as it was a requirement of the commissioner and the toolkit needed to be utilized for one of the RESPONSE's deliverables in the work package.

It takes more than vision and planning to create smart cities that are inclusive, sustainable, and advanced in technology. The careful selection of the appropriate financing mechanisms is a crucial element that turns these goals into reality. Before we dive into this chapter, let us

lay the groundwork for understanding the various financial instruments and approaches that support global smart city initiatives.

The need for smarter, greener, and more efficient cities is greater than ever in today's urban environment. Smart city projects have many objectives, ranging from cutting carbon emissions to boosting urban resilience and raising the standard of living for residents. The goal is clear, but the financial route is frequently a maze of complications. This chapter gives you a guided tour of the financing mechanisms utilized in the most successful smart city projects in the EU and other parts of the world.

When the commissioner was looking for financing mechanisms, the researcher came up with the idea of creating a toolkit. This toolkit's primary use will be as a manual and a decision matrix for self-evaluation criteria to determine which financing option will be most effective for a certain kind of integrated solution or a business. It will provide examples of projects that are most appropriate for the usage of sustainable energy and climate project investments like RESPONSE. As highlighted in the paper, there are several funding and financing options available for creating a competitive market and improving financial outcomes.

6.1 Overview of Innovative Funding and Financing Mechanisms

A smart city project can adopt various financing mechanisms, and Figure 16 presents common options that can be utilized for raising funds for sustainable energy and climate investment projects.

The Financial Term Dictionary on Investopedia (n.d.) is the primary source of the information in the table that follows which is marked as a first step towards the toolkit development. Investopedia was a great resource for breaking down technical terms and helping with basic understanding. It is important to note that, as part of the qualitative comparative analysis method, a comprehensive review of multiple documents, reports, and toolkits was conducted. The definitions are largely consistent with those mentioned in other sources. The concise definitions of terms in the table are intended to provide readers with a basic understanding in line with standard usage. To ensure a thorough assessment, if necessary, additional financial resources will be consulted for a more in-depth analysis. This analysis can also include an examination of the advantages and disadvantages of each mechanism in the future.

FINANCING MECHANISM TOOLKIT			
		Description	Project Implementation
Public	GRANTS	Sum of money given to assist particular initiatives or plans. Governments at the state and local levels as well as supranational organizations like the European Union (EU) may provide money. Grants may need matching funding from other sources and are normally awarded through a competitive process.	European Union's Horizon 2020 programme
	Public-Private Partnerships	PPPs are agreements between organizations from the public and private sectors with the purpose of co-financing and managing projects. PPPs also have the potential to combine the use of public financing with access to private sector resources and expertise.	Cooperation of public and private entities in water-supply and sewage services, transportation and education
Public-Private	Municipal Bonds	A type of investment that enables government to borrow money from the public on the condition that the beneficiary would pay interest for a set number of times. When a bond reaches its maturity, the original investment is also returned. These bonds are often exempted from tax implied by national or local taxes. Municipal bonds are feasible for those with bigger income tax bills.	Projects involving smart energy infrastructure funded via green municipal bonds. Munifin and Finnvera, state-owned agencies, provides bond financing.
	Special Tax Bond	A hybrid security, the special tax bond is a revenue bond that uses special taxation funds to pay down its obligation. Typically, designated taxes are used to impose a particular tax on the broader population. The tax collections are used to pay off the outstanding bonds' interest and principal.	Utilizing higher property tax receipts from new construction to pay for a smart city project.
	Build-operate-transfer (BOT)	Public organization grants a private company concession to build and administer the project for a set time, usually for two or three decades. Control of the project returns to the public entity following this period. Involving three main phases: build, operate, and transfer, a private company constructs a public infrastructure project, operates the facility to recoup its investment and generate profits and finally transfers the ownership of the project to the public entity.	Collaborations on infrastructure for renewable energy, advanced disposal of waste techniques, or eco-friendly transportation options.
	Energy Performance Contracts (EPCs)	Government and energy service provider agreement to increase public building energy efficiency with assured energy savings. Energy-efficient equipment is financed, designed, installed, and maintained by the energy service business for use in public buildings including schools, hospitals, offices of government, and other public facilities. The government pays the energy service provider out of the energy cost reductions brought about by the enhanced machinery. Without making up-front capital investments, this financing model enables the government to increase the energy efficiency of public buildings using less energy. Certificates can be produced which provide information to consumers about the properties they wish to rent or buy, including an energy efficiency rating and recommendations for affordable renovations.	Installing smart energy management systems in city buildings via an EPC
	Crowdfunding	The practice of using modest sums of money from a large number of people to finance through social media or crowdfunding platforms where large networks of individuals are easily accessible, and crowdfunding uses this to connect investors and businesses. Communities can directly contribute to supporting initiatives that are important to them through crowdfunding, which also helps distribute the financial risk across a large number of individuals.	Funding an innovative communal garden project in TYS with crowdfunding. (This can be a potential case due to shared interest among residents and TYS)
Private	Cooperatives	Cooperatives are independent organizations with voluntary membership that support one another in pursuing a common goal. Cooperatives handle all administrative and operational tasks associated with the implementation of energy projects and raise funds through collective membership fees. This scheme is community-based and can help create more opportunities for financing and business ventures. In addition, it ensures the project's sustainability and promotes progressive leadership and empowerment.	In the energy sector, a non-profit community organization can typically create a cooperative business model wherein citizens invest through a cooperative body in the implementation and management of energy-related projects.
	Impact investing	Investment in projects with the intention of generating measurable social and environmental impact, as well as financial returns.	Attracting impact investors to finance a smart water management project

Fig 16. Innovative Financing Mechanisms (research work) (see this link for improved

legibility https://miro.com/app/board/uXjVNHnvE7k=?share_link_id=183331150288)

Each financing mechanism has pros and cons depending on factors including the size and scale of the project, the amount of risk involved, and the availability of funding sources. For instance, grants could provide funds with no obligations, but they also demand a lot of work to secure and might not provide ongoing support. Larger sums of money may be accessed through loans, although they frequently require collateral and interest-bearing payments. Crowdfunding may not be the ideal choice for ambitious projects, but it can broaden access to funds and promote a sense of community. It is essential to carefully consider the advantages and disadvantages of each financing option before deciding which to use for a project. This will be analyzed further with another tool called Decision Matrix. It will be combined with the table, shown in Figure 16, to choose a financing mechanism.

6.2 Decision Matrix for Choosing Financing Mechanism

An analytical tool for decision-making involving several criteria and factors is called a decision matrix. When basic one- or two-dimensional methods are insufficient to accurately weigh various elements, this approach is especially helpful. With options listed along one axis and decision factors along the other, the matrix is arranged like a table or a tree. The significance of each decision factor can be assigned a weight. Teams assign a value to each option after evaluating each criterion and adjusting it for weighting. The numerical outcomes aid in determining the order of importance of each option. Analytical thinkers prefer this approach because it makes it easier to thoroughly examine difficult decisions. (Stickdorn et al., 2018).

Although it offers a structured framework to support decision-making and encourage discussion, the decision matrix does not make decisions. It's a useful tool, particularly when dealing with complex decisions. A decision matrix is a subset of multiple criteria decision analysis (MCDA). Notice that this tool is only as important as the conversations that surround its use, including the establishment of decision factors and weightings. The decision matrix frequently sparks in-depth debates about the values and weights given to various factors. These conversations can highlight knowledge gaps where teams may be speculating because they don't know enough about the available options. Finding these gaps can help direct future studies or prototypes to improve the caliber of decisions. There are a

lot of decision matrix templates online that offer a handy place to start when putting this technique to use. (Stickdorn et al., 2018).

To develop a decision matrix, the researcher consulted two different models that are being developed for financing EE projects. (see Appendix F). The first model was developed by Aleksandra Novikova, in 2017 and the second one was developed by The Carbon Trust, in 2015.

The final prototype of the decision matrix developed for RESPONSE is shown in Figure 17. This financing model is divided into three sections and the innovative financing mechanisms discussed in Figure 16 are categorized in these sections.

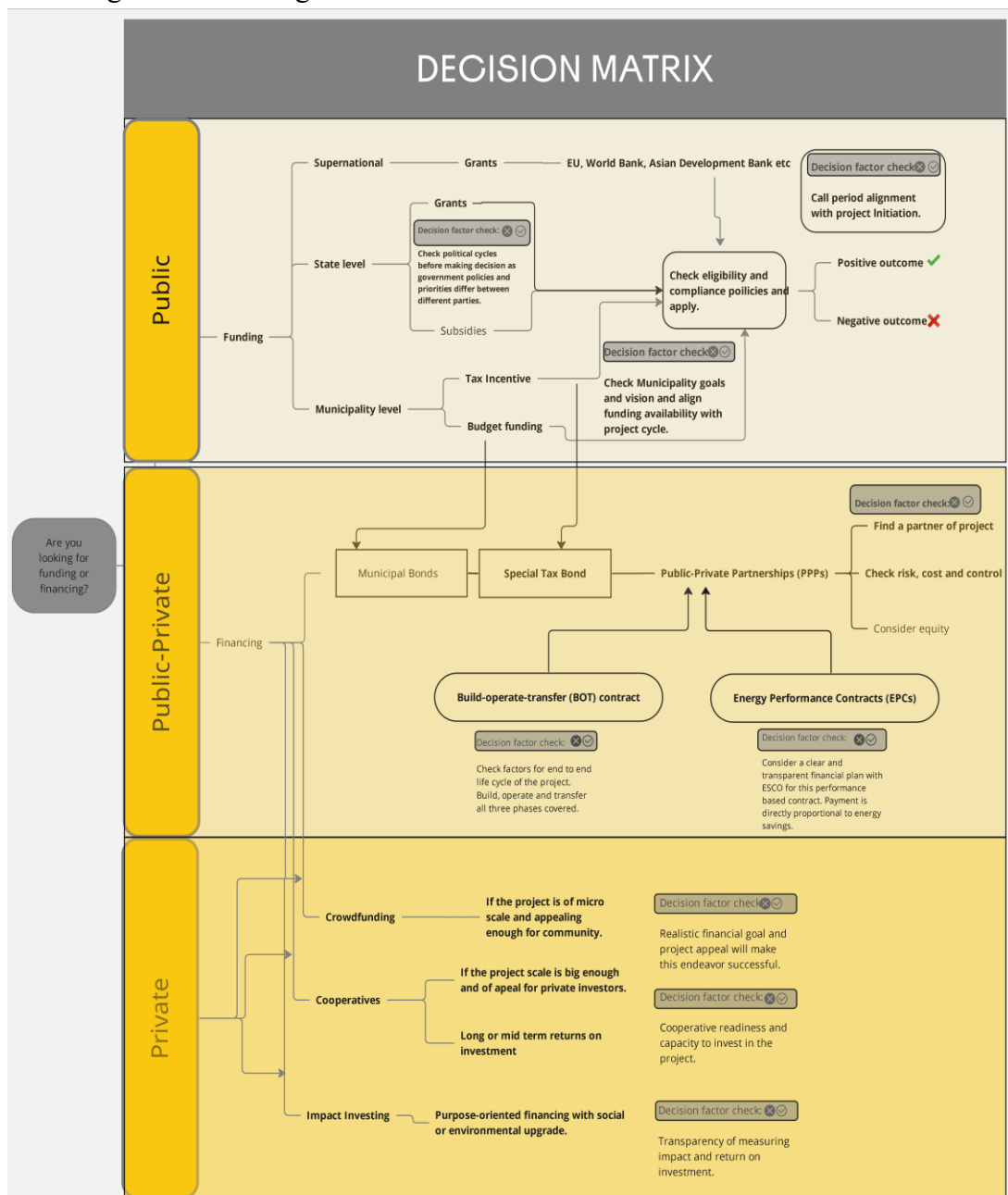


Fig 17. The decision Matrix developed as a prototype after research

(see this link for improved legibility https://miro.com/app/board/uXjVNHnvE7k=?share_link_id=183331150288)

As Novikova suggests the guide for choosing an appropriate financing model depends on the availability of public funding and that policies are in place. National or European funding programs offer lower-cost funding than commercial sources, often for projects not appealing to private investors. Municipalities can finance project costs directly or create a revolving fund. Alternative funding sources include national incentives and policies. In scarce public funds, municipalities may collaborate with private sector and commercial finance providers. (Novikova et al., 2017)

Bigger projects need involvement from the private sector and outside funding, and the complexity of the financing arrangements grows as the project expands. However, it may be difficult to leverage private capital due to high risks or inadequate cash flows. Combining several small-scale projects into one or looking into crowdsourcing options for neighborhood-scale projects is another way to find solutions. (Novikova et al., 2017)

To support one's business case and make it easier to access more conventional financing sources, cities must create well-documented "demonstration projects" that illustrate the potential advantages and payback times. They also need to garner support from the general public and local government. Vancouver showcased its "demonstration project" to gain confidence over institutional and private condominium developers. Otherwise, the stakeholders were not interested in the novel technologies, taking project development risks, or failing to meet crucial construction timelines. (Riahi, 2015)

But the cities or the project owner's role does not end at the "demonstration project". They have to create balance sheets, income statements, and return on investments to attract financiers.

"The balance sheet depicts what a company's assets are (what it owns), what its liabilities are (what it owes), and what its equity is (what is left over) at a specific point in time." The exact time of generating it is generally at the close of a given year or after a quarter. (Makoujy, 2010)

Management of working capital is an opportunity to balance 'accounts receivable', 'accounts payable', and 'inventory'. For growing companies, it becomes a common practice to ignore the balance sheet and give priority to profit and loss only. However, companies that are

regularly involved in keeping a close check on their balance sheet are in a better position to find opportunities to transform underperforming assets and liabilities that are consuming the capital of the organization. (Denis et al., 2023)

The balance sheet assessment is done to discover the possibilities of capital release and when or where it is needed. Financial excellence is critical to implementing strategic efforts. The importance of capital management remains constant, especially when outside financiers are hesitant to release funds. In a situation like this, the relevance of the balance sheet becomes more critical, involving long and short-term insights into capital management and achieving success. (Denis et al., 2023).

As we understand the role of the balance sheet to attract financing for the project, it is critical to understand that the whole business is anchored on return on investment and this is where the stakeholders' interest remains. Explaining the term, Rachlin in his book defines that the overall sum of the activities of a business is the return on investment (ROI). Earnings and return on investment rates decline when expenses are not proportionate to revenue growth. (Rachlin, 1997, p. 3). ROI is a financial management choice that analyzes the challenge, investigates and weighs various investment options, and highlights those qualitative aspects impacting the decision that cannot be quantified. (Rachlin, 1997, p. 5)

To understand ROI, one must first grasp its three primary components: "net sales," "net income," and "investment." They are derived from the consolidated income statement and the balance sheet, the two primary financial statements. (Rachlin, 1997, p. 14)

Tracking ROI helps determine the project's financial viability and stability, which are essential factors examined via the income and balance sheet. This collective monitoring can help RESPONSE establish that all stakeholders involved are achieving financial and economic benefits. This can also support further streams of financing mechanisms.

The ROI concept supports managers in maintaining essential growth for survival. It helps to showcase previous achievements and allows managers to utilize such data to forecast future scenarios. (Rachlin, 1997, p. 5)

The company's expansion and survival are dependent and articulated with the help of these financial factors, which resultantly can influence the choice of financing mechanisms. ROI

and balance sheets help managers provide forecasts of future development and highlight previous achievements. The interchangeable relation of the developed innovative financing mechanisms, decision matrix, and the knowledge of strategic management of working capital will continue to shape RESPONSE's financial journey in the direction of resilient and sustainable upscaling and replication.

6.3 Finance Framework for Integrated Solutions of RESPONSE

RESPONSE should be aware that to implement a network of financing mechanisms and accomplish sustainable goals, one cannot rely simply on one way of funding and grants. Before contemplating a financing framework several things are crucial to consider. The tasks and responsibilities associated with the financing mechanism, both within and outside of the project, should be made explicit in this context.

The financing mechanism must actively involve both state and non-state parties and include a full analysis of current finance policies, plans, and trends. A final agreement should be reached on a finance mechanism roadmap, which can act as a strategic way for the entire project. This roadmap specifies the milestones and sequential tasks that should be accomplished for the finance mechanism to be implemented successfully.

The ecosystem of beneficiaries of finance mechanisms is discussed below. This helps with identifying and securing necessary funding and allows for planning and budgeting for expenses for each of them, throughout the project.

Based on the RESPONSE project, there are several groups of organizations and actors involved in creating Turku's first PED:

- Municipality
- Municipal agencies
- Research institutions
- Tech enterprises
- Citizens

At the same time, these actors when assuming the role of financing scheme beneficiaries, can consider reaching out to the following two subtypes of funding sources:

PUB - Public funding body including local and national budgets, as well as the EU funds.

PRB - Private funding body consisting of loan providers, crowdfunding, and cooperative funding platforms.

Table 2. Beneficiaries' ecosystem and funding sources (Developed with commissioner)

Beneficiaries / owners	Funding sources					
	Public			Private		
	Local	National	EU	EIB/IFI loans	Crowdfunding	Cooperatives
Municipality (City of Turku)	✓	✓	✓	✓		
Municipal organizations & agencies (TYS, Turku Energia, Turku City Data etc)	✓	✓	✓	✓		
Research institutions (VTT, TUAS, FMI, UTU)		✓	✓			
Tech companies (Ferroamp, Sunamp, Oilon)		✓	✓	✓		
Citizens	✓	✓	✓		✓	✓

The local ecosystem of 19 partners has received EU funding through the Horizon 2020 program to implement PED in Turku as one of the lighthouse cities in the RESPONSE project. There is a vibrant ecosystem of circular economy players and the upscaling of the RESPONSE project devoted to sustainable resource management in the context of Turku and other cities can be explored. Table 2 discusses briefly which stakeholders can get what type of funding, categorizing them into the public and private sectors.

The report will further include two use cases for selected and commercially feasible integrated solutions. The benefits of each solution and the possible financing mechanisms that could be available to support implementation will be covered in the case studies below.

6.4 Use Case of 5G Smart City Lighting Poles

As discussed earlier, Turku has established a strategic goal for 2029, hoping to provide its citizens with an easy and convenient daily living. The city aspires to offer services that are not just reachable but also readily available when needed. The goal is also to modernize and digitize services so that they are intelligent and simple to access on digital platforms. The 5G lighting pole is in line with the goal and promotes accessibility, and service delivery, and supports the digitization of services. The graph that follows shows the rapidly expanding global market for smart poles. It is distinguished by a consistent and extraordinary upward trajectory that indicates positive future possibilities.

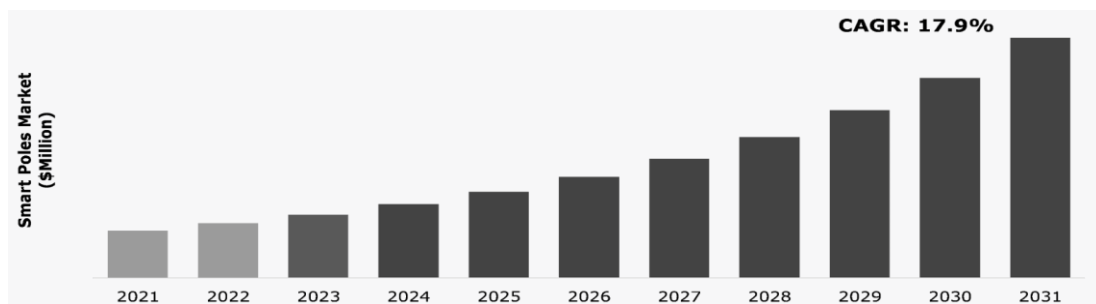


Fig 18. Global Smart Poles Market Analysis (Smart Pole Market, 2023)

Additionally, the solution's SWOT analysis reveals a balance between its strengths and weaknesses. It is a suitable example for debate because it also has opportunities and risks. If there is a fairly balanced mix of strengths, weaknesses, opportunities, and threats, it is viable to study the case further.

SWOT ANALYSIS FOR SELECTION OF 5G POLE AS A CASE



Fig 19. SWOT analysis of 5G poles

6.4.1 Technical Specifications

The development, delivery, and installation of ten 5G Smart City Lighting Poles in Turku's PED neighborhood, carried out by partner Sähkö-Jokinen in coordination with Elisa, is a noteworthy initiative within the RESPONSE project.

These cutting-edge lighting poles not only improve the current 5G network in the Turku PED region but also build a network with extremely low latency. Fast vehicle-to-vehicle (V2V) communication for robot automobiles is one of the many demonstrations and applications made possible by this network technology. The poles act as platforms for various devices and sensors that are carefully positioned where they are most needed to enable intelligent functionality and data gathering. (Virtanen, 2022)

The poles' modular design makes it simple to customize and adjust device ensembles by adding, removing, or changing components to various requirements. Sähkö-Jokinen (pole planning, development, and delivery), Elisa (commissioning of the 5G network and necessary equipment), Turku City (pole installation, lighting, and accessories), and Turku Energia (end user and coordination) are just a few of the stakeholders actively involved in the project. (Virtanen, 2022)

The gathering, aggregation, and linking of IoT data from the PED area to other smart city systems are examples of Integrated solutions. VTT autonomous car and a 5G-connected drone outfitted with a high-resolution CCTV camera that streams real-time 4K video to the city's safety control room are used to evaluate the 5G connection's capabilities. Turku City Data uses real-time analytics and learning algorithms to analyze the project's ongoing flow of data. (Virtanen, 2022)

With nine 5G lighting poles on one side of the road and a tenth additional pole next to the bus stop, these poles were strategically placed along the main street of the PED neighborhood to provide the best coverage and support for the quick and dependable communication needed for autonomous driving demos (another IE solution of the project under mobility category). Additionally, the poles are equipped with a variety of smart gadgets and sensors, such as air quality sensors, motion sensors, and dynamic streetlight management, which improve safety, environmental monitoring, and energy economy. (Virtanen, 2022)

The analysis intends to offer prospective financing mechanisms that could help with the implementation of scaling up this integrated solution and achieving its objectives for the sustainable development of the smart city. The financing mechanisms for this case study will be covered in more detail in the parts to follow.

6.4.2 Blended Finance With the Use of Funding/Loan and BOT Finance Mechanisms

The city of Turku is also collaborating with ICLEI - Local Governments for Sustainability, the largest municipal network in the world, to guarantee that the initiatives are guided by global best practices and cutting-edge information on localizing circularity. Since 1995, Turku has been a dedicated ICLEI Member. Turku intends to allow the global replication of effective projects and approaches started in the Turku region through this relationship. The municipality is a prime example of how smart city solutions may be implemented through the creation of several channels and cooperation with important stakeholders. (“Circular Turku: Regional collaboration for resource wisdom”, 2019-2021)

Turku actively incorporates the ideas of the circular economy into their operations by working with neighborhood businesses, both regional and local. They solicit feedback from these stakeholders and offer them incentives to adopt circular economy principles. To broaden their knowledge base and establish critical actions, Turku also works with national stakeholders like the Ministry of Environment and research organizations like the Finnish Environment Institute. (“Circular Turku: Regional collaboration for resource wisdom”, 2019-2021)

Relying on these partnerships, the city can create opportunities for funding through diverse channels for the implementation of this specific IES - 5G lighting poles. The installation and upgrade of the cityscape may bring increased energy efficiency, future-ready amenities, and improved public safety. However, the implementation of this solution is complex and needs multilayered financing. As a case study for lighting investment, the researcher made use of survey results conducted by a group of researchers. To find a suitable financing model for public lighting investment, they conducted surveys to identify the barriers to implementation and concluded that the fragmented structure of the street lighting supply chain is often the biggest barrier. They found that countries in Europe have a variety of laws governing who

owns, operates, and improves street lighting equipment. The results show that numerous stakeholders are involved in guaranteeing adequate public street lighting, owning the assets, carrying out maintenance and operation, and choosing investments. Because the stakeholders responsible for the modifications do not directly profit from the investment, a split-incentive problem occurs, delaying the decision to implement such an initiative. (Novikova et al., 2017)

To overcome the “split-incentive” issue, the City needs a diversified financing mechanism. Turku's collaboration with ICLEI - Local Governments for Sustainability) ensures alignment with global best practices and knowledge exchange. Building on this partnership, the city can explore opportunities for funding through various channels and engage key stakeholders, including neighborhood businesses, regional entities, and local providers. The city can secure funding from the ELENA (European Local Energy Assistance) program, to conduct a feasibility study, assessing the technical, economic, and environmental aspects of the 5G lighting poles if implemented on a city scale. This program provides funding to conduct project feasibility studies. The study will examine potential Infrastructure development that can lead to energy savings, see if the implementation is viable in the long run, and assess if the solution is scalable or not. If the results seem promising, Turku can start with the municipality's own funding and budget allocation for the implementation. This will show the commitment the City has toward a climate-neutral resilient city vision. The European Investment Bank (EIB) can further boost the municipality's funding. EIB has been engaged in Finland since 1994. It has provided soft loans to different sectors of the country, keeping the industry and Transport sectors at the top with the biggest percentage of investments. Private investors frequently view support from the EIB as a mark of approval, which helps to catalyze additional funding. (European Investment Bank, n.d.)

Several financing programs are offered by EIB and it also encourages blending of financing mechanisms to achieve required objectives. One example by EIB where the City of Turku can seek financing is the Smart Cities Initiative. The main aim of this program is to support sustainable urban infrastructure development projects that can enhance energy efficiency, and improve quality of life for the citizens and boat connectivity. This program offers long-term soft loans with a below-market rate of interest or it can be project-specific financing for the implementation of smart city solutions.

Having EIB on board, the City can also benefit by involving private partnerships with other businesses to invest in the implementation and after-service maintenance of the 5G lighting

poles in exchange for long-term concession rights. This could become a good example of a public-private partnership (PPP) which can further be subcategorized by introducing a build-operate-transfer (BOT) financing mechanism.

As previously stated in Figure 16, in BOT financing, a private party constructs the project, runs it for a predetermined amount of time, and then transfers it to a public partner. The private partner can provide upfront funding for the project and recoup their costs through service charges or revenue-sharing agreements. To ensure the smooth installation of 5G lighting poles through BOT funding, the city can work with technology suppliers, ESCOs, and other pertinent actors. Utilizing private sector innovation while distributing the financial burden is possible with this strategy.

Both public and private partners can benefit from the BOT model as a financing mechanism; the public partners can undertake the project without making any upfront payments, while the private partners can take advantage of the long-term contractual arrangement, which offers stability and secures a specific duration of work operations for the company. The two partners split the risk equally. Another significant incentive for the private partner is to gain market share by showcasing their capacity to install and manage a large-scale project.

To overcome the “split-incentive” barrier, the use of diversified blended financing mechanisms can be a potential solution in this case. Initiating the project with a feasibility study with the help of funding from ELENA, allocating the municipality's budget for the implementation, and securing EIB soft loans can enhance the project profile. This, in turn, will invite investors from the private sector to become key actors in this long life cycle implementation plan of the solution. Bonds can be used as a viable strategy when looking into other funding mechanisms.

6.4.3 Municipal Bonds as Financing Mechanism

Financial and investment measures that support environmental sustainability and counteract climate change are to be adopted by the City of Turku in its strategy for a climate-positive 2029. RESPONSE can provide value to that vision. Here, we provide a different funding scheme utilizing the 5G lighting pole as our use case.

5G lighting poles can be funded through municipal bonds. It can be either a social or green bond, as the solution has a two-sided impact both socially and environmentally. A Finnish financial company called Municipal Finance Ltd., commonly known as Munifin specializes

in financing national environmental goals, encourages low-carbon investment, and places a heavy emphasis on social and environmental responsibility.

MuniFin provides two types of Municipal finances, social financing for investments that provide broad societal benefits and Green financing, which is intended to fund climate- and environment-friendly investments. Discounts on the loan margin are offered to clients working on green finance initiatives. MuniFin issues green and social bonds that are solely used to finance projects that fit within their respective frameworks. Social bonds enable initiatives with significant social impact, whereas green bonds encourage projects with long-term environmental benefits. (Municipal Funding, n.d.)

Figure 20 below shows a good prospect of the company's green and social bond projects helping achieve reduced carbon emissions in recent years.

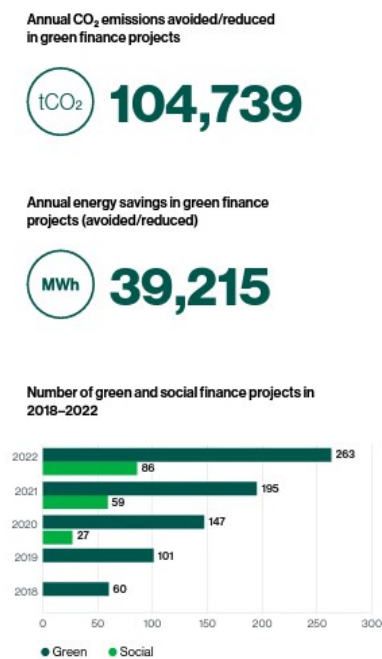


Fig 20. Green and Social finance projects of MuniFin (Source MuniFin Annual Report 2022)

The Munifin team analyzes the project and the viability of issuing bonds for it. To promote 5G lighting poles as a sustainable initiative, Munifin will assess the project against the green finance eligibility criteria.

The account manager handles the general finance application process, and in parallel, the GFT (Green Finance Team) collects information and supporting documentation to evaluate the project's eligibility for green finance, as well as its environmental and social impacts. (Green bond framework, August 2022)

The process applies the four-eyes principle, which requires another member of the GFT to assess the project presentation and determine the approval of the project and its status as an eligible green finance project. After approval, green finance is granted to the customer, and the approved green finance project is added to MuniFin's green project portfolio. (Green bond framework, August 2022)

Munifin presents the project to investors, and once the level of investor interest is established, it completes the bond issuance procedure. Will allocate the bond sale's earnings to pay for the project's installation. Additionally, the company will regularly update bondholders and other stakeholders on the project's development, environmental effects, and social results. Making sure that the use of bond proceeds is transparent and accountable. (Green bond framework, August 2022)

Turku City can get the money required for the construction of 5G lighting poles by utilizing the knowledge and financing choices offered by MuniFin. In addition to supporting Turku's sustainability objectives, the issuance of green or social bonds helps to create a linked, sustainable urban environment. By working with Munifin, Turku City will be able to negotiate the challenges of bond issuing, find funding sources, and adhere to legal regulations.

Turku's installation of 5G lighting poles and lighting upgrades will have several positive effects, including increased energy efficiency, better streetscape amenities, and improved public safety. Advanced lighting technologies, data connectivity, and intelligent controls are all included in the system to optimize energy use and allow for the inclusion of more smart city applications.

6.5 Case Study on Direct Current (DC) – Coupled Bi-Facial Solar Panel System

Solar panels are a very common and widely adopted integrated solution and it has multiple reasons why it is a popular choice. The SWOT analysis shown next can further highlight why this case was chosen for the discussion and analysis of the proposed financing mechanism. But we will first discover what coupled bi-facial solar panel systems are.

6.5.1 Technical Specifications

Provided by Solar Finland Ltd. the Direct Current (DC)-coupled bi-facial solar panel system makes use of a racking mechanism to maximize energy yield. These solar panels have been designed so that they can also catch sunlight reflected off white roof surfaces. Further, the system is connected to the Low Voltage Direct Current (LVDC) microgrid, allowing it to distribute and use the generated power more efficiently. (Wang, 2023)

The adoption of this system can have benefits, including lower greenhouse gas emissions and energy savings. It makes it possible to produce energy on-site, decreasing reliance on conventional energy sources and encouraging environmentally friendly behaviors. This solution also has the potential to be installed anywhere and has a greater impact on energy optimization. Potential Financing Mechanisms for the Solution First, a SWOT analysis of why this integrated solution is a better option to discuss for financing mechanism. As earlier mentioned in the 5G poles case, this IS also portrays varying strengths, weaknesses, opportunities, and threats making it a feasible case study.

SWOT Analysis for selecting DC-coupled bi-facial solar panel as a use case



Figure 21. SWOT analysis of Solar panel solution

To execute this IS two financing mechanisms options can be adopted best suited to the project scope and terms and conditions of partners in the execution. Here the beneficiary can be both an individual domestic household as well as the energy providing company. The first mechanism can be a cooperative funding energy project and the second one can be utilizing Energy Performance Certificates. We can discuss both cases in detail further below.

6.5.2 Cooperative Funding

With the use of cooperative funding and the simplification of administrative and technical processes, the project seeks to finance the installation of DC solar panel systems. In this case, the energy provider and its citizens can collaborate on the cooperative energy project, where they collectively own and invest in renewable energy options. The project intends to enable homes and communities to adopt sustainable energy practices. To pay for the initial installation expenses of DC solar panel systems for participating homeowners, the cooperative will create a financing strategy. Combining cooperative donations, government funding, and prospective collaborations with financial institutions may become part of this strategy.

The first stage is to create a cooperative organization that brings together the local government, citizens, and important stakeholders. Cooperative ownership and decision-making will be supported by this structure. The cooperative will streamline administrative and technical procedures to promote participation and align the process. This can entail helping with the application process, organizing the logistics of the installation, and verifying legal compliance. By utilizing the cooperative's combined purchasing power, the project can get affordable prices for DC solar panels and associated hardware. As a result, overall expenses will be brought down and the installation process will be more reasonable for participating households.

To maintain the efficient operation and durability of the installed solar panel systems, the cooperative will offer technical support and maintenance services. This may involve regular checks, aid with problem-solving, and performance tracking.

6.5.3 Benefits of the Mechanism

A brief discussion on some of the benefits of these financing mechanisms is discussed below:

Affordable solar panel Installation: By assisting households in overcoming the financial hurdle associated with upfront installation expenses, DC solar panel systems are made more widely available and more reasonably priced.

Process simplification: By making administrative and technical procedures simpler, homeowners will have less work to complete and will find it more convenient to use solar energy solutions.

Community Ownership and Engagement: The cooperative strategy encourages residents to feel a feeling of ownership and shared responsibility, fostering participation and cooperation in local sustainable energy activities.

Renewable Energy Adoption: The widespread installation of DC solar panel systems encourages the production of clean energy, lowers greenhouse gas emissions, and aids in achieving regional sustainability objectives.

6.5.4 Energy Performance Contracts (EPCs)

Energy Performance Contracts are another financing mechanism that can be introduced for the implementation of DC solar panel systems. Energy Performance Contracting (EPC) is a financing mechanism that makes it possible to pay for energy improvements by lowering costs.

In an EPC model, a project to increase energy efficiency or incorporate renewable energy solutions is initiated by an external company called an Energy Service Company (ESCO). For RESPONSE, it can be Turku Energia. The total expense of installing a DC solar panel system will be paid off by ESCO. The main objective of EPC is that the ESCO is compensated for the cost savings resulting from the solar panel system installation in the form of renewable energy produced.

The ESCO will only get paid if the project results in the anticipated energy savings. This indicates that they have a compelling motive to see the project executed successfully. On the other hand, the client gains from the ESCO's knowledge and experience. ESCO can engage the customers with a good payment history in the normal business (paying energy bills). This is a win-win situation for ESCO and citizens as the former will ensure performance and later will benefit from energy and reduced bills.

Implementing Energy performance certificates after successful installation is taking the implementation one step further. In the framework of the RESPONSE project, the certificates require buildings to evaluate their energy efficiency first. Using a standardized scale from A to G, with A being the most energy-efficient building, this assessment is conducted.

The following actions can be taken when integrating the Energy performance certificates:

1. Inspections: To acquire information on a building's energy performance, trained personnel inspect the DC solar panel systems.
2. Energy Performance Rating: Using the data gathered, a building is given an energy performance rating on a scale from A to G to indicate its level of energy efficiency.
3. Cost-effective Improvements: The certificates contain suggestions for actions that can be taken to enhance the building's energy efficiency if needed.
4. Mandatory Disclosure: When a building is listed for sale or rent, these certificates must be included in the advertisements. Additionally, they must be displayed to potential purchasers, tenants, or builders throughout the building, selling, or renting process.
5. Transfer to Buyers or Tenants: After a contract is completed, the certificate is sent to the buyer or new tenant, giving them important knowledge about the building's energy performance.

Implementing EPCs in the two-step method as discussed above can aid in promoting building sustainability and energy efficiency. Owners and tenants can make well-informed choices about their energy consumption and possibly implement cost-effective modifications by analyzing and revealing the energy performance of buildings. EPCs can

also help increase a building's worth because studies done in Europe have shown a correlation between better energy savings and higher sale or rental prices.

Households can take advantage of economical DC solar panel systems while actively contributing to the transition to renewable energy by opting for any of the finance mechanisms. This case study exemplifies the potential of giving local communities the tools they need to take control of their energy production and make a positive impact on the environment and future sustainability.

With this chapter ending we answered the third research question which was about the positioning strategy of effective financing mechanisms to be developed so that PED becomes a blueprint for upscaling and replication. With the use case study, the complicated world of smart city project financing mechanisms was discovered. And conclusion was drawn that there is no one-size-fits-all approach and that a variety of factors, such as project size, risk tolerance, and funding sources, influence the choice of financing mechanisms.

This was also explored that there are wide range of tools available to us when we investigate different financing options, including grants, public-private partnerships, municipal bonds, crowdfunding, cooperatives, and impact investing. Every mechanism has pros and cons of its own, so it's critical to match the selection to the particular requirements of the project. A Decision Matrix was introduced, which is an effective tool for determining which financing mechanism is best. This tool can act as a guide, directing us through the various options and making sure we choose the course that best fits the objectives.

The financial framework that is being discussed about smart cities can develop a strategic roadmap for the project's success keeping into account the functions of governing bodies, coordinating structures, and thorough forecasting.

An ecosystem of funders and beneficiaries was discussed and later use case of two integrated solutions for financing was analysed. The discussion of the two IS led to the proposal of two types of financing mechanisms for each of the solutions just to establish that there is no one solution to any problem. Choosing the appropriate financing sources is one of the main factors keeping these cities afloat. Although the toolkit offers a thorough perspective, this is just a stepping stone and it can be further refined as prototyping in service design is an iterative process and can only be developed further with the user's feedback.

7 Risk Management

Identification, assessment, and control of financial, legal, strategic, and security risks to the assets and profits of an organization constitute the process of risk management. These threats or risks could be caused by a wide range of things, such as monetary instability, legal liabilities, poor strategic management, mishaps, and natural disasters. (IBM, n.d.)

Cities and businesses often face obstacles when trying to switch their direction and business models into sustainable and energy-efficient ways. There is a restricted environment surrounding financing such initiatives. The city vision or EU goals are difficult to achieve in such scenarios. As stated in the information gathered from the European City Facility UK Webinar Hosted by COSLA on June 2, 2021, the barriers to financing sustainable energy projects are as follows:

- Limited human resources and capacity
- Conservative approach to project finance
- Lack of experience with developing investment packages
- Reluctance to invest in project preparation
- Difficulty in matching elections and investment cycles (European City Facility UK Webinar, 2021)

The list above suggests that organizations may find it challenging to locate and implement sustainable energy initiatives due to a lack of expertise and knowledge. Since sustainable energy projects have relatively large upfront costs and lengthy payback periods, banks and other lenders may be reluctant to finance them. Similarly, the time and money required to prepare sustainable energy projects for financing may deter some investors from becoming involved. Moreover, on a governance level, the timing of investments in sustainable energy projects may not coincide with governmental political cycles or the investment cycles of private sector investors. This may make it challenging to obtain financing and cause a delay in the adoption of sustainable energy technologies.

This led to the conclusion that these are some of the project-level obstacles in executing and getting secondary financing mechanisms for European Commission sustainable energy projects, particularly those relating to capacity building.

There can be external level obstacles as well to these projects and business models. One important, although underutilized, avenue to address environmental concerns and realize financial gains is through the field of energy efficiency financing. The United States can attain energy independence, decrease its dependency on fossil fuels, and reduce greenhouse gas emissions by almost 40% by 2030 by curbing unnecessary energy consumption, all of which will result in net savings for consumers. Potential annual energy savings are estimated to be around \$130 billion, making the potential financial benefits substantial (McKinsey & Company, 2009). Still, several obstacles stand in the way of realizing these cost savings and reductions in greenhouse gas emissions. These obstacles include but are not limited to, high initial capital costs, lengthy payback periods, uncertainty about savings, and scarce capital availability (Kapur et al., 2011).

The Nicholas Institute for Environmental Policy Solutions and the Environmental Defense Fund collaborated to conduct this report, which explores the literature and industry insights. With a focus on municipalities, universities, schools, hospitals, commercial properties, and industrial facilities, it offers an overview of the energy efficiency market sectors. The obstacles to energy efficiency financing are widespread and impact industrial facilities, commercial properties, municipalities, universities, schools, and hospitals equally. These consist of high initial capital expenditures, savings uncertainty, and risk perceptions. Energy efficiency is not always prioritized in budgets, and institutions and investors face additional difficulties when there are no secondary markets for longer-term agreements (Kapur et al., 2011).

In conclusion, this paper offers a perceptive analysis of the challenges and possibilities present in the energy efficiency financing environment. It highlights how critical it is to remove these barriers to realize the energy efficiency industry's significant cost-saving and greenhouse gas emission reduction potential.

1. High Upfront Capital Costs: This group includes barriers to the one-time expenditure needed for infrastructure and equipment that uses less energy. Energy efficiency projects can be discouraged by the prohibitively high cost of upgrading industrial machinery or

retrofitting building systems, which deters institutions and investors from participating. (Kapur et al., 2011).

2. Uncertainty of Savings and Perceptions of Risk: Investors experience uncertainty due to the absence of reliable methods to quantify and validate energy cost savings. They need to be assured that the anticipated savings will be made. This category also includes the belief that investing in energy efficiency is risky, which prevents its widespread adoption. (Kapur et al., 2011).

3. Budget Prioritization: A lot of organizations give top priority to financial investments that support their main goals, which could include raising patient health, increasing production, or boosting customer satisfaction. It can be difficult to obtain both internal and external funding for energy efficiency projects because it is frequently deprioritized. (Kapur et al., 2011).

4. Absence of Secondary Markets: Investors are discouraged from making energy efficiency investments due to their illiquidity, particularly when the returns have longer time horizons. The lack of secondary markets reduces the appeal of energy efficiency investments, in contrast to established markets where earlier exits are easier. (Kapur et al., 2011).

All of these categories combined show the main obstacles to widespread capital investment in the energy efficiency industry. Unlocking the substantial potential for financial savings and sustainability aspects associated with energy efficiency projects requires addressing these obstacles.

Risk Management Identification, assessment, and control of financial, legal, strategic, and security risks to the assets and profits of an organization constitute the process of risk management. These threats or risks could be caused by a wide range of things, such as monetary instability, legal liabilities, poor strategic management, mishaps, and natural disasters. (IBM, n.d.)

There are obstacles greater than the internal and external levels, these are universal-level obstacles for any such projects. As shown in Figure 22 an organization can suffer losses if the factors mentioned above are not taken care of, and as an investor, one needs to be aware of them before making any financial decisions. This, on a business level, is considered risk management.

Risk factors and management

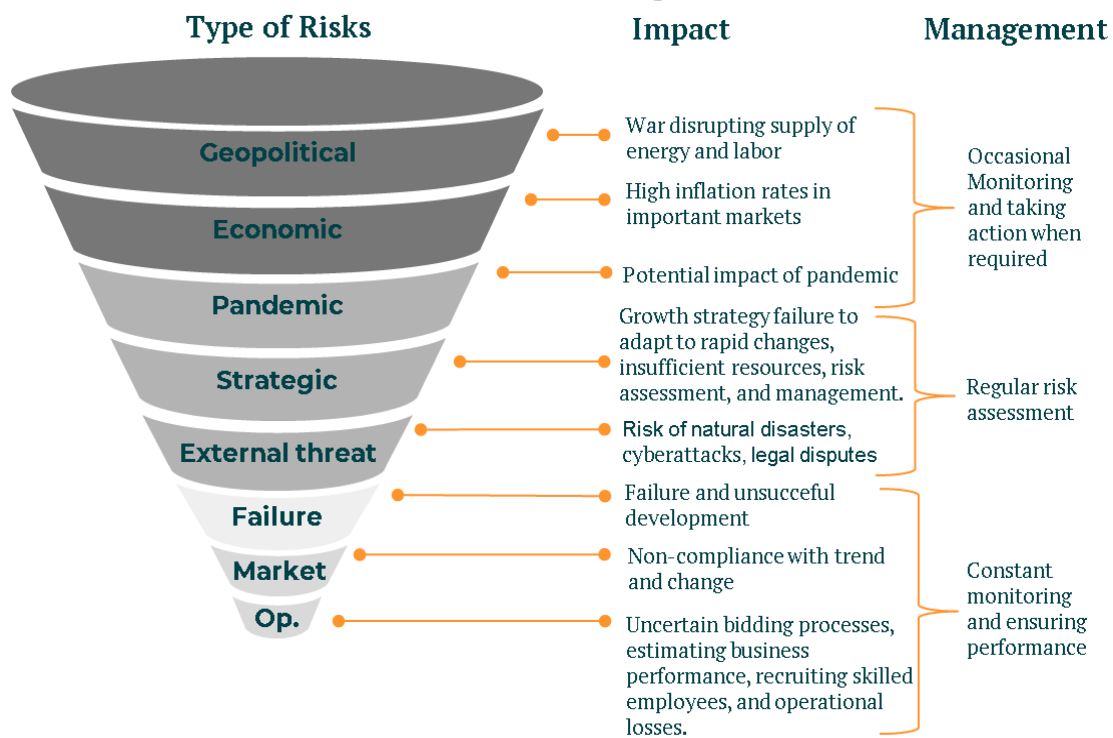


Figure 22. Risk Factors and Management

Risks like geopolitical problems between regions and countries, high inflations affecting the economy, unforeseen problems like a pandemic or external threats, bad strategy, and operational failures can all impact severely any business or sector. Monitoring on a regular, constant, and occasional level can be utilized to avoid the pitfall. Risk Management can be done utilizing tools like auditing through a risk matrix and checklists, evaluations on quantitative and qualitative levels, aligning with policies and regulations and training employees through various methods like workshops and knowledge transfers.

Internal controls are a crucial component of risk management since they guarantee the effectiveness of operations, the accuracy of reporting, and adherence to legal and regulatory requirements. Controls fall into three categories: corrective, detective, and preventive. When it comes to control issues, the most important factors to take into account are who is in charge, why the control is being done, and how it will be monitored. In 2002, the Sarbanes-Oxley Act (SOX) was proposed. In reaction to corporate scandals, SOX mandated compliance for businesses listed on US stock exchanges. Two instances of this type are the Enron and WorldCom scandals. Trading organizations now have to comply with SOX regulations in the USA, which include documenting key controls, mapping out processes,

developing general control and process descriptions, testing, and improving them. (Khan & Jaiswal-Dale, 2018). Such governing policies also help organizations to keep themselves aligned with risk management. In addition to that occasional, regular, and constant monitoring can also ensure better management and performance.

In the context of Risk management, the business model also plays a pivotal role in the success of an organization or a SC project. In a report titled "District Energy in Cities" published in 2015 by the United Nations Environment Program (UNEP), business models are discussed for executing energy projects. While the report mainly discusses district heating and cooling it can be seen as a case study for other energy solution implementations.

Covering finance, policy, and technology, it worked with 45 "champion" cities—all of which used modern district energy—and compiled information about the advantages of modern district energy. We will base our discussion on how business models were discussed and how the Risk, Cost, and Control of those business models were elaborated. Table 3 illustrates different business models and their implications in terms of Risk, Cost, and Control.

Table 3. Business Models in the Context of Risk, Cost and Control

Business Model	Description	Risk	Cost	Control
Wholly Public	Public sector has full ownership and control; aligns with broader social objectives.	Lower	Publicly funded; often leveraging city's cash reserves and public debt.	Maximum
Hybrid Public and Private	Public sector shares risk with private partners; degree of risk varies.	Moderate	Blend of public and private financing; public sector may leverage its balance sheet.	Balanced
Private	Higher risk for private sector, limited risk for public sector; private investors expect higher returns.	Potentially higher	Privately funded; public sector may provide guaranteed demand or incentives.	Private sector has significant control; public sector has limited influence.
Developing Countries	Strong public sector ownership minimizes risk for private investors; public sector takes on significant risk.	Moderate	Public sector-funded; typically without the involvement of liberalized energy markets.	Public sector retains control, but lacks market mechanisms for reflecting benefits.

The best business model selection is based on several variables, such as the project's objectives and scale and the ideal balance of factors such as Risk, Cost, and Control. The

"wholly public" model typically carries the least amount of risk for the public and private sectors. Although it gives the most control, it might not be able to draw in private investment. The "hybrid public and private" models strike a balance, whereas the "private" model may offer greater returns for the private sector but may also entail greater risk.

The feasible model will depend on stakeholders' risk tolerance, funding availability, and local goals. When the public sector can secure financing at favorable terms and prioritizes broader social and environmental goals, the "wholly public" model is frequently preferred. On the other hand, hybrid models—which incorporate both public and private partners—can offer a cost, control, and risk balance, which makes them appropriate for a variety of projects. (Riahi, 2015)

To transition from surviving to thriving, companies should prioritize risk management by understanding larger trends, collecting data, conducting analyses, and using results to inform decision-making. To create transparency around risks, companies should create heat maps, prioritize risks, and understand risk ownership. This will help make risk data understandable at all levels of the organization, enabling a more effective risk management approach. Ensure effective risk governance, by clearly explaining complex risk modeling results to the board, in a way that encourages practical actions. Companies often have data, but building a comprehensive view of the portfolio is challenging. (Petrov et al., 2023)

Answering our fourth and last research question about risk management and potential obstacles in replicating smart city solutions and how to mitigate them. This chapter explored the intricate realm of risk management at multiple levels, addressing obstacles to sustainability in SC projects, particularly those centered on energy efficiency. It underscored the critical role that business models play in this domain.

We inevitably deal with these issues in the changing world that we live in. Decision-making is influenced by the interaction of risk, cost, and control, and innovative approaches like design thinking and the BM generation can lead our way through the changing business environment. Through a user-centric and growth mindset, organizations can not only overcome obstacles but also take advantage of opportunities that pave the way for a more efficient and sustainable future. This chapter concluded the thesis research and addressed the research questions part. But with this new information, we can have a variety of new options and take new directions from here onward.

8 Future Suggestions

The researcher has also developed a future scoreboard which is a small step at the moment. The board as shown in Figure 23 provides an overview of a few suggestions that can become potential avenues if considered in the future.

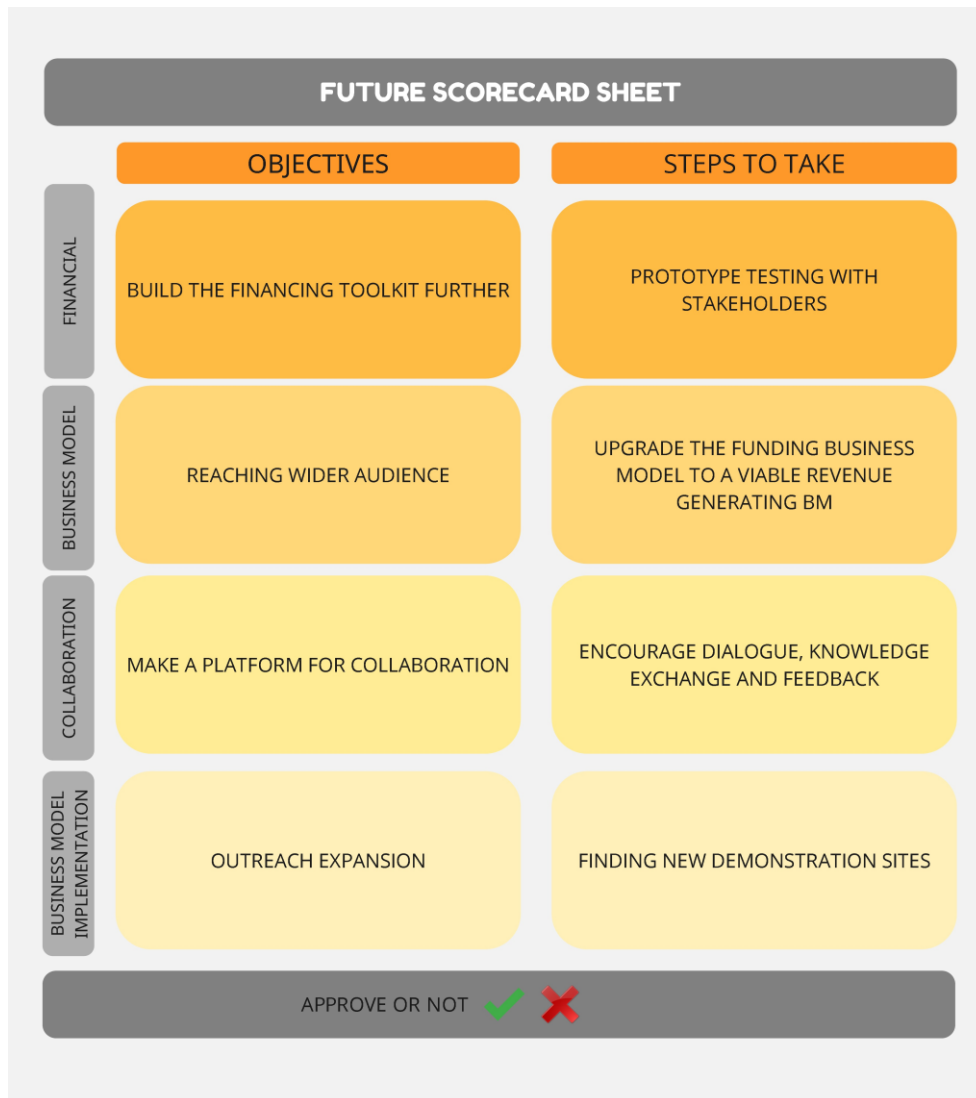


Fig 23. Future Solutions

In the dynamic environments of today, decision-makers need to adopt a fresh perspective on the future. Planning has historically depended on extrapolation and the continuity assumption. In contrast, professional futurists create hypothetical scenarios in the modern era to aid decision-makers in getting ready for unforeseen futures. Product and service

designers develop cutting-edge methods and tools for visualization that enable decision-makers to see new possibilities. Decision makers can address both inbound changes from the outside world and outbound changes, or strategic changes they initiate to reshape their environment, by fusing design and foresight. (Buehring & Bishop, 2020)

We need to include design thinking in strategic management and go beyond products and services. Taking on difficult "Wicked Problems"^{1&2} of today's world, offers a fresh approach to problem solving with design thinking. It also increases our knowledge absorption and fortifies the flexibility and agility of an organization. However, we must acknowledge that developing strategies with the needs and expectations of the user in mind will help organizations make better strategic decisions. Continuous learning and learning through feedback are supported by iterative prototyping. (Graf, 2021)

Innovative BM concepts can be conceived from a variety of angles. But the most important ones of BM innovation are the ones that employ "what if" inquiries in the BMC. (Osterwalder & Pigneur, 2010).

By utilizing the dynamic field of strategic management and decision-making, we can steer the direction of the potential future for PEDs. Making informed decisions is imperative for decision-makers operating in dynamic and uncertain environments. They ought to think about hiring qualified futurists and service designers who can create future scenarios so PEDs can be ready for the unanticipated times ahead. Meanwhile, the incorporation of design thinking into strategic management—which takes a wider view than just goods and services—can enable PEDs to take on challenging "Wicked Problems." PEDs can become more adaptive and resilient by building a culture of continuous learning and integrating user needs and expectations into their strategies. All of this is possible when innovative BMs are explored.

-
1. "These are problems characterized by a context that is not fully graspable, a stated problem that is unique, and the difficulty that there is no right or wrong solution, but rather only better or worse solutions" (Rittel & Weber, 1973).
 2. In his seminal paper "Wicked Problems in Design Thinking", Buchanan (1992) created a new conversation around the term, arguing that designers deal with ill-defined problems and that the creative re-definition of the problem itself is part of the professional skill set of designers. He stated that design lies in the interface of possibilities, constraints, and contingencies (Buchanan, 1992).

The Green Finance Round Table's introduction and Turku Science Park's enormous potential (See Appendix G) offer hope for the future of these ideas. Notably, RESPONSE is currently investigating how to replicate and upscale, and Turku Science Park is one of the possible locations. The future suggestions shown in the scorecard (Figure 23) indicate that the future recommendations, which include creating a new business model, testing the financial toolkit, and setting up cooperative platforms, are promising.

In addition to all of the above suggestions provided, it is also to highlight that the “demonstration site” of RESPONSE holds a potential market value and it should be capitalized by the stakeholders.

8.1 Lessons Learned

Every process comes with learnings and expectations. This thesis also provided some good lessons to be learned by the researcher and can be utilized by others.

Establishing a thorough work plan and clear expectations with a commissioner is an important part of a research study. A shared plan at the beginning of the process can enhance communication and minimize potential misinterpretations. This can be further improved if the researcher becomes a part of the working environment, as it can greatly impact the process. Direct communication and involvement can lead to timely decisions and a quicker exchange of ideas. This can significantly enhance the overall quality of work.

Another lesson learned was being a part of a live project has a significant advantage, and it can bring practical experience in handling timelines, and schedules, and developing communication skills. This hands-on experience provided important insights into real-world work culture. The only limitation encountered was the asynchronous timeframe of thesis work and project timeline, but it can be overcome effectively if a well-structured roadmap is developed by the researcher.

The roadmap and developing a timeline can also help in achieving outcomes that are more results-driven and richer in context. It is also important to note that there is always a chance for further development and refinement. At this point, thesis outcomes are also considered to be a small step signaling that further work is needed in the future on this topic.

The selection of research methods also plays a crucial role in achieving the goals and objectives of the thesis study, and a broad variety of methods and tools should be employed. Careful consideration in the selection of the methods can enhance the results and comprehensively answer the research questions.

Finally, create an opportunity to learn and endorse it without fear. The thesis is the opportunity where the researcher to show the acquired skills and demonstrate the ability to deliver a significant amount of work, but it is also a potential opportunity to learn new things. In this thesis study, the researcher was able to combine familiarity with non-familiar capacities like the field of finance, conjoining with service design. Everyone is encouraged here to take a bold step, as this lifelong learning can go beyond the thesis level with you. Be willing to venture into the unknown.

9 Conclusion

To sum up, the researcher's experience participating in the RESPONSE project as a student of service design and an architect by profession has been transformative. Because of her unique background, the researcher tried to approach this research from a holistic angle, utilizing both architectural expertise and service design principles. Acknowledging the importance of positive energy districts and the creative objectives put forward by the European Commission, this study set out to examine and suggest financing mechanisms for the RESPONSE upscaling and replication. A variety of tools and methods were used, such as quality comparative analysis, e-research, participant observation, and a research wall in addition to traditional service design tools, to better understand the complex problems and look for creative solutions.

With all the deliverables and outcomes, we are aiming to take an important step in closing a critical gap in the development of smart cities. This research lays the groundwork for sustainable and scalable smart city projects by comprehensively addressing difficulties in business model implementation and the integration of funding schemes within PEDs, while simultaneously identifying crucial factors that could lead to transformative changes in the BM.

The study also focused on positioning strategies to create funding mechanisms in the form of a toolkit. This toolkit not only makes PEDs more viable but also considers how they might be used in buildings for the private sector. By doing this, it encourages a wider range of

stakeholders to support smart city initiatives, which promote more thorough urban development.

Exploring the implications of potential barriers, to replicating SC solutions, serves as a proactive approach to risk management. By identifying key risk factors, strategic insights, and implementable mitigation measures can be derived, ensuring the successful resolution of these issues and fostering the broader expansion of innovative solutions.

The RESPONSE project's deliverable D8.2 consists of a collection of replication tools for FCs. These resources support FCs in creating plans for replicating the integrated solutions that are showcased in the project. The toolkit includes planning, knowledge exchange, technical tools (category 1), and capacity-building tools (category 2). This thesis study and financing toolkit can become a part of the deliverable version 2 for use by cities aiming for replication.

In conclusion, this thesis study creates a comprehensive strategy that integrates several important research areas with the ultimate goal of turning smart city initiatives into replicable models. It offers a plan for SC projects to become replicable models in various parts of the city or region by addressing obstacles to replication, integrating funding schemes, identifying transformative factors, developing adaptable funding mechanisms, and addressing challenges in business model implementation.

This research endeavors to make urban innovation shareable, modifiable, and scalable for the collective benefit of cities worldwide. Globally we have reached a stage where it is about time that we create resilient futures for us and our upcoming generations. Developing smart city solutions provides a clear roadmap to adapt strategies against the worst effects of climate change. The future of our cities should be changed, and a focus on sustainability, resilience, and informed decisions is a well-rooted way to innovation. A transformative transition is underway from polluted urban fabric to cleaner and greener surroundings introducing smart solutions that are ready to take up the challenge of climate change. Today, quality and sustainable performance are essential if we want to create healthy experiences and outcomes in our surroundings. But future uncertainties are a crucial part of our thinking processes. The ability to comprehend a changing world and make wiser decisions is increased by all forms of strategic foresight, which is one of the reasons why cities and people who practice sustainable actions will perform better gradually.

With RESPONSE we are one step closer to our obligation of leaving a more favorable and sustainable world for the coming generations. Finding the aurora borealis and following its glow is a new way forward.

10 References

About – RESPONSE. (n.d.). <https://h2020response.eu/about/>

Alex Osterwalder & Yves Pigneur. (2005). Vaughan Broderick. (2023). The 9 Components of Business Model Canvas. <https://vaughanbroderick.com/business-model-canvas-innovation/>

Brundtland, G. H. (1987). Our common future: The World Commission on Environment and Development. Oxford University Press.

Buehring, J., & Bishop, P. C. (2020). Foresight and Design: New Support for Strategic Decision Making. *She Ji: The Journal of Design, Economics, and Innovation*, 6(3), 408-432. <https://doi.org/10.1016/j.sheji.2020.07.002>

Capacity-Building Programme. (n.d.). PROSPECT+. Retrieved April 20, 2023, from <https://h2020prospect.eu/learning-programme>

CARBON NEUTRAL TURKU - Our climate target. (2022, May). Turku. fi. Retrieved September 18, 2023, from <https://www.turku.fi/en/carbon-neutral-turku/our-climate-target>

Clatworthy, S. (2017). *Service design thinking*. Edward Elgar Publishing. <https://doi.org/10.4337/9781785369483.00020>

Dam, R. F. and Teo, Y. S. (2022, May 2). Stakeholder Mapping: The Complete Guide to Stakeholder Maps. Interaction Design Foundation - IxDF. <https://www.interaction-design.org/literature/article/map-the-stakeholders>

Denis, M., Kohls, S., Peeters, P., & Silverman, Z. (2023, April 21). Building optionality: Balance sheet discipline is both timely and timeless. McKinsey & Company. <https://www.mckinsey.com/capabilities/strategy-and-corporate-finance/our-insights/building-optionality-balance-sheet-discipline-is-both-timely-and-timeless>

E-FIX Ambassador Platform. (2021). Energy Efficiency and Renewable Energy Financing in the EU. Retrieved from http://www.energyfinancing.eu/AmbassadorPlatform/E-FIX_Roadmap_26.07.2021.pdf

Erdmann, Sichel, & Yeung. (n.d.). Overcoming obstacles to effective scenario planning. McKinsey & Company. Retrieved February 6, 2023, from <https://www.mckinsey.com/capabilities/strategy-and-corporate-finance/our-insights/overcoming-obstacles-to-effective-scenario-planning>

European Commission. (n.d.). Equity crowdfunding. Access to Finance. Retrieved from https://single-market-economy.ec.europa.eu/access-finance/guide-crowdfunding/how-do-it/equity-crowdfunding_en

1: European Commission. (n.d.). Energy and Smart Cities. https://commission.europa.eu/eu-regional-and-urban-development/topics/cities-and-urban-development/city-initiatives/smart-cities_en

2: European Commission. (n.d.). Smart Cities. https://energy.ec.europa.eu/topics/research-and-technology/energy-and-smart-cities_en

Funding and Tender Opportunities. (2023). European Commission Horizon 2020 Online Manual. Retrieved September 2023, from <https://webgate.ec.europa.eu/funding-tenders-opportunities/display/OM/Grants>

Funding, grants, subsidies | European Union. (n.d.). European Union. https://european-union.europa.eu/live-work-study/funding-grants-subsidies_en

Gibbons, S. (2017, August 27). Service Blueprints: Definition. Nielsen Norman Group. <https://www.nngroup.com/articles/service-blueprints-definition/>

Giourka, P., Sanders, M., Angelakoglou, K., Pramangioulis, D., Nikolopoulos, N., Rakopoulos, D., Tryferidis, A., & Tzovaras, D. (2019). The Smart City Business Model Canvas-A Smart City Business Modeling Framework and Practical Tool. *Energies*, 12, 4798. <https://doi.org/10.3390/en12244798>

Goujon, D., & Murshed, M. (2023, January 16). Finnish and French cities chart Europe's path to clean energy. Horizon: The EU Research and Innovation Magazine. Retrieved from <https://ec.europa.eu/research-and-innovation/en/horizon-magazine/finnish-and-french-cities-chart-europes-path-clean-energy>

Graf, S. (2021). Design Thinking for Strategizing? – A Critical Literature Review. Journal of Emerging Trends in Marketing and Management, 1(1), 110. URL: www.etimm.ase.ro

H2020 PROSPECT. (n.d.). Glossary of financial terms Retrieved April 20, 2023, from <https://h2020prospect.eu/glossary-financial-terms>

Hackathon Turku. (n.d.). Retrieved from <https://h2020response.eu/hackathons/hackathon-turku/>

IBM. (n.d.). Risk management. Retrieved from <https://www.ibm.com/topics/risk-management>

Investopedia. (2023, March 22). What is corporate governance? Investopedia. Retrieved from <https://www.investopedia.com/terms/c/corporategovernance.asp>

Jansen, D. (2021, June 21). <https://www.userfocus.co.uk/articles/desk-research-the-what-why-and-how.html>. Grad Coach. Retrieved November 25, 2022, from <https://gradcoach.com/discourse-analysis-101/>

Kapur, N., Hiller, J., Langdon, R., & Abramson, A. (2011). Show Me the Money Energy Efficiency Financing Barriers and Opportunities. Environmental Defense Fund (EDF) and Nicholas Institute for Environmental Policy Solutions.

Kevin Ramsay Consulting Ltd. (2022). Financing & Funding of Infrastructure in New Zealand. Kevin Ramsay Consulting Ltd. <http://www.krconsulting.co.nz/significant-projects-work-to-date/>

Khan, M. M., & Jaiswal-Dale, A. (2018). Impact of Sarbanes Oxley Act on US firms. *Journal of Accounting & Marketing*, 7(1), 1-7. <https://doi.org/10.4172/2168-9601.1000214>

Leon-Garcia, A., Lenort, R., Holman, D., Staš, D., Krutilova, V., Wicher, P., Nguyen, K. (Eds.). (2015). *Smart City 360°: First EAI International Summit, Smart City 360°: Bratislava, Slovakia and Toronto, Canada, October 13–16, 2015, Revised Selected Papers*. (EAI/Springer Innovations in Communication and Computing). Springer.

Leroy & Sanfilippo. (2021, June). D5.1 Business models' foreground: energy, social, and business flows. <https://h2020response.eu>.

Municipal funding. (n.d.). Retrieved from <https://www.kuntarahoitus.fi/rahoituspalvelut/>

Novikova, A., Stelmakh, K., Emmrich, J., Stamo, I., and Hessling, M. 2017. Guidelines on finding a suitable financing model for public lighting investment: Deliverable D.T2.3.4. Report of the EU-funded project “INTERREG Central Europe CE452 Dynamic Light”, July 2017. https://www.researchgate.net/publication/324602836_Guideline_on_finding_a_suitable_financing_model_for_public_lighting_investment

Osterwalder, A., & Pigneur, Y. (2010, July 13). *Business Model Generation*. John Wiley & Sons.

Petrov, A., Polyakov, Y., Raggl, A., Schabram, J., van der Marel, F., & Wachter, R. (2023, June 20). Resilient Portfolio Growth for Energy Companies in Volatile Times. McKinsey & Company. <https://www.mckinsey.com/industries/electric-power-and-natural-gas/our-insights/resilient-portfolio-growth-for-energy-companies-in-volatile-times>

Qualitative Comparative Analysis | Georgetown University Press. (n.d.). Retrieved November 25, 2022, from <http://press.georgetown.edu/book/georgetown/qualitative-comparative-analysisv>

Rachlin, R. (1997). Return on Investment Manual: Tools and Applications for Managing Financial Results. Sharpe Professional.

RESPONSE – integRatEd Solutions for POSitive energy and reSilient CitiEs. (2023, February 24). RESPONSE – integRatEd Solutions for POSitive eNErgy and reSilient CitiEs. Retrieved January 19, 2023, from <https://h2020response.eu/>

RESPONSE | TYS | Turun Ylioppilaskyläsäätiö. (n.d.). Turun Ylioppilaskyläsäätiö. Retrieved January 19, 2023, from <https://tys.fi/response>

Response to Ylioppilaskylä Residents. (2020, December 9). TYS. Retrieved from <https://tys.fi/wp-content/uploads/2020/12/RESPONSE-Info-Ylioppilaskylan-asukkaille-9.12.2020.pdf>

"RESPONSE" (2020). RESPONSE. Smart Cities Marketplace. Retrieved from <https://smart-cities-marketplace.ec.europa.eu/projects-and-sites/projects/response>

Riahi, L. (2015). District Energy in Cities. United Nations Environment Programme.

Smart Poles Market Report. (2023, March). ResearchDive. Retrieved September 2023, from <https://www.researchdive.com/8559/smart-pole-market>

Stickdorn, Lawrence, Hormess, & Schneider (Eds.). (2018, January). #TISDD METHOD LIBRARY. This Is Service Design Doing. Retrieved 2023, from <https://www.thisisservicedesigndoing.com/methods>

Strategyzer. (n.d.). Building Blocks. Business Model Canvas. Retrieved from <https://www.strategyzer.com/business-model-canvas/building-blocks>

The Design Squiggle (n.d.) Retrieved from <https://thedesignsquiggle.com/>

Virtanen, J. (2022, September 26). Turku's Integrated and Interconnected City Ecosystem (TA#4)- V1.

Wang, S. (TUAS). (2023). D7.2-TA1-implementation-activities-for-Turku-V1. H2020RESPONSE. <https://h2020response.eu/news/project-deliverables/>

Woetzel, J., Remes, J., Boland, B., Lv, K., Sinha, S., Strube, G., Means, J., Law, J., Cadena, A., & von der Tann, V. (2018). Smart Cities: Digital Solutions for a More Livable Future. McKinsey Global Institute.

Work Plan: RESPONSE. (n.d.). Work Plan: RESPONSE. <https://h2020response.eu/about/work-plan/><https://h2020response.eu/about/work-plan/>

Zinchuk, O., Ruuska, N., Liu, H., Virtanen, J., (2022). D5.4 Turku Business Models Portfolio - V1.

11 List of Figures

• Figure 1. RESPONSE project framework comprising five pillars.....	02
• Figure 2. Relationship diagram showing problem area framework.....	06
• Figure 3. Smart City network comprising focal activities.....	09
• Figure 4. Damien Newman’s “Squiggle” represents the design process. The Design Squiggle.....	12
• Figure 5. The design thinking approach cycles through phases.....	12
• Figure 6. Methodology Overview	14
• Figure 7. Project Timeline.....	17
• Figure 8. Participation engagement sprint.....	20
• Figure 9. Energy Mentor Consortium attendee.....	21
• Figure 10. RESPONSE project network.....	26
• Figure 11. Stakeholder map.....	30
• Figure 12. Service Blueprint of EU-funded project (Case study RESPONSE)	32
• Figure 13. How BMC works?.....	33
• Figure 14. Derived from information given in report D5.4 Turku Business Models portfolio – VI.....	34
• Figure 15. S2CBMC.....	36
• Figure 16. Innovative Financing Mechanisms.....	41
• Figure 17. Decision Matrix.....	43
• Figure 18. Global smart poles market analysis.....	48
• Figure 19. SWOT analysis of 5G poles.....	48
• Figure 20. Green and Social Finance projects of MuniFin	53
• Figure 21. SWOT analysis of Solar panel solution.....	55
• Figure 22. Risk Factors and Management.....	63
• Figure 23. Future Solutions.....	66

12 List of Tables

- Table 1. Parallels and distinctions between the two BMs (research analysis).....37
- Table 2. Beneficiaries ecosystem and funding sources (developed with commissioner)47
- Table 3. Business Models in the Context of Risk, Cost and Control.....64

13 Appendices

Appendix A

Slides depicting five clusters of building blocks used for implementation of the RESPONSE project as PED.

RESPONSE Project
Demonstrating Positive Energy District in Turku



RESPONSE

1

RESPONSE Project
Demonstrating Positive Energy District in Turku

Retrofitting cluster (B4)


- Retrofitting buildings (1971)
- Floor area 3 821 m²
- Residential building
- 110 occupants
- Energy need 481 446 kWh/a
- RES production 75 733 kWh/a

Nummenranta cluster (B5)

- Existing buildings (2004-2008)
- Floor area 12 067 m²
- Residential buildings
- 251 occupants
- Energy need 1 459 596 kWh/a
- RES production 75 733 kWh/a

Ikituuri (B2)

- Year of construction 2011
- Floor area 4 220 m²
- Mixed use
- 83 occupants
- Energy need 340 413 kWh/a
- RES production 337 600 kWh/a



Tyysija (B3)

- New construction (2021)
- Floor area 9 950 m²
- Mixed use
- 250 occupants
- Energy need 1 309 500 kWh/a
- RES production 5 822 991 kWh/a

Aitiopaikka (B1)

- Year of construction 2019
- Floor area 10 476 m²
- Residential building
- 300 occupants
- Energy need 1 309 500 kWh/a
- RES production 175 000 kWh/a

RESPONSE

8

Source: (RESPONSE – integRatEd Solutions for Positive eNergy and reSilient CitiEs, 2023)

Appendix B

Work packages Roadmap



Source: (Response: Brochure)

Appendix C

June 06-08, 2023, the “Consortium event Turku”. Photo courtesy Helmi Andersson



Appendix D

June, 2023, the “PED site visit Turku”. Integrated solutions



Heat pump



Photovoltaic solar panel system



Room unit for IoT thermostat



5G lighting pole



District Heating Substation



Phase Change Material (PCM)-based Heat Storage for Domestic Hot Water (DHW)

Appendix E

Research Wall

The Research Wall is a grid of 11 colored boxes, each containing a list of documents and links. The boxes are: PREPARATORY RESEARCH (red border), FINANCE (blue border), TOOLKIT (green border), BUSINESS MODEL (orange border), THESIS REPORT (purple border), THESIS REPORT-SECOND SEMINAR (black border), RESPONSE REPORTS (black border), SMART CITIES (black border), INTEGRATED SOLUTIONS (red border), CASE STUDY (red border), and EU FOLDER (purple border). Each box contains a list of document titles and links, often with small icons representing document types like PDFs or presentations.

Appendix F

Case study of decision matrix models

(Model 1: [Aleksandra Novikova 2017](#))

(Model 2: Developed by Ricardo-AEA Ltd, 2015 based on a diagram developed by The Carbon Trust)

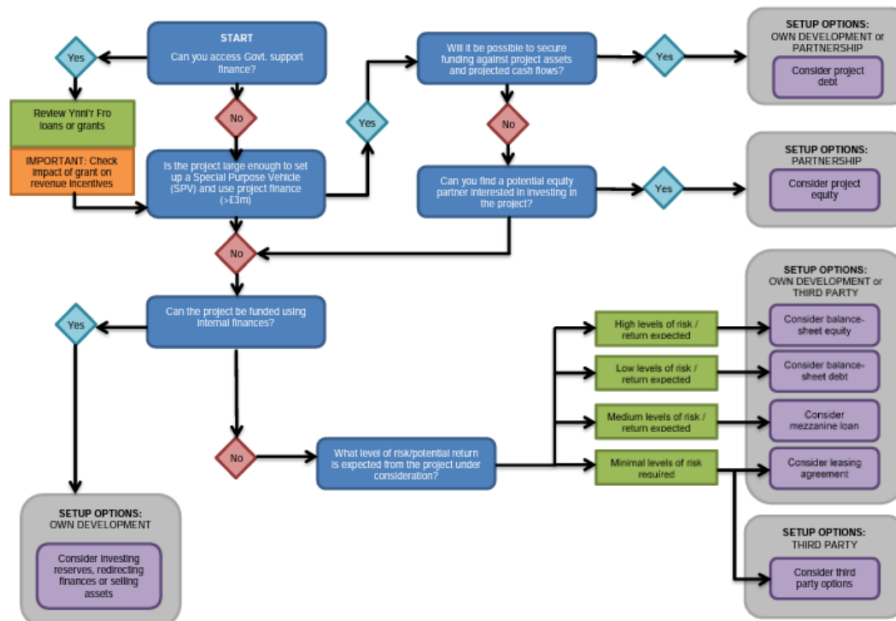
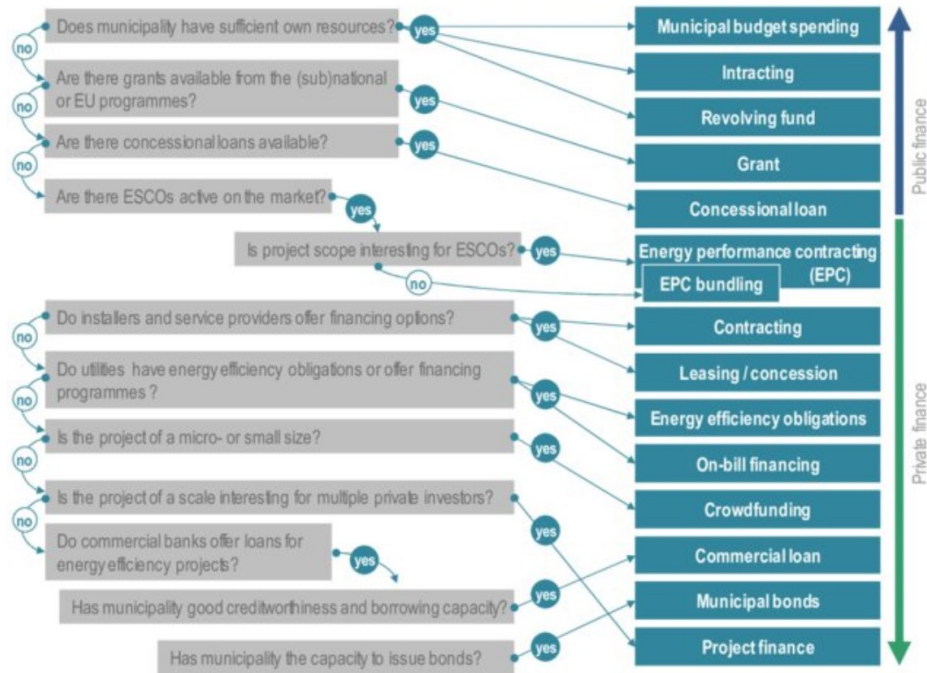


Figure 2: Potential funding arrangements for your project (Source: based on a diagram developed by The Carbon Trust)

Appendix G

Turku and RESPONSE plans

Turku Science Park in the future

13,000+	20,000
A new job	New resident
1,000,000+	€ 4,000,000,000
m2 to build	Investment opportunities

Circular Economy Science Park in the flagship project

- Creating an overall picture of the circular economy about opportunities in the Science Park and defining goals
- Identifying the most effective solutions
- Implementation and concretization of the solutions of Turku's circular economy road map at the district level - Science Park as a pilot area
- Closer collaboration with key players in the region and expert organizations





Year clock for TA preparation 2023

EU taxonomy

In the 2023 budget, the investments are classified according to the main goal of the EU taxonomy, which primarily supports climate goals.

The 2024 budget guidelines take into account the technical evaluation criteria of the six main objectives of the taxonomy and their DNSH criteria, to the extent that they have been published.

The criteria set of the EU taxonomy will be implemented in the city organization with online trainings in the form of workshops during 2023.

The development ideas obtained in connection with the evaluation of trainings and investments are put into practice in cooperation with service entities and group communities.

Low-carbon circular economy city - investment management and climate budgeting, or the VAKU project

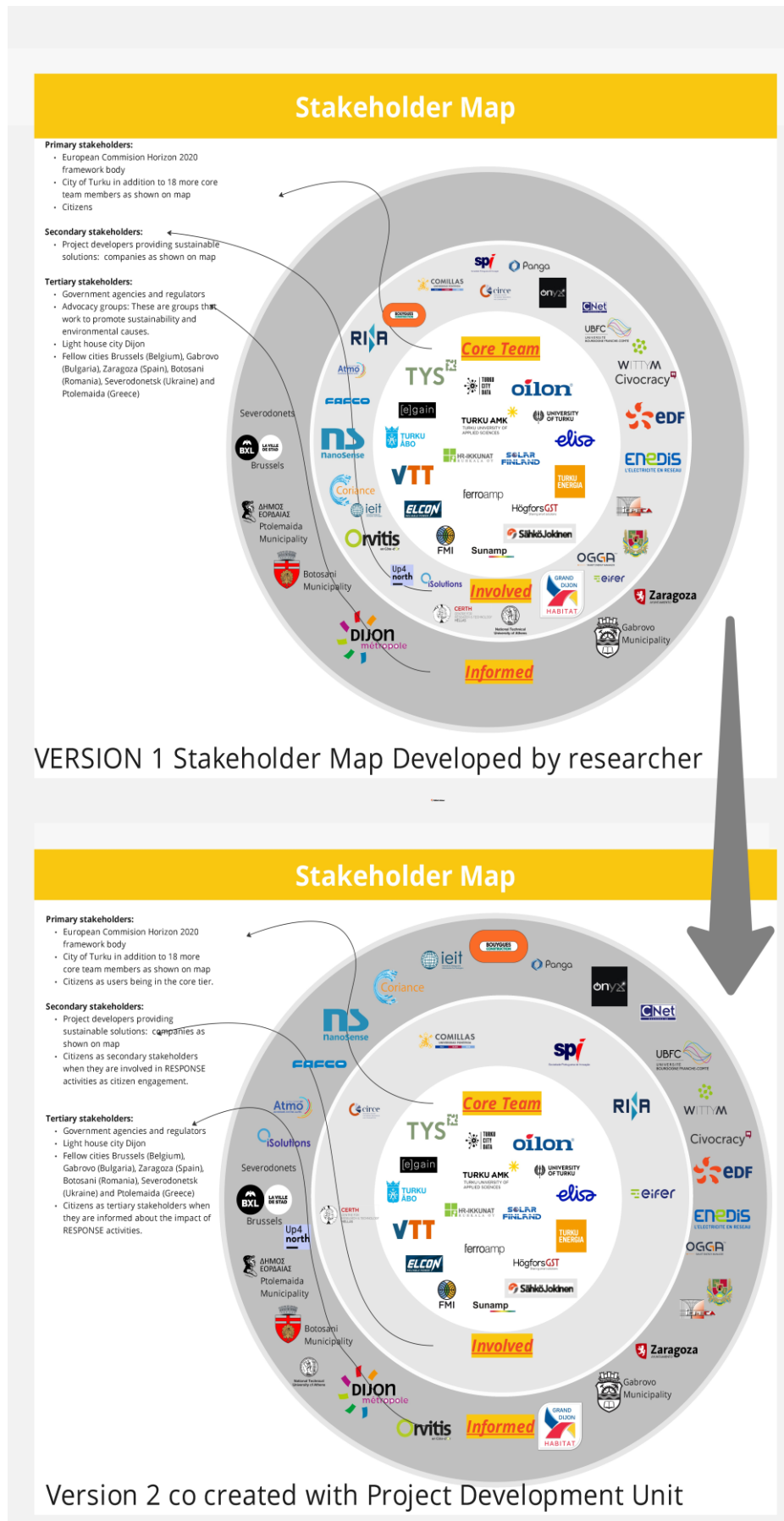
August 2022 June 2024



Source: Turun kaupungin ilmastosuunnitelman päivistytyö.pdf

Introduction to the Green Finance Round Table (Motiva) 15 March 2023 Climate Director
Risto Veivo, City of Turku

Co-Creating System Maps (2/2)



Appendix I

Interview questions for EU Advisor

VS: RESPONSE WP5 Thesis work



Dear [REDACTED]

We discussed having a meeting online today April 12 but did not confirm the timings. Can we please have it in the second half of the day today if it is convenient for you?

- Why is it required to find new funding schemes for RESPONSE?
- Are there any research publications based on this project? or if you can share publications of any other project having similar nature.
- What are the roles and responsibilities of consortium and how are they divided here? A document based on this would be helpful for my research and clarity.
- Does RESPONSE have any positioning strategy defined for coming years? What are the long-term financial targets of RESPONSE?
- Is there any factsheet of the project that can be shared?
- Does EU require risk management from a project execution team?
- What investment appeal is RESPONSE offering for investors? e.g. for crowdfunding.

These are some of the basic things that I want to clarify at this stage, and I will have more questions along the way.

Looking forward to hearing from you.

Thanks, and regards
Shumaila Hamood

VS: RESPONSE WP5 Thesis work



3 attachments (16 MB) Save all to OneDrive - Ab Yrkeshogskolan vid Abo Akademi Download all

CAUTION: This email originated from outside of the organisation. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Hi Shumaila,

As promised here is already some RESPONSE material ahead of our discussion on Monday. Some of the questions Olena or someone else might be more knowledgeable to answer (I can mainly cover the EU funding and financing issues), but let's go through your questions on Monday and let's then continue forward.

- Here attached are RESPONSE fact sheets (brochure, flyer and leaflet).
- From this project webpage you can find the Work Packages and their leaders: <https://h2020response.eu/about/work-plan/>
- Risk management is part of the project management work package (12), lead by EIFER. Please find here the report on the management plan and risk assessment: <https://h2020response.eu/wp-content/uploads/2022/05/D12.3-Quality-Management-Plan-Risk-Assessment-and-Contingency-Planning-Reports-V1.pdf>

Have a nice weekend, and talk to you on Monday