How are public values affected when public actors that own infrastructure assets implement PSS?

A transition towards service oriented projects

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How are public values affected when public actors that own infrastructure assets implement PSS

A transition towards service-oriented projects

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This thesis is written in fulfilment of the requirements for the degree of Master of Science (MSc) for the master program Construction, Management and Engineering (CME) at the Faculty of Civil Engineering & Geosciences at Delft University of Technology.

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Preface

Dear reader,

In front of you lies my Master thesis that is the conclusion of my studies in Construction Management and Engineering. This study has been performed in collaboration with the Province of Noord Holland.

This study allowed me to explore my skills and interests. I got familiar with the concepts of Circular Economy, Innovation, as-a-Service and many many more. I believe I was really lucky, as I found that those are the concepts that I would like to serve during my professional life too. I personally feel the urgency of implementing Circular Economy, and I will use my knowledge towards having an impact on society.

Conducting research is always a challenge. Always. Especially when you touch the subject of Innovation, new challenges are added. When you have to swim in unchartered waters, you don't have a manual to follow.

For the past few months, I have spent endless days of reading papers, contacting people for interviews, formulating my topic and working towards completing it. Especially about finalizing my topic, the road was rocky. The study has taken many turns along the way, starting with as a completely different approach, just to realize that sometimes you cannot stir Innovation, but Innovation steers you towards the desired result. All you have to do is listen to Innovation and let yourself free to its flow.

During research, it is common that you lose your motivation as countless issues can arise. In my opinion, you should not allow that to let you down. On the contrary, you should pick yourself up and try new things. That is the real challenge: how to keep your cool and how to react when things don't go as planned. After all, challenges are just opportunities to achieve a better result.

I would like to thank every single one of the people that contributed in the completion of this research.

First of all, I would like to thank my graduation committee, Ingrid, Daan, Ad and Alexander, for all their efforts and support during the journey. Additionally, they offered their knowledge and expertise, and they also offered a safe environment for me to flourish.

I would also like to thank all the participants that were part of this study, either by participating in the interviews or the expert panel, or by sharing their knowledge, experiences and network with me. I hope reading this report is also useful for you too.

I would also like to thank my friends both in the Netherlands and in Greece who knew how to help me and how to cheer me up when I needed it. Last but certainly not least, I would like to heartfully thank my family. Their support, motivation and help were out of this world. Mum, Dad and Elli, this one is for you.

Enjoy reading!

Lefketi

Rotterdam, May 2023

Abstract

Public clients in the Netherlands have committed to dramatically reduce CO2 emissions. To achieve that, Circular Economy is proposed and more specifically a tool that can lead to Circularity, called Product Service Systems (PSS). PSS is a business tool that is innovative for infrastructure, and public clients are investigating the transition towards service-oriented projects. Literature suggests that when public actors undergo transitions, their public values are also affected. It is yet not thoroughly studied how the public values are coupled with PSS. Aim of this research is to investigate how public values are affected when public actors that own infrastructure assets implement PSS. Firstly, a literature review concerning public values is conducting. Then, the PSS characteristics, barriers and benefits are theoretically studied. A framework that couples public values with PSS is designed. To analyze and enrich this framework, a real-life implementation is studied. The Province of North Holland (PNH) served as case study, and more specifically the guardrails pilot that PNH realized within the Circular Road Program. Interviews were conducted to collect the data. To analyse the interviews, thematic analysis was utilized. Two rounds of analysis were conducted, a deductive and a reflective round. The findings of the thematic analysis were validated and generalized by an expert panel consisting of three experts. As a result, the empirical findings of the results were found. An overview is designed and the theoretical and empirical results are presented and compared. The values that are mostly affected when PSS is implemented are Lawfulness, Accountability, Collaboration and Innovation. The overview is a useful input for public clients, because they can gain knowledge about how they can include the values perspective in their decision-making process.

Executive summary

Public actors in the Netherlands have a mission; reducing greenhouse gas emissions by 95% by 2050, compared to the emissions of 1990. Circularity is a tool achieve to decrease the emissions and the used-resources, while serving societal needs at the same time. Infrastructure is among the priorities of the governmental bodies when addressing their circular agenda. Transitioning to circular practices is a radical change for the prevailing linear system. As a consequence, organizations should strive for a systemic transition towards circular economy.

Different business models can be utilized in order to achieve this transition. One of those models is Product-Service System (PSS). PSS is considered as an innovation for the infrastructure sector, as its implementation challenges current practices of organizations. Kuitert et al (2018) states that when public actors undergo transitions, their public values are also affected. Consequently, the research question is formulated as follows;

How are public values affected when public actors that own infrastructure assets implement PSS?

An overview of PSS related public values and how they are affected in theory and in practice is offered as a deliverable of this research. Receiver of this overview are public actors that own infrastructure and are interested in how PSS can affect their public values. Additionally, a guideline is offered with suggested actions that they can take in order to foster a smoother PSS implementation.

To obtain a deeper understanding of the concepts of interest (public values and PSS) and to combine them, an extensive literature review is conducted. Papers, documents and online research accomodated the literature research.

Firstly, the public value perspective is studied. Public values define the action taken by public actors, due to public actions affecting many values. A theoritical framing on public values is given, as suggested by Kuitert et al. (2018). This framework consists of the public values of Dutch actors of construction sector.

Then, the concept of PSS was studied. To grasp the concept of PSS, its characteristics, benefits and barriers are identified. Those aspects concern the whole system PSS is implemented in; this research focuses on the perspective of the public actor.

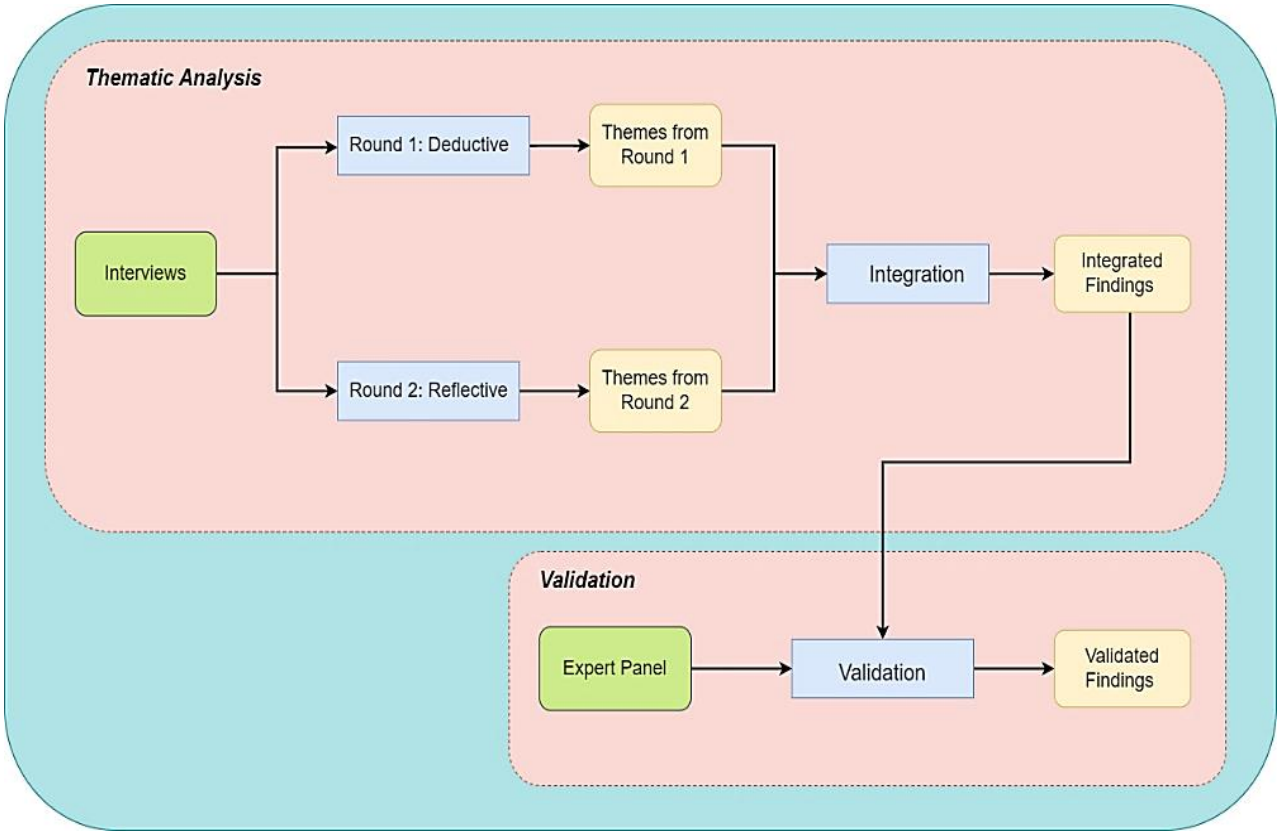
Combining the two concepts, PSS characteristics, benefits and barriers are linked to corresponding public values of the theoritical framework by Kuitert et al. (2018). As a result, a PSS-related public value framework is designed. The PSS-related public values are presented below, as well as their keywords.

PSS-related Public Values	*Keywords*
Procedural Values	
Lawfulness	Defensible, rightfully, legal, legitimate, righteous
Accountability	Responsibility, liability, duty, justification, task, ownership
Collaboration	Cooperation, commonality, partnering, contributing, unity
Transparency	Openness, testable, insightful, controllable, clarity, clearness
Honesty	Accessibility, justice, equitable, equivalence
Wisdom	Uncluttered, understanding, knowledge, insight, information
Performance values	
Effectiveness	Purposiveness, useful effect, contribution
Product values	
Quality	Requirements/specifications/standards, validity, quality of service, value, level, build quality
Innovative	Innovative, development, change, creativity, improvement product/process
Ecological sustainability	Environmentally friendly, natural balance, biodiversity, energy efficiency, durability, sustainable use of raw materials

To analyse the public values a real life implementation of PSS is studied. The Province of North Holland (PNH) served as case study, and more specifically the guardrails pilot that PNH realized within the Circular Road Program. To collect data for the analysis, interviews were conducted. Interviewees were participants of the guardrails pilot from various levels and positions that shared their experience concerning the pilot. The designed PSS-related public value framework served as input to the interviews.

To analyse the interviews, thematic analysis was utilized. Two rounds of analysis were conducted, a deductive and a reflective round. Their results were then integrated, and the outcome of the integration were the initial findings. Those findings are based on the provincial guardrail pilot and need validation and generalisation to other public actors as well. To achieve that, an expert panel was organized. Three innovation

experts from different public organisations reflected on the initial findings, and then the findings were validated. As a result of this process, the empirical findings of the research were found.This process can be shown in the figure below;



After the empirical findings were found, the overview of the PSS related public values can be created. Within the overview, theoretical and empirical findings were presented for each value. The theoretical findings have emerged from literature review and the empirical findings have emerged after the integration of interviews findings and expert panel feedback. For each PSS related public value, those two types of findings created the overview of how it is affected when PSS is implemented.

The overview can be shown below:

Type of value	*Values*	*Coupling PSS based on theory about characteristics/barriers/benefits*	*EMPIRICAL FINDINGS*
Procedural	**Lawfulness**	• A main barrier is the current legislation	• Dealing with public money makes public clients extra careful on how they explain their legal obligations. • PSS, like every innovation, is looked upon with hesitance. • Procurement law sets limits to PSS. Laws and regulations don't fit within the system, because they are made to suit a linear situation. • PSS may be unlawful at the moment, but it is not undesirable by public clients. • PSS should stimulate changing the way the law is written, not its purpose • Legal advisers of public clients are extra careful/hesitant due to construction frauds.

	Accountability	• The party that is responsible for the production stage has control throughout the whole lifecycle • Ownership is transferred to contractor • Beneficial for public clients is that they have no longer responsibilities for any acquisition/use/maintenance/disposal issues of the asset • Main barriers are the bigger risks due to long term perspective, the difficulties in contracting, and that PSS offers an ownerless solution for public clients	• Public clients stay publicly accountable • Public clients believe that they can't have an impact on the asset because of ownership transfer, but they can have an impact through contractual clauses. • Clarity in contracting PSS is important and difficult to achieve. • Requirements can act as a mean to impact who and how is held accountable. Penalty clauses on the contract, transfer responsibility to the contractor to meet certain objectives. • Split of legal and economic ownership, as a mean to clarify responsibilities. • Accountability is irrelevant for the greater cause of achieving circularity
	Collaboration	• The relationship of client and contractor is closer and a sense of fidelity is created • Beneficial is the increased intensity of communication • As a barrier, PSS can create internal conflict as it is a concept difficult to understand and the mindset of the client is not aligned to its principles	• Different perspectives of people inside the pilot vs outside. Inside it was good because they were already partners. Outside there was mistrust towards the contractor because of contractor's intentions and goals. Mistrust is a consequence of traditional roles and responsibilities of involved parties. • If collaboration is successful, a joint team is created and therefore the party that initiates the project is irrelevant. • Innovative projects are "like going on an adventure together with a sketch, not a full map". • Partners should be honest to their relationship. • Common achievement of different organizational goals. True collaboration means that they respect different organizational causes

	Transparency	• The ownership is transfered • Barrier is the fear of sharing sensitive information and the difficulties in contracting	• Due to procurement law everything needs to be transparent about setting requirements and calculating residual value. • Public clients should find a way to measure the value of the asset at the end of the contracting period.
	Honesty	• Barrier is the fear of sharing info	• To make PSS work, a great level of trust between the partners is required. • Instead of collaborating with trustworthy partners, enhance trust among partners. • Trust is established at the beginning but maintaining it is a continuous point of attention throughout the process. • Open data sharing is a prerequisite of trust. Data sharing is required for decision-making but should also be safeguarded. • Partners need to align their mindsets in order to align and maintain trust.
	Wisdom	• Public clients should have a deeper understanding of how PSS works in order to clearly express functional requirements • Beneficial is that PSS leads to technological advancement and knowledge is obtained • Barrier is the lack of PSS experience and knowledge about life cycle costs of the asset	• PSS is a way to obtain knowledge. PSS is a spinoff, to initiate discussion towards circularity. PSS implementation doesn't necessary result in obtaining new wisdom. Action should be taken before initiating the contract to gather the required data. • Acknowledgment of lack of knowledge is compensated by confidence of finding the right solution. • Combination of same data in a different way can lead to wisdom.

			• PSS can stimulate public clients to obtain information about the status of the assets that didn't have so far.
Performance	**Effectiveness**	• PSS is an incentive for economical/environmental solution • Beneficial is the increased availability due to durable materials that need less maintenance	• PSS implies long-term contracts that fits the long-term purposiveness of the public clients on a social level. • Public clients have inherently effectiveness as a value. On the contrary, contractors can potentially be motivated to increase their social effectiveness, although it's not part of their role. Effectiveness can be motivated/artifacted through contract clauses (rewards). • PSS contributes to circularity as a system
Product	**Quality**	• Increased value product is offered • Beneficial is that public client receives customized/top quality service and the asset retains its value	• PSS suggests a different way of defining quality (through functional requirements). Functional requirements leave room for innovation to thrive for. • Guardrails have strict technical requirements.
	Innovation	• transformation of culture, mindset towards value-led • Beneficial is that PSS boosts technological advance and innovation • Barrier is that public clients are skeptical about innovative ideas and over detailed front-end specifications leave no room for innovation	• All innovative aspects (contract, financial, etc.) need the right attention and treatment, for a successful PSS implementation. Whole system approach is needed. • Those aspects were not apparent in the pilot, although it was a big social innovation. Mainly technical innovation in the pilot.
	Ecological sustainability	• Beneficial is the decrease of raw material and that environmental impact of the asset is	• PSS implementation can lead to sustainable results. PSS stimulates circular solutions which relates to social effectiveness. • Public clients should have sustainability as an initial goal and

		reduced if the whole life cycle of the asset is taken into account	focus on sustainable aspect of PSS, in order to achieve sustainability results.

In the discussion section, the main results of interest are pointed out and discussed. For each value of the suggested PSS related framework of Chapter 2.4 the theoretical and empirical findings are compared.

The values of Lawfulness, Transparency and Honesty are challenged when PSS is implemented. Those are procedural values. As literature suggests, focus is shifted from procedural values to product values when new types of contracts like PSS are implemented, and that is why procedural values are challenged. Public clients should follow the law but current legislation is not suitable for PSS. Generally, public clients ought to be transparent. When implementing PSS, it is important to be transparent especially when setting requirements and calculating residual value. Even though honesty is a significant value for public clients, they are quite hesitant in sharing information. The latter is important for a successful PSS implementation. The findings about Accountability suggest that public clients are still held publicly accountable. Even though they are ownerless, but they can have an impact on the asset via contractual clauses. The Collaboration is perceived differently when PSS is implemented. A joint team should be created, based on honest communication. In practice, collaboration is perceived differently inside the pilot and outside. People that are not actively participating in the pilot may show mistrust towards the partner.

Obtaining knowledge is one of the reasons why the guardrail pilot was realized. PSS is a way to obtain knowledge but it does not automatically lead in obtaining it. Acknowledging the lack of knowledge is compensated by the confidence of finding the right, circular solution. One value that is linked with obtaining new knowledge is Innovation. In theory and practice the need of a systemic approach is highlighted. Findings concerning Ecological Sustainability suggest that PSS can stimulate circular solutions and lead to sustainable results, but public clients should have sustainability as their goal and focus on the sustainable aspect of PSS. Lastly, implementing PSS affects the way that public clients express their demands. Instead of technical requirements, public clients should form clear functional requirements.

Additionally, three new themes are pointed out (Goal, Asset type, Human factor). Those themes are not public values but are findings that interviewees and expert panel though they were worth mentioning.

Moreover, conflicts of values are found. Lawfulness and Collaboration are conflicting values, as well as Transparency and Honesty are conflicting Collaboration. That can be explained because PSS suggests a closer collaboration of contractor and public

client, that could be conflicting with the transparency and honesty of the public client and causes issues because of the Procurement Law.

Then, practical implications for the public client are provided, based on the empirical findings. The overview can help public clients gain knowledge concerning how implementing PSS can affect them. Having this overview, public clients can include the values perspective in their decision-making process. Another implication is that the overview can lead to results about how PSS can be fostered through contracting. Lastly, public clients obtain information about what conflicts and tradeoff concerning their values may arise. That enables them to focus their attention on those conflicts and either accept those or take actions to solve them, in order to sustain a balance of their values.

In the conclusions chapter, the sub-questions and the main question of the research are answered. The public values that are mainly affected when PSS is implemented are reviewed. Those values are Lawfulness, Accountability, Collaboration and Innovation. One of the main barriers for PSS implementation is current legislation. That affects Lawfulness, as public clients should obey the law but the law is not fitting PSS at the moment. Moreover, public clients are still held publicly accountable and they can have control on the asset through contractual clauses. Of course, if we consider that the great cause of implementing PSS is achieving circularity, it is not important who is held accountable at the end. As far as Collaboration is concerned, partners collaborate closer when PSS is implemented, but conflicts may arise because of the difficulty of understanding how PSS works. From the aspect of Innovation, it is highlighted that a systemic approach is needed, as Innovation has multiple aspects within a PSS project

Limitations for the research are also presented, concerning both the process of data gathering and the generalization of findings. The number of interviews may be considered a limitation for the research. Moreover, the subjectivity of the interviewees as they expressed their own interpretation of what happened during the pilot and the language barrier may have also hindered the study. Other limitations refer to the generalization of the findings. Since the pilot was completed in a few months, the full contracting period was not considered. In addition, the study utilizes a PSS related public value framework, and not the value framework as presented in literature.

Subsequently, recommendations for further research are given. Those recommendations have arisen from documents, the interviews and the expert panel. The first recommendation is to study different type of assets, preferably assets where it is easier to measure their service and performance. During the interviews, people

made a comparison between the Netherlands and other European countries that have implemented PSS. For that reason, another recommendation of this research is to conduct a comparison case study to investigate the similarities and differences observed in projects of different countries.

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1. Introduction

1.1 Infrastructure sector in transition

As a frontrunner in mitigating climate change, the **Netherlands** has a mission to fulfil its promises to the rest of the world. More specifically, Netherlands aims at reducing greenhouse gas emissions by 95% by 2050, compared to the emissions of 1990 according to Climate Plan of 2019. At the same time, the country aims to maintain and even boost its strong economy. This defines a ***dual ambition* for the country**; achieving economic and environmental prosperity and, more particular, developing a strategy that combines both of the aforementioned ambitions at the same time (Rijkswaterstaat, 2019).

A concept that eliminates waste and enables progress with respect to the environment is **Circular Economy** (referred hereafter as CE). As per report CGR 2021, circularity is a tool to decrease emissions and used-resources, while simultaneously serving societal needs. By following the principles of CE, the humanity can fit within "the doughnut", ie achieve a safe space to thrive with neither breaching critical natural thresholds nor putting its own survival at risk.

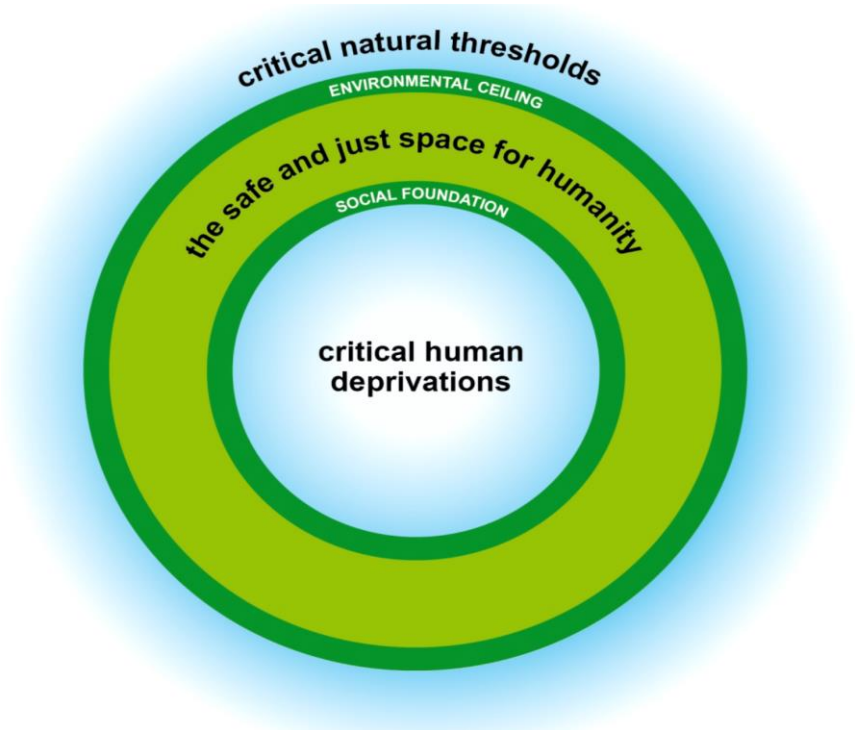

Figure 1-A safe and just space for humanity (Source:Oxfam)

Many scholars have tried to define what circular economy is. Van Buren et al. (2016) suggested that CE "*aims for the creation of economic value, the creation of social value, as well as value creation in terms of the environment".* This constitutes the clearest description of what CE stands for, while including the multidimensional aim of the term.

Efforts towards circular economy should focus on the construction industry (Mangialardo & Micelli, 2018). According to The Transition Agenda (De circulaire bouweconomie, 2018), 35% of the CO2-emissions of the Netherlands is due to construction and demolition waste, while the sector also consumes a huge amount of raw material (28.9 million tonnes). Therefore, infrastructure is among the highest priorities of the governmental bodies when addressing their circular agenda. Another challenge that needs to be addressed is that the country is in the midst of an enormous maintenance operation (Rijkswaterstaat,2019). 40 infrastructure projects will be renovated or replaced soon, as they have reached their expected lifespan. Major public clients should act and investigate innovative future solutions, utilizing their enormous purchasing power.

Several authors suggest that, in order to achieve the transition towards Circular Economy, different business models can be of use (Ellen MacArthur Foundation, 2013). Dutch national ambitions illustrate this in practice, allowing space and boosting innovation for different business models. Current structures are redefined, as the existing systems are deemed obsolete. A broader system approach is required, focusing on the context of CE broader implementation, and not only at the desired solution.

1.2 The need for systemic perspective

According to the updated Circular Economy Implementation Programme 2021-2023 report of the Netherlands, one of the three themes that organizations should focus on is the *systemic transition* from linear towards circular economy (Rijkswaterstaat,2021). That can be explained because circular economy is fundamentally different than linear economy, and therefore requires a different system, with new business models, legislation, and financing among others (Rijkswaterstaat,2021). Strategies that aim in addressing climate change are long-term. The adaptation of the involved parties to the requirements is inevitable, as they are now asked to adopt a new, long-term circular philosophy. This is a top-down approach and needs to be initiated at the organizations' strategic managerial level.

1.2.1 Thinking of a system perspective for PSS

One of the business models that are highlighted and put to the test is Product Service System (PSS). PSS is a concept that can foster the aforementioned transition towards circularity. That is due to the rationale that PSS can be beneficial due to its potential of decreasing material and energy consumption (Adams et al., 2017). Ceschin (2013) reinforces this notion supporting that PSS can decouple economic value from material consumption.

PSS is a complex concept. To address its complexity, there is a need for a systematic approach (Lindström et al., 2015).[1]. In order to embrace PSS, organizations need to radically redesign not only their technologies and operations, but also their strategies, expertise and system integration capabilities (Vladimirova et al., 2011).

Ceschin (2013) suggests that PSS is innovative. More specifically, it is a radical innovation, since it challenges the habits of the organizations involved in its implementation. PSS refers to a new form of collaboration of actors involved in the infrastructure sector. In PSS the contractor is the economic owner of an infrastructure object for the contractual period. The report Handreiking Circulaire weg as a service (2022) suggests that the client pays the contractor for the availability of the object as a service.

Studies have shown that, as an innovative idea for the construction world (mainly due to ownership transfer), PSS can be used in order for an organization to meet its circular objectives (Ceschin, 2013). As a model that can potentially serve circularity, PSS should also take the whole asset lifecycle into account. In order to do so, PSS needs to be organized at a systemic level (Sundin et al., 2009). That means that the product itself, services, stakeholders and the context are also relevant.

The systemic transition refers to a shift in the culture of involved organizations. The philosophy of a public client refers to the principles that the public client should protect and could be represented by its public values. One aspect of the systemic change reflects on how the values of the organization can be recalibrated when the innovative model of PSS is implemented (Kuitert et al., 2018)

Public actors that own infrastructure in the Netherlands are currently rethinking their philosophy in light of the CE transition. Several authorities participate in pilots investigating how they can accelerate transition and what underlying changes this brings forward. These authorities include but are not limited to national and regional

[1] In the present research, the term of PSS is preferred over the term PaaS (Product-as-a-System), as it is linked directly to a systemic way of thinking and reflects in a more comprehensive way the transition into this circular business model.

government, engineering companies, academic partners and more. An example that deserves attention is the Province of North Holland. PNH is always looking for the most efficient method to create and maintain its acreage, and for that reason it is also interested in investigating the implementation of PSS.

They are assessing how PSS can facilitate their transition towards their energy-neutral mission and under what conditions. Their main ambition is to facilitate the transition towards a circular infrastructure sector (Schraven et al., 2022). The province is also interested in how to scale up PSS to other infrastructure maintenance areas such as road, bridge and waterway maintenance, and how that scaling up might affect their modus operandi.

In practice, authorities have very limited knowledge on how they can utilize PSS. Even though public clients are interested in the PSS concept, they are not willing to implement it widely without gaining more knowledge and experience about it. Based on discussions with people that investigate if and how PSS can be a useful tool for the infrastructure sector, it is clear that involved parties want to learn more before they start including PSS in their strategic decision making. Members of PNH have already experienced a successful implementation of PSS in Lighting-as-a-Service (LaaS) and they want to investigate more about how it can fit in their agenda. They are also interested in investigating the barriers and the enablers of PSS before implementing it widely. In a similar way that companies and organizations often implement pilot projects and field tests to gain information and experience about the usability of the innovative option, PNH was motivated to test PSS in a real-life experiment. The pilot represents a critical test of existing theory under unique circumstances. Several partners teamed up and seven pilots took place, each under different conditions.

The pilot is one of the first experiments to be organized and admittedly the most well-orchestrated and up-to-date one. Having real life data is important, and the research will be based on practical data. However, conclusive information cannot be obtained for a complex subject such as PSS based on a development of a singular pilot project. For that reason, further research is also needed.

PSS may be a promising idea for achieving circular objectives, but it is not widely implemented yet. That can be explained because the implementation of PSS is hindered by certain challenges, mainly the uncertainty originating from the lack of pre-existing knowledge and experience concerning PSS. This uncertainty concerns not only contractual, legal and financial aspects, but also lack of clarity towards the end users and the environment, and also the residual value of materials at the end of the contractual period.

From these practical efforts, as exemplified through the Province of North Holland, it appears that a particular challenge related to the expected impact that a fully functional PSS approach will impose in the organization.

Even though extensive research has been conducted in the business world about PSS, the implementation of that idea in infrastructure is still quite vague. There is not a clear view of how the idea of PSS could be applied in the construction industry, and the case of the Netherlands is not an exemption. This shift towards service-oriented approach is not yet systematically investigated thoroughly in literature for the infrastructure sector, despite the fact that PSS in infrastructure is a promising concept for achieving circular objectives.

For that reason, attention is brought in the transition of public clients towards PSS. However, limited literature is available referring to the way that PSS is applied when procuring an infrastructure asset.

When public clients undergo transitions, their public values are also affected (Kuitert et al., 2018). That is because public values are linked to public actions and the context that public actors behave in. In order for PSS to be adopted, companies should strategically try to influence the context (Ceschin, 2013). To tackle this issue, it is the proposition of this research that a public values perspective could better elucidate the context within PSS can operate in. That will enable public clients to better understand the conditions that should be present for PSS to be implemented, and facilitate their decision making about whether they can provide these conditions or not.

Following from this, problem statement relates to the uncertainty regarding **how the values of a public actor that owns infrastructure are affected when implementing PSS.** To be more specific, little is known about how PSS implementation is interconnected with the values of the public clients. There is uncertainty of how PSS affects the existing public value equilibrium.

1.3 Research Objective

It is presumed that when public actors that own infrastructure implement PSS in an infrastructure project, their value regime is affected. Objective of this research is to investigate what are the values that are affected when public actors that own infrastructure implement PSS.

PSS is an interesting model for the infrastructure world, but the question regarding its interaction with the value regime of public actors that own infrastructure is yet to be answered. Specifically, this research aims at investigating how public values are interconnected with PSS characteristics, benefits and barriers and how implementation

of PSS could be performed within the framework of the public values. Theoretical and empirical findings are compared.

1.4 Research Question and Sub-questions

Based on the objective, the main research question (RQ) is formulated as follows;

How are public values affected when public actors that own infrastructure assets implement PSS?

In order to answer it, the main question is divided to research sub-questions (RSQ). They have the following structure; one explorative sub-question (1), then a methodological sub-question (2), then a results-oriented sub-question (3) and finally an implications sub-question (4). The sub-questions should cover the entire research scope. Answering them will lead to the answer of the main research question.

1. How is the PSS model for infrastructure framed from a public values perspective?

   Literature review
2. How to analyze a real-life implementation to study what values are critical to public clients to decide whether they want implementation of PSS or not?

   Methodology used
3. What does the pilot of guardrails as part of the Circular Road provide as learnings for the coupling of PSS with public values, in comparison to usual practice?

   Interviews/documentation
4. How are findings validated and generalized for other public clients?

   Expert panel

The Province of North Holland (PNH) is selected as a case study, and more specifically the guardrail pilot of the Province within the Circular Road Program. The Province recently completed the first pilot where PSS was implemented, and time has come to assess it.

As a deliverable of this research, a PSS-related public value overview is provided. This is an overview of the values that are linked with the implementation of PSS, and how these values are affected when PSS is implemented. Theoretical and empirical findings are compared.

Receiver of this guideline are public clients that are interested in implementing PSS to achieve their circular objectives. The public clients will receive an overview on what the implementation of PSS (both the benefits and the barriers) means for the values

that they represent and want to secure. The overview illustrates the values of a public client that are affected when PSS is implemented and how they are affected.

Purpose of the overview is to give insight on the effect of implementing PSS on public values, both within the public client itself but also in collaboration with the contractor. Having this overview available, public actors that own infrastructure will better understand what happens to their public values when they foster PSS, whether they are perceived differently and whether conflicting values exist within the framework. Public clients will gain a better understanding on what implementing PSS means for the values they want to secure. That facilitates their decision-making process concerning whether they are able and willing to implement PSS and under what conditions.

Lastly, in the implications section public clients are provided with actions they can perform based on the findings of the analysis. These are suggestions for public clients to adapt to real life for a smoother implementation of PSS as far as their public values are concerned.

For whom specifically?

Every member of public clients aims to secure the public values of the organization they belong in. For that reason, this overview can be relevant for all the members of the public clients. Since this overview leads to the deeper understanding of what happens when PSS is implemented, it can be useful for people responsible to decide whether or not PSS will be implemented and under what conditions. For that reason, this overview is more relevant to people that work on the strategic level of public clients and are responsible about the procurement strategy of infrastructure asset. Those actors may include procurers, strategists, and decision-makers, as well as asset managers.

1.5 Research methods

Bryman in the book Social Research Methods (2012) provided the theoretical framework concerning research methods. As he suggests, it is crucial to make decisions about the research upon the type of research, research strategy regarding a qualitative or quantitative analysis, the research method regarding the technique of data collection, the research design or the framework of data collection and analysis and the research approach concerning the in-depth analysis of a single case. On the context of this study, the research method is presented schematically below.

Type of research; exploratory

Research strategy; distinction between qualitative and quantitative. In our case, the research strategy will be qualitative.

Research method; is the technique of collecting data. In this research, the data will be collected by conducting literature review, interviews and an expert panel for validation of the findings.

Research design; provides a framework for the collection and analysis of data. The choice of the research design should suit the context of the study. The research design that this thesis will follow is the case study design.

Approach of the study; This suggests the in-depth analysis of a single case. Since the research strategy is qualitative, the **approach** of the study is inductive.

Hence, based on observations of a specific scenario, generalized conclusions will be drawn.

Framework Component	***Decision***
Type of research	Exploratory
Research strategy	Qualitative
Research method	Literature review, interviews, expert panel
Research design	Case study
Research approach	Inductive

Table 1-Summary of research decisions

Sub-question 1;

How is the PSS model for infrastructures framed from a public values perspective?

Literature review

Firstly, this research will focus on exploring the current body of knowledge that motivates the present research. **Literature review** will provide the theoretical framework of this research and serve to explain why the research question is of

scientific value. Aim of the first step of the research is to theoretically define the terms that will be later used and investigate how they are interlinked.

Public values

Initially, this research will explore how public clients express their principles through their value regime. Public values are affected because of the societal transition caused by climate change and the urgent need to take measures against it. For that reason, innovative ideas (such as PSS) are embraced by public clients, even though their strict value structure can be challenged by that.

PSS

Then, the research will explore how PSS is implemented in infrastructure sector. PSS characteristics will be given to identify how PSS is different from current practices. The benefits of implementing PSS in construction projects will be theoretically identified, concerning not only the contractor and the client, but also the society and the environment. Lastly, the barriers of PSS implementation will also be studied, to obtain a holistic view on how PSS can benefit but also hinder an infrastructure project. Summarizing, a deeper understanding of PSS in infrastructure sector will be achieved. Those two concepts are combined in order to investigate how the implementation of PSS can affect public values. A PSS-related public value framework is designed.

Sub-question 2;

How to analyze a real-life implementation to study what values are critical to public actors that own infrastructure to decide whether they want implementation of PSS or not?

Methodology used

The second sub-question refers on how to deal with the main question in order for it to be answered. This is the methodological sub-question that provides the methodology for the case study (Province of North Holland) that will be used in this thesis. Chapter 3 (Methodology) deals with the answer of this sub-question. Moreover, the analysis method is described. To answer this sub-question, a methodological framework is provided.

Sub-question 3;

What does the pilot of guardrails as part of the Circular Road provide as learnings for the coupling of PSS with public values, in comparison to usual practice?

Interviews/Documentation

In the third sub-question, the case of Province of North Holland will be studied, along with the lessons learnt concerning the pilot of the Province within the program of the Circular Road (CR). Interviews are conducted with people involved in the pilot, to share their experience of this PSS experiment. Furthermore, based on the suggested PSS-related public value framework, the interviewees discuss which public values are connected to PSS and how, and additionally, they point out other topics of importance.

Sub-question4;

How are findings validated and generalized for other public clients?

Expert panel

To validate the analysis findings but also offer a generalized perspective to them, an expert panel is organized. Experts from various public clients reflect on the findings based on their knowledge and experience. Findings from the analysis serve as input on the expert panel and they are either confirmed or adjusted where required. In this way, the findings are validated and generalized for other public clients. Empirical findings are found.

1.6 Research scope

For the conduction of the present research, boundaries need to be set. This enables the thesis to be feasible and within the predefined timeframe. It is decided that the study will refer to the strategic level of public clients. Ceschin (2013) indicates that an organization's values and identity can be clearly and conceivably sketched by strategic design for sustainability. This suggests that the design that takes place in the strategic level influences the sustainability strategies of the organization, while assimilating its core values and principles. For that reason, and since the decision of PSS implementation is at the strategic level for the Province, this research is performed from a strategic point of view. Additionally, the case study regards the pilot of the PNH in the CR program, as it is the most relevant and recent experiment that can contribute to achieving the objective of this research.

1.7 Scientific and industrial relevance

This research will allow decision makers (on a theoretical but also a practical level) to gain more knowledge about what the service-oriented principles are and how they could be implemented on the infrastructure sector.

The developed overview can contribute to the decision-making of public bodies in their transition towards implementing circular strategies. Public clients strengthen their position against uncertainties that the implementation of PSS implies. They obtain

knowledge that facilitates their decision-making on the strategic level regarding PSS. It prepares and reinforces the public clients towards answering the following question: Is PSS the appropriate/fitting tool for them to procure infrastructure assets?

An important feature is that the overview is based on real-conditions input, based on the public clients' point of view. It provides an insight on the implementation of PSS in real life circumstances. Within the overview, a comparison of theory and practice is realized. Public clients gain a better understanding of the public values that are affected when they implement PSS and how they are affected.

Additionally, it enriches the scientific knowledge as well as the experience of public clients upon PSS related issues. This will enable the organizations to obtain a clearer picture of how PSS fits in their portfolio, and highlight the key elements where internal intervention is needed.

1.8 Research Outline

In the following figure the outline of the research is displayed. This illustrates the corresponding context for each chapter, how the chapters are linked to each sub-question, along with the methods that are used to answer it.

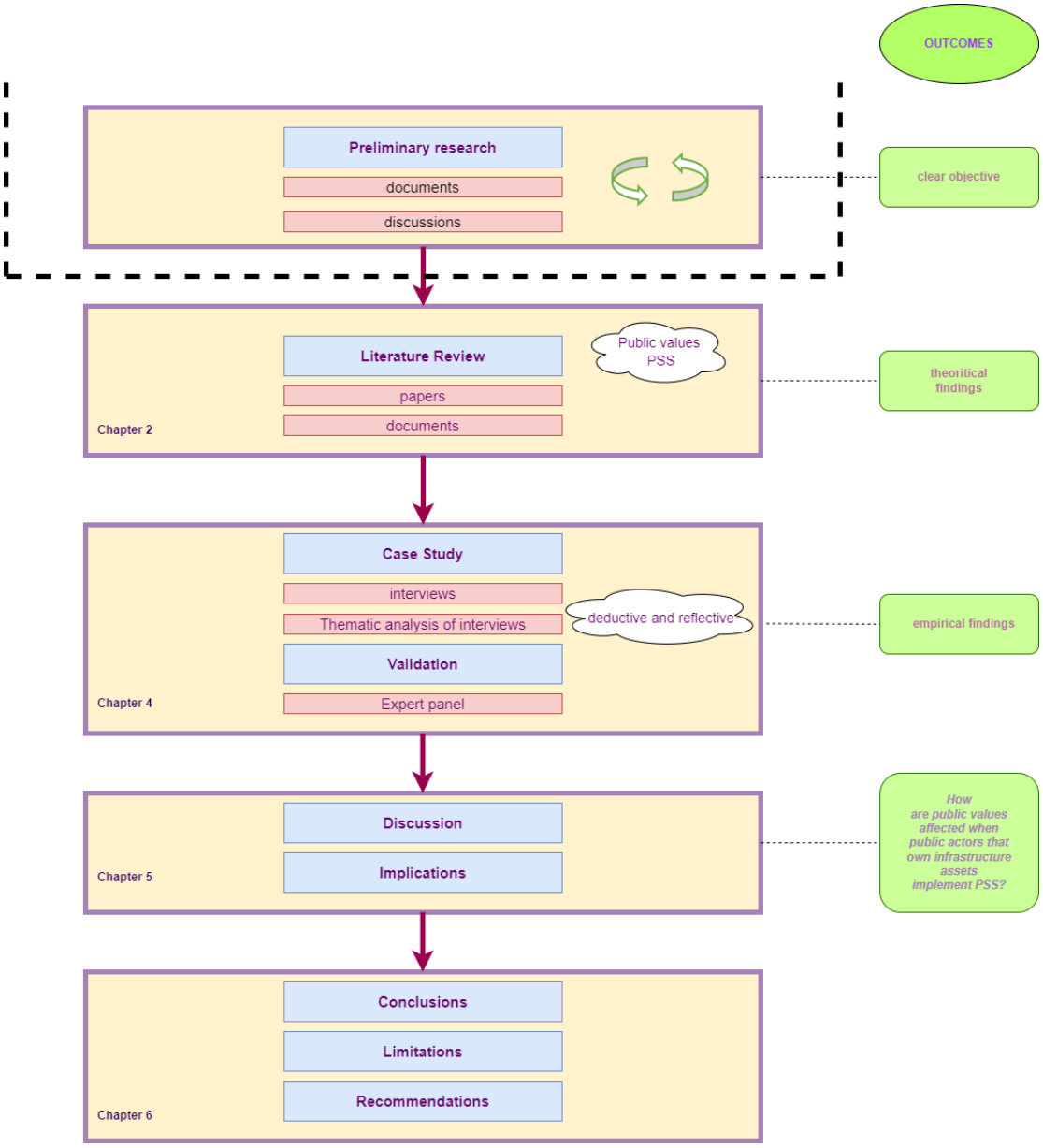

Figure 2-Research Outline

2. Literature Review

2.1 Reviewing existing literature about main concepts

To build a solid theoretical background and answer the first sub-question, the existing body of knowledge on the topic needs to be gathered. Therefore, a literature review is conducted. According to Bryman (2012), there are two forms of literature review, narrative review and systemic review. The majority of the literature reviews, including the present one, follow the guidelines of the narrative review. A narrative review is the critical reading of the literature and comprehensive assessment that leads to an overview of the field of interest. Its purpose is to identify studies that describe a topic, to allow researchers to learn about the topic and understand it better.

In this research, initially the scope is wide, having Circular Economy as the starting point. Goal is to obtain further knowledge upon Circular economy and how it can be achieved in the Netherlands. This led to focusing on PSS, as a promising business model that can help actors achieve circular objectives. Books and articles concerning circular economy and PSS were found, in order to obtain a holistic view. Additionally, an online search was conducted in scientific databases (Google scholar, ScienceDirect and Research Gate). Various keywords were used (Circular Economy, Infrastructure, PSS, PaaS, public values). Relevant papers were found and then the titles and abstracts were studied. If found relevant, the papers were studied in more detail and notes were kept. Additionally, papers were recommended by others of the field. When relevant, they were also studied in detail and the most interesting parts were noted down.

In this thesis, PSS and the values of public actors that procure infrastructure are the two main pillars of interest. Firstly, the scene is set and the role of public values is investigated. The perspective of public values is provided, and the public value theoretical framing is displayed. Subsequently, the model of PSS is studied. to gain a better understanding on PSS, its characteristics, benefits and barriers are studied. Lastly, the two topics of interest (public values and PSS) are combined. Each of the PSS characteristics, benefits and barriers is linked to public values.

2.2 Public values

2.2.1 Public clients secure public values

According to De Bruijn & Dicke (2006), ‘*’Public values are a reflection of what society believes; are important values in the production of certain products or services and whose provision is the responsibility of the government*’’. **Public values are those aspects that public entities, governments, have accepted as important enough to be secured**. The initial goal of public clients is to secure their public values, while respecting and accepting additional values that other stakeholders may introduce (Kuitert et al., 2018).

Societies undergo many transitions, like the transition that is needed in order to fight climate change. These transitions have a notable impact on the construction industry. The transitions of recent years create a need for public clients to adopt a wider view on how public values are perceived. A better understanding is required about how public values are affected when public bodies deliver public services in a non-conventual, not business-as-usual way. The new ways of delivering public services create the recalibration of public values and how they can be interpreted by public clients. Among new ways of delivering public services is the business model of PSS.

2.2.2 New types of contracting affect public value delivery

Public bodies change the way they deliver public service. Therefore, new types of contracting emerge, like integrated contracts. Those contracts suggest that the collaboration between public and private bodies changes. The collaboration of the involved parties becomes closer and the responsibility for creating public values is shared between the private and the public actors, instead of being only on the side of the public body. Private actors undertake the responsibility to accomplish public goals, while public clients are now responsible to govern tasks instead of creating them (Kuitert et al., 2018).

The aforementioned elements of integrated contracts can also be found in PSS contracts. PSS as a business model requires a closer collaboration between client and contractor, and a relationship built on trust and honesty. Moreover, the responsibility of creating value is heavily on the contractor’s side, because of the ownership transfer. Those characteristics of PSS contracts are similar to those of integrated contracts. Even though the connection of integrated contracts with public values is already investigated, the connection of PSS with public values is still not known.

Public values have been characterized as an addition to how public clients can modernize their management. However, it is not clear if -and how- the values can affect public programs and services, because our understanding of public values has not progressed greatly in the past (Davis, 2008). Public values can define the action taken by public actors because public action encloses and affects many categories of values (Davis, 2008).

Another role of public values is that they can support public clients' decision to change their governance themes (*regovernmentalization*) (Dunleavy et al., 2006). According to Kujala et al., (2020), the challenges of complex infrastructure projects concern mainly the way that the work is governed within a complex environment, and not the technical challenges. Aligning various perspectives of multiple actors with different values, knowledge, culture etc. is more challenging than just facing the technical aspect of a project. Multiple perspectives should be aligned in order to achieve a shared understanding of project goals and, ultimately, achieve those goals. Learning how public values are affected when PSS is implemented is important for public clients, in order to face the challenges of complex infrastructure projects that arise.

In order for PSS to be adopted and diffused, companies should strategically try to influence context (Ceschin, 2013). As underlined by Wong (2004), the diffusion of a PSS in the market is strongly connected to the culture in which it will operate; As a matter of fact, the Netherlands is among the greatest implementors of the PSS across the globe (Wong, 2004).

In this, public clients have a complex role to play. As representatives of people, they have ethical rules and societal norms, whereas as institutions they have organizational structures, they obey legislations and they follow long established patterns/culture behaviors. As part of their responsibilities in their commissioning role, public clients have to ensure public values (Kuitert et al, 2018). At the same time, public clients are guided by their own values towards achieving their goals, as they need to be profitable by making feasible business cases and also respect taxpayers' money. As a consequence, the context they usually operate in tends to be stiff.

In the Netherlands, public construction clients are comprised of the government, the provinces, the municipalities and the water authorities. Provincial authorities are responsible for linking the central government with the municipalities. In their agenda includes, among others, the regional economic policy and spatial planning in rural areas. Public clients act both as PSS promoters (through procurement requirements) and users of the services (Ceschin, 2014).

2.2.3 Types of public values and conflicts

De Graaf & Paanakker (2014) distinct the public values in two different types; procedural and performance type. Procedural values concern the quality of the process and which standards of government action should be met. In other words, they describe how the public clients should act. Performance values relate to not wasting tax-payers money and providing good services to the citizens. De Bruijn & Dicke (2006), enriched the distinction by adding a third category; substantive product-related values that can be specified for each sector. Kuitert et al., (2018) utilized those papers and integrated the aforementioned two approaches. A public value framework is created that consists of those three categories; procedural, performance and product related values.

To begin with, public clients' performance should meet certain standards. Those standards are represented by **procedural** values. In other words, procedural values govern how public clients should act. Some of the main procedural values are transparency and safety.

Public clients are representatives of the people interests. That can be expressed by **performance** values. Those values are effectiveness and efficiency. Those values ensure that public clients use the public funds properly.

Lastly, public clients are responsible for ensuring that public works are of quality. The products of the public actions need to meet certain requirements. The values that mirror that responsibility are called **product-related** values. Certain of those values are quality, beauty, functionality.

Recently, a shift of public values is observed, especially when main goal is to develop a long-term relationship between client and contractor. From procedural values that were dominant for the previous years, to product oriented (or performance) values. Focus is drawn upon product values of innovation, sustainability and quality of services, instead of procedural values related to lawfulness (Kuitert et al., 2018).

Theis can potentially lead to conflicts and tradeoffs of values (Kuitert et al., 2018). More specifically, the aforementioned paper presents six value conflicts that were observed and they were divided in two categories; Dilemmas in balancing different types of values and dilemmas in being a public construction client.

Conflicts concerning balancing different types of values:

1. Lawfulness vs collaboration
2. Renewal vs publicness
3. Soft vs hard values

Conflicts concerning being a public construction client

1. Responsibility vs equality
2. Transparency vs collaboration
3. Continuity vs incidents

The theoretical framework proposed by Kuitert et al. can be shown in the figure below;

Values	Keywords
Procedural Values	
Lawfulness	Defensible, rightfully, legal, legitimate, righteous
Accountability	Responsibility, liability, duty, justification, task, ownership
Collaboration	Cooperation, commonality, partnering, contributing, unity
Participation	Involvement, engagement, consultation, partaking, contacts with citizens
Transparency	Openness, testable, insightful, controllable, clarity, clearness
Integrity	Correct, carefully, incorruptible, discreet, respectable, rectitude, uphold norms and values
Safety	Social control, protected, (sense of) security, no risk, assurance, protective measures
Equality	Impartial, equivalent, non-discrimination, balanced, proportionally
Honesty	Accessibility, justice, equitable, equivalence
Collegiality	Loyalty, coherence, solidarity, harmoniousness, faith, helpful, fraternally
Wisdom	Uncluttered, understanding, knowledge, insight, information
Health	Vitality, mobility, welfare, social contacts, comfort, healthy living environment
Performance values	
Efficiency	Results-driven, expedient, time/money - result
Effectiveness	Purposiveness, useful effect, contribution
Product values	
Quality	Requirements/specifications/standards, validity, quality of service, value, level, build quality
Functionality	Usability, efficacy, practicability, applicability, practical, utility
Innovative	Innovative, development, change, creativity, improvement product/process

Ecological sustainability	Environmentally friendly, natural balance, biodiversity, energy efficiency, durability, sustainable use of raw materials
Economical sustainability	Competition, progress, employment opportunities, continuity, mobility, affordability
Socio-economical sustainability	Consistency, cultural heritage, room for diversity, authenticity
Context	Stakeholders, situation, circumstances, perspectives, relationships, configuration, surroundings, atmosphere
Character	Appearance, signature, symbolizing, distinctive, characteristic
Beauty	Exterior, splendor, fine, aesthetics, attractive
Integrality	Complete, total, full, mixed-use

Table 2-Theoretical Framework/Keyworks by Kuitert et al. (2018).

2.3 Product-service systems (PSS)

The willingness to deviate from a linear model that no longer satisfies social and financial needs is already present. Policy makers, as well as companies, are now trying to examine deeper the concept of Circular Economy (Geissdoerfer et al., 2017).

Alhola et al. (2019) suggests that the use of new business concepts can promote CE. Product-service systems is one of these concepts. Numerous researchers suggested that PSS is one of the concepts that can facilitate the transition towards circular economy (van Ostaeyen et.al. 2013, Tukker, 2015). What motivated them is to find a way to unlink consumption of products and materials from the satisfaction of getting the corresponding service. Additionally, PSS aims at finding the requested sustainable balance that satisfies environmental, economic and social needs (Maxwell et al., 2006).

By definition, Product-service systems (PSS) is '*a mix of tangible products and intangible services designed and combined so that they are jointly capable of fulfilling final customer needs'* This model suggests that focus should be drawn upon the satisfaction of the clients' needs, instead of the product that is being developed. Ultimately, aim of the system is to create added value with less material used (Tukker & Tischner, 2006). Firms develop business models that aim to provide services to the consumers, instead of offering products (van Ostaeyen et al., 2013). In a slightly different approach, van Buren et al. (2013) suggest that PSS is a combination of two concepts; 'servitization' and 'productization'. That means that PSS offers both the product and the service at the same time.

2.3.1 PSS needs systemic changes

Circularity is linked with PSS. Even though PSS cannot guarantee the achievement of environmental results, it surely has the potential to contribute to it (Ceschin, 2014). UNEP (2002) and the report of TU Delft concerning the Circular Road suggest that although PSS is a promising model concerning circularity, it can complete circular goals only after focusing on circularity from already the design and development phases. In other words, PSS should be designed in a way that it fits-the-purpose of circularity.

Even though PSS is an attractive concept for companies and organizations, the fundamental redefinition of current structures that this concept entails is a major deterrent for its implementation. Adopting PSS principles influences radically the organization's strategies, risks, network and modus operandi in general. To tackle these hesitations, a systematic approach can be applied to assist the organizations into implementing PSS (van Ostaeyen et.al, 2011).

In order to achieve innovation within the PSS framework, the parties that are involved in the implementation of PSS have to reconsider their collaboration, their roles, their skills and their responsibilities in comparison with the other parties involved (Wallin et.al, 2011).

2.3.2 PSS characteristics

To gain a better understanding of what PSS is, several PSS characteristics will be examined. To begin with, PSS has a life-cycle perspective. Being a combination of products and services, this life-cycle approach enables the optimization of the aforementioned combination. As a result, the party that is responsible for the production stage has control throughout the whole lifecycle. Additionally, PSS provides the opportunity to create solutions of increased value by integrating components in new ways and considering the whole lifecycle. This serves as an incentive for the provider to develop a more economical and environmental solution, and therefore the value of the offered product/service is increased. When performing in a mature industry (like the construction industry), companies can achieve growth by using PSS, as they can also use other competences rather than just physical products. Moreover, another characteristic of PSS is the relationship between the provider and the customer, as it is closer and more trust-based. Lastly, a key element of PSS is the ownership. In PSS, ownership is no longer transferred to the customer, in order for the customer to use the product (Lingegård et al, 2011).

The transformation towards PSS is challenging. Vladimirova et al. (2011) identifies nine elements of change on the journey towards servitization. The most influential factors concerning the transformation towards PSS is Culture and Customer.

Culture is one of the most critical factors in the transformation. To begin with, involved actors need to change mindsets and culture. Shifting ownership is one of the key elements as far as mindsets are considered. The organizational culture shifts from technology-led to service-oriented and from features-led to values-led. This shift towards values-led culture is a great challenge for organizations. To achieve this shift, strong commitment by organizational leadership is required. The emerging service culture should be protected, and the two cultures (existing and emerging) should be integrated.

Another critical factor is the Customer. By implementing PSS, the dynamic among involved parties changes. New types of relationships are built with the customer. For that reason, collaboration is crucial. The customer requirements must be understandable, even though they may not be expressed in technical terms anymore. On the other hand, the provider should also make clear to the customer how their requirements are met by the service offered. For both sides, a deeper understanding is required of how PSS works and how the system becomes less product-centric under PSS.

2.3.3 How PSS works

Not a lot of papers are relevant to PSS in infrastructure and even less state how PSS is implemented in this sector. For the following description of how PSS works, the white paper by the Coalition Circular Accounting ‘’Pursuing Financial Reality of the Circular Road, A pathway to Road-as-a-Service’’ (2020) is utilized.

In BAU, the client is responsible for formulating the technical demands, as well as the design process of an infrastructure project. The contractor is often only responsible for realizing the design that is handled by the client. That is usually the case for small scale, non-innovative projects. Therefore, the client holds the ownership of the project throughout the lifecycle, and the contractor gets paid based on the realization of the technical demands that are set by the client.

In the PSS approach, the collaboration between client and contractor is quite different. First of all, the client defines the functional demands of the project. The ownership of the project is split in two parts; legal and economic. The client holds the legal ownership of the asset, just like in the BAU approach. The **innovation** of the PSS approach lies

in the economic ownership. Now, the contractor retains the ownership of the raw materials of the asset. The contractor is also responsible for the use of the asset as a service (maintenance/repair) and bears the costs for that. The two parties are contractually obligated to obey the above for a predefined amount of time.

According to the contract, the client has to periodically pay the contractor an amount of money. The payment is agreed based on functional requirements (for example availability of the road). At the end of the contracting period, the contractor will receive the residual value of the materials used. For that reason, the contractor wants the material to be in the best possible situation at the end of the contracting period. This also incentives the contractor to optimize the maintenance process and use materials that are durable and of fine quality. The whole supply chain system shifts, as new suppliers, partners and raw-materials are needed. Experience and expertise of the contractor are the greatest strengths of the contractor in order to ensure the optimal value of the asset at the end of the contract period. Innovation also plays a significant role in that, since it can offer pathways to new, durable materials and innovative processes that can be of great use.

Since the client is obligated to buy back the asset at the end of the contract, certain concerns arise; what is going to be the value of the materials by that time? and how can that be defined beforehand? Especially for the pilot of PNH concerning the guardrails, this concern is significant, since the steel price in the year 2050 is difficult to predict and the province may pay a huge amount for the materials of the asset, due to potential steel scarcity and the non-existence of alternative guardrail materials by that time.

2.3.4 Benefits of PSS

There are numerous reasons why PSS could prove beneficial in achieving the goals of circularity. The aspects that are benefited by PSS are the economy in general, the contractor and the client of an infrastructure project (van Buren et. al., 2013)

Economy in general/Society: As the model of PSS focuses on providing services and not materials, the economy will be dematerialized. This means that, unlike linear economy, this business model is less dependent on raw materials. The COVID pandemic has displayed how important that feature is. This characteristic can place PSS as a business model that can diminish import costs (Micklethwaite, 2008).

Another feature of PSS is that it can boost technological advancement (Ceschin, 2014). New, innovative solutions are developed in order for service to be provided.

This refers to a technical point of view, as well as a process-concerned one. Even after the completion of the contract, the technological advancement remains, as well as the knowledge obtained throughout the lifecycle of the contract.

PSS serves as an educational tool for the customers. It teaches them to make full use of a product while causing the least environmental harm (Ceschin, 2014). Public parties can lead by example by implementing PSS in their large-scale projects, and citizens can adjust their personal philosophy to that approach and implement similar concepts to their everyday life.

Environment: PSS is a business strategy of resource-efficiency that maximizes the services that are provided to costumers, without adding more material overflow in the economy (Tukker, 2015). In other words, the overall consumption of raw materials can be decreased, as the value of materials is preserved and the involvement of new materials is avoided.

This model is based on value retention of the asset. Additionally, the contractor has the incentive to offer proper maintenance and repairs, preserving the value and potentially even extending the asset's lifecycle, decreasing overall total operational costs (Ceschin, 2014). In the end of the lifespan the materials remain of high quality.

Lastly, when PSS is implemented, the environmental impact of a product or an (infrastructure asset) is reduced. For this to be true we should consider the whole life cycle of the product. In the long term, energy emissions and pollution are reduced and the development achieved is sustainable (Mont, 2002).

Contractor: First of all, PSS can boost market competition and create new opportunities for the companies involved (Goedkoop, 1999). This can improve the company's competitiveness, since PSS transforms the relationship of the client and contractor into a long-term collaboration (Manzini et al.,2001). Moreover, the contractor can attract new customers, which can be of high significance in a strategical level (especially in mature industries) (Ceschin, 2014).

Contracting firms protect their assets from being mishandled or destroyed before they reach the end of their lifetime. **Asset management** is an aspect that helps developing strategies and making choices to ensure that materials and asset maintain their value as long as possible. Additionally, the project can be designed with the option to dissemble assets, and use some of their parts in other projects, to reduce their cost. This refers to **Circular Design**. Circular Design takes into account the whole lifecycle of the asset, including maintenance, repairs and reusability.

Client: As Ceschin (2014) claims, the client can also benefit from the implementation of PSS. **The client is no longer responsible** for any issues that can rise concerning the acquisition, the use, the maintenance and the disposal of the asset, as the risks lie on the contractor's side.

Based on the knowledge and the freedom provided to the contractor**, the service offered is optimized** throughout the lifecycle. The solution provided is the best solution possible, as the party that has designed it has the both innovative power and the expertise. Additionally, the product developed is highly customized to the functional requirements set by the client. As a result, offering service instead of product is beneficial for the client, as the service that the client receives is top-quality and the technical level of the products is higher.

To summarize, PSS is beneficial for the society and the environment, for the contractor side but also for the client side. However, it should be highlighted that challenges can arise, given the complexity of the system that PSS is implemented in. Infrastructure is by nature a highly complex field, which is enhanced by the complexity of PSS. The barriers that could surface should be identified and paired to the corresponding enablers that can help overcome them.

Relationship of customer and client; longer relationships with customers, relationship doesn't end after tendering or purchase, but continues for the many-year contract period. (Ceschin, 2014). Their connection is stronger and, as a consequence, that can increase the intensity of their communication. Furthermore, as the solution provided is a combination of customized product and services, it is difficult to be copied. That enhances the competiveness of the provider, and a sense of fidelity is created.

Since contractors are responsible for the asset for a longer time, they choose to use more durable materials. That leads to increasing availability of the infrastructure by having less maintenance (Lingegård et al., 2011). Nevertheless, when companies become responsible for the product by retaining ownership, they facilitate the implementation of more advanced and efficient technologies and resources (van Buren et. al., 2013).

2.3.5 Current criticism - Why not PSS?

Even though PSS is a promising concept for achieving circular objectives, it is not vastly implemented yet. The main reason for that is the limited knowledge and experience concerning that concept (van Buren et. al., 2013). Empirical data are not

widely available yet due to difficulties in sharing information, and also organizations are unfamiliar with the data and tools in order to export useful conclusions about PSS.

Lingegard et al. (2011) state that the lack of knowledge can also concern knowledge about the life cycle costs. Lacking this knowledge, organizations may not be able to understand the benefits of PSS. Their traditional mindset holds them back from appreciating what PSS could offer to them.

Especially about public clients, one of their main characteristics is that they have the ‘’dominant logic’’. Being historical and prestigious bodies, they have developed a certain viewpoint of how infrastructure assets should be managed. Metaphorically, these bodies have a large mass that is difficult to shift towards new directions. For that reason, public actors that own infrastructure tend to be skeptical when facing innovative ideas, and hesitate making radical changes to their organizations.

In order to create incentives for innovative ideas to be promoted, strong public support is needed. Public clients with their strong procurement power, should encourage support and facilitate innovative concepts, otherwise their realization could be hindered (Lingegård et al., 2011). On the other hand, governments find it difficult to implement policies in order to promote and diffuse innovations like PSS (Mont & Lindhqvist, 2003; Ceschin & Vezzoli, 2010). One of their difficulties is the over-detailed specifications during the front-end stage of how to do things. That leaves little room for innovation. (Lingegård et al., 2011).

Ceschin (2014) categorizes the barriers that parties involved in the implementation of PSS can deal with as barriers for PSS promoters, for customers, context-related and institutional.

Since public clients can play a double role in the implementation of PSS, they can act both as the promoter of PSS but also as the user of the service. In other words, public clients serve as the party that provides PSS and tries to establish it, as well as the customer of the service that will be offered. For that reason, public clients can face barriers that are connected with both of these aspects.

<u>From the promoter’s perspective</u>

Generally, the concept of PSS is a concept difficult to grasp and even more difficult to manage. This can create internal conflicts, as the mindset of the promoter of PSS is not aligned with its principles. To prevent that, new competences, skills and experience are needed for the organization.

As far as the risks of the organization are concerned, engaging in a PSS mindset leads to being exposed to bigger risks. Due to the life cycle approach of the PSS, the

investments of the projects are long-term, so the investments are riskier (compared to a linear/short-term investment). Additionally, there is another financial barrier. The quantification of the market innovation is really challenging. That is caused due to some aspects of a project that cannot be measured, like the environmental impact or social aspects. Additionally, as previously suggested, risk is increased, which makes innovation less market-attractive.

As far as relationships of promoters is concerned

There is fear of sharing sensitive information and conflicts of interests between actors arise. Moreover, defining contracting clauses and negotiating can be challenging.

From the customer's perspective

For the customers point of view, the greatest challenge is changing their culture. That is essential in order to appreciate an ownerless solution that still fulfills their requirements. (Mont, 2002).

The lack of knowledge as far as the life cycle costs are concerned is another barrier. This makes it difficult for the customer to acknowledge the advantage of being offered a solution for their requirements without ownership (White et al., 1999).

About context in general

Providing support for PSS is quite challenging. Public clients are responsible for that by creating policies that regulatory drivers. Governments use their policy making to facilitate the diffusion of PSS but their complex role makes that more difficult. (Mont & Lindhqvist, 2003; Ceschin 2013). Having a huge purchasing power, public clients can stimulate the market and create drivers. However, marketing innovation is really challenging (Ceschin, 2013).

2.4 How can public values be coupled with PSS

The purpose of research is to study which values are affected when PSS is implemented. For this purpose, it is important to understand how PSS operates within a project. The body of theoretical knowledge of PSS shows how PSS operates by describing the characteristics, benefits and barriers of the model. The theoretical knowledge of PSS is combined with the public values of the organization. This combination can show which public values are linked to the implementation of PSS by public actors who own infrastructure. This ensures that only the relevant public values are highlighted during this research, and the interviews concern the values that are on the spotlight. Since the research is explorative and the deliverable of the research is an overview, it is more valuable and fruitful to focus on the most relevant public values at first, as they will provide the most interesting findings.

After the PSS characteristics, benefits and barriers are studied, the public values of actors of the construction world are also studied. Having as input the theoretical background of PSS and public values, a theoretical framework of PSS-related public values is designed.

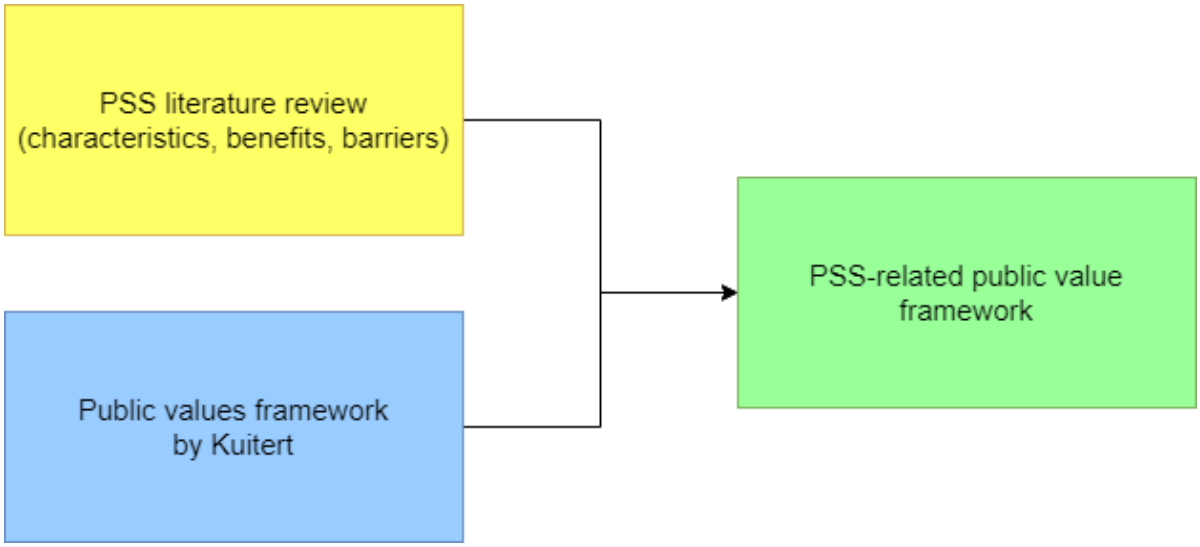

Figure 3-PSS related public values framework

The public values framework designed by Kuitert is adjusted to the knowledge gained after the extensive literature review conducted on PSS. To be precise, the PSS characteristics, benefits and barriers are coupled with the public value that they can have an impact on. Each of the PSS characteristics, barriers and benefits is assigned to the most relevant public value out of the framework by Kuitert et al. That way the most relevant public values in connection with PSS implementation emerge. These values form the PSS-related public value framework.

Firstly, the PSS characteristics are linked to public values from the theoretical framework. For example, one of the characteristics that can be found in PSS literature is that ownership is transferred. This can be linked to the public value of transparency and accountability. Later on, this is a topic of the interviews; which public values are affected by transferring ownership and how?

Literature review also reveals the theoretical benefits of PSS. Those benefits are coupled with public values from the framework by Kuitert et.al (2018), as depicted below.

Lastly, the barriers that are identified in the literature are coupled with public values from the framework of Kuitert et al. (2018). To give an example, one of the main barriers concerning PSS implementation is lack of knowledge. Public clients do not

have the knowledge needed yet to implement the new model, and that can be linked to their value of wisdom.

The public values that are connected to PSS characteristics, benefits and barriers formulate the suggested PSS related public value framework. The designed PSS-related public value theoretical framework consists of the most relevant to PSS public values. Those are the public values that will be studied later on, based on how implementing PSS affects them. The designed framework can be found in table 3;

Type of value	*Values*	*PSS characteristics*	*PSS benefits*	*PSS barriers*
Procedural values	Lawfulness			Current legislation (Mont & Lindhqvist, 2003; Ceschin 2013)
	Accountability	the party that is responsible for the production stage has control throughout the whole lifecycle, ownership is transferred (Lingegård et al, 2011)	public client is no longer responsible for any acquisition/use/maintenance/disposal issues of the asset (Ceschin, 2014)	Risks are bigger due to long term perspective (Ceschin, 2014) difficulties in contracting (Ceschin, 2014) ownerless solution (Mont, 2002)
	Collaboration	closer relationship of client and company, sense of fidelity is created	Intensity of communication with contractor is increased (Ceschin, 2014)	PSS creates internal conflicts as the mindset

		(Lingegård et al, 2011)		of the client finds PSS a concept difficult to grasp (Ceschin, 2014)
	Participation			
	Transparency	ownership transfer (Lingegård et al, 2011)		fear of sharing sensitive information, difficulties in contracting (Ceschin, 2014)
	Integrity			
	Safety			
	Reliability			
	Equality			
	Honesty			fear of sharing information (van Buren et. al., 2013)
	Collegiality			
	Wisdom	deeper understanding of how PSS works to clearly express functional requirements (Vladimirova et al., 2011)	PSS leads to technological advancement and knowledge is obtained (Ceschin, 2014)	lack of experience and lack of knowledge about life cycle costs (Lingegård et al, 2011)

	Health			
Performance values	Efficiency			
	Effectiveness	incentive for economical/environmental solution (Lingegård et al, 2011)	increased availability (due to durable materials that need less maintenance) (Lingegård et al., 2011)	
Product values	Quality	increased value product is offered (Lingegård et al, 2011)	value retention of the asset (Ceschin, 2014) public client receives customized/top quality service Ceschin (2014)	
	Functionality			
	Innovative	transformation of culture, mindset changes towards value-led (Vladimirova et al., 2011)	boosts technological advance and innovation (Ceschin, 2014)	Public clients are skeptical about innovative ideas, over detailed front-end specifications leave no room for innovation (Lingegård et al., 2011)

	Ecological sustainability		decrease of raw material (Tukker, 2015) environmental impact of the asset is reduced if the whole life cycle of the asset is considered (Mont, 2002)	
	Economical sustainability			
	Socio-economical sustainability			
	Context			
	Character			
	Beauty			
	Integrality			

Table 3-The designed framework

3. Methodology

After deciding upon the core of the research methods in Chapter 1.5, in this chapter a more detailed description on methodology used will be given. This chapter explains why the case was selected, and elaborates on more details concerning the case study and the people involved in this research.

This chapter deals with the second sub-question;

How to analyze a real-life implementation to study what values are critical to public actors that own infrastructure to decide whether they want implementation of PSS or not?

3.1 Case study research

3.1.1 Justification of research decisions

This research has an **exploratory** type, as an attempt to explore the daily practice and search for patterns (Verschuren & Doorewaard, 2010). Since the focus is on the comprehension of a practice, the qualitative research strategy fits this research better. A research method that fits the context of this study is the case study design. By using a case study, it is possible to explore the practices that are executed in real life. In order to collect the data needed, documents referring to the case study are studied. However, documentation is not sufficient on its own, and interviews are conducted to gain more knowledge from people with personal experience upon the subject. Lastly, the results need validation. For that reason, an expert panel discusses the results and provides comments aiming in their validation.

Even though there is no fixed formula of whether case study should be used as the research design, there are several indicators that motivate its selection. According to Yin (2003), if the following characteristics are present, then the selection of case study as a method is justified; firstly, if there is a ‘’how’’ or ‘’why’’ question referring to the way a phenomenon works and additionally, if the research is focused on a real-life phenomenon that requires an in-depth description. Then, the case study should be preferred.

Baxter & Jack (2008) suggest that **qualitative case study** is the fitting methodology to study complex phenomena within the context within which they are placed.

Additionally, ‘’lived reality’’ is represented by this method. However, it is difficult to reconstruct field methods and their documentation is rarely detailed. This justifies the need for conducting *interviews* along with *documentation* analysis to obtain a clearer overview of the case (van de Ven & Poole, 1995). Individuals, groups or organizations share their experience, which is studied based on the case study method (Sekaran & Bougie, 2016).

As Yin (2003) indicates, case study research is a linear but iterative process. Firstly, there is the planning stage, followed by the design. Then there are the stages of preparing, collecting and analyzing, interconnected with an iterative and almost circular relation. Lastly, sharing is the final stage, where the findings of the research are shared to the public.

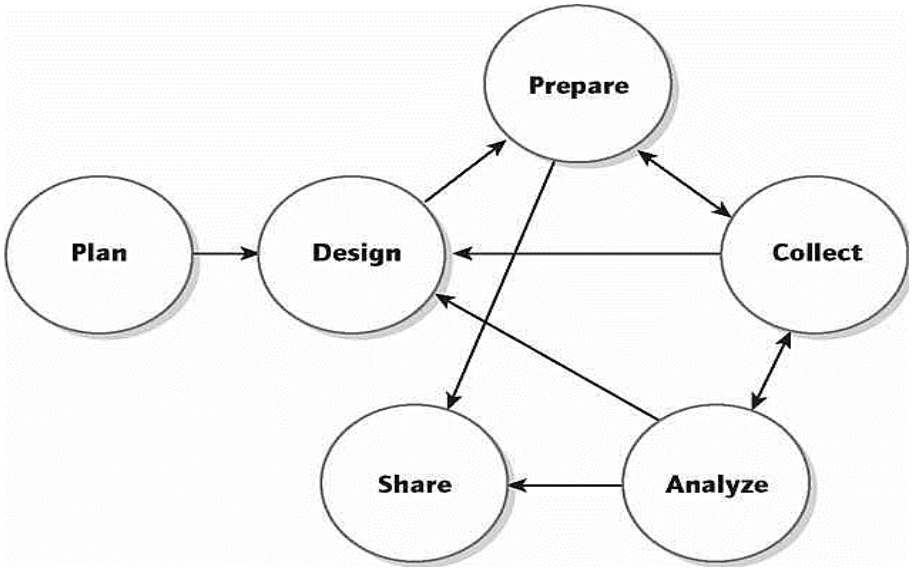

Figure 2-Case Study Research: A linear but iterative process. (Source:Yin,2003)

3.1.2 Preliminary research

Even before selecting the specific case, preliminary research is executed. That facilitated the exploration of how public clients view PSS and identifies the needs that are relevant for the subject at the specific moment. In this research, preliminary research was conducted by exploratory interviews. This shaped the research perceptive and the boundaries, so it served both the researcher scientifically but also the subject and receiver of the overview from the public client’s side. Additionally, it facilitated the initial contact with people involved in relevant projects and the networking in general, and also the interviewees.

Besides interviews, the preliminary research consisted of documentation study and preliminary literature review about the main concepts of interest; circular economy, PSS, public procurement etc. Relevant provincial documents, governmental documents, papers and books were studied, in order to define the topic. Documentation is significant for the research, as they reflect a formal view on relevant project. However, it is important to highlight that documents can also include an objective perspective, especially as far as PSS is concerned, because it is a quite new concept for infrastructure and limited research has taken place.

In the present research, the selection of the Circular Road Program was almost evident, as it is the most recent and orchestrated in detail case where PSS was implemented. The Program of Circular Road (De Circulaire Weg) is a joint effort of governmental bodies and construction firms that aims in investigating the implementation of PSS in the Dutch infrastructure. Within the program, technical innovations, new forms of collaboration, shift of current roles and responsibilities are considered, as a real-life experiment that can facilitate the decision making of the involved parties. Public authorities (one of them is PNH) and private construction companies are collaborating in 7 pilots within the program. The exploratory interviews referred to this specific program, as well as the documents studied. Since the documents are a formal reflection provided by TU Delft, they are of scientific value and are considered valid.

The iterative nature of the case study process entails that the preliminary research could be lengthy, until the objective becomes crystal clear. Multiple discussions took place in order for the objective to be crystal clear and reassure its dual value; the objective should have scientific value as well as practical value, given the fact that this research is a graduation internship by TU Delft in collaboration with the Province of North Holland.

3.1.3 Case study selection

After the preliminary phase, the main issues that need attention are pointed out. After discussions with members of the PNH and people with PSS knowledge and experience, the topic of interest is clarified; if and how can PNH embody PSS in their agenda. On a higher level, the topic refers to public actors that own infrastructure, the public values they represent and how these values can be affected when PSS is applied. Being a public client that recently implemented PSS, the Province of North Holland serves as the case study.

After the selection of the Province of North Holland as the case study, the PSS related projects were searched. As it turns out, PNH has only one recent and completed pilot concerning PSS. Attempts have been made at the past, but they were either not successful or there was no documentation archived that could serve as input. For these reasons, the previous attempts are considered not relevant for the research, and focus remains on the pilot of the PNH within the program of Circular Road. The pilot refers to the maintenance of roadside furniture (namely guardrails) in Kop van Noord-Holland by the construction firm ‘’Dura Vermeer’’ and their collaboration based on the as-a-service philosophy.

The pilot is a test of the Province before deciding whether PSS fits their strategies and goals. Despite that, the pilot is utilized in this research, because of its high relevance. The pilot represents a critical test of existing theory under unique circumstances. It refers to the first well-organized attempt of Dutch infrastructure actors to gain experience and knowledge by implementing PSS in real life. For these reasons, its selection is justifiable.

Summarizing, the case is selected based on certain criteria that are imposed by the researcher. These criteria refer to some characteristics that should be fulfilled by the selected case, concerning location, etc. The aforementioned criteria are displayed in the matrix below;

Selection criteria	**Explanation of selection**
Location	The Netherlands
Industry	Infrastructure
Time of realization	Recent-ongoing
Owner of infrastructure	Public client
Type of procurement	PSS

Table 4-Selection criteria

3.1.4 Data Collection

An essential step for the research is the collection of the data. For this research, the data will be collected by conducting **interviews** to the participants of the selected project, the guardrail pilot (PNH). This method is selected because it offers a personalized exchange of information (Jain, 2021), compared to surveys. In the literature, interviews are suggested as one of the suitable data collection tools when a new research project starts (Adams et al., 2007).

To collect the needed data, a body of questions is created. These questions target at increasing the knowledge of the interface of public values and PSS, based on the pilot of the PNH. Since the research strategy is qualitative and the type of research is exploratory, the interviews are semi structured. That entails that the questions for the interviewees are open and aim in revealing information that cannot be found in documents. These questions serve as a guideline to initiate the discussion and set the topic of the discussion on the public values and PSS. That reassures that the discussion will be relevant to the research and that it can offer the needed data for the analysis.

The body of questions is created based on the theoretical framework that is developed in the literature review. After the most relevant public values are selected based on literature review, they are the pillars of the questions of the interviews. That ensures that the public values of interest are covered during the discussion, and the interviewees give their opinion concerning those. On the other hand, the questions also leave room for the interviewees to state other subjects and values that they consider important. The openness of the questions offers the participants the opportunity to focus on the subjects that they believe that are relevant for the case and need to be highlighted. To be more specific, the participants will share their experience concerning how PSS was implemented in the pilot of the guardrails, the public values that are affected and the barriers and benefits were observed. Public values will serve as a framework to analyze those.

Another important aspect to highlight is the selection of the interviewees. It is significant who will be asked to answer the questions, as their viewpoints shape the outcome of the research. To offer a holistic perspective, the participants that will be selected have different hierarchical positions in the PNH. Additionally, apart from participants from the PNH, the contractor's side is also interviewed, as well as members of the program who are neither on the contractor's nor on the public client's side. Summarizing, participants should be:

- Directly engaged to the pilot
- Familiar with PSS
- Representing different positions of the project
- Willing /available to participate

For this research, five people were interviewed. The interviewees are people that participated in the pilot of guardrails or know what happened during the pilot, so they can share their experience and knowledge about what happened and how public values are affected when the pilot was realized. Three of them are members of the

province, there is one member of the program and one member of the contractor's side. This ensures that it ensures that the contractor's side is taken into account. Additionally, there is more objectivity and the findings are less influenced by personal opinions. Two of the interviewees are on the strategic level of the PNH and they are advisors for provincial policies. The number of participants is quite small, due to the decision to interview people that were directly involved in the pilot and can provide a better insight.

Before conducting the interviews, a list of semi-open questions was created. The questions were about the pilot and what were the main strengths and barriers of the process, what stood out for the people involved and how they would comment their experience in it. After that, the rest of the questions were more focused on the public values of the developed PSS-related public value framework. This ensured that the discussion remained relevant to the topic of the research and that people commented on the public values of the pilot.

To help the interviewees understand clearly the concept of the questions and to ensure that the answers were relevant to the designed PSS related public value framework, a list with the PSS related public values was provided, as well as explanatory keywords for each of them. This can be shown in table 6;

PSS-related Public Values	*Keywords*
Procedural Values	
Lawfulness	Rightfully, legal, righteous
Accountability	Responsibility, liability, duty, ownership
Collaboration	Cooperation, partnering, unity
Transparency	Openness, controllable, clarity, clearness
Honesty	Justice, equitable, equivalence
Wisdom	Understanding, knowledge, insight, information
Performance values	
Effectiveness	Purposiveness, contribution
Product values	
Quality	Requirements/specifications/standards, quality of service
Innovative	Innovative, change, improvement product/process
Ecological sustainability	Environmentally friendly, sustainable use of raw materials

Table 5-Designed PSS-related public value framework/keywords

3.2 Thematic analysis

3.2.1 Description of thematic analysis

A clear analysis design is helpful to describe how the collected data will be handled. In this case, thematic analysis is used. Thematic analysis is one of the most common methods of data analysis for qualitative research. As a data gathering method, interviews are compatible with thematic analysis (Braun & Clarke, 2013). Thematic analysis enables the researcher to identify patterns within the data. These patterns (or themes) can be used to pair and interpret the data. A useful tool for that is coding.

Theoretically, there are two lines of thought; the reflexive and deductive approach. In the reflexive approach, the themes are created from handling the data. In the deductive approach, the researcher tries to allocate data to pre-identified themes. Due to its flexibility as a method, it can be used to explore participants' lived experiences and practices.

In the present research, people involved in the pilot of the Circular Road share their lived experiences from the pilot within the Circular Road. Evidently, everyone experienced the pilot through their personal prism. As a result, this is not a case of black and white, but there are lessons to be learnt that are hiding amongst the greys. To clarify and pair experiences about how they perceived the public values within the pilot, thematic analysis is used. The themes of the analysis are the public values that are the most relevant and affected when PSS is implemented.

Braun & Clarke (2006), who originally developed the thematic analysis process, designed a data analysis method of six steps;

Step 1 familiarization

This step is about getting to know your data before starting the analysis. This entails that the interviews are registered/transcripted, along with additional notes taken during the interviews. This also creates a clear version of the interviews' transcriptions data.

Step 2 coding

In this stage, coding takes place. After the texts of the interviews are clearer, they are read again and parts of them are highlighted. These highlighted parts are labeled with ''codes''. The codes represent the meaning of the highlighted text and what the interviewee really means with the corresponding sentence. The codes are produced based on cognitive interpretation.

Step 3 generating themes

After the codes are ready, they are grouped in themes. Themes are the identified patterns that are observed among the codes. In the first round (deductive), the themes are prespecified as the values that form my theoretical framework. In the second round (reflective) the themes emerge from grouping the codes.

Step 4 reviewing themes

Having the themes already described doesn't mean that all of them are relevant and useful. Perhaps different grouping approach is more useful for the research, or some themes are of no need anymore.

Step 5 defining themes

The final themes are listed and a description of each of them is provided. The themes need to be understandable and clear. In the deductive round, these themes are values that are present in the proposed theoretical framework. In the reflective round, these themes can be apart from a public value, other significant finding that stood out during the interviews.

Step 6 writing up

In the final step of this method, the results are presented. Each theme is discussed on how often is present during the analysis and what does it mean. Examples from the interviews can be of help. The conclusions from the analysis are extracted for each round.

3.2.2 How it was used

Purpose of the analysis is to validate the proposed theoretical framework and examine how public values that are theoretically affected when PSS is implemented were affected on the guardrail pilot. Participants of the pilot share their experience and discuss whether and how the values of question were affected.

After the theoretical framework is developed in Chapter 2.4, the most relevant public values that emerge from literature stand out. The questions of interviews are targeted in those values, but also include general questions about what the interviewees find important to share about the pilot. This structure of questions ensures that all of the important and relevant matters of the pilot experience will be touched upon.

To ensure the latter while analyzing the interviews, two rounds of analysis are designed. The first round is based on the deductive approach, while the second round is reflective and highlights any other matters (themes) that are generated by the data. In the end, the results of the two rounds are integrated and the final themes are

reported. There are the initial conclusions of the research that will later on be discussed by an expert panel.

After both rounds are completed, the themes that are defined in them are integrated. These are the initial conclusions of the research that are going to be validated from the expert panel.

3.3 Methodological process

The figure 4 below describes the study process and the outcomes from each step. This figure answers to research sub-question 2.

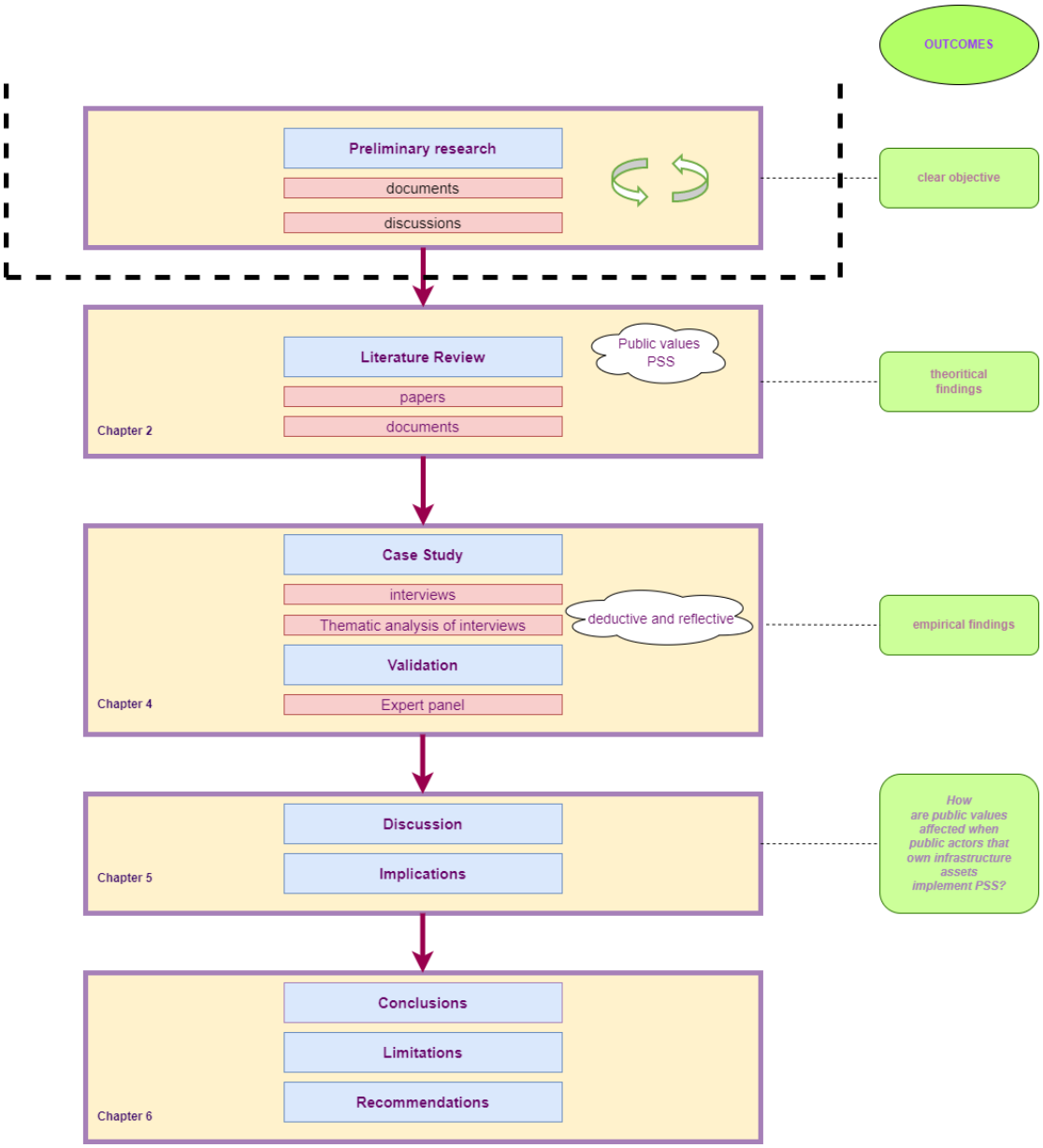

Figure 3-Study process and the outcomes from each step

4. Case study

This section answers the sub-question 3;

''What does the pilot of the Circular Road provide as learnings for the synergy of PSS with public values, in comparison to usual practice?''

4.1 Province of Noord Holland (PNH)

Province of North Holland (PNH) is one of the twelve provinces of the Netherlands. From an economic point of view, PNH is perhaps the most vital part of the Dutch Economy. With population of almost three million people (2.911.054), it is the second most densely populated Dutch province. Its thriving economy consists of various fields; innovative agriculture, maritime and offshore, energy etc. (Provincie Noord-Holland, n.d.-a)

Province of North Holland aims to be a sustainable, accessible and innovative province. The strategies of the Province are shaped accordingly to the objectives of the Paris climate agreement, as well as the Dutch governmental ambitions (Coalitieakkoord, 2019).

PNH acknowledges the major challenges that has to face in the coming years. One of those challenges is how they can ensure that their economy remains flourishing while remaining committed to their environmental goals. To achieve that, they are investing in sustainability and focus on how to transition smoothly to more sustainable practices.

4.1.1 Circular ambitions

In alignment with the above, PNH made a commitment; to be fully circular and climate neutral by 2050. This may seem like a dot in the horizon but by 2030, the province aims to be halfway on that journey. In collaboration with the business community, residents, knowledge institutions and other authorities, the province tries to stimulate circular entrepreneurship (Provincie Noord-Holland, n.d.-a).

The province itself purchases and tenders as much as possible in a circular manner, setting a good example and stimulating the market to embrace circular objectives. This suggests that the purchasing and tendering policies are being modernized. One of the fields where circular practices are firstly implemented is Infrastructure. PNH encourages circularity in infrastructure and leads by example, by purchasing and contracting in a circular way (Noord-Holland, nd.) The province investigates and

provides resources on how the transition towards circularity can be done in the optimal way for the society. (Coalitieakkoord, 2019-2023).

PNH wants to accelerate the transition towards circularity because PNH acknowledges the potential effects circularity can have. On one hand, circular practices can boost the economy because the costs will decrease and fewer raw materials need to be extracted and purchased. On the other hand, circularity can also contribute to achieving circular objectives, as CO_2 emissions will drop due to reusing of raw materials. For that reason, they are focusing on how they can transition smoothly to circularity (Provincie Noord-Holland, n.d.-b).

Besides the numerous advantages of circularity, PNH is still facing some barriers concerning the transition to a circular economy. The urgency for transitioning is not yet felt as there are pre-existing laws and regulations which hinder circular practices and also additional knowledge is required for successful transition. However, PNH is actively making efforts to overcome those bottlenecks that hinder the transition (Provincie Noord-Holland, n.d.-b).

Among the many responsibilities of the PNH is to maintain the provincial road network of North Holland. Provincial infrastructure is improved, replaced or expanded where required. PNH follows sustainable practices to manage its infrastructure. In total, PNH is responsible for 645 km of roads and 50 km of bus lanes. To manage and maintain those, PNH has collaborated with contractors through **area contracts**. Those contracts last for a longer period of time and the contractor is responsible for completing tasks concerning road infrastructure within a predefined area. Those tasks include maintenance of bridges, asphalt work, mowing greenery, ensuring functionality of traffic lights and maintenance of provincial guardrails (Provincie Noord-Holland, n.d.-c).

More specifically, for the area of Kop van Noord-Holland, PNH entered an area contract on 2015 with area contractor WaakSaam. The contractor is responsible for ten years to manage and maintain road infrastructure in the aforementioned area. WaakSaam is combined by four companies; Dura Vermeer, Ploegam, Van den Biggelaar and Van Doorn (Waaksaam, 2023). Along with Dura Vermeer, PNH wanted to investigate sustainable options of maintaining road infrastructure, which is why the province participated in Circular Road Program.

4.1.2 Participation in Circular Road Program

The Circular Road is a program that started in 2020 and lasted for two and a half years. Numerous partners participated in the program, by joining forces to test a new

business model for the infrastructure sector (PSS). PSS can facilitate the transition to circularity by locating the responsibility of the assets to the contractor's side instead of the public client. That relocation of responsibility can stimulate a long-term circular perspective and boost innovation, as the contractor has financial incentive to minimize the subsequent expenses they will bear by investing in better quality/materials, innovation and more advanced technology from the initial stages of the project. 11 partners developed 7 projects concerning different conditions where PSS is implemented. The partners that participated investigated if PSS can lead to more circularity and gained practical knowledge about how PSS can be implemented in the Dutch Infrastructure sector (De Circulaire Weg, 2023).

A successful former pilot on LaaS (Light-as-a-Service), motivated more provinces to experiment with the model. One of those provinces is PNH that was curious on how that business model can be implemented in their organization as well, simultaneously fulling circular ambitions that the PNH seeks to achieve. For that reason, the PNH is open to experiment and innovate with new ideas for infrastructure.

PNH decided to participate in the Circular Road Program to investigate whether or not PSS is a contract form that can promote circularity in the infrastructure field. Within the program, PNH can test PSS in real life conditions. The program allows the testing of PSS as a contract form that can incentivize the extension of the lifespan of materials and assets. As a result, the Province can gain knowledge on how to achieve circularity that can facilitate their strategic decision making and whether or not PSS is the proper tool for their transition towards circularity.

PNH posed several questions that were important for them as a public body that took place in the program. Some of those questions concerned mainly the contracting of PSS: how and when is this approach scalable for maintaining for example bridges or waterways. One of the main questions posed by PNH within the CR is 'what does this approach mean for your own organization' (De Circulaire Weg, 2023). The research question of this research can be considered relevant to the aforementioned question, as public values are affected when the organization faces changes. PSS is an innovation for the infrastructure sector and innovation could influence the way public clients make their governance decisions.

4.1.3 Description of pilot of CR

Three actors collaborated for this pilot. PNH and Dura Vermeer worked together in order for the pilot to be realized, and TU Delft closely observed and provided scientific assistance (Schraven et al., 2022). The pilot is being carried out within the existing

area contract of PNH with Dura Vermeer. With the area contracts, Dura Vermeer is responsible for the maintenance of the provincial infrastructure in the Kop van Noord-Holland. For this to be included in the Circular Road Program as a PSS experiment, circular conditions and KPIs were added as points of attention. As a result, a new type of contract (UAV-CE) is drawn up on the area contract (Handreiking Circulaire weg as a service, 2022).

PNH chose the roadside as an area for PSS. When PNH decided to participate in the Circular Road program, the chosen asset were the provincial guardrails. Even though ownership of the guardrails is not transferred to the contractor, the contractor is responsible for the maintenance activities of the guardrails because of the area contract. The pilot is guardrail-as-a-service. Scope of the pilot was renovation of the guardrails located at N250 between 113,350 and 115,500km (Schraven et al., 2022).

Guardrails were selected for various reasons. First of all, guardrails provide impact-oriented service. PNH believed that this type of service should be investigated as far as reuse of materials is concerned, in order to provide more circularity. Moreover, PSS was considered to be a feasible model for this asset financially, legally, organizationally and from a management perspective (Schraven et al., 2022).

Lingegård and Svensson (2014) suggest that the environmental impact from the infrastructure is mainly attributed, among others, to the consumption of materials and more specifically the consumption of steel. This can also explain why PNH decided to test PSS in guardrails, as it is known that guardrails made mostly out of steel and they are among the roadside objects with the highest CO_2 footprint (Schraven et al., 2022).

Another reason why guardrails were picked is because of their modular design and their high scalability. As a road accessory, guardrails are treated by the PNH as an asset.

The current and only policy of PNH about dealing with guardrails is to comply with existing regulations. Guardrails should obey to strict technical details, as they are stated by national and European standards and requirements. When they don't meet those standards anymore and they become rusty, they are removed and new guardrails take their place. With this practice, materials are wasted, as they are not reused.

This pilot aimed to find new ways of maintaining guardrails with a more circular way. Four different options were examined and assessed. The alternative that prevailed is dismantling existing guide rail for renovation and supplying new guardrails with renovated planks. The status of the guardrails is inspected to find when the guardrails are rusted and their service life is coming to an end. If their status is bad, they are dismantled, de-zinced and re-galvanized. Then, they can be reused with the same

technical new value. Until now, the guardrails are double-sided. In the pilot, the guardrails are single-sided. That means that used material is reduced in half. Consequently, costs become lower, materials (steel and zinc) are preserved and the guardrails still deliver their service. This is how circularity is boosted, especially when findings are applied in a bigger scale (Schraven et al., 2022).
The matrix 6 below displays a comparison of characteristics of former (normal) situation of guardrails and the situation within the pilot (PSS).

	Former (normal) situation	**New PSS situation**
Type of guardrail	Double-sided	Single-sided
Regulation	NEN5190/5191	NEN-EN1317
Policy	Only comply with regulations	Comply with regulations and have circular design
Replacement	When they don't meet the requirements anymore or when accident happens	Before end of their service life, when the layer of zinc is rusted

Table 6-Matrix comparison of characteristics of former and pilot guardrails

To gain a deeper understanding of what happened in the pilot and how PSS was implemented by the PNH, five interviews are conducted. During those interviews, interviewees shared their experience about what happened during the pilot and what stood out with significance for them. They were asked what worked out in the pilot and what didn't. The suggested PSS related public value framework was presented, and they were asked to comment on that, while they also reflected on the public values of the pilot.

4.2 Thematic Analysis of public values from interviews

In the figure 5 below the thematic analysis is presented; interviews are the input for the two rounds. After those two rounds are completed and themes from each round are found, the themes are integrated. As a result, integrated findings emerge. Those findings are presented to the expert panel who reflects on the findings to validate and generalize them on other public clients as well. The findings are validated and sub-question 4 is answered.

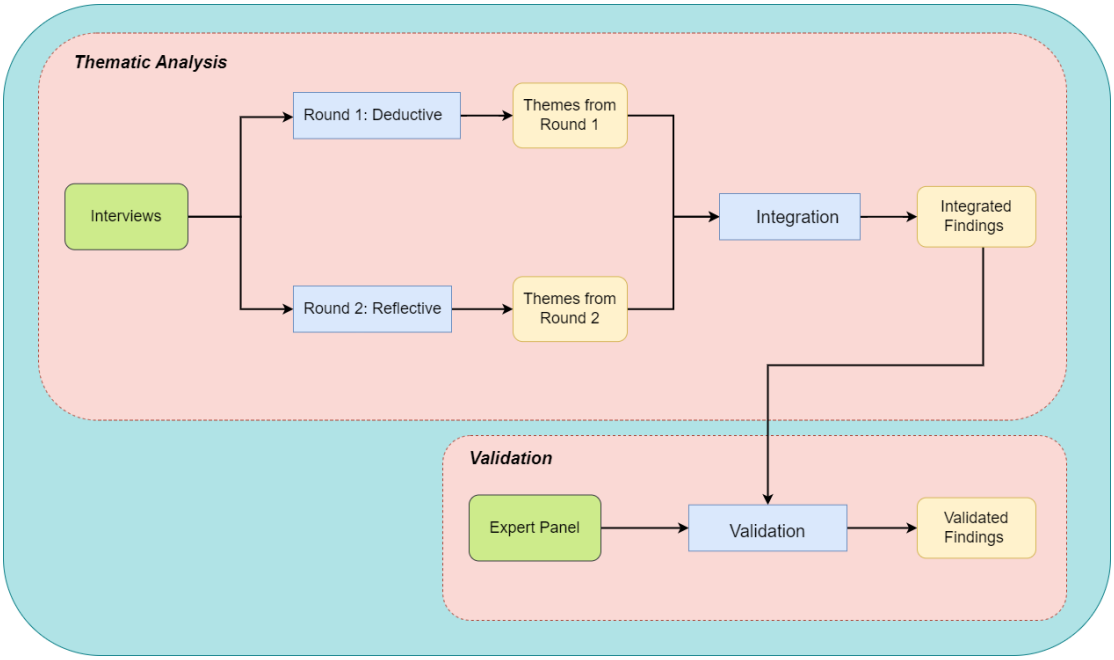

Figure 4-Thematic analysis

4.2.1 Deductive round

During the first round of analysis, the data are scanned in order to identify patterns. Those patterns are predefined and they are the values indicated in the PSS-related value framework, as shown in Table 4. To be more precise, the transcripts of the interviews are read and where the predefined codes are mentioned directly or indirectly, the corresponding text is highlighted. Each code-value is feeling expressed through that part of the text. The context of the highlighted text is the way the interviewees have experienced the public values. The predefined codes -values are as per table below.

PSS-related Public Values	*Keywords*
Procedural Values	
Lawfulness	Defensible, rightfully, legal, legitimate, righteous
Accountability	Responsibility, liability, duty, justification, task, ownership
Collaboration	Cooperation, commonality, partnering, contributing, unity
Transparency	Openness, testable, insightful, controllable, clarity, clearness
Honesty	Accessibility, justice, equitable, equivalence
Wisdom	Uncluttered, understanding, knowledge, insight, information
Performance values	
Effectiveness	Purposiveness, useful effect, contribution

Product values	
Quality	Requirements/specifications/standards, validity, quality of service, value, level, build quality
Innovative	Innovative, development, change, creativity, improvement product/process
Ecological sustainability	Environmentally friendly, natural balance, biodiversity, energy efficiency, durability, sustainable use of raw materials

Table 7-Keywords for public values for the interview process

This process concerns all the interviews that were conducted. Subsequently a matrix is created where the PSS related values constitute the rows, and the interviewees are the columns of the matrix. Every transcript is combed through and the spots where the PSS-related values come into view are highlighted. At the end of each transcript, the codes-values that have shown up are summarized.

This summary is the context of each cell of the matrix.

For example:

	Interviewee 1	**Interviewee 2**
Lawfulness	What does interviewee 1 think about the lawfulness of the pilot?	What does interviewee 2 think about the lawfulness of the pilot?
Accountability	What does interviewee 1 think about the accountability of the pilot?	What does interviewee 2 think about the accountability of the pilot?

Table 8-Matrix example

After all the transcripts are coded, a new column is created in the matrix; a column consisting of the conclusions for each PSS-related value. The opinions of all the interviewees are integrated and conclusions are drawn about each value that emerged from the transcripts. In the end of this round, a conclusion for each value is drawn.

The codes-values found in the interviews are the following;

Lawfulness

Example: "*transferring ownership is related to lawfulness, you have to carefully write all the aspects to protect yourself from things that could go wrong"*

Conclusion:

- As a public client, PNH handles money from Dutch citizens. Dealing with public money requires the Province to be extra careful on their legal obligations.
- Procurement law creates a strict legal framework and sets several limits. According to procurement law, public owner cannot assign a project over a certain value/scale. Such projects need to have either an already running contract in place or be subject to tender process.

Accountability

Example: "*even though you transfer the ownership, in the end the province will be responsible"*

Conclusion:

- The public client is still accountable by the public eye.
- Because the public client transfers the (economic) ownership to the contractor, they lose control on the assets
- It was not totally clear by the province how the tasks were assigned and what were their responsibilities.

Collaboration

Example: "*I think it was a good partnership, we were very open and happy that we were partners".*

Conclusion:

- A stark difference in perspective of people from inside the pilot versus from the outside.
- Within the pilot the collaboration was good. Outside of the pilot there is a lack of trust towards the contractor. People from strategic level of the province are hesitant.

Transparency

Example: *"there must be transparency about calculating the residual value".*

Conclusion:

- Procurement law requires everything to be transparent.
- The topics where transparency is highlighted in the pilot are about setting (functional) requirements and about calculating residual value.

Wisdom (Key words; Understanding, knowledge, information)

Example: *“the pilot made us more aware”*

Conclusion:

- PNH obtained some knowledge about how PSS works in a small scale but not a deep understanding about how it works or about the impact it can have on the long-term.
- Province didn’t act proactively in learning, they wanted knowledge to be handled to them.

Honesty

Example: *“honesty as in openness, sharing openly data”.*

Conclusion:

- Honesty, open collaboration and trust between partners are key when entering a contract.
- The partners should share data openly in order for knowledge to be achieved. This is very important specifically for calculating residual value.

Effectiveness

Example: *“PSS has an effect on effectiveness, in a sense of purposiveness”.*

Conclusion;

- PNH has a long-term view and ambitions. Their actions have purposiveness on a long-term social level.

Quality

Example: “*quality is affected for sure because you ask for another type of requirement, now you ask for functional requirements”*

Conclusion:

- Quality of the guardrails must be re-defined through functional requirements in contrast with the strict technical requirements that were applied until now.

Innovation

Example: “*it became too much too quickly into looking for technical solution”*

Conclusion:

- People had different perceptions about how innovation was present in the pilot; should that be limited to technical aspect through guardrail renovation or also applied to system and process innovation?
- The PNH gave room to the contractor to innovate but the innovation focused primarily on the technical solutions.

Sustainability

Example: *"we had nice, big results in sustainability"*

Conclusion:

- Very significant sustainability result but only if you act proactively.
- The result could be more sustainable in the long-term if the contractor had taken the lifecycle into account.

4.2.2 Reflective round

After the completion of the first round and the extraction of one conclusion for every relevant value, the interviews are ready for the second round of analysis. The second round doesn't have predefined codes, but the codes are generated from handling the data. The codes are the topics that stand out from the discussion and they are the topics that the interviewees decide to focus on, based on their experience within the pilot. After the first round is already completed and the interviewees opinions are analyzed once, there is a better overview of how data are interconnected throughout the whole pilot from different points of view. For example, during the first round it was clear that there were communication issues of the participants, as not everyone was on the same page about the continuation or not or the experimentation with as-a-service.

Additionally, new elements are pointed out concerning the existing themes from the first round. That happens because during the second round, indirect connections are located and revealed. They will be embodied in the themes from first round in the integration of the themes.

For this round, a new matrix is created. The names of the interviewees constitute the rows, and next to each name there are the issues that come up after the corresponding transcripts are handled. Those issues are the topics that each person decided to mention and topics that were important for them to focus on, based on their experience and knowledge with the subject. Those topics were either elements that emerged now and can be connected to the public values studied in the first round or new elements

that are not present in the suggested framework but are important for the pilot and need to be stated as well.

While analyzing, new codes stood out. Some of those codes are relevant to themes that already existed in the first round. Consequently, they are coupled to values from the first round of the analysis. The themes-values of the suggested framework that are present at the second round too, were the Collaboration and the Knowledge.

Collaboration:

- the already existing collaboration with the area contracts benefits the collaboration within the pilot.
- Interviewees disagree on who initiated the idea and the pilot.

Knowledge:

- PNH obtained information about the status of the assets; what type of guardrails they had, in which condition etc.

Those two will be integrated in the themes of the first round in the integration stage.

That was not feasible for each and every one of the emerged codes. Apart from the above, several topics were mentioned, that could not be categorized as public values but needed distinguished codes. Those constitute of codes that don't belong in the suggested framework as found in literature review in chapter 2.4, but they were essential for the research and needed to be included.

After the identification of the extra points of interest, they were grouped in wider categories accordingly to their context. This categorization was performed in order for the new themes to be similar with the previous themes, as identified in the first round. This ensured that all the acknowledged themes are investigated in the same level of detail and the findings are homogeneous. This created three additional themes (Goal, Contracting and Human factor). Those three themes will not be part of the value-framework, but will serve as important findings in the Discussion chapter.

To present an example, some interviewees mentioned that the province has a societal task that needs to be fulfilled and others mentioned that the contractor is a company that always seeks larger margin. Those elements, when combined, create the theme of Goals.

Goal:

- The two partners had different goals in the pilot. They shared the goal of sustainability, but the contractor focused on achieving larger margin and the public client has a societal task. This can be a barrier if the partners want to form an alliance.

Contracting:

- Given the type of assets, the contracting is difficult. Guardrails are not easily measurable with KPIs and they are not a technological asset like cameras.
- The pilot had a limited scope and the conclusions are missing the full impact of the model.

Human factor:

- The people involved in a pilot are crucial for its success. They didn't have asset management knowledge.
- The internal communication of the province was lacking, as members of the province didn't know whether they will participate in the second part of the program or not.

4.2.3 Integration round

After the two rounds are completed and all the codes are identified, it is time to integrate those into the themes that are the result of the whole analysis process. The values-themes found in the first round will be enriched with the elements concerning those values from the second round. In other words, codes from the second round are integrated in already existing themes of the first round, when possible. Since knowledge elements are present on both of the rounds, an integrated Wisdom theme is created, consisting of all the findings concerning knowledge. Moreover, collaboration elements that are identified in the second round are integrated in the theme-value Collaboration from the first round.

Following, the themes from the second round (Goals, Contracting and Human Factor) will be integrated in the analysis findings. In the end, the integrated interview findings consist of the themes that resulted from the first and the second round of the thematic analysis. Those findings are going to be validated by an expert panel, so that experts can reflect on them and share their experience and knowledge.

4.3 Initial findings

After the two rounds of thematic analysis, the final themes are found. Those are the public values from the suggested framework (Table 4) that are affected when PSS is

implemented. Moreover, the additional themes that emerge after the second round of the thematic analysis are presented.

Final and additional themes are the initial findings of the analysis, as found after the thematic analysis on the interview data. They serve as input for the expert panel on the next stage. Those findings are going to be validated by experts from different public bodies. Those experts will share their opinion on those initial findings, and based on those opinions the validated-generalized empirical findings are drawn. The expert's reflection on the findings will facilitate a deeper understanding of the literature and the pilot.

The Initial Findings can be found in Appendix A-Tables 11 & 12.

4.4 Validation-Generalization

To achieve the validation and generalization of the Initial findings (Appendix A), an expert panel is organized. The expert panel consists of three innovation experts. They represent the following public bodies; ProRail, Rijkswaterstaat and Waterboard. Two online meetings took place, in order for the experts to discuss the analysis findings and give their feedback. The findings from analyzing the interviews from the pilot and the feedback from the expert panel are both considered empirical findings.

A matrix concerning Empirical Findings is created, consisting of the Initial findings, Feedback from the expert panel and the Validated-Generalized Empirical findings. The latter is the integration of the first two.

The findings of the thematic analysis served as input for the expert panel (first column of the matrix). The three experts provided their feedback on them and they shared suggestions for the public clients, to foster PSS in their agenda (second column of the matrix). This is how validated-generalized empirical findings occur in the third column. Those empirical findings are the result of this process and they will later be included in the overview matrix.

The Empirical findings are presented in Appendix B-Table 13.

4.5 Overview of PSS related public values

Type of value	*Values*	*Coupling PSS based on theory about characteristics/barriers/benefits*	*EMPIRICAL FINDINGS*
Procedural	**Lawfulness**	• A main barrier is the current legislation	• Dealing with public money makes public clients extra careful on how they explain their legal obligations. • PSS, like every innovation, is looked upon with hesitance. • Procurement law sets limits to PSS. Laws and regulations don't fit within the system, because they are made to suit a linear situation. • PSS may be unlawful at the moment, but it is not undesirable by public clients. • PSS should stimulate changing the way the law is written, not its purpose • Legal advisers of public clients are extra careful/hesitant due to construction frauds.

	Accountability	• The party that is responsible for the production stage has control throughout the whole lifecycle • Ownership is transferred to contractor • Beneficial for public clients is that they have no longer responsibilities for any acquisition/use/maintenance/disposal issues of the asset • Main barriers are the bigger risks due to long term perspective, the difficulties in contracting, and that PSS offers an ownerless solution for public clients	• Public clients stay publicly accountable • Public clients believe that they can't have an impact on the asset because of ownership transfer, but they can have an impact through contractual clauses. • Clarity in contracting PSS is important and difficult to achieve. • Requirements can act as a mean to impact who and how is held accountable. Penalty clauses on the contract, transfer responsibility to the contractor to meet certain objectives. • Split of legal and economic ownership, as a mean to clarify responsibilities. • Accountability is irrelevant for the greater cause of achieving circularity
	Collaboration	• The relationship of client and contractor is closer and a sense of fidelity is created • Beneficial is the increased intensity of communication • As a barrier, PSS can create internal conflict as it is a concept difficult to understand and the mindset of the client is not aligned to its principles	• Different perspectives of people inside the pilot vs outside. Inside it was good because they were already partners. Outside there was mistrust towards the contractor because of contractor's intentions and goals. Mistrust is a consequence of traditional roles and responsibilities of involved parties. • If collaboration is successful, a joint team is created and therefore the party that initiates the project is irrelevant. • Innovative projects are "like going on an adventure together with a sketch, not a full map". • Partners should be honest to their relationship. • Common achievement of different organizational goals. True collaboration means that they respect different organizational causes

	Transparency	• The ownership is transfered • Barrier is the fear of sharing sensitive information and the difficulties in contracting	• Due to procurement law everything needs to be transparent about setting requirements and calculating residual value. • Public clients should find a way to measure the value of the asset at the end of the contracting period.
	Honesty	• Barrier is the fear of sharing info	• To make PSS work, a great level of trust between the partners is required. • Instead of collaborating with trustworthy partners, enhance trust among partners. • Trust is established at the beginning but maintaining it is a continuous point of attention throughout the process. • Open data sharing is a prerequisite of trust. Data sharing is required for decision-making but should also be safeguarded. • Partners need to align their mindsets in order to align and maintain trust.
	Wisdom	• Public clients should have a deeper understanding of how PSS works in order to clearly express functional requirements • Beneficial is that PSS leads to technological advancement and knowledge is obtained • Barrier is the lack of PSS experience and knowledge about life cycle costs of the asset	• PSS is a way to obtain knowledge. PSS is a spinoff, to initiate discussion towards circularity. PSS implementation doesn't necessary result in obtaining new wisdom. Action should be taken before initiating the contract to gather the required data. • Acknowledgment of lack of knowledge is compensated by confidence of finding the right solution. • Combination of same data in a different way can lead to wisdom.

			• PSS can stimulate public clients to obtain information about the status of the assets that didn't have so far.
Performance	**Effectiveness**	• PSS is an incentive for economical/environmental solution • Beneficial is the increased availability due to durable materials that need less maintenance	• PSS implies long-term contracts that fits the long-term purposiveness of the public clients on a social level. • Public clients have inherently effectiveness as a value. On the contrary, contractors can potentially be motivated to increase their social effectiveness, although it's not part of their role. Effectiveness can be motivated/artifacted through contract clauses (rewards). • PSS contributes to circularity as a system
Product	**Quality**	• Increased value product is offered • Beneficial is that public client receives customized/top quality service and the asset retains its value	• PSS suggests a different way of defining quality (through functional requirements). Functional requirements leave room for innovation to thrive for. • Guardrails have strict technical requirements.
	Innovation	• transformation of culture, mindset towards value-led • Beneficial is that PSS boosts technological advance and innovation • Barrier is that public clients are skeptical about innovative ideas and over detailed front-end specifications leave no room for innovation	• All innovative aspects (contract, financial, etc.) need the right attention and treatment, for a successful PSS implementation. Whole system approach is needed. • Those aspects were not apparent in the pilot, although it was a big social innovation. Mainly technical innovation in the pilot.
	Ecological sustainability	• Beneficial is the decrease of raw material and that environmental impact of the asset is	• PSS implementation can lead to sustainable results. PSS stimulates circular solutions which relates to social effectiveness. • Public clients should have sustainability as an initial goal and

		reduced if the whole life cycle of the asset is taken into account	focus on sustainable aspect of PSS, in order to achieve sustainability results.

Table 9-PSS related public values

5. Discussion - Implications

This chapter discusses the results of the analysis and highlights findings of interest. To begin with, the public values of the overview are discussed and a comparison between theoretical and empirical findings is held. The public values that were part of the suggested PSS-related public value framework but not found relevant during the case study are briefly mentioned and afterwards discarded from the proposed framework. Moreover, the second round of the thematic analysis resulted in new themes that are not part of the public value framework, but they were significant findings that should be also incorporated in the research.

5.1 Discussion

5.1.1 Discussion on PSS related public values

When PSS is implemented, public values are affected. In the following section, each PSS-related value from the overview is discussed in detail.

Lawfulness is challenged. Public clients should follow the law and ensure the legitimization of the commissioning. Current legislation is one of the main barriers for PSS implementation. Procurement law sets limits to PSS, because the existing law suits linear projects. Since PSS is desirable by public clients, laws and regulations should be rewritten to fit its needs of PSS. Theory is confirmed by practice.

Accountability is theoretically both benefited and hindered when PSS is implemented. The party that is responsible for the production stage of the asset has control throughout its whole lifecycle. Public actors that own infrastructure are benefited because they are no longer responsible for the asset. A barrier of PSS concerning Accountability is that, due to the long-term perspective of PSS, risks are ultimately bigger and there are difficulties in contracting. Empirically, public clients are held accountable by the public. Transfer of ownership means that the public clients remain ownerless, so they cannot control the asset or have responsibility of it. Empirical findings suggest that this is not completely valid. Public clients can still have an impact via clear contractual clauses. Public clients, through the requirements and penalty clauses they formulate, can transfer accountability to the contractor. In order to clarify responsibilities split, ownership can be split in legal and economic. In general, implementation of PSS aims in achieving circular objectives, therefore accountability

should be considered less important, because public clients have the greater aim to achieve circularity.

Collaboration is perceived differently when PSS is implemented. The relationship of public and private actor becomes closer and their communication becomes more meaningful and intense. Since PSS is a concept difficult to grasp, it can cause internal conflicts. In practice, collaboration is perceived differently inside the pilot and outside. However, in this particular case the two parties were already partners before the pilot, which facilitated the smooth collaboration. Outside of the pilot, there was mistrust towards the contractor's intentions; reasons for this lies in the participants' traditional roles and responsibilities. In a successful implementation of PSS, a joint team is created by the public client and the contractor. In practice, meaningful communication means that partners are honest to their relationship and that they strive for common achievement of different organizational goals.

Transparency is theoretically challenged. Public clients are hesitant in sharing information that can be sensitive and there are difficulties in contracting, fact which is confirmed in practice. Transparency is also a requirement of Procurement law. When implementing PSS, it is important to be transparent especially when setting requirements and calculating residual value.

Honesty is linked to fear of sharing information. To implement PSS, partners should greatly trust each other. This trust is established at the beginning but should be maintained throughout the whole process. Open data sharing is a prerequisite of trust and data sharing is required for decision-making. However, data should also be safeguarded.

Wisdom is a value that is very affected by PSS implementation. Theoretically, public clients should be able to express clearly requirements in a non-technical way. To do so, they should have a deeper understanding of how PSS works. Practically, public clients lack experience and knowledge about PSS and the life cycle perspective it suggests, and that hinders its successful implementation. When PSS is implemented, knowledge is obtained by the public clients and technological advancement is achieved. Empirical findings suggest that PSS does not necessarily result in obtaining new wisdom. PSS is a way to obtain knowledge and boost circularity, but action should be taken when initiating the contract. Acknowledging the lack of knowledge is compensated by the confidence of finding the right, circular solution. Combination of same data in a different way can practically also lead to wisdom. Another type of

wisdom that emerged empirically is that the public client can obtain information about the status of assets.

Theory about **effectiveness** is confirmed by empirical findings. PSS and the long-term contract it implies, incentivizes public clients for an economical/environmental solution that fits their long-term purposiveness on a social level. Practically, there is a difference between public clients and contractors. Effectiveness is an inherent value for public clients, but it is not part of the contractor's role. Public clients can incentivize contractors to increase their social effectiveness, through rewards in contracts.

Quality is theoretically benefited with PSS. Customized assets of increased value are offered and they retain their value for longer. Empirical findings show that quality is defined differently when PSS is implemented. Instead of technical requirements, PSS suggests that functional requirements are formed, which leaves room for innovation to thrive. In the pilot, guardrails must obey to strict technical requirements, but in assets like those, little room is given for innovation to thrive and quality to be increased.

In theory, **innovation** and technological advance are boosted when PSS is implemented. A PSS barrier is that it is an innovative concept and public clients tend to be skeptical about innovative ideas. PSS does not only refer to technical innovation. One aspect of innovation is how public client's culture changes and they now have a value-led mindset. Empirical findings confirm the theory and suggest that all aspects of innovation (contract, financial, etc) need the right attention and treatment for a successful PSS implementation: a systematic approach is needed. During the pilot, the technical innovation prevailed, even though it was part of a big social innovation.

The last PSS related public value is **ecological sustainability**, Theoretically, PSS implementation leads to decrease in overall use of raw material. Moreover, if the whole life cycle of the asset is considered, the environmental impact of the asset is also reduced. Empirically, PSS can stimulate circular solutions and lead to sustainable results, but public clients should have sustainability as their goal and focus on the sustainable aspect of PSS.

During the analysis, interviewees are asked to comment on the public values that are given to them, and describe which of them stood out during the pilot. Those values were the values of the suggested PSS-related public value framework. The interviewees linked all the given values with experiences they had from the pilot and described how these were present in the pilot in comparison to other projects they have been involved in.

5.1.2 Conflicts of values

Literature review suggests that conflicts of public values exist, due to the shift in focus away from procedural and performance values towards the more product-oriented values. That means that values like innovation and sustainability become more and more important for public clients. This is validated by the present research as well. Public clients become more interested in investigating innovative ideas that can promote sustainability, so they focus on product-oriented values instead of procedural.

The conflicts found on the present research are:

Lawfulness vs Collaboration

On one hand, public clients should ensure that lawfulness is met and they act according to the law. Procurement law suggests that equity and non-discrimination is ensured for the procurement process. Current legislation is a barrier for PSS implementation. On the other hand, PSS suggests that collaboration of the partners should be close and it should be based on trust. In order for such a type of collaboration to be realized, time is needed because partners need to create a close relationship. That is easy to occur when partners build on earlier collaborations. However, that is not lawful for the public clients, because it is not complying with the Procurement Law. This finding is in agreement with literature, as Kuitert et al. (2018) suggest that one of the value conflicts concerning balancing different types of values is Lawfulness vs Collaboration.

Transparency and Honesty vs Collaboration

Public clients should be able to explain every decision they make. As a result, they need to be completely transparent towards the public. Additionally, public client should be transparent and honest towards the contractor, in order for a trust-worthy and close collaboration to be achieved and knowledge to be obtained. Transparency and honesty are required in PSS especially during setting requirements and calculating the residual value of the asset. Partners need to openly share data, as that is a prerequisite of trust and it will facilitate the decision making. However, public clients should also safeguard data and documents. Public clients should be careful about what data they can hand over to the contractor and when. Kuitert et al. (2018) also indicated that Transparency vs Collaboration is one of the six value conflicts they observed.

5.1.3 Additional points of interest from the thematic analysis

The next topic are the themes of the second round of the thematic analysis. During the second round (reflective), new codes emerged that could not be incorporated in the existing list of public values which emerged from the first round. Those codes were grouped accordingly to their context and three new themes are created; **Goal, Contracting** and **Human factor**. Those themes were also presented to the expert panel, so that experts could share their opinion on the grouping and the content of the three of them.

The first new theme is **Goal**. From the thematic analysis it was found that partners have different ambitions. Interviewees believed that contractors only want larger profit margin, while public clients focus on their societal task. Expert panel validated the goal of public clients, but disagreed on the contractor's goal. Experts stated that larger profit is not the only goal of contractors, but they also appreciate the security and continuous business offered by long term contracts. Experts suggested that an equilibrium between societal task (public actor that owns infrastructure) and profit margin (private actor) is important and that the partners should be open about their goals from the beginning. That is linked to the purposiveness of the public clients. Consequently, this theme can be included in the public value of Effectiveness.

The next theme is **Contracting**. Findings show that contracting had difficulties during the pilot, as guardrail is not an asset with measurable service. Moreover, guardrails are not based on technology like cameras, so the technological advance is not rapid. They are not an asset whose provided service is immediately recognized, but are only utilized in the case of an accident. Another issue of the pilot was that the scope was so limited, that they missed the full impact of the model. Experts suggested that having a limited scope can serve as a limitation of the research, as the long-term nature of PSS is not accurately represented. For actors to have a complete overview of the impart of PSS implementation, the whole duration of the contract should be taken into consideration. As a result, this theme can be renamed "**Asset Type**". This theme can be useful at the beginning of the project, to determine which assets are fitting the model the best.

The last but equally significant theme is **Human factor**. Interviews and expert panel highlighted the significance of human factor. People involved in the pilot lacked asset management knowledge and there were internal communication issues within the public client. Experts mention the importance of team assessment to identify the right partners. Fitting capabilities, mutual trust among project participants, and a fitting

combination as partners, is a prerequisite of PSS. The fitting combination can be achieved through personal connections among public and private parties. Actors with modern opinions and mindset are needed. To ameliorate internal communication of public clients, team members should share their learnings and challenges. This can be considered part of the Collaboration value concerning the skills that individual members of the partners should have. It is also useful input on how the teams of the partners should be formed.

5.2 Implications

The practical implications for the public client are discussed in this section, based on the findings of the thematic analysis and the expert panel.

First of all, this overview helps public client to gain knowledge on what his decision on implementing PSS means for the public values he wants to secure. This knowledge is much needed as one of the main reasons why public clients are skeptical about PSS is that there is lack of knowledge concerning the effect of its implementation. Having this overview, public clients can include the values perspective in their decision-making process.

The overview can have implications for contracting. The analysis of the findings leads to interesting results concerning how contracting can foster PSS. One of the characteristics of PSS is transferring ownership to the contractor. Public clients can formulate contractual clauses in order to retain some control over the asset without having its ownership. Public clients, through requirements and penalty clauses, can transfer accountability to the contractor. Since contractor's purposiveness is not evident, it can be motivated by public clients through contract clauses (rewards). Moreover, public clients need to focus on how they could measurability the results of PSS implementation. That will make their contracts clearer and more transparent. Additionally, the Legal advisers of public clients should overcome their hesitance and become more accepting towards PSS.

Public clients need information about how their values are affected when PSS is implemented. To sustain a balance in their values, they should acknowledge what conflicts and tradeoff concerning their values may arise. That enables them to focus their attention on those conflicts and either accept those or take actions to solve them. To ease the conflict of lawfulness versus collaboration, public clients should try to enhance trust among the partners instead of collaborating with already trustworthy partners. Public clients should also decide the degree of transparency and honesty

that they should reach in order to facilitate the collaboration with the contractor, while simultaneously safeguarding their data.

6. Conclusions

6.1 Major insights

In chapter 6 the conclusions of the research are presented: How are public values affected when public actors that own infrastructure assets implement PSS? Four sub-questions are defined. Answering those sub questions leads to answering the main research question. Those sub-questions have a certain logic of how they are defined. First of all, there is an explorative sub-question (1), then a methodological sub-question (2), then a results-oriented sub-question (3) and finally an implications sub-question (4). This structure ensures that all the necessary steps are followed, in order for the research to be of value based on scientific principles.

- **Sub-question 1:** ***How is the PSS model for infrastructures framed from a public values perspective?***

The first sub question concerns the theoretical exploration of the research topic. This is realized through literature review, with papers and reports. The literature review of the research has two main pillars; PSS and public values. Those two subjects are reviewed by conducting a literature review. Those pillars are combined, and their combination answers sub-question 1.

To begin with, public values is one of the two pillars of the conducted literature review. Public clients undergo several transitions in the past years, as new societal needs submerge. An interesting perspective to study how public clients undergo these transitions is the perspective of their public values. Literature suggests that when public clients undergo transitions, their public value framework is also affected. Kuitert et al. (2018) gathered the public values of Dutch infrastructure actors and presented a public value framework for construction clients, consisting of 23 values. This public value framework is the outcome of the second pillar.

The second pillar that completes the performed literature review is PSS on infrastructure. Since PSS is a business model that is not widely implemented in infrastructure, it is also not widely understood. For that reason, it is important to obtain a deeper understanding on PSS. Even though there was a difficulty in locating relevant articles, PSS needed to be comprehended. To achieve this comprehension, the main

characteristics of PSS were defined, along with the way that PSS works when implemented in infrastructure. To deepen the knowledge on this second pillar of the literature review, benefits of PSS on society, environment, contractor and client were defined. On the other hand, PSS is not (yet) implemented in Dutch infrastructure, because of the inevitable barriers its implementation entails. Those barriers are also of significance for the research and they are also stated in a subchapter.

Purpose of conducting the literature review and studying about PSS and public values of Dutch construction actors is to combine them in a framework concerning the values that are linked with PSS characteristics, benefits and barriers.

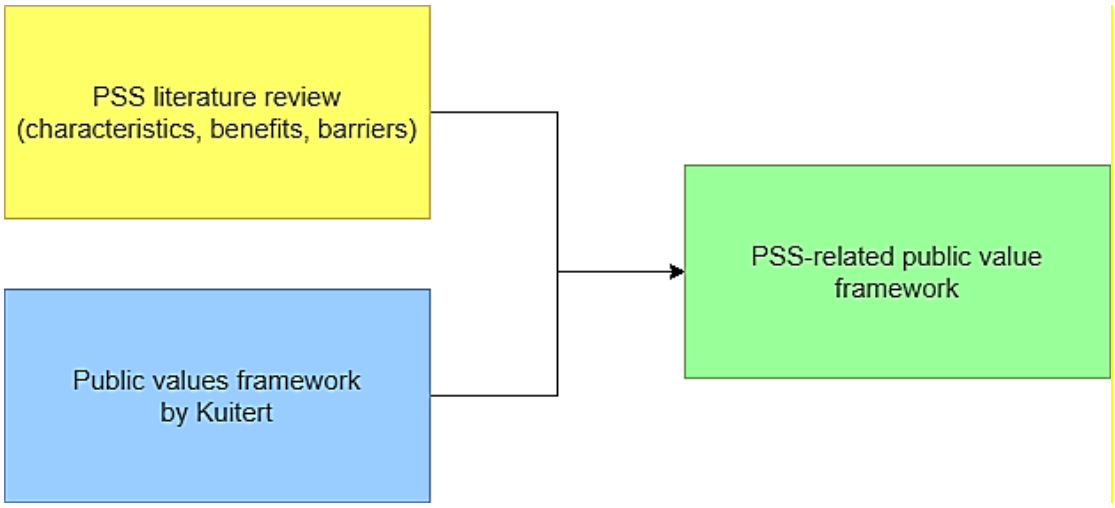

Figure 5-PSS-related public value framework

The figure above shows the two pillars that were combined, resulting in developing a suggested framework. The suggested framework is the PSS-related public value framework. The values that compose the framework are the public values of the framework by Kuitert et al. (2018) that are linked to characteristics, benefits or barriers of PSS. Those values are the most relevant-to-PSS public values, so these values are the ones that are coupled with the implementation of PSS. As a result, the following framework is designed:

PSS-related Public Values	*Keywords*
Procedural Values	
Lawfulness	Rightfully, legal, righteous
Accountability	Responsibility, liability, duty, ownership
Collaboration	Cooperation, partnering, unity

Transparency	Openness, controllable, clarity, clearness
Honesty	Justice, equitable, equivalence
Wisdom	Understanding, knowledge, insight, information
Performance values	
Effectiveness	Purposiveness, contribution
Product values	
Quality	Requirements/specifications/standards, quality of service
Innovative	Innovative, change, improvement product/process
Ecological sustainability	Environmentally friendly, sustainable use of raw materials

Table 3-Framework used as interview input.

This suggested framework will serve as input for the interviews. Participants of the case study will comment on the PSS-related public values and how they were affected when PSS was implemented in the guardrail pilot of the Circular Road Program. After that is completed and the case study's findings are analysed, an expert panel will reflect on the PSS-related public value framework. This ensures that the suggested framework will be validated and generalized for other public bodies as well.

- **Sub-question 2: How to analyze a real-life implementation to study what values are critical to public clients to decide whether they want implementation of PSS or not?**

In the next sub-question, the methodology used for the study of the PSS related values is discussed. In this chapter, methodological decisions are made and justified. The research method selected is the case study design, because it allows the exploration of real-life practices. Apart from documentation, interviews are conducted in order to collect the data needed for the analysis. Lastly, the findings produced from the thematic analysis need validation. For that reason, an expert panel is organized, allowing experts from various public bodies to reflect on the findings allowing experts from various public bodies to reflect on the findings, which are then compared between theoretical and empirical findings.

The sub question 2 is answered by designing the process of the whole research. That can be illustrated in the figure below;

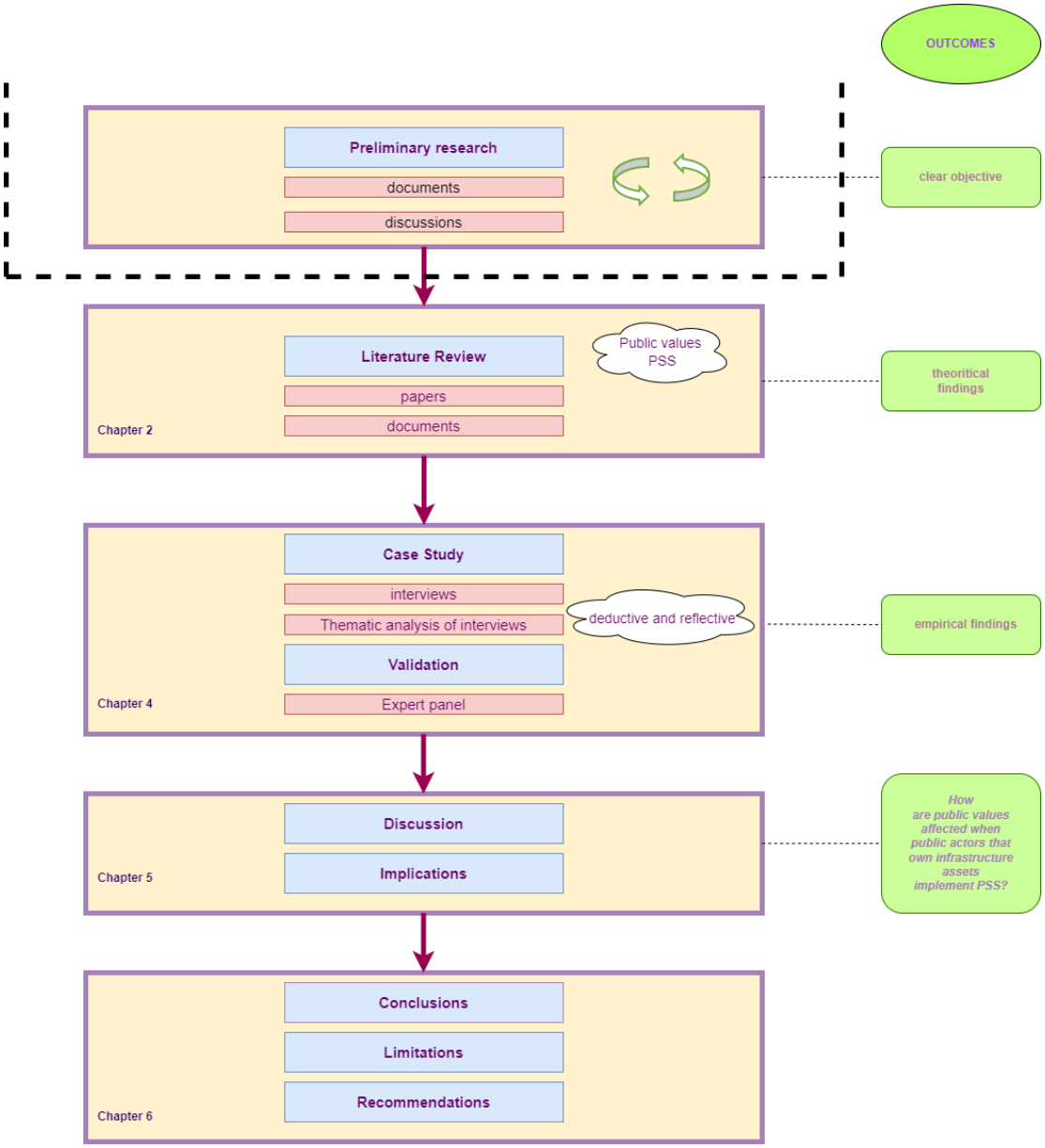

Figure 6-Research process

- **Sub-question 3: What does the pilot of guardrails as part of the Circular Road provide as learnings for the coupling of PSS with public values, in comparison to usual practice?**

Deductive round; during this round, the themes are predefined. Those themes are the public values that form the PSS-related public value framework, namely Lawfulness, Accountability, Collaboration, Transparency, Wisdom, Honesty, Effectiveness, Quality and Innovation. The transcripts of the interviews are scanned and the parts where those themes are identified are highlighted. Those themes are the patterns that are

found in the data. In the end of this round, the data for each value are combined and conclusions are drawn for each value.

Reflective round; during this round, the most significant topics are noted down for each interview. The codes are not predefined but they emerge from the data. Those codes refer to information concerning either the values of the first round or topics that the interviewees wanted to discuss about, as they believed those were important for the pilot. After those codes are found, they are grouped accordingly to their context in wider categories. Where possible, they were incorporated in the already existing themes from the first round (Wisdom and Collaboration). Where this is not possible, new categories are created. Those categories are new themes that are going to serve as extra points of attention latter on. They will be discussed in chapter 5 Discussion. The new themes are Goal, Contracting and Human Factor.

Integration; when both of the two rounds of analysis are complete, the themes from the first and second round need to be integrated, to conclude to the final integrated themes of the analysis. The codes from the second round are integrated in the themes of the first round where possible. The final themes are the adjusted first round themes and the second round (new) themes.

In summary, the analysis findings are the learnings that emerged from the pilot, based on the analysis of the participants interviews. They can be found in Appendix A.

- **Sub-question 4: How are findings validated and generalized for other public clients?**

To validate the analysis findings but also offer a generalized perspective to them, an expert panel is organized. Experts from various public clients reflect on the findings based on their knowledge and experience. Findings from the analysis served as input on the expert panel and they were either confirmed or adjusted where required. Additionally, new points of attention emerge concerning the implementation of PSS and how that affects the public values of interest. The comments of the experts are noted down and processed, in order for clearer output to be extracted as the feedback of the expert panel. In this way, the empirical findings are validated and generalized.

This feedback can be shown in Appendix B. This is answering sub-question 4.

After answering all the sub-questions, it is time to combine them and answer the main research question. Answering the research question is the goal of the whole research. The research question is the below:

- **How are public values affected when public actors that own infrastructure assets implement PSS?**

An overview is presented. PSS related public values are discussed on how they are affected when PSS is implemented. Theoretical findings (literature) are compared to empirical findings (interviews and expert panel), and the most interesting differences are pointed out. This overview helps public clients gain a deeper understanding of how their values are affected when PSS is implemented. This is important because public clients need knowledge that can facilitate their decision making concerning the implementation of PSS in their organization.

One of the main barriers in PSS implementation is that current legislation sets limits to PSS. Of course, the purpose of the law is correct, but the law Is written with linear model in mind. Since public clients are interested in implementing PSS, the law should be rewritten with PSS in mind.

Another public value that is very affected with implementation of PSS is accountability. Even though theoretically the public client is not responsible for the asset, as he doesn't have control on it, the public still believe that responsible are the public clients. As a matter of fact, the public client can have control on the asset through contractual clauses. If we consider the great cause of implementing PSS, achieving circularity it is not relevant who is held accountable at the end.

As far as collaboration is concerned, it is closer when PSS is implemented. Internal conflicts may arise, due to the difficulty of understanding how PSS works when someone is not involved in its implementation. In a successful PSS implementation, public client and contractor may have different organizational goals but try to accomplish them together.

Lastly, innovation is also affected. PSS is innovative for infrastructure, and partners should change their mindsets in order to accommodate it. Innovation has multiple aspects within a PSS project, and they should all be treated. In other words, a systemic approach is needed.

6.2 Limitations

There are several limitations for the research. These limitations were observed both during the data gathering and also during the generalization of the findings of the research.

First of all, there was limited literature available about PSS application in infrastructure. PSS is a known model for the business world, but it is considered innovative for the infrastructure sector. Due to that, not a plethora of papers and documents are available to conduct the literature review.

6.2.1 Limitations of data gathering

Number of interviews: This is a limitation of the present research, because there is a limitation in time and resources. As a master thesis, the timeframe of research is predefined and limited. It is decided to keep the number of interviews limited, but make the selection of participants carefully so that they are representative of the topic discussed and they have knowledge on the matter. That way, the interviews are more relevant and valuable. Additionally, the number is limited because only a few people were involved in the pilot of the guardrails. Moreover, the involved members had limited availability and were hard to reach. It was quite difficult to convince people to spend time in research, and that decreases the number of interviews that can be scheduled within the timeframe.

Subjectivity: The data gathered on this research are via interviews. As a consequence, the data are based on individuals that are being interviewed and their personal experience. Based on that, the data are strongly interconnected to personal perspective. As a consequence, subjectivity issues also arise. Subjectivity is also present from the researcher's point of view, as interpreting the results is also highly subjective.

Language barrier: Language was a limitation throughout the research. Several documents were available only in Dutch. Moreover, most of the interviewees are Dutch, and as a result people were hesitant to participate in the research.

6.2.2 Limitations on generalization of findings

Only a pilot and it was a test: The case study studied concerned a test pilot of Province of North Holland. It was a quite small-scale pilot with only a few kilometers of road being studied. This can be considered as a limitation, as the small size of the pilot can restrict the generalization of the findings.

Pilot completed in a few months; full contracting period not considered: PSS implies long-term contracting but this pilot was completed in a few months. This is a limitation because the full impact of PSS was not taken into account.

PSS-related values instead of the whole framework: In chapter 2.4, a theoretical framing of PSS related public values was presented. From all the public values summarized by Kuitert et al., (2018), only the most relevant values were taken into consideration. The 23 general public values were reduced to the 11 most relevant to PSS, according to the literature review that was conducted. As a result, additional results of interes may be missing, concerning the remaining values that were left out.

6.3 Recommendations for further research

This sub chapter provides recommendations for further research based on the gathered information by documents, interviews and the expert panel.

The first recommendation concerns the conflict that arises for the public client about sharing information. Being honest and transparent with the information is significant in order for close relationships to be built, but public clients handle sensitive information that they need to safeguard. This dilemma needs investigation; how much and what type of information should public clients share with contractors?

Another recommendation is to study different type of assets. Guardrail is an asset that has strict technical requirements that do not leave much room for innovation. Choosing another type of asset can be useful for further research, to examine how different assets that are more fitting to the philosophy of PSS as a model can perform. It is recommended for further research to study assets that the service they provide is more linked with the experience of the user and its performance is measured more easily. If possible, the scope of the aforementioned case study should be big enough so that PSS can be fully developed in the long term. That allows public clients to get the full impact of the overview.

During the interviews, it was mentioned that Netherlands has certain differences compared to other European countries (Denmark, France) about how PSS is perceived. In the Netherlands, legal advisors are extra careful and there is not extended experience of how PSS is implemented in infrastructure and the impact it can have. Therefore, a comparison case study is recommended, to investigate the similarities and differences observed in projects of different countries. This can lead to interesting conclusions that can be utilized by Dutch actors to their decision making.

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Appendix A

Below the Initial findings are presented. Firstly, the final themes are given (Table 11) and then the additional themes are presented (Table 12).

PSS-related Public Values	*Initial Findings*
Lawfulness	Dealing with public money makes public client extra careful on how they explain their legal obligations. Procurement law sets limits
Accountability	Accountability still with the public client in the public eye but now they cannot have an impact because of ownership transfer
Collaboration	Different inside the pilot and outside. Inside it was good because they were already partners. Outside there was mistrust towards the contractor because of contractor's intentions and goals. They disagree on who initiated it
Transparency	Due to procurement law everything needs to be transparent about setting requirements and calculating residual value.
Honesty	Open data sharing is needed , collaborate with trusty partners
Wisdom	Public client can obtain knowledge about how PSS works but not a deep understanding. They can also obtain information about the status of the assets.
Effectiveness	Public clients have a long-term purposiveness on a social level, contractors don’t have it
Quality	strict technical requirements for guardrails Different way of defining quality (through functional requirements)
Innovative	Different ways of about how innovation is perceived Mainly technical
Ecological sustainability	Nice sustainability results IF you act proactive

Table 4-Initial Findings-Final Themes

Additional themes	*Findings*
Goal	They have different ambitions. Contractors want larger margin. Public clients have societal task
Contracting	Difficult because guardrails are not measurable and not based on technology. Limited scope so they missed the full impact of the model
Human factor	It is crucial and they lacked asset management knowledge. The internal communication of the public client had issues.

Table 5-Initial Findings-Additional Themes

Appendix B

Values	*EMPIRICAL FINDINGS*		
	Thematic analysis findings- Input for expert panel	*Feedback from expert panel*	*Validated generalized Empirical findings*
Lawfulness	• Dealing with public money makes public client extra careful on how they explain their legal obligations. • Procurement law sets limits	• PSS is innovative, laws and regulations don't fit within the system, because they are made to suit a linear situation. • Every innovation is looked upon with hesitance. • PSS may be unlawful at the moment, but it is not undesirable. • PSS should stimulate changing the law (Not its purpose but on regulations, the way they are written). • Legal advisers extra careful/hesitant due to construction frauds.	• Dealing with public money makes public client extra careful on how they explain their legal obligations. • PSS, like every innovation, is looked upon with hesitance. • Procurement law sets limits to PSS. Laws and regulations don't fit within the system, because they are made to suit a linear situation. • PSS may be unlawful at the moment, but it is not undesirable.

			• Legal advisers of public clients are extra careful/hesitant due to construction frauds. • PSS should stimulate changing the way the law is written, not its purpose
Accountability	• For the public, accountability is still with the public clients. • Public clients believe that they can't have an impact because of ownership transfer.	• Initial finding is not true because public clients can have an impact through contractual clauses. • Clarity in contracting is important. • Requirements as a mean to impact accountability • Penalty clauses on the contract, transfer responsibility to the contractor to meet certain objectives. • Split of legal and economic ownership, as a mean to clarify responsibilities. • Accountability is irrelevant for a greater cause	• Public clients believe that they can't have an impact because of ownership transfer BUT they can have an impact through contractual clauses. • Clarity in contracting is important. • Requirements as a mean to impact accountability. Penalty clauses on the contract, transfer responsibility to the contractor to meet certain objectives. • Split of legal and economic ownership, as a mean to clarify responsibilities. • For the public, accountability is still with the public clients. • Accountability is irrelevant for a greater cause

Collaboration	• Different perspectives inside the pilot vs outside. • Inside it was good because they were already partners. • Outside there was mistrust towards the contractor because of contractor's intentions and goals. • They disagree on who initiated the pilot.	• If collaboration is successful, a joint team is created and therefore initiative party is irrelevant. • Innovative projects are “like going on an adventure together with a sketch, not a full map”. • Partners should be honest to their relationship. • True collaboration means that they respect different organizational causes. • Common achievement of different organizational goals. • Mistrust is a consequence of traditional roles and responsibilities of involved parties.	• Different perspectives of people inside the pilot vs outside. Inside it was good because they were already partners. Outside there was mistrust towards the contractor because of contractor's intentions and goals. Mistrust is a consequence of traditional roles and responsibilities of involved parties. • If collaboration is successful, a joint team is created and therefore initiative party is irrelevant. • Innovative projects are “like going on an adventure together with a sketch, not a full map”. • Partners should be honest to their relationship. • Common achievement of different organizational goals. True collaboration means that they respect different organizational causes

Transparency	• Due to procurement law everything needs to be transparent about setting requirements and calculating residual value. • Find a way to measure things.	• Validation of findings	• Due to procurement law everything needs to be transparent about setting requirements and calculating residual value. • Public client should find a way to measure things.
Honesty	• Open data sharing is needed. • Only collaborating with partners you trust.	• To make PSS work, a great level of trust between the partners is required. • Instead of collaborating with trustworthy partners, enhance trust among partners. • Trust is established at the beginning but maintaining it is a continuous point of attention throughout the process. • Open data sharing is a prerequisite of trust. • Partners need to align their mindsets in order to align and maintain trust. • Data sharing is required for decision-making but should also be safeguarded.	• To make PSS work, a great level of trust between the partners is required. • Instead of collaborating with trustworthy partners, enhance trust among partners. • Trust is established at the beginning but maintaining it is a continuous point of attention throughout the process. • Open data sharing is a prerequisite of trust. Data sharing is required for decision-making but should also be safeguarded. • Partners need to align their mindsets in order to align and maintain trust.
Wisdom	• Public client obtain knowledge about how	• PSS is insecure new territory. Acknowledgment of lack of knowledge is	• PSS is a way to obtain knowledge. PSS is a spinoff, to initiate discussion towards

	PSS works but not a deep understanding. • They also obtain information about the status of the assets.	compensated by confidence of finding the right solution. • PSS implementation doesn't necessary results in obtaining new wisdom. Action should be taken before initiating the contract to gather the required data. • PSS is a spinoff, to initiate discussion towards circularity. • PSS is a way to obtain knowledge. Combination of same data in a different way, leads to wisdom.	circularity. PSS implementation doesn't necessary result in obtaining new wisdom. Action should be taken before initiating the contract to gather the required data. • Acknowledgment of lack of knowledge is compensated by confidence of finding the right solution. • Combination of same data in a different way can lead to wisdom. • Public clients can also obtain information about the status of the assets.
Effectiveness	• Public clients have a long-term purposiveness on a social level. • Contractors don't have it.	• PSS implies long-term contracts. • Public clients have inherently effectiveness as a value • Contractors can potentially be motivated to increase their social effectiveness, although it's not part of their role. • Effectiveness can be artifacted through contract clauses (rewards). • PSS contributes to circularity as a system, so individual effectiveness insubstantial.	• PSS implies long-term contracts that fits the long-term purposiveness of the public clients on a social level. • Public clients have inherently effectiveness as a value. On the contrary, contractors can potentially be motivated to increase their social effectiveness, although it's not part of their role. Effectiveness can be motivated/artifacted through contract clauses (rewards).

			• PSS contributes to circularity as a system, so individual effectiveness insubstantial.
Quality	• Strict technical requirements for guardrails • Different way of defining quality (through functional requirements)	• Functional requirements leave room for innovation to thrive. • Circularity can be achieved through widespread implementation of a single concept (standardization) • Circularity can be achieved by innovative tailor-made solutions. Those two options are mutual exclusive.	• PSS suggests a different way of defining quality (through functional requirements). Functional requirements leave room for innovation to thrive. • Guardrail have strict technical requirements
Innovation	• Different ways of about how innovation is perceived. • Mainly technical innovation in the pilot.	• Perception of innovation (only technical) is an interesting finding, as there were different innovative aspects (contract, financial, etc.) involved in a huge innovative initiative. • Those aspects were not apparent, although it was a big social innovation. • All of those innovative aspects need the right attention and treatment, for a successful PSS implementation. • Whole system approach is needed.	• All innovative aspects (contract, financial, etc.) need the right attention and treatment, for a successful PSS implementation. Whole system approach is needed. • Those aspects were not apparent in the pilot, although it was a big social innovation. Mainly technical innovation in the pilot.
Ecological sustainability	• Nice sustainability results. • If you act proactively.	• Sustainability as an initial goal.	• PSS implementation can lead to sustainable results. PSS stimulates

	• Expensive to get the results.	• Focus on sustainable aspect of PSS, in order to achieve sustainability results. • PSS stimulates circular solutions which relates to social effectiveness. • PSS implementation can lead to sustainable results.	circular solutions which relates to social effectiveness. • Public clients should have Sustainability as an initial goal and focus on sustainable aspect of PSS, in order to achieve sustainability results.

Table 6-Empirical Findings-(detailed)