REDUCING AMBITION EROSION TO ACHIEVE STRATEGIC SUSTAINABILITY AMBITIONS

A RESEARCH ON THE REALISATION OF STRATEGIC SUSTAINABILITY AMBITIONS IN THE EXPLORATION PHASE

BY CRISTEL VEEN

MASTER THESIS

DELFT UNIVERSITY OF TECHNOLOGY

Royal HaskoningDHV
Enhancing Society Together

TU Delft Delft University of Technology

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by

Cristel Veen

Student Name	Student Number
C. Veen	4556712

Chair:	Dr. Ir. A. Straub
1st Supervisor:	Dr. Ir. E.J. Houwing
Supervisor Royal HaskoningDHV:	Dhr. P. Gosselink
Project Duration:	Dec, 2022 - Jul, 2023
Faculty:	Faculty of Civil Engineering, Delft

Royal HaskoningDHV
Enhancing Society Together

TU Delft

Preface

This master thesis was written and researched for the master Construction Management and Engineering at the Delft University of Technology. In order to obtain my masters degree, I have conducted research on sustainability within the civil engineering infrastructure sector from December 2022 until June 2023. After 3 years studying this master, I am excited to finally finish my degree by investigating a topic that I feel very passionate about and requires improvement within my field of study. The past seven months have had their ups and downs, humbling me with the euphoric feeling of discovering something new in science while also experiencing the challenges of uncertainty at times.

I would like to express my gratitude to my thesis advisor, Ad Straub, for his guidance throughout this research. Erik-Jan Houwing, my primary counsellor, has been instrumental not only in advising me on this master's thesis but also in other projects during my studies. Thank you for the continuous motivation to explore further and for our numerous brainstorming sessions. This research was carried out in collaboration with Royal HaskoningDHV, and I would like to thank Peter Gosselink for providing insights into sustainability within the infrastructure sector and enabling me to write my thesis in partnership with the company.

On a personal note, I would like to extend my appreciation to my parents who have supported me in every way for the past 7 years. I am also grateful to my brother and sister, who have always been ready with advice when needed. I would like to thank Jule and Anniek for their unwavering support throughout my academic journey. A special thank you goes to my roommates, who have been by my side through the highs and lows of the past three years and have shown me true friendship, especially during the last seven months. Femke, thank you for being there to listen to me discuss all the little things in life, whether it was during our tiring yet joyful morning bus rides or coffee breaks at the faculty. Without you, I couldn't have accomplished what I have, and it wouldn't have been the same. To Thomas, for his remarkable ability to always make us laugh and his never-ending supply of free coffee. A thank you to Jade for being a constant source of inspiration, for encouraging me to pursue my ambitions, and talking about all the possibilities in the future. To my friends who were graduating alongside me and who provided daily motivation and support at the faculty. These are all memories that I will cherish forever.

The goal of this research was to investigate how ambition erosion can be reduced and strategic sustainability ambitions can be safeguarded into realisation. With the knowledge I have from my bachelors and masters and my passion for sustainability, I wanted to understand why strategic ambitions were hindered within the construction process. Therefore, I investigated the process itself, the barrier to sustainability, how they are formed and what sustainability actually means within the infrastructure sector. The research employed both theoretical and empirical approaches, involving semi-structured interviews and case studies to gain a comprehensive understanding of the situation and how to improve it. This research contributes to the scientific community by addressing ambition erosion within the construction process, which has not been extensively studied, and by identifying the barriers that exist in the exploration phase. From a practical standpoint, this research adds value as it results in a framework that can be used by consultancy engineers to safeguard strategic sustainability ambitions into realisation. By following the steps outlined in the framework and increasing engagement and collaboration within the project team and between stakeholders, ambition erosion can be reduced, and strategic sustainability ambitions are safeguarded into realisation.

Delft, June 2023

Abbreviations

Abbreviation	Meaning
ECI	Environmental Cost Indicator = Milieu Kosten Indicator (MKI)
BPQV	Best Price Quality Value
GRH	Ground, Road, and Hydraulic Engineering sector
RHDHV	Royal HaskoningDHV
TBL	Triple Bottom Line

Table 1: Abbreviation and its meaning

Summary

Sustainability has gained global recognition due to the detrimental effects of human activities on the environment, resulting in climate, and weather extremes. In the Netherlands, various sectors, including construction, ICT, textiles, and catering, are required to enhance their sustainability practices. The infrastructure sector, responsible for 30% of the country's carbon dioxide emissions, has become a focal point for policymakers. Factors such as non-renewable material use, machinery energy consumption, habitat destruction, and infrastructure type have contributed to its environmental impact (CO2 En Milieu, 2020). As part of a nationwide sustainable transition, the Dutch government has set ambitious goals to make the construction within the infrastructure sector more sustainable, aiming to reduce primary resource usage by 50% by 2030 and achieve full circularity by 2030. These ambitions are outlined in regulations and policy, thus form strategic ambitions (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2022). However, these strategic sustainability ambitions are often not fully realised as ambition erosion occurs (CROW, 2011).

How can ambition erosion be reduced and strategic sustainability ambitions be safeguarded into realisation?

Methodology

This research aims to investigate the realization of strategic sustainability ambitions within the construction process of the Ground, Road, Hydraulic Engineering sector within the infrastructure sector. It employs a combination of theoretical and empirical research methods to gain a comprehensive understanding of the barriers and challenges associated with sustainability in the sector.

The theoretical research involves a literature review to explore existing theories on sustainability, barriers to ambition, and the necessities for the formulation of strategic sustainability ambitions. Scientific journals, papers, reports, and books are used as sources. The empirical research comprises semi-structured interviews with engineering-consultancy firms and contractors. The interviews are translated to empirical data through a thematic analysis based on the framework of Braun and Clarke (2021) and aim to gather insights into the realisation of strategic sustainability ambitions and their realisation from a practitioner's perspective. Moreover, a case is conducted to analyse the occurrence of barriers and the translation process of a strategic ambition within an approach established and suggested by Duurzaam GWW, a government-supported initiative. The case study investigates, the placement of barriers within the process and the necessary stakeholders for safeguarding and realising the ambitions. The research also includes a validation phase with expert interviews to gather feedback and refine the model during which the RACI framework was implemented to clarify and allocate roles in each step of the process. By combining theory, interviews and a case-study, a comprehensive framework is redesigned that answers the research question.

Results

The research employed a combination of theoretical and empirical methods, including a case study, to improve the exploration process and address ambition erosion in realising strategic sustainability ambitions. The findings suggest that clear and comprehensive definitions of sustainability, incorporating all three pillars (People, Planet, Profit), are necessary to stimulate the sustainability transition for future generations. Successful realisation of ambitions requires a clear continuation from strategic to tactical and operational levels. However, barriers exist in the process of defining, establishing, specifying high-level strategic sustainability ambitions into project-level requirements and validate them. The research identified 28 barriers from theory and empiricism categorised into four themes: (1) capacity building, (2) motivational related, (3) collaboration related, and (4) process related barriers.

The framework improves the process by implementing actions, such as conditions, steps, and instruments, to mitigate barriers and reduce ambition erosion, depicted in a shrunk version of the final framework in Figure D.1 in Appendix D. This includes using instruments like ECI values, DuboCalc, Ambitieweb, and Omgevingswijzer, as well as setting conditions and steps. For example: ensuring information availability, measurability of measures, qualitative and quantitative requirements balance, cost indication, scope definition, a minimal sustainability achievement, and mandatory demonstration of realised measure

Next to additional steps and tools, internal and external collaboration is implemented in the framework. To continue ambitions into realisation, external collaboration among stakeholders such as consultancy-engineering firms, contractors and public clients is crucial. Creating a shared understanding of sustainability, increasing knowledge, and stimulating implementation can increase the willingness and intrinsic motivation to strive for sustainability. Internal collaboration is suggested for engagement within the project team by allocating roles, responsibilities and accountability to uphold the sustainability ambitions.

Compared to the approach by Duurzaam GWW that is currently used, the redesigned framework provides extra steps/conditions that mitigate the barriers and shows what actors, roles and specific functions are necessary to realise the strategic ambitions. Furthermore, the redesigned process focuses more on the aspects of defining, establishing, specifying and validating as the Duurzaam GWW incorporated the tender procedure. Also, other tools such as the BPQV criteria tool and methods of analysis are added to the framework which are not stated in the approach. These enhancements contribute to a more effective realisation of strategic sustainability ambitions at the project-specific level.

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Problem Definition

1.1. Introduction

Ambition is a key driver for change and development of construction in the infrastructure sector. Specifically, sustainability ambitions are emerging to change the direction of the sector and transition it to an environmentally friendly industry. Recent scientific research by IPCC (2022) has emphasised the linear relationship between carbon dioxide emissions and the average temperature on Earth. Concluding that society is on a self-destructing path and cannot continue to proceed with the current way of producing and executing. Due to the warming of the earth, there have been extreme weather conditions over land and oceans, the sea level is rising, and ecosystems are being destroyed. With this course of action, our future will depend on the rate, peak and duration of warming which cannot exceed 1.5 degrees by 2100. One of the main solutions will be creating a net zero global anthropogenic CO2 emission society. In combination with forcing a reduction in non-CO2 radiative energy, it will reduce the risk of global warming for the next decades (IPCC, 2022). The industrial sector and infrastructure sector will need to adapt to mitigate the risk of the global temperature rising. To mitigate this risk, there is a need for the reduction of overall energy demand, the substitution of low-carbon materials in the infrastructure sector, progress with circular economy, the implementation of electric production and low-emission heat sources (Åhman et al., 2016). The infrastructure sector deteriorates climate change with its different processes such as construction, use and end-of-life. Several factors cause unfavourable environmental effects, for example, the production of steel and concrete contributed more than 7 % in 2007 (Allwood et al., 2011). The IPCC has set high global ambitions to resolve or mitigate the risks that can result from climate change. While climate change is a global problem, the Netherlands also has set high ambitions for sustainability development within the infrastructure sector.

1.2. Sustainability ambitions in the Netherlands

In the Netherlands, different sectors must improve to become more sustainable, thus the Dutch government has implemented multiple policies in the past five years to endorse and stimulate sustainability practices in different sectors. One of the big contributors to the climate crisis is, the construction of the infrastructure sector as it is responsible for 30% of the overall carbon dioxide emissions in the Netherlands (CO2 En Milieu, 2020). Several factors have led to the negative impact on the environment including the use and production of non-renewable materials, the energy consumption of machinery, the removal of ecology, and the type of infrastructure constructed. As a part of a nationwide sustainable transition, the Dutch government has expressed their ambitions to evolve the infrastructure sector to become more sustainable. These ambitions are expressed through regulations and policy and are strategically formulated. For example, decreasing the use of primary resources by 50% by 2030 and being fully circular in 2050 (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2022).

In 2017, the Ministry of Infrastructure and Waterways conducted research on the carbon dioxide emis-

sions of their projects. For the whole process beginning from extraction for production, transport, realisation and end-of-life, the ministry is responsible for 0.7 Mton C02 emissions. Additionally, nitrogen oxides are harmful to our environment and are a residual product due to construction. Therefore, the government aims to achieve emission-less construction by 2030 resulting in an annual decrease of 1,9 kton of NOx, 0.2 megaton CO2 and 5-ton fine dust (Ministerie van Landbouw, Natuur en Voedselkwaliteit, 2022).

For the Ground, Road, and Hydraulic Engineering (GRH) sector, there are four main infrastructure networks: the main rail network, the main road network, the main waterway network, and the main water system. The Ministry of Infrastructure and Water Management has the ambition to work climate neutral and circular on these objects by 2030. Examples of the implementation to achieve these goals are the use of electric construction vehicles and the use of recycled asphalt. By implementing these types of solutions, a reduction of 25% will be achieved. In order to realise a reduction of 50%, the focus needs to be put on different methods of working, different systems, different production processes, sustainable procurement and innovative norms. This sector has a significant impact on the environment; however, sustainability practices are still lacking in this sector. Specifically the following points caused by the GRH sector have an impact on the environment (Schouten, 2022):

1. Infrastructure projects hinder the environment and habitat of flora, fauna, and animals. Moreover, the extraction of resources to produce materials and conduct construction also have an impact on that habitat. For example, constructing a road or renovating a bridge can divide the habitat of animals in two (Schouten, 2022).
2. The emissions of greenhouses are caused using resources to extract and produce materials such as steel and concrete which is often used in the GRH sector. Additionally, vehicles and machinery produce greenhouse emissions as they primarily run on fossil fuels (Schouten, 2022).
3. Nitrogen is a significant issue within the civil engineering sector and construction in the GRH sector as machinery also emits nitrogen and has an impact on the surroundings of the project (Schouten, 2022).
4. Within the GRH sector, there is an increase in toxic or contaminated substances, more specifically known as PFAS. The soil becomes contaminated with these substances which cannot be processed resulting in an impact on the project and its environment (Schouten, 2022).

To achieve a sustainable transition within the sector, the government collaborates with sustainability platforms but also relies on engineering-consultancy firms and contractors to be innovative within their practice. Moreover, the Dutch government stimulates the market to evolve by implementing buying strategies, rules and regulations and innovation programs to stimulate sustainability implementations on all aspects (Ministerie van Infrastructuur en Waterstaat, 2023b).

1.3. Sustainability ambitions within the construction process and its stakeholders

Governmental organisations or public clients have formulated their ambitions into policy objectives. Due to different factors such as the process itself but also the actor's interests, thus ambition erosion occurs during the construction process. Ambition erosion indicates the gradual loss of ambition through a process. Consequently, the different phases and actors involved to achieve sustainability ambitions either cause or influence ambition erosion (CROW, 2011).

1.3.1. Actors and Process

Ambition erosion occurs throughout the construction process. Each phase focuses on different attention points during which ambitions are formulated on a certain level and can be stimulated or lost. The construction process consists of different stages in which ambitions are carried through shown in Figure 1.1. Within the GRH sector, there are five different phases of an object that can be distinguished ranging from (1) initiation, (2) exploration, (3) elaboration and (4) realisation to (5) maintenance and demolition (Ministerie van Infrastructuur en Waterstaat, 2022b, Gerardi, 2022):

Phase 1: Initiation

During this phase, the initial strategic sustainability ambition is set. A governmental organisation, functioning as a public client will address a problem within the infrastructure sector.

Phase 2: Exploration
During this phase, the problem is analysed by the consultancy-engineering firm that is representing the public client. During this phase, actions/measures that will help achieve the ambitions are considered. The exploration phase considers three aspects:

1. Project conception: This step forms the basis of the conception of what will be achieved in the project and how to fulfil the initial ambitions set in Phase 1.
2. Design phase: Design occurs before the elaboration during which procurement begins. Once the objectives of the project are clear, it is the responsibility of the consultancy-engineering firm to put the ambitions on paper for the contractor. The design step involves schematic design, contractual design and design development.
3. Preliminary cost evaluation: A cost estimation is done before proceeding as the costs of works, and materials to achieve the initial ambitions are necessary to ensure the feasibility.

This stage is also where bidding occurs. The above steps are used to form project specifications that are used to place inquiries towards the contractor.

Phase 3: Elaboration
During this phase, the final actions are established. Pre-construction services and procurement occur. This broad phase incorporates multiple components before physical construction is conducted. The result of this phase should be a finalised planning, streamlined design, assembled supplies and labour. Next to a cost estimation process, this phase also considers procurement as a component. During procurement, the acquisition of the materials, labour and equipment is fulfilled.

Phase 4: Realisation
During this phase, physical construction takes off by a contractor. The planning that is drawn in phase 3, is started. During this phase certain factors are considered to stay aware of: logistics and storage, primary contract details, health and safety, quality control and possible design challenges. During and at the end of the renovated or constructed object budget, sustainability and planning are assessed as key performance indicators.

Phase 5: Maintenance and Demolition
During this phase, the renovated or construction object will need to be maintained. Moreover, at the end of the life cycle, partial demolition can take place.

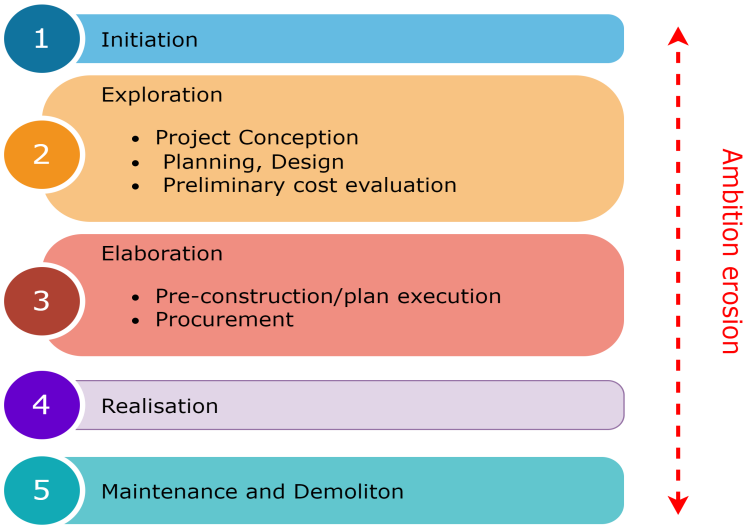

Figure 1.1: Construction Process

Within the infrastructure sector, there are different type of contracts that can be used for construction. However, ambition erosion occurs more within integrated contracts as not every requirement and criteria needs to be strictly specified and measurable. Within the construction process for integrated contracts, there are three standard stakeholders with specific roles involved in and responsible for continuation of ambitions (Pianoo, 2023):

- **The public client** initiates the project and sets the strategic sustainability ambition.
- **The consultancy engineering firm** that represents the public client. Depending on the contract, they are responsible for the design/engineering and fulfilling the roles of:
  - Project manager: focuses on the safeguarding of quality and is responsible for the final delivery of the object.
  - Environmental manager: focuses on the relationship between the environment and related stakeholders. This role is responsible for the contact with the surroundings where construction takes place.
  - Technical manager: focuses on the control of risks and knowledge within the technology and organisational aspects of the construction.
  - Contract manager: focuses on the relationship between the client and the market (contractors). This role is responsible for the buying phase and the contracts between the different parties.
- **The contractor** who carries out the works and depending on the contract can also be responsible for the design.

However, the different phases of the construction process influence the continuation of the initial ambitions. Renuka et al. (2014) reviews critical risk factors in the life cycle of construction projects and conclude that the two sources of risk are non-engineering and engineering. As ambitions are influenced by human behaviour, engineering risks such as client risk, design risk and contract management & tendering risk tend to impact the success of a project.

1.3.2. Formulation

To achieve the sustainability goals initiated by the Dutch government, ambitions are formulated on a strategic level. Main ambitions such as ‘circular by 2030 or carbon-neutral by 2025’ or transition pathways form a high-level basis for the implementation of sustainability.

Previous research has signified the demarcation of the three formulation levels for achieving sustainability ambitions. Bocken et al. (2019) analyse the development of circular economy strategies in organisations for which the S-T-O (strategic-Operational-Tactical) framework was used to investigate the development. The study concludes that the framework is a solid foundation to formulate and examine ambitions to achieve circularity goals. A study by Arababadi et al. (2017) aims to assess the energy policies of the European Union on strategic, tactical and operational levels. The research can formulate the energy policy for the three levels which aim to reduce greenhouse gases and promote renewable energy. Supporting the first research, this research also states that the strategic level is the overall goal. The paper describes the tactical level as specific measures and actions to achieve the policy. Finally, the operational level looks at the practical implementation while looking at measurements and feasibility for implementation.

Loewe and Rippin (2015) identify a gap in the translation of a strategic ambition as a challenge due to which sustainability targets are not achieved. The challenge to implement a high-level sustainable strategy into a project-level measure can be complex due to unclear targets and a divided industry. Within this process, different barriers occur due to which the high-level ambition does not align with the level of ambition in the end product. For example, Van Dijk et al. (2021) researched the translation of strategic sustainability goals such as the green deal for a toxic-free environment and highlights the misalignment between strategic ambitions and operational implementation possibilities. The research concludes that both policymakers and chemical scientists need to take additional steps within their process and develop tools and methods to increase the efficiency and transparency of their definition and establishing process. Similarly, Milhorance et al. (2022) emphasise the significance of translating

strategic policy and ambitions into actions in practice. The study examines the implementation gap in climate adaptation strategies in Brazil and Colombia and emphasises the necessity of understanding the translation process. In order to bridge the gap between strategic sustainability policy and practical outcomes, a strong commitment from all stakeholders, adequate financial resource allocation and alignment coordination mechanisms is crucial. Despite, the research conducted on a general policy level and within the chemical sector, there remains a research gap within the infrastructure sector.

Concluding, an ambition is formulated strategically by a public client and will need to be translated to the tactical and practical level for implementation. Within the construction process, ambitions are formulated on these levels. Figure 1.2 shows on the left side during which phase each ambition occurs or is formulated. Strategic ambitions are formulated at the highest level and form the basis in the initiation phase by the public client. During the exploration phase, these initiated strategic ambitions must be translated and specified to be able to perform in the elaboration phase by the consultancy engineering firm. Within the elaboration phase, operational requirements are necessary to conduct pre-construction, procurement and to be able to assess the sustainability performance. Thus, the translation process of the three formulations of ambitions occurs during the exploration phase. The right side of Figure 1.2 shows the translation of the ambitions happening within the exploration process and example of how each level of an ambition can be formulated in a specific way by a certain actor.

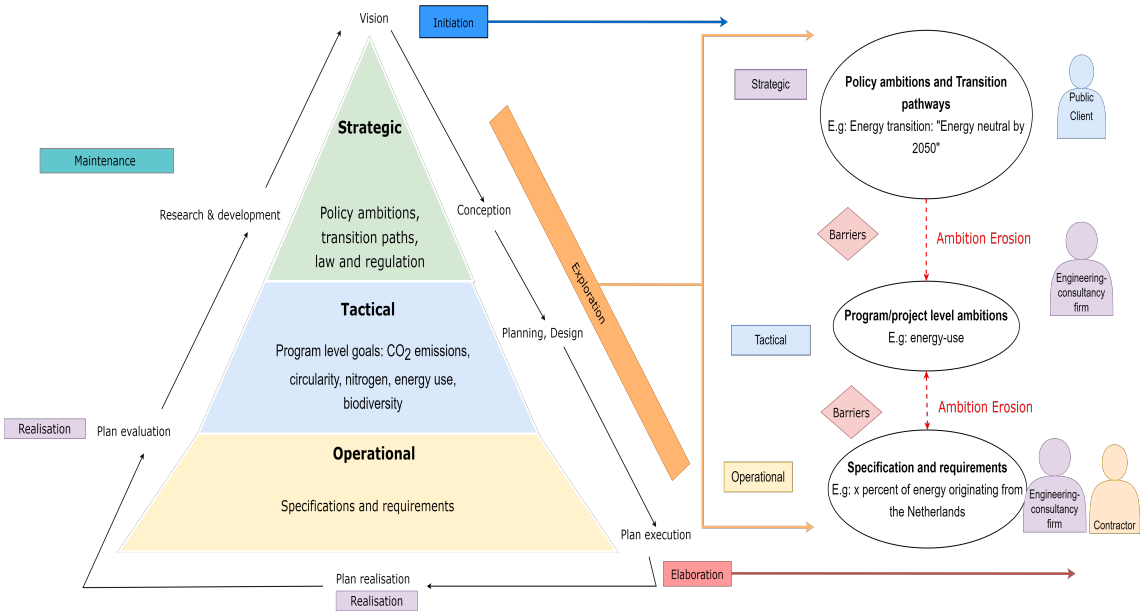

Figure 1.2: Ambition erosion within the exploration phase for strategic, tactical and operational formulations

Though the existence of barriers to sustainability has been identified within the infrastructure sector, their occurrence within the exploration phase of the process, specifically for strategic sustainability ambitions has not been researched. In order to realise strategic sustainability ambitions, it is necessary to understand when each barrier takes place in the process and how they can be safeguarded. Consequently, it is important to bridge the gap between scientific knowledge and practical implementations in the infrastructure sector, thus the gap should both theoretically and empirically be addressed (Kerkhoff and Lebel, 2006). Addressing this gap is crucial to effectively translate strategic sustainability ambitions into practical implementation within infrastructure projects. Therefore, the research focuses on the process from strategic ambitions to operational ambitions on the project level.

1.4. Research Question

How can ambition erosion be reduced and strategic sustainability ambitions be safeguarded into realisation?

1.5. Sub-Questions

- Sub-question A: What is the scope of sustainability within the infrastructure sector?
- Sub-question B: On what levels can ambitions be defined and what information is necessary to define and set ambitions?
- Sub-question C: What are the barriers to the continuation of ambition in the infrastructure sector and how can they be mitigated?
- Sub-question D: How do consultancy engineering firms working for public clients define sustainability ambitions during the exploration phase and how can it be improved?

2

Research Methodolgy

This chapter outlines the scope, relevance, and methodology to investigate the stated research questions. This research was conducted with a combination of theoretical research, semi-structured interviews, and a case study. As sustainability is constantly evolving within the infrastructure in the civil engineering sector, both theoretical and empirical research is necessary to arrive at a comprehensive understanding.

2.1. Scope

The scope of this research was limited to the infrastructure sector in the Netherlands with particular emphasis on the Groundwork, Road, and Hydraulic Engineering (GRH) sector. The research excluded the main rail network from this sector as it serves a different purpose and nature in its projects. Rail construction projects aim to facilitate train transportation for which construction, expansion, renovation and maintenance of the railways is necessary. Other types of infrastructure focus on the construction, maintenance, renovation, and improvement of transport and water infrastructure. The projects aim to increase mobility, accessibility, and the living environment, whereas rail construction focuses on ensuring the safety and efficiency of the rail network. Although both rail construction and other GRH projects fall within the same sector, they differ in specific technical and operational aspects, which could complicate the research as they may have contrasting ambitious visions. For example, rail construction must adhere to higher safety standards. Including the railway sector in this research would have resulted in a scope that was too broad given the time span of the research.

The research assumed an integrated contract agreement 'UAV-GC' and tendering process which allows an engineering-consultancy firm to represent a public client where the responsibility of the design and engineering can be for both the contractor and engineering-consultancy firm. This research specifically focused on the design of contract specifications and requirements for sustainability ambitions as they are relevant for defining, establishing, specifying, and validating ambitions from strategy to project level implementation. Within the exploration phase, designing the to-be-realised or renovated object was outside of the scope as it would have been too large of a research for the given time. Other phases, such as demolition, design, and supply were out of scope as well as the relevant stakeholders for these phases.

2.2. Theoretical Research

To understand the theoretical point of view on strategic sustainability ambitions and their barriers, a literature study was conducted. It was necessary, to analyse what science stated on the topic, to fully comprehend why sustainability is still a challenge within the construction process. Moreover, the literature explored the definition of sustainability, the barriers to ambition and the levels of ambitions. By reviewing existing theories on these concepts, a comparison was made with empirical data. For the

literature review, scientific journals, papers, reports, books, government reports, and internal publications from Royal HaskoningDHv 'RHDHV' were used. The following sub-questions are investigated by researching its existing theoretical knowledge:

- *Sub-question A: The definition for sustainability for this research was analysed through literature.*
- *Sub-question B: The levels of ambitions and the necessary information to define them are investigated through literature.*
- *Sub-question C: The existing barriers from scientific and management literature were investigated.*

2.3. Empirical research

The empirical research was partially executed through semi-structured interviews as a means to gather empirical data. Semi-structured interviews were used for data collection and to open the conversation with relevant stakeholders. This type of interview was chosen as it allows the researcher to gather new information and have a conversation that is not necessarily planned out in the initial set-up of the interview (Blandford, 2013). The interviews were conducted with relevant actors from different organisations to obtain information on their experience with sustainability ambitions, the existing barriers, and the process they go through when defining and setting ambitions. In the infrastructure sector, there is the public client perspective that initiates the project, the engineering-consultancy firm that will represent the public client and the market party such as a contractor. The research focuses on the process from strategic ambitions to operational ambitions on the project level for integrated contracts. Therefore, the perspective of the engineering-consultancy firm and a market party is used as data. The market party solely represented contractors and no other stakeholders as this was outside the scope of this research. By obtaining perspectives from both sides, different barriers were identified. The research aimed to conduct between 9 and 12 interviews with consultancy engineering firms and contractors as this provided a solid foundation for a small-scale study (Marshall & Rossman, 2016). The primary objective of these interviews was to gain insight into the barriers and the actual process of defining strategic sustainability ambitions and their realisation from a practitioner's point of view and to add empirical knowledge to the known theory of sub-question B, C and:

- *Sub-question B: The levels of ambitions and the necessary information to define them are investigated by conducting interviews and adding the empirical data to the existing theoretical knowledge, which resulted in a comprehensive overview of both perspectives.*
- *Sub-question C: The existing barriers from scientific and management literature were investigated. From empiricism, more barriers and their occurrence were identified which added knowledge to theory and provided an extensive identification of all existing barriers. Moreover, possibilities for mitigation were found in empirical data.*
- *Sub-question D: The semi-structured interviews allowed interviewees to share their experience and the different steps that usually are taken during the exploration phase to define and set ambitions and possible mitigation steps were discovered*

2.3.1. Interview protocol

The interview protocol is intended to be a guide for the interviewer to ensure that all rules are followed. The interviews were held online and in real-life and were recorded in the meeting room. Interviews were initiated through email in which the objective of the research and the relevance for the interviewee was explained. Once the interviewee had agreed to participate, an informed consent was sent to the interviewee to explain the data gathering method. Appendix A entails the interview setup in Dutch including the questions. After the interviews were conducted, they were transcribed and sent to the interviewee. Once the interviewee agreed on the paper version of the interview, it was used as empirical data. The interviewee will stay anonymous, only their function and company name are shared to provide insight into their perspective.

The interview protocol is set up to provide insight and answers to the sub-questions stated in Chapter 2. There are key topics that are considered to form the basis of the semi-structured interviews which are the research questions and the theoretical research. However, semi-structured interviews were used to gain knowledge on practical experience but also information that was not expected beforehand. With this approach, there is the possibility of deviation from the standard interview questions to investigate the interviewee's perspective. The following topics were:

1. Definition of sustainability
2. The barriers and meaning of sustainable ambitions
3. The translation process of ambition to specification
4. Measuring ambitions

The information from the semi-structured interviews provides knowledge that is obtained through real-life experience. This information is valuable as it can extend scientific theories and concepts but also provide insight into practical implications that have not been described by scientific research or are unknown. Through empirically researching the barriers to sustainable ambitions, the theoretical knowledge of it can be extended but also the application and implementation of sustainable ambitions can be clarified for the construction process specifically.

2.4. Case Study

A case study was used to explore contextualised insights into the strategic sustainability ambitions within the GRH sector, aiming to understand a real-life process (Rowley, 2002). For this research, an approach by Duurzaam GWW was selected which allowed on analysis on the translation process within the exploration phase and the occurrence of the barriers within the process. Additionally, the approach by Duurzaam GWW is supported by the government and is based on policy, thus it provided a solid foundation for the translation process and provided interesting insights into how it differentiates from the empirical process based on the conducted interviews. The case study provided the opportunity to integrate the empirical process with the process from Duurzaam GWW, resulting in an integrated process that functioned as the foundation for the framework. Moreover, the case study entails the placement of the barriers within the process, and the necessary stakeholders for the implementation of ambition resulting in a framework that provided insight on how and where to reduce the impact of these barriers.

- *Sub-question C: The existing barriers from scientific and management literature were investigated. From empiricism, more barriers were identified which added knowledge to theory and provided an extensive identification of all existing barriers and their occurrence. The case study, provided the opportunity to place the barriers in a particular step within the process resulting in an overview of when each barrier occurs and possibilities for mitigation.*
- *Sub-question D: The semi-structured interviews allowed interviewees to share their experience and the different steps that usually are taken during the exploration phase to define and set ambitions. The case-study provides a policy based process that should be used to define, set, specify and validated ambitions to operational requirements. By integrating these two processes, a realistic process was found that was used as a basis for the framework to answer the main research question.*

2.5. Validation

To validate the framework, expert interviews were conducted to receive feedback on the applicability and correctness of the framework. Four expert interviews were conducted each from a different perspective. Three expert interviews with consultancy engineering firm Royal HaskoningDHV (RHDHV) and one expert interview with the contractor party 'BAM'. Based on their expert opinion the framework was altered to a more applicable version from all perspectives. The validation of the framework resulted in a final framework that answers the main research question.

2.6. Reasoning Methodology

There are several benefits to this combination of theoretical and empirical research (interviews and case-study):

- Comprehensive understanding: Analysing theoretical concepts, theories and frameworks related to the research, will provide a foundation for the empirical investigation. Through theoretical research, the empirical findings can be explored and examined from a theoretical perspective resulting in a more comprehensive understanding.
- Practical Applicability: By using a case study, the research provides an analysis of the real-life situation (process) which allows for an analysis of the context, complexities and contextual factors. By applying a case study, the gap between theory and empiricism is narrowed. Practical solutions can be explored as this methodology provides the opportunity to investigate theoretical concepts in practical environments and identifies the practical implications (Dooley, 2002).
- Triangulation of evidence: By integrating the three types of methodologies, the findings can be triangulated. Triangulation includes comparing and extending perspectives and information from different sources to ensure the feasibility and validity of the research. By triangulating the findings in this research, the robustness of the final result is strengthened and addresses the possible limitations of each method (Dooley, 2002).
- Theory building: By integrating theory, empirical research and a case study, the research can add value to theory building. The empirical findings can extend, validate and build upon existing theories and scientific conclusions, resulting in the development of scientific knowledge within the GRH sector. Moreover, this research provides the opportunity to investigate and address the research questions from multiple perspectives, ensuring a multi-faceted analysis of the research topic (Dooley, 2002).

By integrating theoretical research, empirical research and a case study, a balanced analysis is conducted that combines theoretical concepts, empirical evidence, and contextual insights. The methodology adds value to both the theoretical and practical field yet also increases the depth of the research, resulting in a comprehensive conclusion.

2.7. Research Relevance

The contributions of this research are both scientific and practical.

2.7.1. Scientific relevance

This research has scientific relevance as ambition erosion is a concept that has not been researched generally. Even though there is scientific research on strategies on how sustainability is to be stimulated within the infrastructure sector, little research on barriers within the process itself has been conducted. Exploring the occurrence of barriers to sustainability ambitions and their impact in the exploration phase will provide knowledge on its impact in the different phases of the process. This research will add knowledge by investigating the gap between strategic ambitions to operational specifications and understanding where these barriers occur based on theoretical research, empirical research, and policy from a case study.

2.7.2. Practical relevance

From a practitioner's point of view, it is hard to realise strategic sustainability ambitions within the construction process due to ambition erosion. Sustainability often loses the battle of priority during the multi-criteria decision-making processes, budgeting and organisational levels within the sector. This research adds practical relevance as it aims to create insight which roles are necessary and what actions can be taken within the exploration process as outside of the process to mitigate ambition erosion and safeguard the realisation of strategic sustainability ambitions.

2.8. Structure of research

In Figure 2.1 the structure of the research shows what part of the research is answered or provides insight and information to the sub-question. Each green block represents information that is added/provided to be able answer the research question. Sub-questions B, C and D were answered through multiple methods of research as their information needed to be integrated from both theory and empiricism.

- **Sub-question B**: Investigates known literature, explores and adds knowledge from the field. This sub-question was answered by combining information from both the theoretical research and the interviews (two green blocks).
- **Sub-question C**: Investigates known barriers through literature, adds existing barriers from a practitioners' point of view and investigates their occurrence within a case study. This sub-question was answered by combining information from both the theoretical research, the interviews and the case study (three green blocks).
- **Sub-question D**: Explores the process of defining ambitions within the exploration phase during interviews and integrates this knowledge with a case study to set a final process with mitigation actions. This sub-question was answered by combining information from both the interviews and the case study (two green blocks).

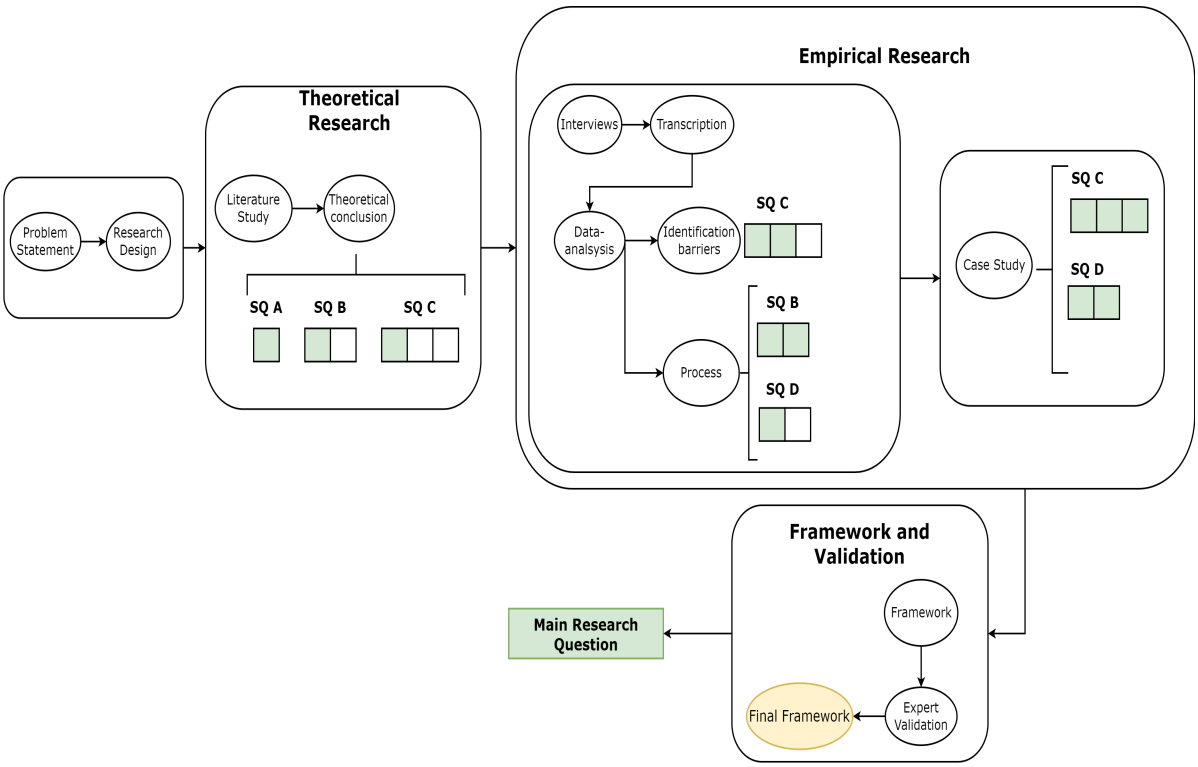

Figure 2.1: Structure of methodology

3

Theoretical Research

This chapter discusses the theoretical research that has been conducted on the definition of sustainability, the origins of ambitions, and its barriers within the infrastructure sector as the research focuses on the process from strategic ambitions to operational ambitions on the project level. The chapter aims to answer the sub-questions A, B, and C.

3.1. Current definition of sustainability

In 1978, the Brundtland report addressed multiple factors that resulted in global environmental problems from which the term sustainability originated. The report stated a global definition being: ”Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”(World Commission on Environment and Development, 1978). Even though it is useful to have a globally set definition, the meaning of it may vary for every country. The main goal of today’s society aims for a better environment for the next generation by protecting ecological balance and environmental systems from destruction (Sev, 2009). In order to investigate sustainability ambitions, it is important to clarify how the sustainability definition aligns with the indicated research.

Yılmaz and Bakış (2015) define sustainability as, “using of natural resources in such an equilibrium condition that they do not reach decay, depletion and nonrenewable point and handing down the next generations by developing them.” Moreover, Hotelling (1931) describes sustainability as the optimal way to exploit non-renewable sources from an economic point of view. Later on, the UN world commission expressed its concerns and gave the term sustainability its recognition in the Brundtland Report as natural resources are becoming scarce and CO2 emissions are bringing society in danger, environmental concerns are highly expressed.

Sustainability has evolved over time with multiple models shown in Figure 3.1. The concept of sustainability holds many definitions and can be divided into three parts on which multiple theories are built. Tennakoon and Janadari (2022) discuss sustainability as a concept that is built on three pillars. An environmental pillar, economic pillar and social pillar can all be seen as separate disciplines or sectors. Evolving into a triple bottom line (TBL) model which is based on three dimensions called the ‘3P’: People, Planet and Profit aligning with the three pillars also called dimensions. It is argued that these dimensions cannot be isolated as they have an interactive nature. The three dimensions can be seen as three constructs that reach sustainability when it reaches the baseline, more known as the “triple bottom line” (TBL) which is visualised as the circles of sustainability. However, TBL is criticised for being a weak sustainability model as the intersection between all dimensions has a low possibility. In contrast to the “weak model”, the spheres of sustainability on the far right of Figure 3.1 is seen as a strong sustainability model as within this model the main priority is conserving nature in the purest form. Though TBL is seen as a weak model it only indicates the need for research as these dimensions are intertwined. Therefore, it is argued that in order to evolve one of the dimensions the other should be taken into account as they have interactive behaviour (Reddy and Thomson, 2015).

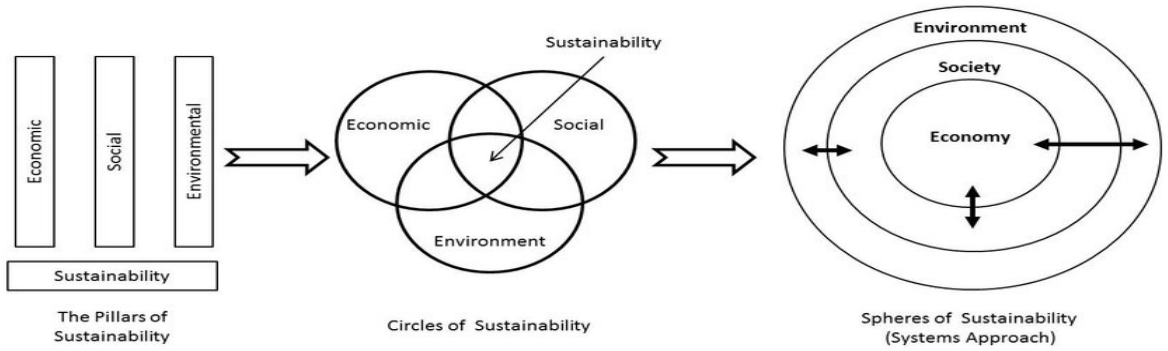

Figure 3.1: Evolution of sustainability models (source: Saharum et al., 2017)

Zooming in on a definition or theory for sustainability within construction, society mostly thinks of environmental sustainability. Abidin and Pasquire (2007) investigate the integration of economic, environmental and technical sustainability through value management. While, sustainability in the infrastructure sector often refers to the reduction of environmental costs by stimulating prevention, reuse, recycling and less on economic benefits. Edum-Fotwe and Price (2009) discuss that each dimension can exist as a separate issue during construction development based on an order. The orders are an addition to the existing framework of the circles of sustainability shown in Figure 3.2. On the other hand, the research states that overlap in the second order can exist but will result in a negative impact on the third dimension. In order to optimise all three dimensions in the third order, it is needed to map and define all factors and requirements for each dimension while correctly assessing the factors on the same level. Therefore, it is not mandatory to incorporate all dimensions but the impact on each dimension needs to be taken into account. In order to understand how ambition erodes and how it can be specified, barriers on the three levels can all be taken into account as they are in the end all intertwined.

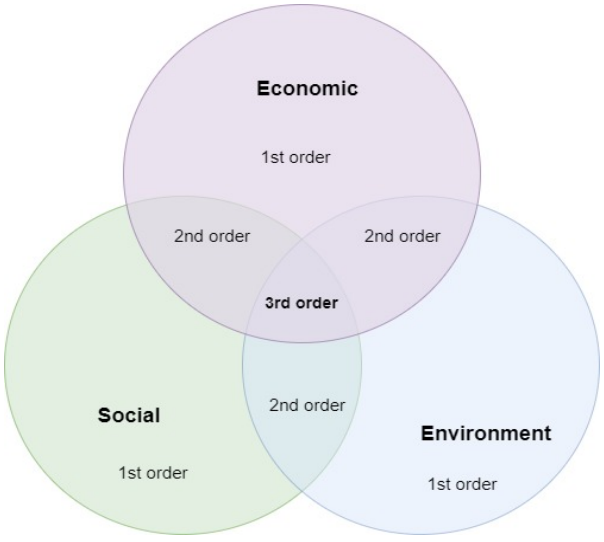

Figure 3.2: Orders of sustainability (EdumFotwe- and Price, 2009)

Amongst scientists and theorists, there is an ongoing discussion of the definition of the term and what is taken into account when looking at sustainability. For instance, the Cambridge Diary (2023) defines sustainability as: “The quality of causing little or no damage to the environment and therefore able to continue for a long time”. Sahely et al. (2005) describe sustainability more extensively and define it as: “the balanced and systemic integration of intra and intergenerational economic, social, and environmental performance.” In contrast to the past definitions Geissdoerfer et al. (2017) argue that

sustainability is an integration of the different systems and should strive for balance. This is defined as: “Sustainability is framed as the balanced and systemic integration of intra-and intergenerational economic, social, and environmental performance” (p. 5). Most research only applies to one dimension of sustainability and few consider all dimensions. However, at least acknowledging and potentially taking into account all dimensions can reduce the understanding and implementation of sustainability. Moreover, Sharma and Henrique (2004) discuss the limitations of only three dimensions and argue that stakeholder accountability should be a fourth dimension.

Concluding from all different theories and definitions, the most fitting definition of sustainability for this research that will function as a guideline is described by Munyasya and Chileshe (2018) as:

> *“The adoption of principles of sustainable development in infrastructure development projects execution, by striking a balance between environmental protection, wellbeing and economic prosperity for the benefits of both the present and future generations”*

3.2. Origin of ambitions

Sustainability ambitions are based on goals set by the government and society. Ambitions are also established through policies and guidelines set by the government. It has a significant influence on the practices within the sector as it guides the market and decision-making, yet also stimulates sustainability developments. Policy and law are one of the most important information components when defining ambitions as they set standards that the market must meet and discuss sustainability ambitions on the highest levels. In 2015, the United Nations adopted the 2030 Agenda for Sustainable Development, which includes the Sustainable Development Goals (SDGs). The SDGs provide a global framework for addressing social, economic, and environmental challenges, serving as a guiding vision for sustainability efforts (Biermann et al., 2017). Within the Netherlands, there are several laws and guidelines that support the country’s sustainability vision. Studies have shown that environmental regulation can stimulate the reduction of negative environmental impacts such as energy consumption, and greenhouse gas emissions but also stimulates the implementation more sustainable practices (Zhang et al.,2021). There are several regulations that need to be accounted for when setting an ambition for a construction project. The “Klimaatwet” states a reduction of 95 percent of greenhouse gases by 2050. The ‘Klimaatakkoord’ and ‘Omgevingswet’ are a continuation of this law that describes measures and regulations for a sector specifically (Ministerie van Infrastructuur en Waterstaat, 2023a). The policies and regulations do not only aim to reduce greenhouse gas emissions but also stimulate sustainable developments. Specifically, in the GRH sector, there are multiple policies that shape the current progress of sustainability within a construction project. For example, the nitrogen policy was introduced to reduce the amount of nitrogen due to the use of fossil fuels. Measures such as the implementation of electric vehicles and machinery, the registration of effects on the Natura 2000-gebieden and changes in transport and logistics have been taken to support the policy (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2022). It is important to understand and know the relevant policies and regulations for the formulation of an ambition as law and regulation can disrupt the feasibility, implementation, and assessment of an ambition. Moreover, it is important that the ambitions are in line with the stated policy and regulations such as euro standards, building codes and standards. It is important to take this information into account as it is crucial for setting realistic ambitions that can be operationalised (BSI, 2023).

Furthermore, environmental sustainability has emerged as a central social responsibility challenge for organisations and businesses, leading executives to establish ambitions to determine their social responsibility, ecological responsibility while staying economically competitive (Orlitzky et al., 2011). In short, ambitions also originate from an organisational level. Due to the growing recognition of the necessity for sustainability, organisations formulate their own programs and goals to achieve sustainability within their operations considering the triple bottom line of people, planet, and profit. Various decisions made at the organisational level such as the salary of executives, what innovative technologies are to be installed, and the energy use of an office have implications on the social and natural environment. Many sustainability ambitions are documented on company websites and annual reports, reflecting organisations’ commitment to adding value and striving for sustainability, even in the absence of specific policies (Montiel, 2008). Additionally, stakeholder pressures play a crucial role in driving organisations

and businesses to consider environmental and social impacts. These pressures encourage greater accountability and the implementation of more ethical practices (Haleem et al., 2022). Moreover, environmental movements including climate change activism and conservation efforts raise awareness of environmental issues and advocate for sustainable practices, such as renewable energy, waste reduction, and the preservation of natural resources. Considering the objectives and goals of these movements can help align ambitions with broader societal expectations and increase the social responsibility of an organisation. Within the civil engineering sector, there are multiple organisations that advocate sustainability practices for construction such as CB'23 and Duurzaam GWW (Platform CB'23, 2021). These organisations advocate for sustainability implementations and form an external driver for contractors, consultancy engineering firms and other parties within the civil engineering sector (Duurzaam GWW, 2023). Thus, climate change awareness drives these organisations and parties to formulate ambitions themselves when considering or participating in a project or within their company.

Moreover, ambitions can originate from an individual aspiration. Personal ambitions stem from the motivations of individuals, which are influenced by the culture they experience in their personal or work environment. These individual ambitions can shape the direction of an organisation and facilitate the transition toward sustainability, fostering motivation and engagement within the company (Tokarz & Malinowska, 2019).

At last, there is certain information needed to define and set these ambitions. In the GRH sector within the Netherlands, the Dutch government has implemented multiple guidelines and visions to stimulate the sustainable transition. The environmental impact forms the basis for ambition. Therefore, it is important to understand what is meant by an environmental impact such as greenhouse gas emissions, energy use, water consumption and resource completion. Within the infrastructure sector, the Environmental Cost Indicator (ECI) is widely used to assess the environmental impact of a construction project. This tool aims to set the bar for a sustainability goal in a quantitative way by looking at its contribution to climate change, human toxins, and resource depletion (Ministerie van Infrastructuur en Waterstaat, 2023a).

These are some of the key origins and influences that have shaped sustainability ambitions. Over time, there has been a growing recognition of the interconnectedness of social, economic, and environmental systems, driving efforts to create a more sustainable future.

3.3. Barriers for sustainable ambitions within the infrastructure sector

Chapter 1 discussed the implementation of sustainability measures which often face the issue of ambition erosion. Management and scientific literature state different perspectives on how ambition is established and is translated through an organisation or in a process (Brorström, 2021). Sustainability ambitions encounter different barriers that prevent them from being realised. There are four clusters of barriers identified and described in this chapter to provide insight on sub-question B.

3.3.1. Knowledge and awareness related barriers

A lack of awareness and knowledge are identified as one of the key drivers for ambition erosion by Durdyev et al. (2018). Stakeholders within the infrastructure sector lack the general knowledge of implementing sustainability as they have a low understanding of the benefits of sustainable practices. A lack of knowledge also entails the professional knowledge and measures that can be implemented. This barrier is seen as one of the biggest challenges for sustainable implementations as many entities are not familiar with sustainable construction principles, tools, and methods (Ametepey et al., 2015). Due to the high pressure of sustainability in the sector, new technologies and policies result in an innovative sector. Thus, staying aware of improvements can sometimes become challenging for the stakeholders. Next to the emerging technologies, regulations and policies form another barrier. Moreover, Hasan (2018) identifies the lack of awareness and education as well as a lack of resources to be the cause of the gap between sustainability ambitions and the implementation of them on an operational level resulting in unrealised ambitions at the end.

3.3.2. Finance related barriers

Finances are another key barrier for sustainable implementation in the sector. Within the infrastructure sector, resources indicate several factors such as costs, and the level of priority for a project. Sustainable implementations are often viewed as a high cost during construction. The success of a sustainability ambition is dependent on the implementation by the client and contractor. According to Ametepy et al. (2015) there is a fear of high investment for sustainable construction as the perception of sustainability is expensive, and sustainability can bring unforeseen costs. The fear for investment and the high cost of sustainable materials and technologies causes the ambition to fade early in the process as it leads to a low priority for implementation (Tokbolat et al., 2020). Even when there is a desire to implement sustainability ambitions, stakeholders experience a high level of competition as they still exist in a linear regime. Competition is an economic barrier as it conflicts with the implementation of ambition as the costs connected to a project always decide which organisation is better. As sustainability is a component that is not standardised, each actor wants to distinguish itself with the most innovative sustainability measures. Furthermore, priority of the ambition has a significant impact on the continuation of the ambition throughout the process. Not only costs are taken more seriously but also short-term deadlines and planning make it difficult for sustainability to earn a place as they receive a higher priority due to the interests of the client. Therefore, budget and time constraints make it challenging to implement long term sustainability goals into the projects (Sourani & Sohail, 2011). Due to prioritising resources in the short-term for economic gain, the long-term ambitions are often lost resulting in ambition erosion.

3.3.3. Organisational barriers

Governmental organisations are influential stakeholders when it comes to sustainability. The sustainability ambition becomes merely a strategic intention due to the lack of resources and the correct allocation to create any factual change for public sustainability. Sustainability ambitions might not be the actual solution but can shift along with the control of involved stakeholders. However, these ambitions may be real intentions but can fade once affected by organisational systems.

While et al. (2004) suggests that the necessity of solving environmental issues has stimulated public organisations to create and incorporate sustainability programs, and policies to safeguard said ambitions and gain support. However, it raises the question of whether the necessity is becoming more political than operational. The “sustainability fix” is best as while this strategy may lead to increased sustainability efforts, it is often as much about changes in the political discourse as it is about material change in the ecological footprint’ (While et al., 2004: 554). Sustainability is a concept that is based on three pillars of environment, social equality, and economics, but studies suggest that social equality is oppressed as economics and environmental protection are prioritised (Krueger and Gibbs, 2007). Consequently, barriers such as the willingness for implementation, competition, and power of an actor can alter the realisation of sustainable ambitions.

Willingness is a barrier that can only be overcome when stakeholders change their DNA and their view on the priority of sustainability over time. Management literature focuses on managers and company executives in sustainability transitions as they play a critical role in shaping and implementing sustainability strategy within their company. Ambitions for sustainable transition typically arise through niches, regimes, and exogenous socio-technical landscape developments and through power within an organisation the ambitions are communicated. The concept of power deduced from institutional theory and rules can be understood through the term regime, which is a set of rules, all linked to each other (Geels, 2004). Geels stresses that not every actor has the same resources or interests thereby communication lacks throughout the whole system. However, the concept regime is rooted in power, dominance and vested interests as power originates from regulatory rules of regimes and power struggles between aspirations and emerging niches often hindering sustainability ambitions (Grin et al., 2010).

Moreover, hierarchy within an organisation can deter ambitions as the higher level and lower level might not agree on the set ambitions or might not be willing. Koistinen et al. (2022) finds that top managers that functioned as change agents within their company often encounter resistance from higher up in the organisation also seen as the structure. A sustainability ambition has a higher chance to be communicated to various levels if the manager is pioneering, problem-solving, competitive, and resilient. The power of an actor depends on the recognition of responsibility. If an actor does not

feel responsible to implement sustainability, they have the power to block it. Furthermore, Sharma and Henrique (2004) describe the importance of responsibility of the involved stakeholders. Even if all stakeholders are willing to use their power and are interested in executing the project sustainably, there is a chance of ambition erosion due to the different responsibilities of different stakeholders and not feeling the right level of responsibility.

Within the construction process, multiple stakeholders are involved that have different interests and are relevant for different phases. Due to a lack of communication and collaboration, stakeholders do not exchange visions and knowledge. Therefore, a lack of awareness and knowledge to achieve sustainability goals is stimulated. Moreover, it can be challenging as the construction process does not allow to stimulate it as it is not a priority, thus making it difficult for cooperation to realise sustainability ambitions (Häkkinen & Belloni, 2011). Stakeholder engagement provides insight into current sustainability challenges that might not have been considered in preliminary phases. Through collaboration and engagement, the involved stakeholders can disseminate knowledge and help the core team overcome sustainability issues yet also increase the willingness for implementation (Bal et al., 2017). Moreover, Durdyev et al. (2018) describe the new norms and codes to not always support sustainable practices as they might contradict the scope of a project or may be challenging to understand. Though, law and regulation can stimulate the sustainability transition in the infrastructure sector, it can also hinder it as innovation, or the scope of the project might not align with it.

3.3.4. Process related barriers

Additionally, measuring the impact of sustainability actions is challenging due to the lack of knowledge and the lack of progress within sustainable development. Clear measurements relating to the ambitions are necessary. Loewe and Rippin (2015) find that sustainability actions are often hard to measure as they do not comply with the level of ambition and lack the correct data to measure. Several studies show that ambition erodes or is lost throughout the process due to a gap between strategic ambitions and operational requirements that cannot be used operationally. Therefore, measuring the impact of the sustainability actions resulting from the initial ambitions is challenging (Weitkamp, 2015). Even though strategic targets and indicators exist that translate the initial ambitions, they do not fully represent them. Therefore, measuring the impact of the sustainability actions resulting from the initial ambitions is challenging. The challenge to implement a high-level sustainable strategy into a project-level measure can be complex due to unclear targets and a divided industry.

3.4. Conclusion

From theoretical research, sub-questions A, B and C can theoretically be answered. Sustainability is a broad definition within the infrastructure sector. While some assume it only concerns an environmental aspect measured in emissions and pollution, other scientists incorporate the social and economic aspects into its definition. From the theoretical analysis, the following definition is derived for this research as it is argued that one aspect cannot exist without the other. *“The adoption of principles of sustainable development in infrastructure development projects execution, by striking a balance between environmental protection well being and economic prosperity for the benefits of both the present and future generations.” (Munyasya & Chileshe, 2018)*

In conclusion, ambitions are established at various levels and influenced by a range of factors. At the organisational level, executives set ambitions to address social responsibility, ecological responsibility, and economic competitiveness. These ambitions are driven by the recognition of social and environmental impacts and are formulated through programs and goals that consider the triple bottom line. Stakeholder pressures and environmental movements further shape ambitions by promoting accountability, ethical practices, and advocating for sustainability initiatives. Additionally, personal ambitions stemming from individual motivations and cultural influences play a role in shaping organizational direction and fostering engagement. Moreover, policies and regulations at the government level provide a framework for sustainability efforts, guiding decision-making and promoting sustainable practices. Understanding and aligning ambitions with relevant policies and regulations is crucial for feasibility, implementation, and assessment for sustainability ambitions in the infrastructure sector. Ambitions are established from policy and regulations such as euro standards, “the Klimaat Wet” and global policies.

Tools like the environmental cost indicator, building codes, euro standards, and policies ensure strategic ambitions to align, stimulate, and assess sustainable implementations throughout the sector. It is important to note that these sustainability ambitions originate from the highest level in the government and are published as a strategy to become climate and energy neutral. Overall, the interconnectedness of social, economic, and environmental systems underscores the importance of setting realistic and operationalizable ambitions to achieve a more sustainable future.

Next to the analysis of the definition of sustainability and the origin of ambitions, twelve theoretical barriers to sustainability ambitions have been identified through scientific and management literature. Figure 3.3 shows an overview of the four categories of barriers within the infrastructure sector.

- Knowledge and awareness related barriers
- Finance related barriers
- Process related barriers
- Organisational barriers

It is concluded, that each of these barriers occurs in the process of realising an ambition. In order to realise an ambition, it needs to be translated to an operational level. The identified barriers hinder the process of realising these ambitions, however literature does not specifically discuss when these barriers occur in the construction process or within the exploration phase. Therefore, these barriers are considered when investigating barriers to ambitions in empiricism and are integrated into one identification.

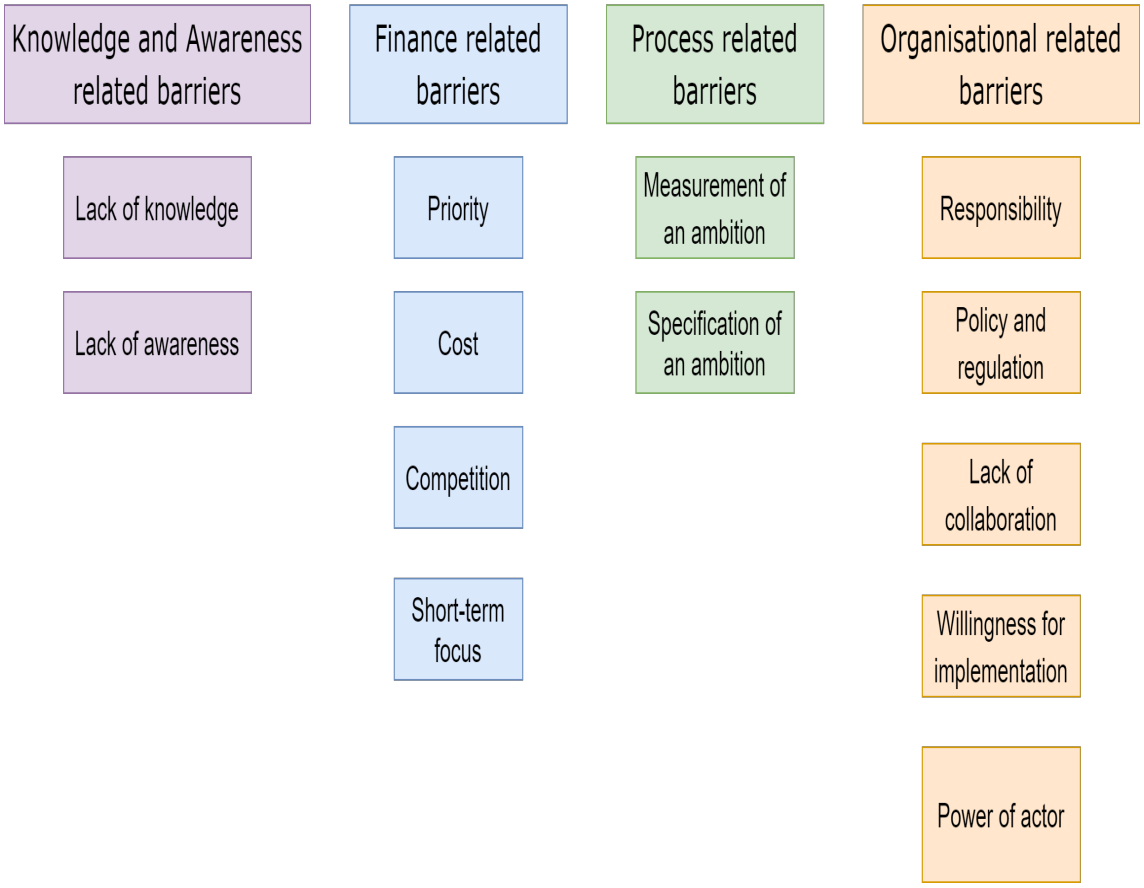

Figure 3.3: Identified barriers from literature

4

Empirical Research

Theoretical research has discussed barriers to achieving sustainability ambitions. However, it does not specifically address the occurrence of these barriers during the exploration phase of the process or how the current process defines strategic sustainability ambitions. Therefore, an empirical research is conducted to understand how and why ambition erosion occurs in practice, investigates the exploration phase and specifically how ambitions are defined, established and specified by consultancy engineering firms for an integrated contract and how these identified empirical barriers can potentially be mitigated. This chapter provides insight to answer sub-questions B, C, and D as it discusses the barriers identified from empiricism, their occurrence in the construction process, possible mitigation actions and the exploration phase deducted from empirical data. The empirical research is conducted by interviewing consultancy-engineering firms and contractors. This chapter builds upon the interview protocol described in Section 2.3.1 and discusses the interviewee selection. In Appendix A, the setup of the interviews and the interview questions can be found in Dutch.To facilitate a comprehensive understanding of the findings that contribute to answering the sub-questions, this chapter describes the methodology of the data analysis and presents the analysis findings. By gathering and analyzing empirical data, this research aims to enhance our knowledge of ambition erosion within the civil engineering sector's construction practices.

4.1. Interviewee selection

The goal of the empirical research is to understand current proceedings and how to improve them. The selected interviewees have a level of experience with defining, establishing, specifying and validating sustainability ambitions in the construction process and identify as one of the functions/roles stated in Chapter 1. This research focuses on the construction process, more specifically the exploration phase for a project that uses an integrated contract 'UAV-GC'. For this type of contract, three parties are involved in communicating and realising sustainability ambitions:

1. The public client
2. A consultancy-engineering firm
3. A contractor

Interviewees are selected from consultancy-engineering firms and contractors to provide insight into their perception of ambition erosion as they are involved in realising and translating the strategic sustainability ambitions of the public client to tactical and operational project level requirements to use during construction and procurement. Gaining insight on how barriers occur during this process and the process itself, will provide insight on how the process of a strategic ambitions to an operational requirement should be improved. By improving the process, it can be ensure that strategic sustainability ambitions do not erode throughout this process so that they can be used in the next steps of the construction process. The following three roles working in a consultancy-engineering firms or in a contractor company are interviewed to obtain specific knowledge:

- Contract manager: This role specifies measures to specifications in a contract which are needed for assessing if an ambition is achieved. They are interviewed for this research as the literature states that the translation of an ambition to operational specification is unclear and complex. By interviewing contract managers, insight into the process of specification to requirements/criteria and their experience with sustainable ambitions is gained.
- Sustainability expert: This role has all the information and knowledge on sustainability and its ambitions within the sector. By interviewing sustainability experts, insight into sustainability practices and their barriers during the exploration phase is gained. Moreover, the process of translating ambitions from the highest level to a specification can be mapped through the experience of this role.
- Project/Technical manager: This role is expected to manage the construction process and create overall value for the construction. This role is interviewed as they have a different perspective on sustainability ambitions as they also have other objectives to take into consideration. From these interviews, the view on sustainability and their experience with establishing and translating sustainability ambitions is discussed. Moreover, the process of translating ambitions from the highest level to a specification can be mapped through the experience of this role.

4.2. Methodology Thematic Analysis

4.2.1. Translation interviews to empirical data

Marshall and Rossman (2016) suggest that between 6 to 12 interviews is sufficient to draw conclusions for a small-scale qualitative study. In total, 12 interviews were conducted with people all active in the infrastructure sector. These interviews lasted an average of 50 minutes each, and the shortest interview was 48 minutes while the longest interview was 75 minutes. Table 4.1 shows an overview of every interviewee and their abbreviation for the data analysis. The abbreviation for each interviewee is used throughout the analysis.

Organisation	Role	Abbreviation Reference
Consultancy Engineering Firm	Contractmanager Royal HaskoningDHV_A	(CMRH.A)
Consultancy Engineering Firm	Contractmanager Royal HaskoningDHV_B	(CMRH.B)
Consultancy Engineering Firm	Contractmanager Royal HaskoningDHV_C	(CMRH.C)
Consultancy Engineering Firm	Contractmanager Royal HaskoningDHV_D	(CMRH.D)
Contractor	Sustainability Consultant Heijmans	(SC.H)
Contractor	Sustainability Consultant Boskalis	(SC.B)
Consultancy Engineering Firm	Sustainability Consultant Royal HaskoningDHV_A	(SCRH.A)
Consultancy Engineering Firm	Contract manager/sustainability coordinator Witteveen+bos	(CM.WB)
Consultancy Engineering Firm	Sustainability Coordinator Royal HaskoningDHV_B	(SCRH.B)
Consultancy Engineering Firm	Sustainability Coordinator RoyalHaskoningDHV_C	(SCRH.C)
Contractor	Contract manager Van Hattum en Blankevoort	(CM.HB)
Consultancy Engineering Firm	Technical Manager RoyalHaskoningDHV	(TM.RH)

Table 4.1: Selection interviewees

4.2.2. Analysis of data

The interviews are analysed by conducting a thematic analysis. The analysis is based on the framework by Braun and Clarke (2021) that is used to analyse qualitative data. This approach uses a combination of open and closed coding to investigate possible themes while providing insight into the already stated sub-questions.The following steps are suggested by Braun and Clarke and form the foundation for the data analysis in this research:

- Familiarising yourself with the data: This involves reviewing the data several times to become familiar with the content and to identify initial impressions or patterns in the data.
- Generating initial codes: This involves identifying and labelling segments of data that are relevant to the research question or topic.
- Searching for themes and reviewing themes: This involves sorting and organising the initial codes into potential themes based on the similarities and differences in the data. This involves refining

and defining the potential themes by reviewing and comparing them to the data set as a whole.

- Defining and naming themes: This involves creating a clear and concise description of each theme and giving it a name that reflects its content.
- Producing the report: This involves presenting the findings of the analysis in a clear and coherent manner, using quotes and examples from the data to illustrate the themes

The data analysis will reveal the current exploration and collaboration process, and the existing barriers hindering sustainability ambitions which are clustered into categories to use in the case study. To analyse the interviewee statements and categorise them, Atlas Ti 23 is utilised. The framework of Braun and Clare formed the foundation for the methodology of the data analysis for this research shown in Figure 4.1 and can be summarised with the following steps:

1. All interviews were transcribed according to the interview protocol.
2. All interviews were read as there needs to be familiarisation with the data.
3. The theoretical categories identified in Chapter 3 were used as a foundation to cluster quotes.
   (a) Knowledge and awareness related barriers
   (b) Finance related barriers
   (c) Strategy related barriers
   (d) Organisational related barriers
4. Rereading the interviews and gave theme/names to the quotes that did not fit within the theoretical category and signified as a barrier. “
5. Comparing the theoretically identified themes with the remaining quotes and renaming the four main themes.
   (a) Capacity building barriers
   (b) Motivation related barriers
   (c) Collaboration related barriers
   (d) Process related barriers
6. Categorised the remaining codes and clustered quotes into the new four themes.
7. Clustered the quotes to a code name within the theme
   (a) within theme, clustered codes into sub-themes for a specific part in the process related barriers en specific resource in capacity building barriers.
8. Analysed the empirically identified barriers and themes in Section 4.3.
9. The theoretical barriers identified from literature in Chapter 3 are compared to the empirical barriers and added/integrated into one overview.

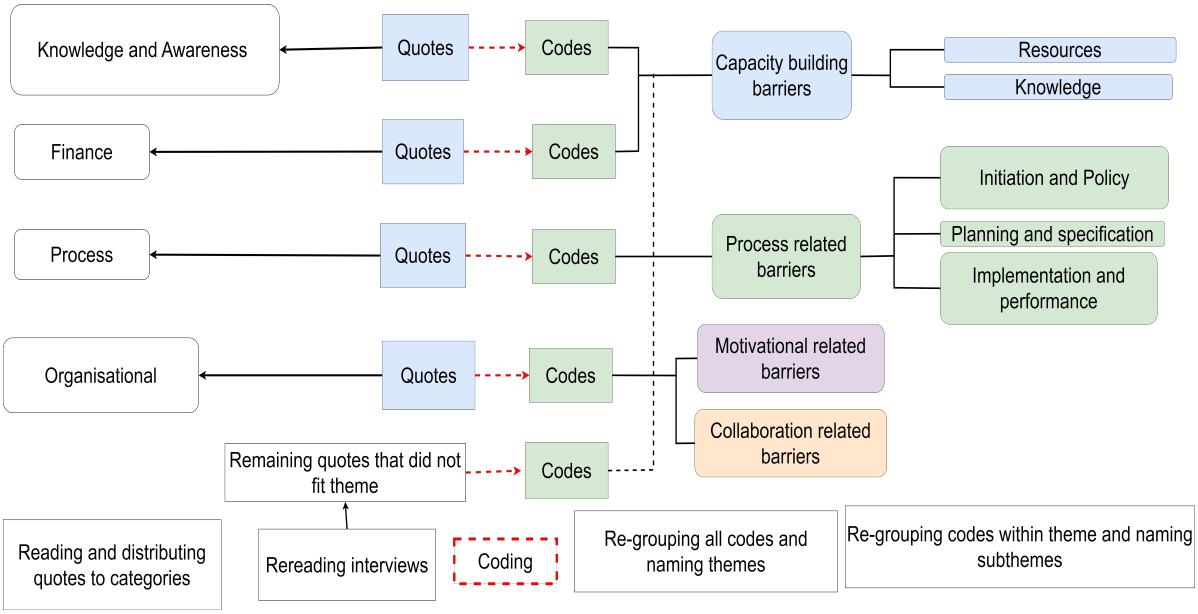

Figure 4.1: Methodology of empirical data analysis

4.2.3. Example methodology

To understand the methodology of the data analysis, two examples are described. One for a barrier that was identified on the basis of a theoretical category (closed coding) and one that emerged from the open coding.

Identified category: Process related barrier

The following sentences were read in an interview: *"So, in practice, you see that these ambitions exist, but often no budget is allocated. Rijkswaterstaat (a Dutch government agency) is starting to allocate budget for it now, by the way, but often there is no budget. There is a project leader who is trying to accomplish 30 very difficult things. Sustainability or circularity is not a priority in that case."*

In the theoretical research the category 'Process related barriers' was identified. When reading an interview, looking for any quotes process related were highlighted and clustered to the theme. Next, significant, and remaining quotes had been given an open code. The categorised quotes were coded and other open codes that were related to the process were categorised as process related barriers. Once all quotes were coded within the theme, these codes were grouped into sub-theme to show what part of the process they hindered.

Unidentified category: Motivational related barrier

The following sentences were read in an interview: *"Often, it doesn't really come to life in the workplace, and just this week I was sitting with a procurement advisor, and I asked, "What are your purchasing ambitions? Are you committed to sustainability, circular purchasing, right?" I wanted to know if sustainable purchasing is included in your policies. And it turns out that it is there, but they don't plan to adhere to it. Ultimately, it fades into the background again."*

This quote shows that there is a lack of motivation to use sustainability. When reading the interviews, it was apparent that in order to be able to implement sustainability the actor needs to be personally motivated. The quote was called a lack of motivation. Other quotes with the same indication were given the same code as they all indicated a lack of motivation internally and externally within the company. Once all interviews were read for the second time and coded. It showed there was another code that was also motivation related (lack of willingness to change). Next, the quotes that were clustered to the theoretical themes were reread and given codes. However, none of these quotes fit with motivation and mindset. A new theme emerged that described the internal drive for sustainability, resulting in the

category 'Motivational related quotes'. This theme is later compared with the theoretical barriers which adds knowledge to the current theoretical identification discussed in Section 4.5.

4.3. Findings

This section discusses the findings of the data analysis to identify barriers to sustainability ambitions. Each theme and its barriers are described in this chapter to explain: the empirically identified barriers, their occurrence and possible mitigation and are added to the theoretically identified barriers later in this chapter. An overview of the description of the barrier, its occurrence and possible actions can be found in Appendix B and the definition of each barrier in Appendix C.

4.3.1. Theme 1: Capacity Building barriers

This theme discusses the resource and information component as a barrier to sustainability ambitions in the infrastructure sector. There is a need to have the necessary knowledge and resources to stimulate sustainability ambitions and be able to implement sustainable measures. This theme is divided into two subcategories: resource based barriers and knowledge based barriers.

Sub-theme: Resource-based barriers

Within this sub-theme, the codes: competition, costs and fast-changing environment are identified as barriers. These three barriers are identified through a data analysis of the interviews.

Fast changing environment refers to the dynamic and constantly evolving conditions in which construction projects operate, such as changes in regulations, market trends, and technological advancements. This is an external barrier that sets the tone of the environment ambitions exist in. Interviewees state that sustainability practices for construction within the civil engineering sector receives more attention, due to which each party needs to be implementing new measures and technologies. Public policy enforces new law and regulation that focuses on different points each time which changes the necessary sustainability focus and practices. For example one interviewee stated: *"That is really the most important thing. Look, three years ago, electric equipment was still really new. In three, four years, it will be very different, being in that transition. If we had said earlier, you want to build emission-free, well, then you had to discuss it with the construction team. Now, I would just make it a contractual requirement." (SCRH.C)*. This barrier occurs outside of the process of formulating ambitions and cannot be controlled by market parties and consultancy engineering firms as it is an environment, they work in.

Competition plays a significant role in influencing the decision-making process regarding the inclusion of sustainability measures, both for clients and contractors. In some cases, contractors may choose not to prioritise sustainability in their bids due to the lack of an even level playing field. The interviews reveal that contractors are primarily driven by commercial considerations, aiming to submit an appealing bid in order to secure the project. Unfortunately, sustainability often does not feature as a standard requirement during the tendering phase. Consequently, contractors or consultancy engineering firms may find it challenging to incorporate sustainability into their proposals, especially when competing against rivals who solely prioritise budget considerations without incorporating sustainability measures. For example, one interviewee stated: *"However, for many clients, the maximum discount that can be obtained through such measures is so small that the investments we, as contractors, have to make in order to achieve that sustainability are more expensive than the discount we can obtain. Therefore, it is essentially us, the contractors, who have to make the investment rather than the client. And that is a reason for a contractor, being a commercial company, not to make a particular investment in sustainability." (SC.B)* and *"If another contractor comes out cheaper, then we won't get the project. So, it's always a kind of trade-off whether we want to prioritize sustainability. We all want to execute it in a more sustainable way, but if someone else is going to carry it out, then we won't be able to execute it sustainably at all, so to speak." (SC.H)*.

Competition is a barrier that could be mitigated by pre-conditionality. The quotes: *"The contractor does want to participate, but it shouldn't be risky, and they still need to earn a decent living. The contractor simply wants to run an enjoyable project. That's the motivation for these people to go to work, even if*

we sometimes think otherwise. That's the problem, but you have to set the conditions in such a way that they can also comply." (CM.WB) and *"Currently, in the market, there is only a certain quantity of machines that operate electrically, so you cannot demand full electrification everywhere." (SCRH.B)* show that it would help to have sustainability as a pre-conditional component so that every actor follows the same vision and needs to implement it.

Costs refer to the financial challenges associated with sustainable construction projects, such as the higher upfront costs of sustainable materials, technologies, and practices, and the potential for lower returns on investment. The interview data shows that this barrier occurs when defining the ambitions and deciding what measures to take. Often the cost of a measure is not considered when establishing ambitions. For example, interviewees stated: *"Well, one of the problems we encounter in sustainability and also in health is that there are ambitions, but there has never really been an assessment of how those ambitions can be achieved. So, what is required to achieve those ambitions? There has also never been a consideration of the costs." (SCRH.C)* and *"The rest of the toolkit is still focused on, and those are the most powerful instruments, primarily on costs. In cases where other hard control mechanisms, such as money in the contract, are still considered primary, it is difficult to truly centralize the sustainability ambition and make it land effectively among market parties."(CM.HB)*.

Moreover, the cost of a project has more priority than sustainability during the construction process. It is apparent that costs are not taken into consideration early enough in the process due to which sustainability practices are often eliminated before contract design supported with the following statement: *"You have an idea of what your task is going to be, but you don't know how it will play out in practice. It's very difficult to steer in that direction, especially considering that the tendering period is not sufficiently long. And if you make it longer, it will significantly increase costs, making it challenging to gather consensus and steer in that direction." (SCRH.A)*.

Conclusion: resource-based barriers

Resource-based barriers can be distinguished into three barriers such as the perception that sustainability is expensive and the limited budget available for a project. Therefore, costs obtain priority often resulting in dominating the direction of a project and leaving sustainability behind. The fast-changing environment and innovation lead to parties not being able to follow up as they lack knowledge of these emerging technologies and policies. Moreover, contractors and consultancy engineering firms claim that they are limited to working sustainably due to the competition caused by the need for differentiation. Due to the elevated level of competition, sustainability is not implemented in a proposal as the party feels they cannot distinguish themselves based on the price.

Sub-theme: Knowledge-based barriers

Within this sub-theme, the codes: the lack of knowledge on the implemetnation of tools and measures, experience, and definition of sustainability are identified as barriers. These three barriers are identified through a data analysis of the interviews.

Lack of knowledge refers to the challenges associated with applying sustainable measures, technologies, and practices in real-world construction projects, for example; the lack of technical expertise, the difficulty of integrating new solutions with existing systems, and the lack of awareness and training. The interview data shows that due to the specific knowledge required to be able implement sustainability practices; ambitions are often lost as few people have this knowledge. For instance, interviewees stated: *"Yes. Well, you see, it's something that is emerging, so we still need separate experts for that. For example, in a project, we also have a few sustainability advisors, but ideally, it should be integrated into everyone's workflow." (CMRH.A)* and *"Well, we all have a significant knowledge gap, so we don't really know which buttons need to be pushed collectively to make a more sustainable choice as a society. Sustainability is indeed a very challenging phenomenon; it's a very stubborn monster." (CM.HB)*. Moreover, the empirical data shows that due to the lack of knowledge from the public client during the initiation, the project itself is unclear resulting in a loss of ambitions as the vision can differ. Public clients don't have the same knowledge as consultancy engineering firms of contractors for sustainability implementations or the feasibility of their sustainability ambitions, thus the ambitions are often lost within the beginning of the construction process as these interviewees stated: *"The public client in-*

deed lack knowledge, they are not familiar with anything new, and sustainability is considered strange, so the focus on sustainability was lost again." (SCRH.B) and *"I think that with sustainability aspects, it tends to be vaguer, and that's also just the case. But you actually see this in all areas, that there is simply too little capacity and knowledge among clients. Honestly, I don't see this changing easily because they already have problems just getting work done, and these kinds of matters are quickly perceived as burdensome, causing them to be overshadowed." (SC.H)*

Due to the lack of knowledge on a general level within a project, there is a need for more engagement and external collaboration so that these different roles and organisations engage and disseminate knowledge. *"Together, we will complement each other in terms of content because whether it's an assistant engineer or a contract specialist, they don't have that knowledge and expertise. The sustainability expert, in terms of content, they cannot assess what is feasible. They will indeed also consider when it is well articulated." (SCRH.A)*, the quote shows that collaboration between experts and general roles is necessary to uphold the sustainability ambitions.

Experience refers to the challenges associated with the lack of experience and expertise in implementing sustainable solutions, technologies, and practices in the infrastructure sector. The execution of a project is often guided by the method in a previous project. Reference projects or experience, consultancy engineering firms and contractors indicate the different possibilities for establishing measures, procurement and measuring sustainability as *We have some example projects. So, indeed, we formulate selection criteria, for example, Step 4 is a very specific requirement. You must have at least Step 4 to participate in this project. We often include MKI or DUBOCalc in the selection and evaluation criteria for the tender. And we have hard requirements specified in the contract, and we have examples of all of that.(CMRH.C)*

However, it can also cause a loss of ambition as experience is heavily relied on. *"So, it's much more about ensuring the knowledge from other projects is available for reference, and that is very complex and challenging. It often relies on coincidental personal contacts or past experiences that we have had."(CM.HB)* and *"Well, I think people need examples and practical methods. It's not that people don't want to. In project teams, I always see that sustainability is a policy objective, but it's also something they want to implement. Sometimes, it's challenging to make it practical. (CMRH.A)"* indicate that without experience, consultancy consultancy engineering firms and contractors either do not have the knowledge to implement new/indicated sustainability practices or are not allowed as they do not have enough experience resulting in a loss of ambitions within the exploration phase and procurement phase.

Definition of sustainability refers to the challenges associated with defining and balancing the social, environmental, and economic aspects of sustainable construction, such as the difficulty of prioritising different sustainability goals, the lack of consensus on what sustainability means in practice, and the potential for conflicting interests and values. Within the construction of the civil engineering sector, the definition of sustainability can be interpreted from different perspectives as there is not a clear agreement on it, for example *"You can consider it from different perspectives, right? So, from the sustainability world, you're probably familiar with the 3 or 4 P's that apply to it. Sustainability has a wide range of definitions, so that's where you need to start. For which aspect? Only for the planet, or also for profit or people, right? That's always the immediate question, so how do you approach it? Once you have clearly defined the scope within which you want to work on sustainability, then the question arises." (CM.HB)*.

Moreover, the vision of the public client indicates what sustainability is for the given project. *"At the moment we are circular, meaning that we want to pass on resources infinitely to future generations. However, if we pass on asbestos along with those resources, then we are perpetuating asbestos indefinitely to future generations. Are we really practicing true circularity in that case? The next generation will continually face significant health problems. So, what is sustainable then?" (SCRH.C)*. Due to the lack of clarity on its definition within the sector and within a project, ambitions are considered differently than they were meant to be and or hard to realise resulting in ambition erosion during the beginning of the process. Thus, the definition of sustainability should be validated multiple times and clearly initiated in the beginning of a project.

Conclusion: knowledge-based barriers
Based on the quotes, knowledge-based barriers can be divided into the lack of experience, the lack of knowledge on the implementation of measures and tools and the definition of sustainability. The quotes show that sustainability has a different meaning for each actor leading to a lack of consensus. A key barrier that is also described in theory is the lack of knowledge on how to implement sustainable solutions but also how to effectively measure and demonstrate them.

4.3.2. Conclusion Theme 1: Capacity building related barriers

Based on the quotes provided, the infrastructure sector faces several barriers to realising sustainability ambitions and practices. One of the biggest challenges is the perception that sustainability is difficult, expensive, and a burden on projects. This attitude can lead to a lack of prioritisation for sustainable measures when establishing sustainability ambitions, especially when budgets are limited, and project managers are juggling multiple priorities. Another barrier is the competition for contractors, which can lead to a lack of investment in sustainable practices as they fear they will not win the proposal with a high price. Additionally, contractors may face challenges as the question is not a viable investment for themselves.

Furthermore, the lack of knowledge and experience in implementing sustainable practices can hinder progress in the sector. For example, there may be limitations on the use of recycled materials due to certification requirements, which requires a level of expertise to navigate. Despite these challenges, there is a growing recognition of the need to promote sustainability in the infrastructure sector. The definition of sustainability is broad and encompasses various aspects of environmental, social, and economic impact. As such, there is a need for collaboration within the exploration phase and innovation to find new ways of implementing sustainable practices that work within the constraints of the industry.

In conclusion, the infrastructure sector faces significant barriers to implementing sustainable practices, including a lack of knowledge and experience, limited financial benefits, and constraints set by client requirements and quality standards. However, with a commitment to collaboration and an increase in knowledge, there is an opportunity to overcome these challenges and create a more sustainable industry. The identified empirical barriers occur specifically when defining and establishing the strategic sustainability ambitions within the exploration phase. Based on empirical data, an overview of the barrier and its occurrence in the process and the action for mitigation is given in Table B.2 in Appendix B and the definition of the barrier is given in Appendix C.

4.3.3. Theme 2: Motivational related barriers

This theme discusses the barriers: lack of willingness to change and lack of intrinsic motivation. These barriers are rooted in the mindset of people working in the infrastructure sector.

Lack of willingness to change refers to the conservative mindset of an actor. Within the infrastructure sector, change is necessary but not every actor sees the importance of it or is not willing to make it a priority instead of other factors as they can also be quite conservative oriented. These people may struggle to embrace sustainability due to their method of working and education for example, *"The world is still dominated by older white men who grew up in a certain time and were educated during a different era. Some of them may have difficulty making the transition to thinking about sustainability in an integrated way. So if you give them an overview and have them thoroughly go through it, you will have made the first step." (SCRH.C)*. However, providing them with a comprehensive overview and guiding them through the process can be an effective first step in fostering change. Moreover, there is a resistance to change within in a project team as they question the need for change and whether their current practices are wrong. *"With some colleagues, things are going very well, but with other colleagues, you also feel the natural resistance of, 'Why should we do it? Why do we need to change? Are we doing it wrong?' No, we need to change because we can do better."(TM.RH)* emphasises the potential for improvement and the necessity of change. There is a challenge of maintaining sustainability efforts within organisations, as administrators may face resistance and skepticism. Concrete, for example, can raise questions and concerns about its sustainability. Overcoming these obstacles requires addressing reservations and engaging administrators effectively as stated in: *"In the end, an*

administrator must take over the work that we have accomplished and maintain it. Within an organisation, you still see quite a bit of resistance in some way to get these things done. It's quite difficult. However, they have reservations about whether certain things are more sustainable, such as concrete. This often raises a lot of questions within an organisation and also for an administrator." (SCRH.B).

Lack of intrinsic motivation refers to the mindset of the actor. Not every involved actor is motivated to pursue a high level sustainability ambition, thus can block them or not uphold them through the process. Within the construction of the civil engineering sector the lack of intrinsic motivation forms a large barrier for sustainability ambitions.

The empirical data indicates the lack of intrinsic motivation in sustainable practices and underscore the significance of organizsational culture, accountability, and collective efforts. It is highlighted that sustainability should not be centralized, relying solely on sustainability consultants, but rather embraced collectively within projects indicated in: *"And, what you're actually saying is that sustainability should never be centralised, and that's actually what we do in projects, right? We hire a sustainability consultant. If you look at that hierarchy, it's actually also a matter of how you're organised. You really have to want it together. You should also be held accountable together for your sustainability goals." (CM.WB)*. While individual motivation is valuable, the success of sustainability transitions cannot solely depend on the presence of enthusiastic individuals as stated by (SCRH.C): *"Motivating people is good. You can't build a transition on individuals alone. You need individuals, but you can't let the success of your transition depend on the presence of enthusiastic people by chance."*

The responsibility for integrating sustainability into projects and processes lies with sustainability consultants, but there is a need for intrinsic motivation among project and technical managers as *"They still leave it up to the sustainability consultant. There is more of a need for intrinsic motivation among project managers and technical managers to get started with sustainability. However, the responsibility to ensure that sustainability is properly integrated into the project and process implementation lies with the sustainability consultant." (SCRH.A)*. The significance of top-down and bottom-up approaches is also emphasised: *"If you don't have any driving forces top down, you will never get it done bottom up. We are now actually doing it from both sides. We have summarized a business ambition of RHDHV in our policy, from which we have set multiple objectives and among them, certain ambitions bottom up. You will only be able to achieve it top-down if there is recognition, acknowledgment, and support for it bottom-up." (TM.RH)*, with recognition, acknowledgment, and support from the top fostering motivation and success at the grassroots level.

Moreover, the disparity is noted between policy-driven sustainability initiatives and the perception of sustainability as a burden at the operational level. Intrinsic motivation becomes essential, as demonstrated in cases where project organizations embrace sustainability and foster collaboration, resulting in positive outcomes as stated: *"Yes, and often you see that from the client's side it's very much policy driven. We want sustainability as a municipality, and then the people who have to execute it on the work floor often see it as a burden. For example, in Arnhem, I think it's very nice. There, it's really done from within us, so there's just the project organization that says, yes, we just want to work sustainably. So, they started to promote it, and then you also see immediately in partner projects that it works because the people you make a product with are intrinsically motivated and willing to take an extra step." (SC.H)*.

4.3.4. Conclusion Motivational related barriers

From this theme, two motivational barriers are determined. The analysis suggests that there is a lack of intrinsic motivation. Addressing the challenges for the industry requires a change in mindset as it cannot be fulfilled by a few motivated individuals. It requires actors to become intrinsically motivated yet also willing to change and adapt to this new priority. Unfortunately, many actors within the process lack the motivation and willingness to put sustainability as an important ambition. To overcome this barrier, there is a need to improve and stimulate intrinsic motivation and promote its importance among stakeholders within the industry by stimulating collaboration and engagement between stakeholders and within the project team. Based on empirical data, an overview of the barrier and its occurrence in the process and the action for mitigation is given in Table B.1 in Appendix B and the definition of the barrier is given in Appendix C.

4.3.5. Theme 3: Collaboration related barriers

Empirical data shows that stakeholders face multiple challenges that are related to collaboration. This theme includes the following three barriers: responsibility, late collaboration, and lack of communication.

Responsibility refers to the sense of feeling the need to uphold sustainable ambitions. Assigning responsibility can be complex when multiple people are involved. Each actor or role assumes that someone else will take responsibility thus the sustainability ambition is often lost. There is a lack of clear ownership which results in ambition erosion emphasised in: *"So, it's often difficult to give sustainability a place because you don't really have an owner. Many people are involved and it's a bit like with flex workspaces. If everyone is an owner, no one is an owner. So, if everyone is responsible, the chance is great that no one will do anything." (SCRH.C)*. Moreover, a clear division in who is responsible for keeping the data for the sustainability practices up to data is lacking resulting in a lack of information and a lower level of sustainability in the end product as was stated in the interviews: *"So, everyone is like, 'Yeah, I just take it from the double calculation because all the values are there.' Yes, that's just taken from there and of course, there is an occasional adjustment. However, if you're not confronted with the fact that it doesn't meet the requirements in practice and no one checks it, and no one holds the party accountable for it, then there is no motivation to change that data." (SC.H)*.

Often roles do not feel responsible for its implementation and will move the responsibility further down the line from public client to contractor. However, later in the process sustainability is more complex to incorporate thus ambition erosion occurs. Due to the lack of sense of ownership and responsibility, there is a tendency to shift the responsibility of sustainable practices to contractors. However, this stakeholder can only influence at the end of the construction process once initial discussion on the implementation of the strategic sustainability ambitions have already been facilitated. *"You can easily shift your ambition to a contractor and say, 'Hey, come up with a plan, best contractor, and explain how you will approach sustainability in the project.' And then you might get a discount of €20 million for your project. So, as a technical manager, I have facilitated sustainability to the maximum, and I'm done after having 6 discussions. Good luck to the contractor." (TM.RH)* shows that ambition erosion occurs due to moving the responsibility to a later phase in the process.

Additionally, the responsibility for meeting sustainability requirements typically lies with the project team, although the involvement of a sustainability advisor or contract advisor may be necessary initially. As stated in the empirical data: *"Afterwards, you really have to go through those requirements together with the project team or the core team of the project. In essence that responsibility lies with a sustainability advisor, a contract advisor for a first approach. Then you just have to establish a project team and the responsibility lies with the project team, not with a sustainability advisor." (CM.WB)*. However, once established, the project team becomes primarily responsible for sustainability, while the role of the advisor diminishes. This highlights the dynamic nature of sustainability responsibility, with the advisor playing a supportive role in the early stages while the project team assumes greater ownership over time.

Lack of communication refers to both internal and external communication lacking between project team members and between the client, contractor, consultancy-engineering firm. The lack of both internal and external communication poses a significant challenge in fulfilling sustainability visions and ambitions. Roles and actors often fail to communicate, leading to limited knowledge dissemination and a lack of shared vision. As empirical data states, *"Yes, you have all stakeholders together, and one stakeholder has a different interest than the other, of course. And often they don't talk to each other. Well, by putting them all together at the table in such a session, it works, and then you don't really have to do anything."(CMRH.C)*. However, if all stakeholders were in a collaborative environment where interests could be openly discussed the sustainability ambitions could be more easily realised. Moreover, the empirical data emphasises the importance of recognising the need for communication in sustainability initiatives, stating, *"There is often not an opportunity to talk about that, and I think it's also important for a client to realise that this space for communication is sometimes needed to have a conversation about it. (SC.B)"*. This quote further underscores the significance of providing a platform for open conversations. The empirical data emphasises the need for effective and open communication between stakeholders. By bringing stakeholders together and facilitating providing a space for discussions, the potential for addressing conflicting interests, fostering cooperation in sustainability-related

matters is increased and the realisation of sustainability goals becomes more feasible.

Late collaboration refers to not involving the correct roles with the necessary knowledge during the right step in the process. The empirical data shows that an actor or expert is sometimes not involved in a part of the process which leads to a lack of knowledge or unfeasible implementations. For instance, a sustainability advisor can be involved later in the process when the scope and sustainability opportunities are already narrowed due to other ambitions. As stated in the empirical data, *"Yes, when I look at my role, it also depends on when I enter a process. If it's right before a tender, which I understand as well, there's little I can achieve in terms of design since the design is already in place. Then I also look at where the room is given, given that the designers have provided their input, to still make progress in terms of sustainability before the tender. It also depends on where your sphere of influence lies." (SCRH.A)* shows that involvement of the sustainability advisor throughout process can result in more realisation of the strategic sustainability ambitions.

Furthermore, the roles of the contractors and managers are not really considered when establishing ambitions for the scope. *"But the contractor is at the tail end of the development process, so they have relatively limited impact on those sustainability ambitions."(CM.HB* and *"Because that is also something to inquire about, and that is often part of the management aspect: how does a municipality deal with that? And those are indeed very challenging matters that should be considered in the preliminary phase." (SC.H)* show that involvement or consideration of the role and collaboration with the public manager after realisation and contractor is necessary to establish feasible measures for the sustainability ambitions.

4.3.6. Conclusion Theme 3: Collaboration related barriers

In conclusion, collaboration between stakeholders and team members is a key driver for the implementation of sustainability ambitions. One of the main barriers is the late collaboration within the project team due to which opportunities are missed or formulations are unclear in the early stages of the project when establishing and specifying to measures. Moreover, the lack of communication leads to misinterpretation of the initial ambitions due to which different levels of the goal are realised. Furthermore, the lack of responsibility occurs in the whole exploration phase among the stakeholders within the process limits the chances of implementing sustainability. Sustainable measures and their implementation currently rely on the sustainability expert or the contractor for which it may be too late to create a real impact. These barriers highlight the need for better collaboration and clear responsibility to assure the achievement of the initial sustainable ambitions. Based on empirical data, an overview of the barrier and its occurrence in the process and the action for mitigation is given in Appendix B in Table B.3 and the definition of the barrier is given in Appendix C.

4.3.7. Analysis Theme 4: Process related barriers

The last theme describes process related barriers, which are categorised in three sub-themes. Initiation and policy categorise barriers that are governmentally oriented and occur during initiation and establising ambitions. Planning and specification are barriers that are most relevant to the process of translating (including establishing and specifying) strategic ambitions to specifications such as contract requirements and Best Price Quality Value (BPQV) criteria. Implementation and performance discuss barriers that are encountered when measuring and validating sustainable development.

Initiation and Policy barriers

This sub-theme discusses two codes that are translated to the barriers lack of precondition and contrasting law and policy. The following data analysis of the interviews support the identification of the two barriers:

Lack of pre-condition indicates that sustainability is not a mandatory component and can often be neglected if not set as a standard component within the process and contract. On a policy level and within consultancy engineering firms, sustainability is not commonly considered a standard component that is pre-conditioned to be incorporated in a project or program. This lack of mandatory requirements means that the implementation of sustainability practices becomes reliant on individual motivation. As the quote states, *"And sometimes we also experience in tenders that sustainability is not really required. If the client simply does not want to tighten or clarify those requirements. Then we just pull the plug*

because we see and think that there is simply no distinction to be made. Yes, and sometimes we just want to quit." (SC.H). This quote highlights that when sustainability is not mandated or prioritised by the client, it can lead to a lack of motivation and prioritisation to incorporating sustainable practices.

Sustainability often loses the battle for priority as pre-conditionality is lacking, leading to ambition erosion. Without clear requirements and pre-conditions, sustainability may be seen as an optional component that can be overlooked or disregarded. As these quotes state, *"Actually, the organisation should demand this much more strongly. In fact, an ambition should not be an ambition, but simply a requirement from the organisation." (SCRH.B)* and *"But sustainability must be a prerequisite. It should be a conditional aspect in the decision-making process of the designers or the contract people or the project managers. But we will only achieve this when people really internalise the word sustainability in their DNA and that's not the case yet." (TM.RH)*. By making sustainability a pre-condition and setting clear expectations, there is a greater chance of avoiding ambition erosion when establishing ambitions and their measures to ensure that sustainability ambitions are realised.

Contrasting law and policy indicates that relying solely on existing laws, regulations, and standards can limit the range of desirable sustainability options available. This suggests that the current regulatory framework may not fully support the pursuit of sustainability goals and might hinder innovative and more effective solutions from being implemented as this quote states *"So you also need to provide space for market parties to incorporate or prescribe sustainable solutions themselves, but the danger is that you rely on current laws and regulations and standards, so to speak. And in doing so, you cut off various options that are actually desirable from a sustainability point of view." (CMRH.A)*.

Moreover, there is tight regulation in place concerning flora and fauna which leaves little space for contractors and consultancy engineering firms to add value to the biodiversity. *"There is already very specific legislation and regulations regarding floors, hair, and fauna. That is already tightly regulated. And that is also done based, among other things, on biodiversity, so the regulatory space that you ultimately have at the end of the chain. Because as a contractor, you are at the end of the chain, so the regulatory space you have left at that time is almost zero. You simply must comply with the flora and fauna and the habitat directives. I don't know what else. So there is actually hardly any added value to be developed, so it just doesn't deliver anything. It probably causes a lot of hassle without actually contributing to biodiversity." (CM.HB)* suggests that the current regulations might not effectively align with sustainability objectives and may require further evaluation and adjustments to promote meaningful outcomes.

Additionally, there is also complexity to finding a balance between different environmental factors that align with their regulations. For example, *"With nitrogen specifically, the legislation has recently been changed. And for example, for large ships, you can install one thing on the exhaust of those ships that emit very little nitrogen and particulate matter but makes the engine run harder, so it emits more CO2. What is more important then? Where are your environmental burdens? Sometimes these are considerations that you have to make based on what the clients want." (SC.B)*. The quote indicates that considerations and challenges involved in working with the regulations for the sustainability transition while finding a balances solution considering the different environmental factors when establishing ambitions and measures for the construction of the object.

Conclusion: Initiation and Policy barriers

Within the construction of the infrastructure sector, the absence of clear and standard sustainability preconditions and contrasting policies and regulation hinders the stimulation and promotion of sustainability ambitions. The lack of precondition hinders the prioritisation and awareness level of the importance of sustainability within the process. If sustainability is not pre-conditional early on it is not expected to have obtained a high level at the end of realisation. The contrasting policy and regulations such as nitrogen emissions and biodiversity areas cause complexity in the decision-making for the most efficient environmental efforts. These process-related barriers that are existent early in the process, more specifically initiation and establishing, require consistent and clear regulations and require sustainability practices that are pre-conditionally embedded within each step so that it is embedded in the mindset of all stakeholders involved. Based on empirical data gathered from the interviews and its analysis, an overview of the barrier and its occurrence in the process and the action for mitigation is given in Table B.4 in Appendix B.

Planning and Specification barriers

This sub-theme discusses the following six barriers that have been identified in the empirical data: scope, complex trade-off measures, vague specification, interpretation of the ambition, and project specificity. These barriers all occur during the planning and specification of the ambitions as they influence establishing and specifying a strategic ambition into a measure or specification for contract design and preparation.

Vague specification of measure and requirement refers to one of the reasons that the translation is complex, and the ambitions or measures are vaguely specified. This makes the overall translation from ambition to specification complex as it can become subjective. Empirical data shows that the vague specification starts during initiation where the public client formulates their vision into strategic sustainability ambitions. As these quotes state, *"In some cases, it can be a real mess when starting a project, as you may not know what the client wants. Often, the clients themselves do not carry out the necessary investigations beforehand, and even the project objectives are not clearly or well-formulated. How can you achieve that if you don't even know your objectives well? You really have to make that translation and first make it clear to everyone what it's all about. And that may sound silly, but it's actually necessary every time." (CMRH.C)* and *"Rijkswaterstaat claims to have a sustainability ambition, but when I ask for it, I don't get a clear answer. They often only talk about being "sober and efficient," but that's not a sustainability ambition. It's a bit too simplistic, and it won't cut it." (TM.RH)*.

When an ambition or measure is vaguely specified it creates space for interpretation but also increases the chance of a low level achieved ambition due to the different possibilities when defining the ambitions to a tactical and operational level resulting in a low level achieved ambitions. As stated in the following quote: *"By 2050 at the latest, you know, so what does that mean? A goal has been set, a year and a very vague task. However, just translating what has been determined at the strategic level of policy into operational level is a challenge that 99 percent of project managers simply cannot make. I can't make it very easily either." (SCRH.C)*. This barrier can be reduced if the ambition is clearly defined in the beginning or if a minimal level of sustainability can be established as for example is stated by SC.H *"The key issue lies mainly with the clients and engineering firms in ultimately translating it to the market. So, in my opinion, sustainability is still often seen from a political standpoint. They want to be sustainable as a client. However, the problem mainly lies in the tendering process and how to make it concrete and how to do it properly within the procurement rules." (CMRH.B)*.

To address this challenge, it is crucial to address the lack of clarity in the exploration phase. This involves discussions between the public client and consultancy engineering firms, but also between contractors and the client to ensure that sustainability goals are properly understood and translated into actionable measures. If the criteria are unfeasible, engaging in a discussion with the client regarding the issue becomes necessary. The use of tools like the proportionality guide can aid in these situations by establishing a level playing field and minimizing interpretation differences during the bidding process. As it stated, *"To ensure clarity in the translation of sustainability goals from a strategic level to an operational level, the key lies with the clients and engineering firms who must translate these goals to the market. However, sustainability is often viewed from a political standpoint, with the issue lying in the lack of clarity in the procurement process and how to make sustainability goals concrete within the bidding rules. It is crucial to address this lack of clarity during the procurement phase, and if the criteria are unfeasible, the client must be engaged in a discussion regarding the issue. The use of the proportionality guide is an aid in such situations, as it ensures that a level playing field is established and that there is no room for interpretation differences during the bidding process. This can be a difficult conversation to have with clients who may be resistant to such discussions. "(CM.HB)*.

Complex trade-off measures refers to when a trade-off is conducted when two measures do not align with each other or complicate each other. It results in an unclear indication which measure will add the most value or will give the most benefit towards the project. For example,"*"There's a dike section that needs to be raised, but there's a row of trees in the way. The people living their value those trees for various reasons, such as shade and recreation. While removing the trees would be ideal for safety and dike expansion, preserving them could be more sustainable as they cannot be easily replaced elsewhere. When too many sustainability ambitions are established, more measures can be created and can contrast each other." (CMRH.D)*.

An excessive number of objectives can result in conflicting interests as was stated: *"I think that if*

that happens, then you have had too many objectives. You should not focus on circularity, biodiversity, climate adaptation and some scorching all at the same time. If you set the ambition high for all 4 of them simultaneously, you will end up with increasingly conflicting interests. It is much better to choose one good objective and invest in it further." (CM.WB). Focusing on circularity, biodiversity, climate adaptation, and other objectives concurrently can lead to competing priorities. It is more effective to select a single objective and dedicate efforts towards its advancement. Furthermore, project-specific circumstances can give rise to challenges. For instance, *"That is very project specific, but sometimes we get into situations where, due to the fact that we are not allowed to emit nitrogen in a certain area, the cars have to take a much longer detour route. This means that they actually end up emitting much more in total. It is not in the vicinity of a nature reserve." (SC.B)* shows a trade-off that needs to be made in practice. It is necessary to consider, the broader context and be aware of this complication when establishing and specifying ambitions.

Project specificity refers to each project being specific, thus each measure needs to be applied in a different way. There is no standardised way to find the correct measure and its implementation as stated, *"No project is the same, in one project I can openly talk about sustainability and other ambitions. And in another place, if I even mention sustainability, people get goosebumps. No project is the same." (TM.RH)* and *"In the civil engineering field, you have different solutions for every project. While you can apply existing solutions, you always need to tailor them to the specific project requirements. (CMRH.D)"*. Often project specificity is dependent on the wish of the client as an ambition can be fulfilled in many ways: *"So the first step is to simply look at it, understand it, and do we have the same ideas about it and can I then fill it in? That is actually the standard process, but it is so variable per client that we do not have standard processes for that." (SC.H)*.

Scope decreases the level and number of ambitions during translation as it determines the priorities the project focuses on. As the scope often narrows, it limits the possibility of for the implementation of sustainability ambitions and establishing measures as is quoted, *"There are various factors at play, such as the number of years something needs to last, and those are also requirements or starting points, which hinder sustainability as it does not fit in the scope. That is often the problem in the civil sector." (CMRH.D)* . Also, a lot of measures can be distinguished on different levels such as energy use and nitrogen are used. However, depending on the scope of these terms they can be measured or defined differently and once one is used often the other cannot be implemented anymore. As is stated by SCRH.C, *"Nitrogen and energy consumption are much more complex because it involves delineation. You need to clearly define the specific type of energy being consumed. You can consider the energy used in material production, energy consumed during construction work, energy for lighting, and even the energy used by road users. These are already four different forms of energy consumption".*

Interpretation of ambition refers to the challenge of interpreting a formulated strategic ambition which lead to varying scopes and levels of ambition. Clients do not always formulate their goals specifically, resulting in different measures and approaches to achieving the sustainable goals. This can lead to a potential loss of ambition if the minimum or zero level of ambition is adopted or not even considered. As is stated, *"That's the situation you're describing and we're still intrinsically motivated, but the phenomenon remains that the client doesn't always ask for what you really want from the start. The client's request is by definition unclear and can be interpreted in multiple ways, and we try to give hands and feet to that in our plan of approach, so we first try to challenge that." (TM.RH)*, clarification between the contractor, civil engineering firm and public client is required to understand the initial ambition. Moreover, accurately estimating what the client is truly seeking and how it aligns with their policies can be difficult as SC.B stated, *"But then sometimes it's difficult to estimate. What is the client really looking for and how does that fit into their policies and how do they want it to be measurable? That can be difficult sometimes." (SC.B)*.

However, correct alignment between stakeholders and their interpretation can be enforced through collaboration and efforts to understand and verify each other's interpretation as CMRH.B stated, *"And I just take what they have written, and indeed, as you mentioned, it can be very different, sometimes with very little written down. So, you have to engage in a conversation, asking about their ambitions or simply asking directly, and that way, you find out what the intention is, and then you try to give shape to it so that they can demonstrate it afterwards."*

Conclusion Planning and Specification barriers

In conclusion, the quotes indicate that multiple barriers cause hindrances in the process of translating a strategic sustainability ambition to an operational level. These barriers include the vague specification of measures and requirements, complex trade-off measures, project specificity, ambiguous interpretation of ambitions, unclear project objectives, and inadequate contract design processes. It is important to establish a clear understanding of the sustainability goals in this process. Moreover, finding the correct criteria and stimulating discussion to avoid these barriers is essential. The specificity of each project causes the lack of standard processes. Additionally, a clear scope for interpretation, guidelines, and collaboration are essential as is the prioritisation of the objectives when setting the ambitions to avoid conflicting interests. Based on empirical data gathered from the interviews and their analysis, an overview of the barriers and their occurrence in the process and the action for mitigation is given in Table B.5 in Appendix B.

Implementation and Performance barriers

This sub-theme discusses codes that translate to barriers that occur during the implementation and performance of the ambition. The following barriers were identified during the data analysis from the interviews: Overarching measurement, lack of weight in tender, measurability or demand, lack of demonstration of measures, and lack of information.

Overarching measurement refers to measures that are often overarching in the form or requirement, criteria, or indicator. This can become a barrier for ambition erosion, as certain sustainability aspects cannot be verified separately. When this occurs, a measure cannot easily be validated which may result in a different end-product then initially presumed. As is stated, *"It surprises me that they choose biodiversity, but not those other domains. However, what I do wonder about is the dependency or independence of those criteria. You need to ensure that you don't measure things twice, for example, CO2 and NOX often go hand in hand."*, overarching measurements lead to dependency for which validation can become complex.

Moreover, overarching measurements of different ambitions lead to a more complex awarding system during the tendering and also expression of KPI's to measure them as these interviewees stated: *"And, you see that a lot and you see that much more often. With these kinds of things, they have a lot of overlap with each other and then you don't know how it fits into the project. That's the difficulty with creating all kinds of KPIs. The more you express them, the more overlap they will have again." (CM.WB)* and *"I have also seen assignments where they had applied with: 'We would like to take measures on emission reduction, circularity, and biodiversity, but by taking measures on circularity, you automatically achieve emission reduction. So, you saw the same measures appearing in both of those chapters. Then you have to wonder whether we should weigh that twice or whether the wording is strange. It was just a fact that we emit less if we don't have to extract new stones. So, the wording from a client's perspective is still relevant. Actually, a circular measure is really part of your overall sustainability strategy and is not necessarily a separate type of measure." (SC.B)*. Overarching measurements are to be considered as a challenge during the specification of the measures and ambitions to ensure feasible measures and requirements that can be correctly demonstrated and should be considered during the specification for requirements and criteria.

Lack of weight in tender indicates that the component sustainability only plays a small factor in the tender/contract from the engineering-consultancy firm to the contractor or from the inquiry from the public client. Therefore, sustainability is sometimes neglected as it does not provide the opportunity to obtain a better bid or distinguish itself thus there should be a standard weight for sustainability within contract design and procurement as is stated: *Well, then it has to do with how sustainability is taken into account in the tendering process and fortunately, you see that sustainability is increasingly gaining importance. Often, you already knew in advance that the topic of sustainability was hopeless." (SCRH.A)* and *"When designing a lock gate, you have different options such as steel, wood, or plastic. Often, cost, and potential risks are used as criteria in the decision-making process, along with considerations of design aesthetics. However, sustainability is not frequently considered as a criterion in this context." (CMRH.B)* .

Measurability of measure or demand refers to the formulated measures or demands that are often hard to measure which are usually discovered during the assessment of a measure. The information

necessary to measure, may sometimes be based on assumption instead of real data or can be based on outdated data, thus leading to a different outcome as stated, *"Yes, but the same goes for a CO2 figure, there is still some work to be done to verify that it is accurate, because you can just call out a random number and say, well, our project emits so many tons of CO2. Well, I think I've done my job. No, then it should indeed be examined, okay, how is that figure composed? So, there is also something behind it, and the same can be said for more qualitative aspects. (SCRH.A)*. Moreover, measuring sustainability with the current tools is not a sufficient method to be able to measure sustainability, as *"Well, there's also the measurability issue because you see that it's often approached very theoretically from a tendering perspective. Then, in practice, it's actually never measured. Even after the tendering procedure has taken place, they have something like, well, that's behind us, now let's just get back to work, and there's actually no one actively testing that anymore." (SC.H)* was stated.

Furthermore, qualitative criteria are more challenging to measure as they cannot be quantified, therefore no standard way of verification. Thus, a different level of ambition can be realised in the end. As an interviewee stated, *"Yes, that's correct. "Hinder" is a subjective concept. There are certain requirements, for example, when it comes to when light can shine or when the noise level should not exceed 80 decibels. One person may consider it as pleasant background noise, while 80 decibels might be considered excessive by another person. On the other hand, someone else might find 50 decibels to be acceptable as background noise, while others might consider it too loud." (SCRH.A)*. Qualitative criteria are often seen as subjective measurements, thus hard to measure and leaves room for interpretation concerning the level of ambition that needs to be achieved. Moreover, components often use a broad term but are more complex to be measured. For instance, energy use occurs in multiple phases of the construction process but also in different places and for different products, so it becomes quite complex to measure.

Setting a realistic measurement in an early stage is hard to do as you don't know if it is feasible. *"You can measure safety, but the more you measure it, the more you can deceive yourself, right? Look at the MKI value, you can measure it, but you are just fooling each other. So, how should you measure it? I think a good measuring instrument is still lacking to make safety or sustainability measurable. The MKI value, that's not it for me." (TM.RH)*. In order to be able to measure sustainability, conditions need to be taken into the process when specifying measures to requirements and criteria.

Lack of demonstration refers to lack of assessment of the implemented sustainability implementations as stated, *"Well, there's also the measurability issue because you see that it's often approached very theoretically from a tendering perspective. Then, in practice, it's actually never measured. Even after the tendering procedure has taken place, they have something like, well, that's behind us, now let's just get back to work, and there's actually no one actively testing that anymore." (SC.H)* and *"There is essentially a system in place where if the specific environmental requirements are not met, there can be a potential penalty clause of one and a half times the value of the fictional discount gained. Therefore, this has the potential to result in a very high penalty. However, what is often observed is that the traceability between such an environmental requirement and the total fictional discount is not so straightforward, creating a grey area that leads to discussions. As a result, the actual sanction associated with it is rarely applied."(CMRH.B)*.

When there is no demonstration, delivering an end result with a different level of ambition can occur which is not fair to the competing contractors. This can become demotivating; therefore, sustainability is also not stimulated to be implemented within the construction. There is a lack of demonstration as it not a standardised procedure and requires an excessive amount of administration, as stated *"Nitrogen is a different case, because we have a standard norm nowadays. They have to show it when they do the work so that less nitrogen is caused than permissible. But it is not really checked whether that standard is met because there is no fixed method."(CMRH.C)* and *"And that is also the case with MKI. There is a value in dubbocalc and that is it. It is a very theoretical approach and that can be fine. Only sometimes it is also a bit of an idea to play with numbers. Is it really substantiated? Well, then you also have to measure it in practice or the assumptions that are theoretical are actually coming true. And I miss that a bit in many of these things, and the question is also whether you want that, because it becomes an enormously expensive cost item. It is already a major administrative burden to keep track of all this in such a project. However, that is why it remains a very theoretical approach."(SC.H)*.

Moreover, there capacity to validate at the end of construction is limited due to the complexity of the

process and other attention points thus gets lost once the process is fulfilled, *"I think that's where the crux is, and the complexity is often related to MKI scores. You can actually cheat a little bit with that, and clients actually have no idea, no capacity to check those things. You see that sometimes really strange things come out in tenders." (SC.H)*. Nonetheless, it is important to have mandatory demonstration to stimulate contractors to deliver their promised proposals and increase the knowledge within the civil engineering sector. However, the optimal method for demonstration remains unknown.

Lack of information refers to not always having information to calculate the impact on the environment. If calculations cannot be made to calculate the impact but also verify the cost to the environment or the emissions for instance then clients are unwilling to accept the suggest sustainability implementations, as *"We also sometimes have situations where we would like to try out a new innovative mixture or a new concrete reinforcement made of a different material than metal, but there is no environmental data available for it. In those cases, we decide not to bid on the project because we cannot qualify it, so we won't be able to come out on top."(SC.B)* was stated. Due to innovation of the infrastructure and methods, using tools such as the environmental cost indicator (ECI) that provide measurability for a measure is not always possible as the information to quantify them is not available. If the information is non-existent, actors can make an assumption or lose the requirement.

Conclusion: Implementation and Performance barriers

The quotes from the conducted interviews state the difficulty of measuring and implementing sustainability specifications in practice. Challenges such as the difficulty of measuring aspects of sustainability such as biodiversity, ecology, and circularity but also the use of certain tools such as ECI indicate that in practice sustainability is not always achieved. Furthermore, the formulation and definition of the right criteria and requirements are crucial. They should be independent and avoid overlap to ensure a fair tender process and clearly formulated ambitions. Moreover, it is important that the information for these criteria is available, accurate and dependable and that the measures promised are also mandatory demonstrated. Furthermore, there is a high need to validate the sustainability component in the process throughout the project's life cycle so the initial ambition can be analysed and achieved. Based on empirical data gathered from the interviews and its analysis, an overview of the barrier and its occurrence in the process and the action for mitigation is given in Table B.6 in Appendix B.

4.3.8. Conclusion Theme 4: Process related barriers

After analysing the quotes above, there are several barriers that the infrastructure sector faces in terms of sustainability. One of the main barriers is the difficulty in measuring sustainability, which leads to a lack of understanding and appreciation for its importance. Additionally, vague specifications and complex trade-offs make it challenging for construction companies to prioritise sustainable measures. Furthermore, the lack of information, demonstration, and weight in tenders also hinders the implementation of sustainable measures. Project specificity and interpretation of ambitions also play a significant role in the construction industry, as different projects have varying requirements and priorities.In addition to these factors, the infrastructure sector also faces challenges due to contrasting laws and policies, which can create confusion and a lack of consistency in sustainability standards. Finally, the lack of preconditions in projects can make it difficult to implement sustainable measures effectively.

Overall, the construction industry must overcome these barriers to achieve sustainability goals successfully. Collaboration between stakeholders, clearer specifications and requirements, and standardisation of sustainability measures could help address these challenges and enable the construction industry to become more sustainable.

4.4. Conclusion Empirical barriers

From the analysis, there were 24 barriers identified from twelve interviews with both consultancy engineering firms and contractors. It can be concluded that all barriers occur during the exploration phase where defining, establishing, specifying and validating the barriers is necessary to be able to use them as requirements and criteria further in the process. Moreover, there is also a focus on the initiation phase as some barriers occur due formulation of ambitions within this phase. An overview of the barriers, their occurrence and possible actions derived from the empirical data following the data analysis

methodology can be found in Appendix B. The identified empirical barriers are categorised in the following four categories:

1. Capacity building barriers
   (a) Resource based barriers
   (b) Knowledge based barriers
2. Motivational related barriers
3. Collaboration related barriers
4. Process related barriers
   (a) Initiation and policy
   (b) Planning and specification
   (c) Implementation and performance

Table 4.2 shows an overview of the amount of times a barrier/code was identified in the interviews with the highest being the most mentioned barrier.

Code	# repetitions
○ Lack of knowledge on implementation of measures	40
○ Measurability of measure and demand	38
○ Vague specification of ambition, measure or requirement	35
○ Cost	33
○ Lack of demonstration	27
○ Lack of intrinsic motivation	23
○ Lack of willingness to change	23
○ Interpretation of ambition	20
○ Scope	20
○ Project specificity	19
○ Complex trade-off measures	18
○ Experience	18
○ Responsibility	16
○ Innovation	15
○ Lack of information	15
○ Overarching measurement	14
○ Definition of sustainability	13
○ Lack of precondition	13
○ Lack of communication	11
○ Late collaboration	11
○ Competition	10
○ Contrasting policy and law	9
○ Lack of weight in tender	8
○ Fast changing environment	7

Table 4.2: Repetition of codes from data analysis

4.5. Expansion of Theoretical and Empirical barriers

In Chapter 3, twelve theoretical barriers have been identified through scientific and management literature. However, barriers that occur specifically within the construction of the GRH sector in the civil engineering sector are not well researched. Therefore, the empirically identified barriers and insights are used as the main foundation as it is more extensive. Some theoretical barriers align with empirical barriers and some are added extra to the empirical division. In order to fit the theoretical barriers into the empirical categories the following changes were made from the theoretical themes:

- Finance related barriers: The barrier 'priority' is added to sub-theme resources in the empirical framework.

- Knowledge and awareness related barriers are added to the sub-theme knowledge in the empirical division.
- Organisational related barriers: This theme is divided into the empirical motivation related and collaboration related barriers as empirical data shows distinguishing its importance between these barriers is possible. 'Policy and regulation' align with the process-related barrier in the empirical model and will be kept in that category. 'The power of an actor' falls under motivational-related barriers as it describes the influence of an actor.
- Process related barriers: This theme discusses all process-related barriers and is divided into empirical themes as they can be divided on process and capacity perspective. The barrier 'competition' will be kept in the empirical resource-related barriers sub-theme. The other two align with identified barriers in the empirical model and will be part of the processrelated barriers.

The following changes result in the final division and categorisation of barriers that are shown Figure 4.2.

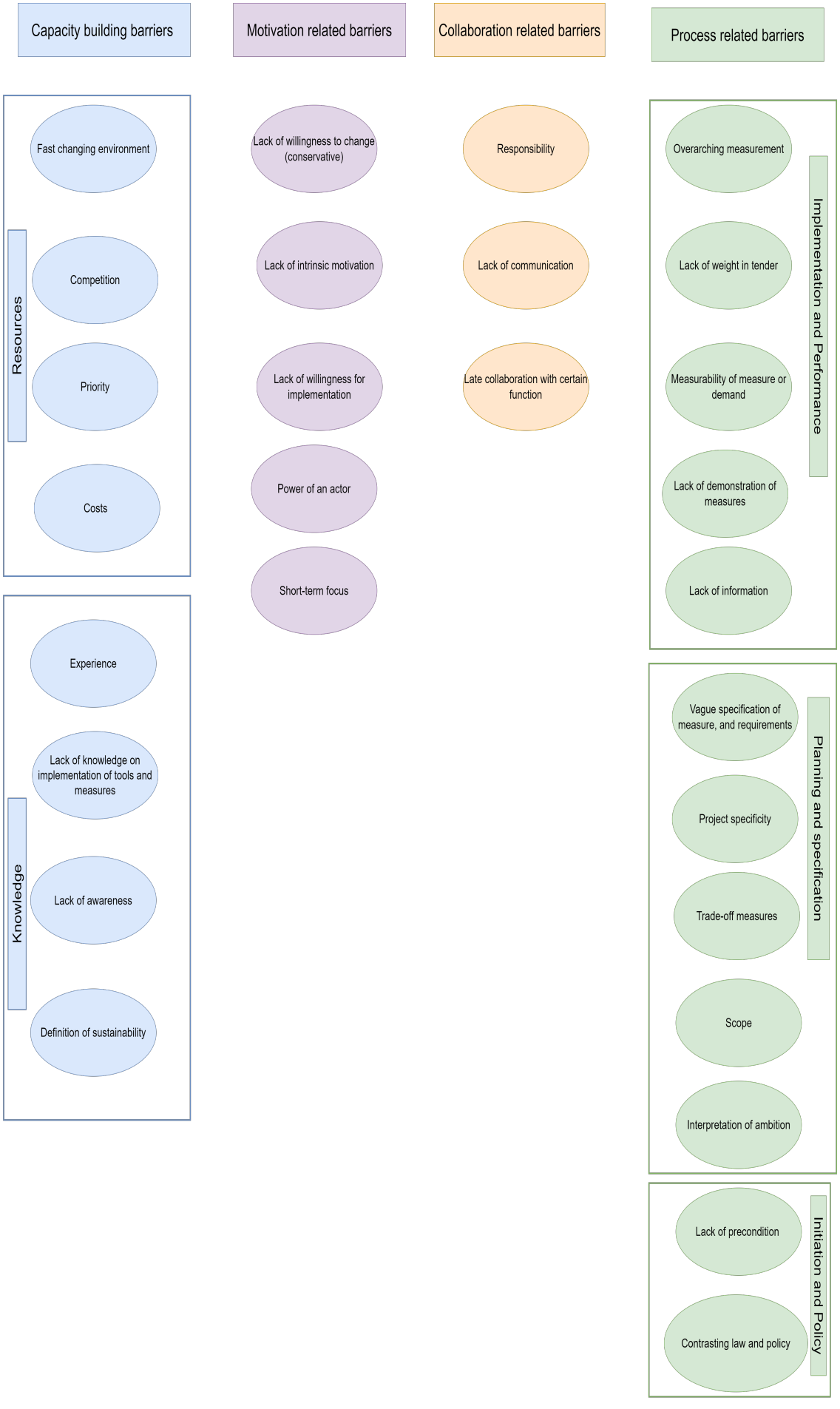

Figure 4.2: Final identification categorisation of empirical and theoretical barriers

In conclusion, the infrastructure sector faces ambition erosion due to four categories of barriers. Ambitions are often not achieved due to a lack of knowledge, resources, motivation, and willingness to change within the sector. Communication and collaboration issues hinder the implementation of sustainability measures. Responsibility for implementation is often shifted to different actors, leading to a loss of ambition. The construction process itself has barriers that contribute to ambition erosion, including vague strategic ambitions, complex measurability, lack of preconditions, information gaps, conflicting laws, and a lack of demonstration. Despite these challenges, promoting sustainability and improving clarity, collaboration, and communication among stakeholders is crucial. Understanding and addressing these barriers is vital for the future of the infrastructure sector. The key lies in maintaining ambition throughout the entire process, from consultancy-engineering firms to contractors in integrated contracts. Therefore, the identified barriers are to be analysed within the process from strategy to operational and to discover in which step these barriers specifically occur and how they can be mitigated by these actors.

From the interviews the occurrence of barriers was discussed in parts of the process within the exploration phase and within the construction process shown in Table 4.3 which will be used as a basis to place the barriers in the re-designed process of the case-study. In order to analyse these barriers in the process, an up-to-date representation of the exploration phase from empiricism is necessary and is discussed in the next section. With a correct indication of how strategic sustainability ambitions are currently defined, established, and specified to operational requirements, understanding how barriers are affecting the process and possible mitigation can be investigated. A concise overview of the barriers can be found in Appendix B and the definition of each barrier in Appendix C.

Process Part	**Barrier**
Initiation	Lack of precondition Responsibility
Analysing question and chances	Definition of sustainability Experience Lack of knowledge on implementation of tools and measures
Establishing	Costs Lack of pre-condition Interpretation of ambition Lack of willingness to change and implement Project specificity Late collaboration with specific function Contrasting law and policy Competition Priority
Translating and specifying	Scope Lack of information Vague specification of measure, and requirements Trade-off measures Lack of weight in tender Lack of knowledge on implementation of tools and measures Lack of communication
Validating and measuring	Lack of demonstration of measures Lack of information Measurability of measure or requirement Overarching measurement
Whole process	Power of an actor Lack of awareness Short-term focus Fast changing environment Lack of intrinsic motivation

Table 4.3: Occurrence of theoretical and empirical barriers based on literature and the thematic analysis

4.6. Exploration process from empirical data

In order to analyse these barriers in the process, a representation of the exploration phase from empiricism is necessary. During the interviews, the process of exploring, defining, specifying and validating ambitions is discussed to create insight into the process from a practitioner's point of view which will provide insight to answer sub-question D.

Figure 4.3 is based on empirical data described below and shows the process a strategic sustainability ambition goes through to come to an operational requirement for contracts in practice from the perspective of sustainability experts, contract managers, contractors and project/technical managers. Moreover, the process in the figure describes what actors and roles are involved in what step. Next to understanding the different steps in the process, an overview of the involved actors in each steps, provides the opportunity to understand how the barriers might be mitigated from a social perspective.

Step 1 This step is usually conducted by the sustainability expert and often involves a knowledge session with other roles to come to a consensus on the meaning of sustainability for the project. Within this step, the 'Omgevingswijzer' is only used by the sustainability expert.

Step 2 The second step involves a list of measures that will achieve the initial sustainability ambition. To draft this list of measures, 'Ambition web' is sometimes used by the sustainability expert only. This step is solely conducted by a sustainability expert.

Step 3 The third step involves the project team and sometimes the sustainability expert and is divided into two rounds. The first round takes into account the long list of measures that will achieve an ambition and considers them with various methods such as a high-impact and high investment analysis, priority, or trade-off analysis. During this round costs and measurability of the measures are not taken into account when cutting measures from the list. In the second round, costs and measurability are taken into account, and will decide which measures are implemented to achieve the established ambition.

Step 4 In the fourth step, the measures are translated into specifications. Interviewees stated that there are three ways to formulate these measures: BPQV criteria, process requirements, and object requirements. These requirements and criteria can be formulated or expressed with the widely used CO2 performance ladder and ECI values. The translation to specification is conducted by the contracting team, where systems engineers have specific guidelines for SMART formulation.

Step 5 Afterward, the bids delivered by the contractor are assessed and considered. However, there is no standardised way for consideration as the tender process depends on the client, project, and contracting team.

Step 6 The last step looks at the justification of the measures in which verification of the delivered contract criteria and requirements are assessed.

This process within the exploration phase in Figure 4.3 provides insight on how strategic ambitions are defined and translated to operational specifications within practice. By mapping the process, a comparison with a case study is conducted in Chapter 5 to design a final process that can place all identified barriers potentially mitigate them.

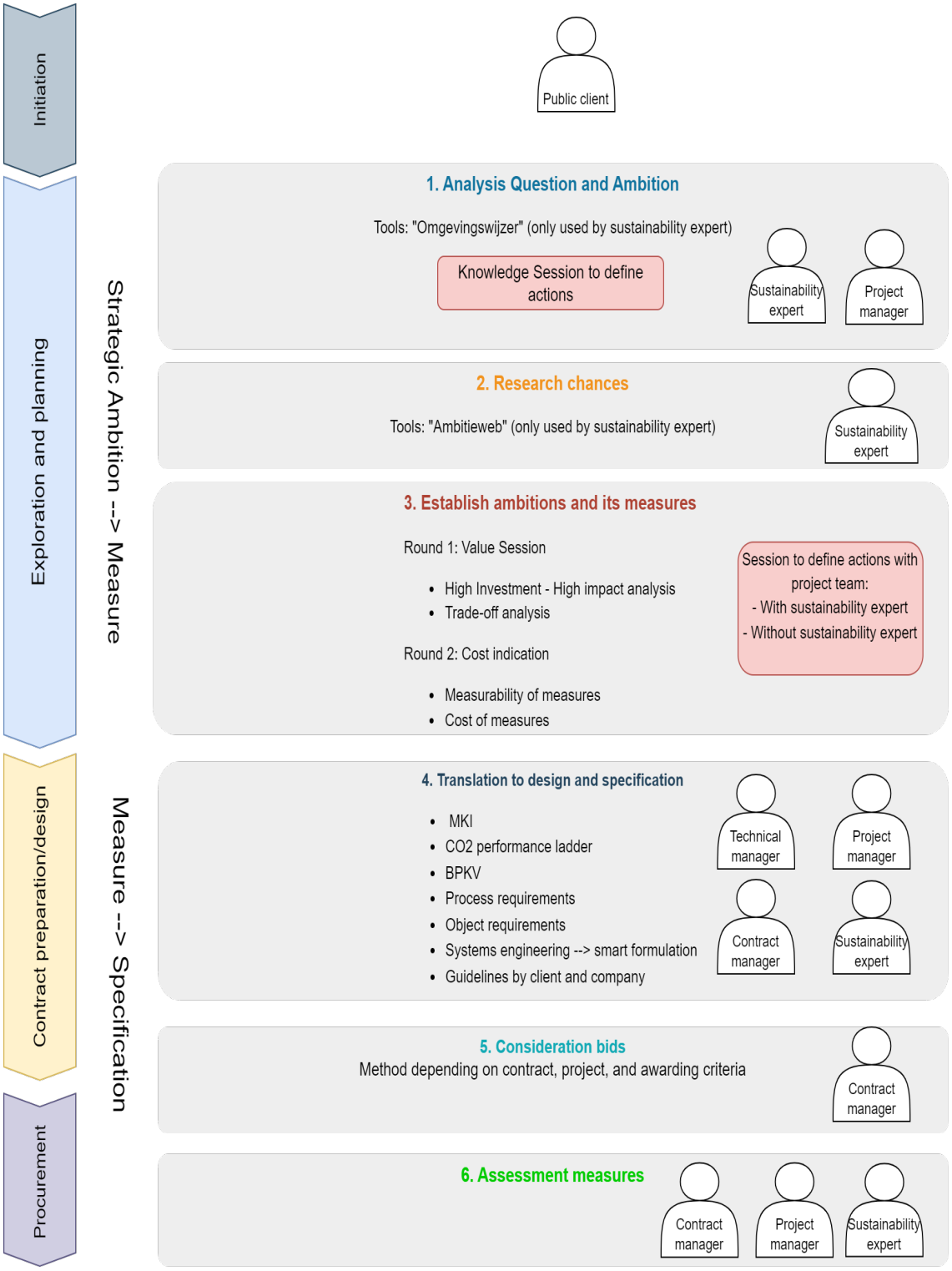

Figure 4.3: Process of defining and realising an ambition from empiricism

5

Case Study

In this chapter, the identified barriers, their occurrence, and processes are explored in a case study. The case study involves an approach by Duurzaam GWW for the consultancy engineering firms that describes the necessary steps to define, establish, specify, and validate sustainability ambitions from the public client to a valuable specification for implementation. This approach is chosen as the case study as it is based on governmental policies and instruments and is urged to use within construction projects. By integrating the empirical process and the process by Duurzaam GWW, a comprehensive process from both policy-oriented and empirical perspectives can be deducted in which the occurrence of the identified barriers can be explored and a process that mitigates these barriers can be designed. Thus, this case study will specifically provide insight into sub-question C and D. The findings gathered in Chapter 2.2 and 2.3 is used to analyse the case study and integrate both perspectives.

5.1. Approach Duurzaam GWW

Duurzaam GWW is a prominent platform within the civil engineering sector, focusing on promoting sustainability within the infrastructure sector and the GRH sector. The organisation has developed a step-by-step plan that can be implemented by a consultancy engineering firm to effectively continue strategic sustainability ambitions from the planning and exploration phase until contract design for the contractor. Additionally, Duurzaam GWW holds significant support from government authorities that also function as a public client in the infrastructure sector. Both theoretical research and empirical research state the persisting challenges associated with defining sustainability ambitions and successfully specifying and translating them into practical actions at the project level within the sector. Consequently, the approach is used as a foundation to comprehend the occurrence of each barrier and what actions need to be considered to reduce these barriers in the process.

5.1.1. Steps within approach

Duurzaam GWW has identified 5 steps that need to be taken to explore, define and specify the ambition into a specification shown in Figure 5.1. The first step allows the exploration of the inquiry and its ambition. Once the ambition is understood, research with measures that can be taken to achieve the ambition is explored and investigated in step 2. Duurzaam GWW urges the user to base its measures on ‘Ambitieweb’ and ‘Omgevingswijzer’. In the third step, all measures will be taken into account and a list of the ambitions and measures that will be implemented in the project are established. During step 4, these measures are translated into design specifications and contract specifications for which DuboCalc and the CO2 performance ladder can be used as indicators. The fifth step indicates the assessment of the measures and considerations. Finally, the sixth step justifies the sustainability component. However, a precise explanation of this step is not given by the organisation.

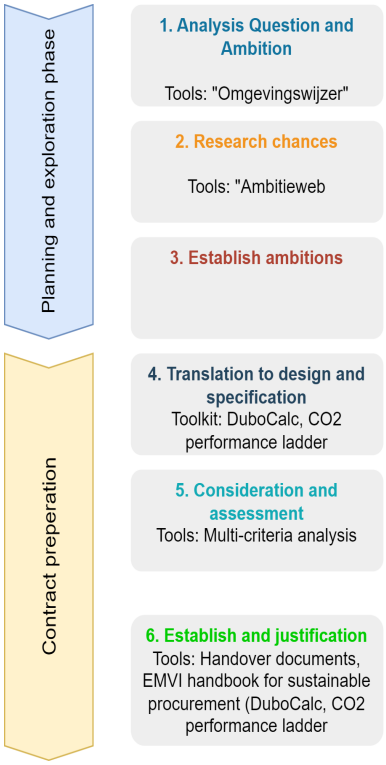

Figure 5.1: Approach Duurzaam GWW

5.1.2. Instruments

Within the approach of Duurzaam GWW, certain instruments are provided to define ambitions and create insight into the meaning of the initial sustainability ambitions.

'Omgevingswijzer'/Environment Guide

The aim of this tool is to map sustainability possibilities within a project. The tool provides a structure to discover different focus points of the following twelve sustainability themes: Energy, Water and Climate adaption, soil, ecology, Use of space, Quality of space, Well-being and Health, Social Relevance, Accessibility, Investments, Circularity and Materials and business climate. For example, the theme of energy use has four different focus points: energy saving, sustainable energy, storage of energy, and transport of energy. The goal of this tool is to create awareness and insight into sustainable ambitions. The tool incorporates the three pillars of sustainability (people, planet, and profit) which aligns with the identified definition of sustainability in Section 3.1 and can be used as input for ambition web (DuurzaamGWW, 2023).

'Ambitieweb'/Ambitionweb

Ambition Web is used to visualise sustainability themes and the different levels that are connected to each theme. The method aims to clarify the different levels visually on three levels and aligns with the identified definition of sustainability in Section 3.1(Duurzaam GWW, 2023).

1. Aims to create insight on the biggest negative impacts and how to achieve a minimal sustainability goal.
2. Aims to show a goal that will reduce the negative impact significantly for the specific theme.
3. Aims to discuss the added value of an action such as climate neutral or circular. This level focuses more on the positive impact.

CO2 performance ladder

The CO2 performance ladder is a tool that is provided by the Dutch government for engineering firms,

companies, and contractors. The CO2 ladder functions as a certification system that shows the level of measures a company takes to reduce their CO2 emissions. During a tender or in a contract, the level of certification can be used to ensure the promised CO2 reduction in their works resulting in a form of evidence that some form of sustainability is existent or will be implemented. The CO2 ladder has five levels that focus on reducing the carbon footprint with level 5 being the highest certification. Each level indicates certain actions that can or will be taken in the project or within the organisation executing the works (OECD, 2016). Stichting Klimaatvriendelijk Aanbesteden en Ondernemen, ''SKOA'' (2022) has set new ambitions for the period of 2022-2024 in which they will focus on the efficiency of the CO2 performance ladder as a procurement instrument. Nevertheless, the CO2 ladder is mostly applied to the sustainability of the company itself as it looks at indicators such as energy generation, passenger transport, supply chain (Green Deal, 2022).

DuboCalc
Dubocalc is a method that can be used to calculate the costs to the environment and is most often used in the tender process. The tool takes all environmental effects into account for each phase of the construction process. The environmental effects are formulated in monetary values also called the environmental cost indicator (ECI). This tool is often used in BPQV criteria tenders, where the ECI value is used as an awarding criterion. It also offers the possibility to show the improvement of sustainability within a design or construction process (DuurzaamGWW, 2023).

5.2. Integration of process

To place the barriers and place the necessary actions to mitigate these barriers, an integrated process based on the case and empirical data is necessary. Figure 5.2 shows the process that is used for the placement of the barriers and the final process. Minimal changes were made as steps 1 to 4 in the empirical and case study align. However, step 5 considers the bid. This step was taken out and was seen as a phase that is not specifically discussed as it depends on the project and differentiates per client. The consideration of bids and selection based on awarding criteria requires a more in-depth analysis that is beyond the scope of the research yet will be discussed in the discussion in 7.1. Finally, the justification of measures and step 5 and 6 of the approach by Duurzaam GWW were integrated into step 5 ‘Verification and Validation’. These steps were integrated as they treat the demonstration, justification, and validity of the promised and realised measures.

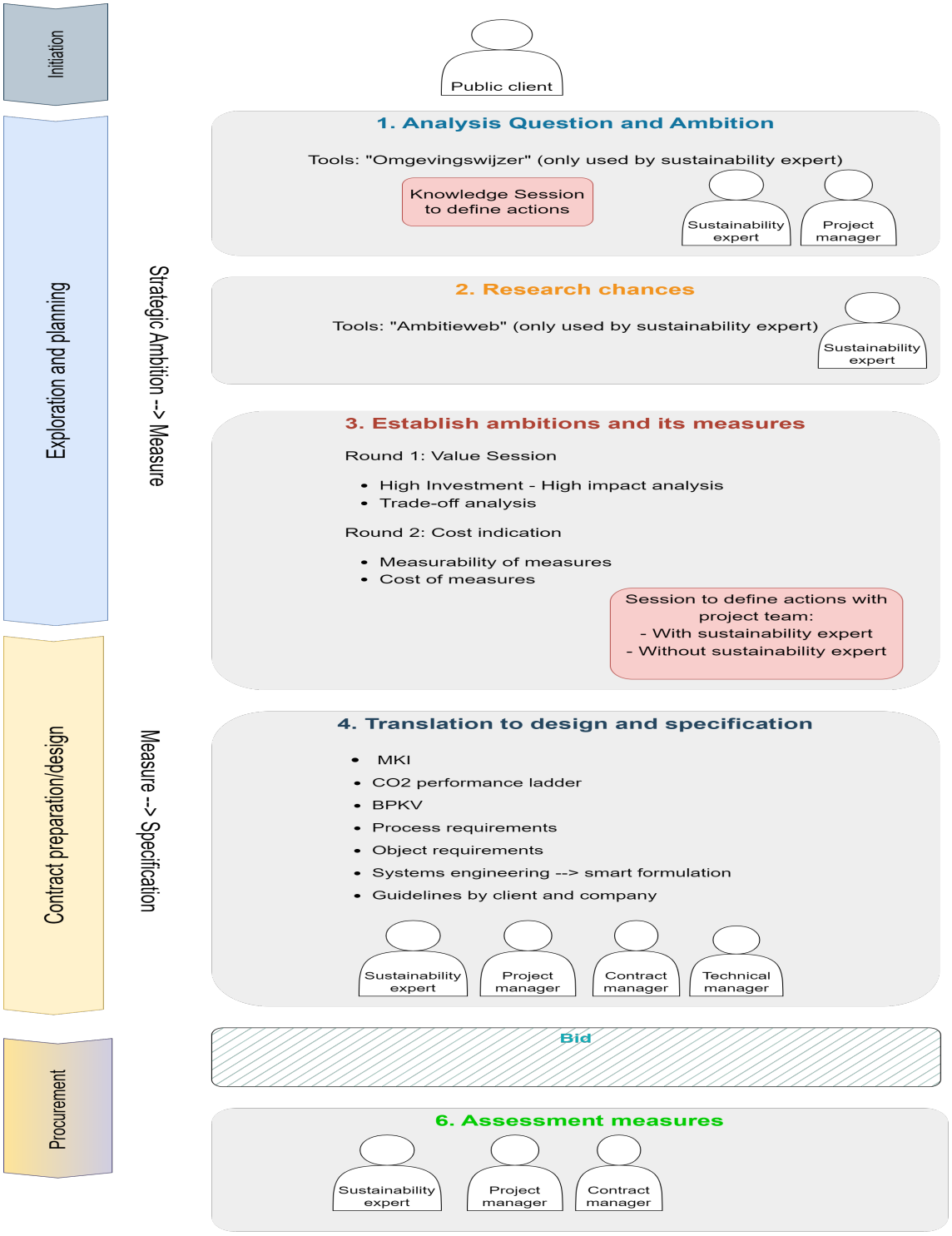

Figure 5.2: Integrated process empiricism and Duurzaam GWW

5.3. Barriers within process

The identified barriers are placed in the integrated process based on the actions and conclusions from the theoretical research and thematic analysis also summarised in Table 4.3. This model not only addresses sub-question B but also contributes to the scientific understanding of barriers to ambitions as previous research has not specifically examined their occurrence within the exploration phase of the

construction process.

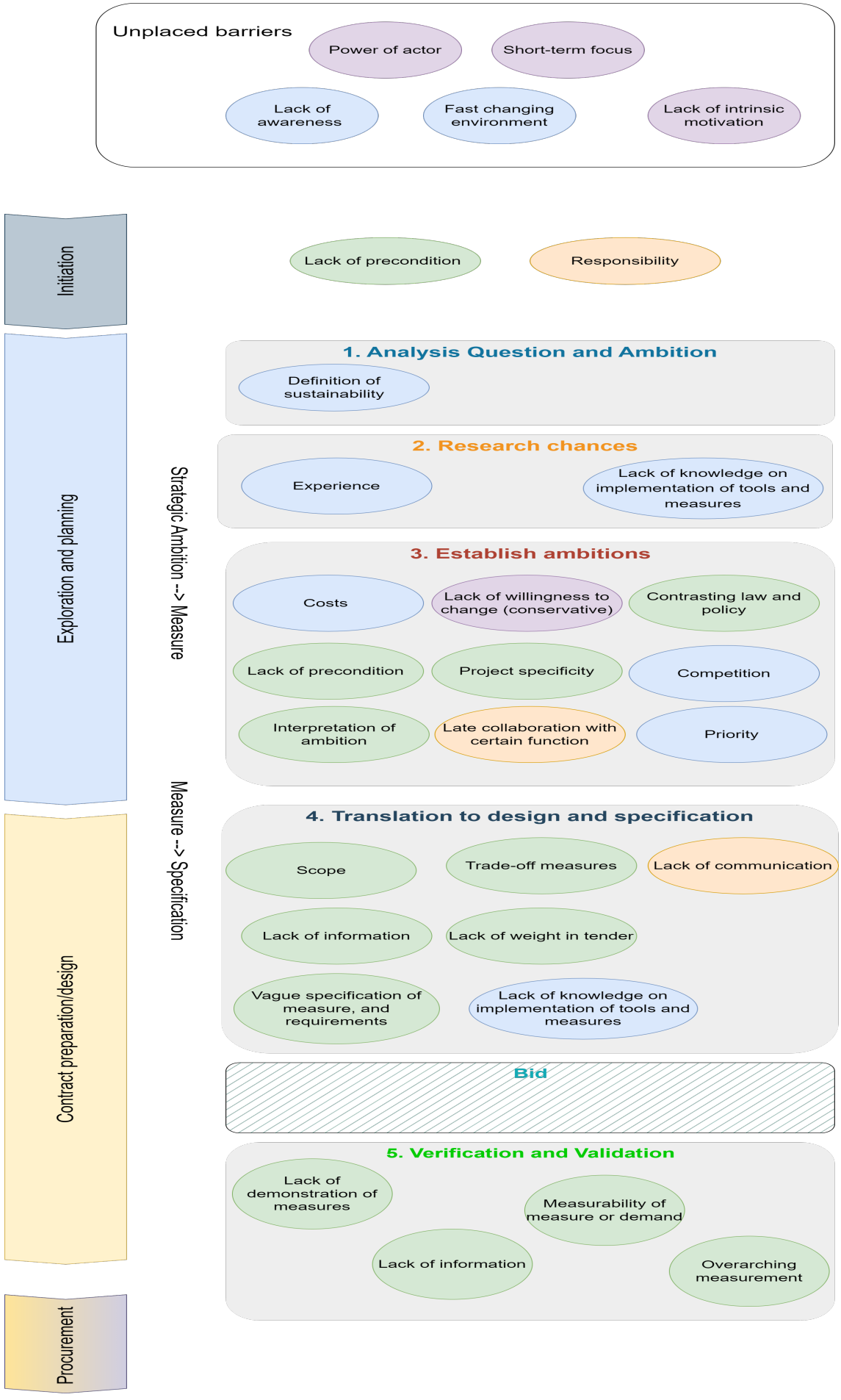

Figure 5.3: Placement of barriers within process

5.4. Collaboration within the process

To mitigate the identified barriers that are placed in the process, actions can be taken. Next to implementing conditions and rules within the steps to mitigate barriers, engagement between different roles and between external and internal parties can mitigate some identified barriers. The theoretical research discusses stakeholder engagement and an increase in communication by enforcing collaboration. The empirical research also discusses increased validation moments, internal and external collaboration. The approach from Duurzaam GWW does not include the involvement of certain roles and actors, however a division of involvement in each step can mitigate some of the identified barriers and adds pracitical relevance.

5.4.1. Mitigated barriers due to improved collaboration

A collaboration framework can reduce the impact of the following barrier that is based on the conclusions from the theoretical barriers and overview of actions in Appendix B. Empirical and theoretical research, highlight the indispensability of collaboration in achieving sustainability goals. Collaboration indicates: internal and external collaboration moments where validation of the vision or interpretation occurs, awarding responsibility, and clarifying engagement and participation within the project team. Both chapters discuss the following barriers that could be solved with collaboration:

- Lack of communication: Collaboration improves communication as different perspectives are shared and individuals will aim for a shared understanding (Bal et al., 2017). Also, *"Yes, you have all stakeholders together, and one stakeholder has a different interest than the other, of course. And often they don't talk to each other. Well, by putting them all together at the table in such a session, it works, and then you don't really have to do anything."(CMRH.C)*.
- Lack of awareness: Collaboration can bring together different expertise and perspectives, through sharing knowledge and visions, the importance of the concept is shared. When collaborating, individuals can develop an understanding of the necessity for sustainability within the sector (Hasan, 2018).
- Lack of knowledge: Collaboration facilitates the exchange of knowledge and expertise amongst distinct roles. Best practices, methods, measures, and experiences can be discussed fostering a learning process in the infrastructure sector. This exchange enables individuals to work (in)dependently on the subject and gain new insights (Bal et al., 2017). Also, *"Together, we will complement each other in terms of content because whether it's an assistant engineer or a contract specialist, they don't have that knowledge and expertise. The sustainability expert, in terms of content, they cannot assess what is feasible. They will indeed also consider when it is well articulated." (SCRH.A)*.
- Power of an actor: Through collaboration, individuals and their interests are openly discussed. The power of an actor is decreased as shared-decision making is stimulated to reach a shared vision on the sustainability goal to be achieved (Geels, 2016).
- Lack of intrinsic motivation: During collaboration with multiple individuals, the sense of purpose is stimulated and the connection towards sustainability may be supported. A shared vision during collaboration allows individuals to obtain a personal connection to the matter and creates a supportive environment (Koistinen et al., 2022). Also, *"And, what you're actually saying is that sustainability should never be centralised, and that's actually what we do in projects, right? We hire a sustainability consultant. If you look at that hierarchy, it's actually also a matter of how you're organised. You really have to want it together. You should also be held accountable together for your sustainability goals." (CM.WB)* .
- Lack of willingness to change: Through collaboration, individuals are forced to take multiple perspectives into account which results in the consideration of sustainability even when the individual itself is not willing (Koistinen et al., 2022). Also, *"The world is still dominated by older white men who grew up in a certain time and were educated during a different era. Some of them may have difficulty making the transition to thinking about sustainability in an integrated way. So if you give them an overview and have them thoroughly go through it, you will have made the first step." (SCRH.C)*.
- Responsibility: Through collaboration, the division of tasks and the feeling of responsibility in-

creases. Discussing and exchanging visions promotes a shared understanding of what is required to achieve sustainability ambition. As individuals work together, their accountability is represented within the group, thus taking responsibility will be increased (Sharma and Henrique, 2004). Also, *"So it is often more difficult to implement sustainability because you don't really have an owner. Many people are involved, and it's a bit like with flexible workspaces. If everyone is an owner, no one is the owner. So if everyone is responsible, then there is a high chance that no one will take action." (SCRH.A)* .

- Interpretation of an ambition: Through collaboration and verification with the client and internal team, the interpretation of the ambition can be verified and agreed upon. As stated in the empirical research, *"And I just take what they have written, and indeed, as you mentioned, it can be very different, sometimes with very little written down. So, you have to engage in a conversation, asking about their ambitions or simply asking directly, and that way, you find out what the intention is, and then you try to give shape to it so that they can demonstrate it afterwards." (CMRH.B)*.
- Definition of sustainability: By verifying the definition of sustainability with the client, the objective for the project is clarified and will uphold the initial strategic ambition.
- Late collaboration: By improving internal collaboration and involving certain roles in steps, strategic sustainability ambitions can be safeguarded. As stated in the empirical research, *"Yes, when I look at my role, it also depends on when I enter a process. If it's right before a tender, which I understand as well, there's little I can achieve in terms of design since the design is already in place. Then I also look at where the room is given, given that the designers have provided their input, to still make progress in terms of sustainability before the tender. It also depends on where your sphere of influence lies." (SCRH.A)*.

5.4.2. Involved actors and roles

Collaboration can be defined into two segments and focuses on the engagement between roles within the project team yet also communication and participation externally between the stakeholder and internally within the project team of the consultancy engineering firm. The identified actors and stakeholders from empiricism verifies the identified roles in Chapter 1 and describes specific functions/roles that are necessary to define, establish, specify and validate strategic sustainability ambitions to operational contract criteria and requirements. There are three main parties with specific roles:

1. The public client
    - Public manager: manages the constructed object after realisation.
    - General public client: can take different forms depending on the collaboration method of the project. For this research, the public client can take on any specific role, however is the representative from the public client side that initiated the strategic sustainability ambition.
2. An engineering-consultancy firm that represents the public client
    - Project manager: focuses on the safeguarding of quality and is responsible for the final delivery of the object.
    - Environmental manager: focuses on the relationship between the environment and related stakeholders. This role is responsible for the contact with the surroundings where construction takes place.
    - Technical manager: focuses on the control of risks and knowledge within the technology and organisational aspects of the construction.
    - Contract manager: focuses on the relationship between the client and the market (contractors). This role is responsible for the buying phase and the contracts between the different parties.
    - Sustainability expert: provides knowledge on the implementation of measures to fulfill the strategic sustainability ambitions.
3. Contractor: representative and can take on the role necessary for the process.

5.4.3. Collaboration moments

For this research, collaboration is a synergistic and inclusive approach where individuals or groups come together, fostering internal and external communication channels, actively participating and engaging stakeholders. It aims to achieve shared goals, exchange knowledge, and leverage diverse perspectives to drive innovation, problem-solving, and decision-making processes in a cooperative and mutually beneficial manner.

Internal collaboration moments

This entails the participation from the project team of the consultancy engineering firm, the allocation of responsibility and how it should be improved.

External collaboration

This entails improved stakeholder engagement and communication between the public client, consultancy engineering firm, contractor by implementing more moments to verify and validate the strategic sustainability ambitions with the three main parties.

Collaboration Framework

The indicated collaboration moments within the process in Figure 5.4 shows which role is necessary to spread knowledge, create a shared understanding and clarify who is responsible to continue the sustainability ambition. Each step involves distinct roles and the green figures represent the roles that are responsible to uphold the sustainability ambition. Before the exploration of the ambition from the consultancy-engineering point of view, it is important to note that the public client is required to feel responsible to implement sustainability during the initiation of the project. The empirical data shows that it is crucial to increase responsibility early in the process to maximise its continuation through the process and into realisation. Therefore, each involved role, its responsibility, and its impact is described.

Step 1

The empirical data from the interviews indicates that the sustainability expert from is the only responsible role for the analysis of the question and ambition. By suggesting the involvement of the project manager and holding them both responsible, a shared vision will continue. Next to this step, the understanding of the ambition is discussed with the public client through verification.

Step 2

The empirical data from the interviews indicates that the sustainability expert is involved and the only responsible role for the analysis of measures to achieve the ambition. Within this step, it is important to involve an environmental manager or specialist that can share their expertise on sustainability matters.

Step 3

The empirical data from the interviews indicates that in this step multiple roles are involved. The project manager is held responsible for the continuation of the initial ambitions, and the technical manager for the features and other roles that are relevant to the scope and share their vision. Within this step, a sustainability expert is not always involved as sometimes the team will continue with the measure list of step 2. The collaboration framework involves the sustainability expert in this step and awards responsibility to uphold the agreed-upon sustainability ambitions. Within this step a feedback loop or verification session with the public manager and public client should be organised, to agree on and verify the established ambitions and aligning measures.

Step 4

The empirical data from the interviews indicates that in this step multiple roles are involved such as a systems engineer, contract manager, technical manager, and sustainability expert. The empirical data suggests awarding them all responsibility to guarantee the continuation of the initial sustainability ambitions.

Step 5

The last step includes the contractor, project manager, sustainability expert, and technical manager. From empirical data, it is gathered that these functions are all important to be able to validate and verify

the promised and realised measures. Within this step, the contractor, contract manager and project manager are responsible for the demonstration of the measures and the sustainability expert is involved to verify specific sustainability details.

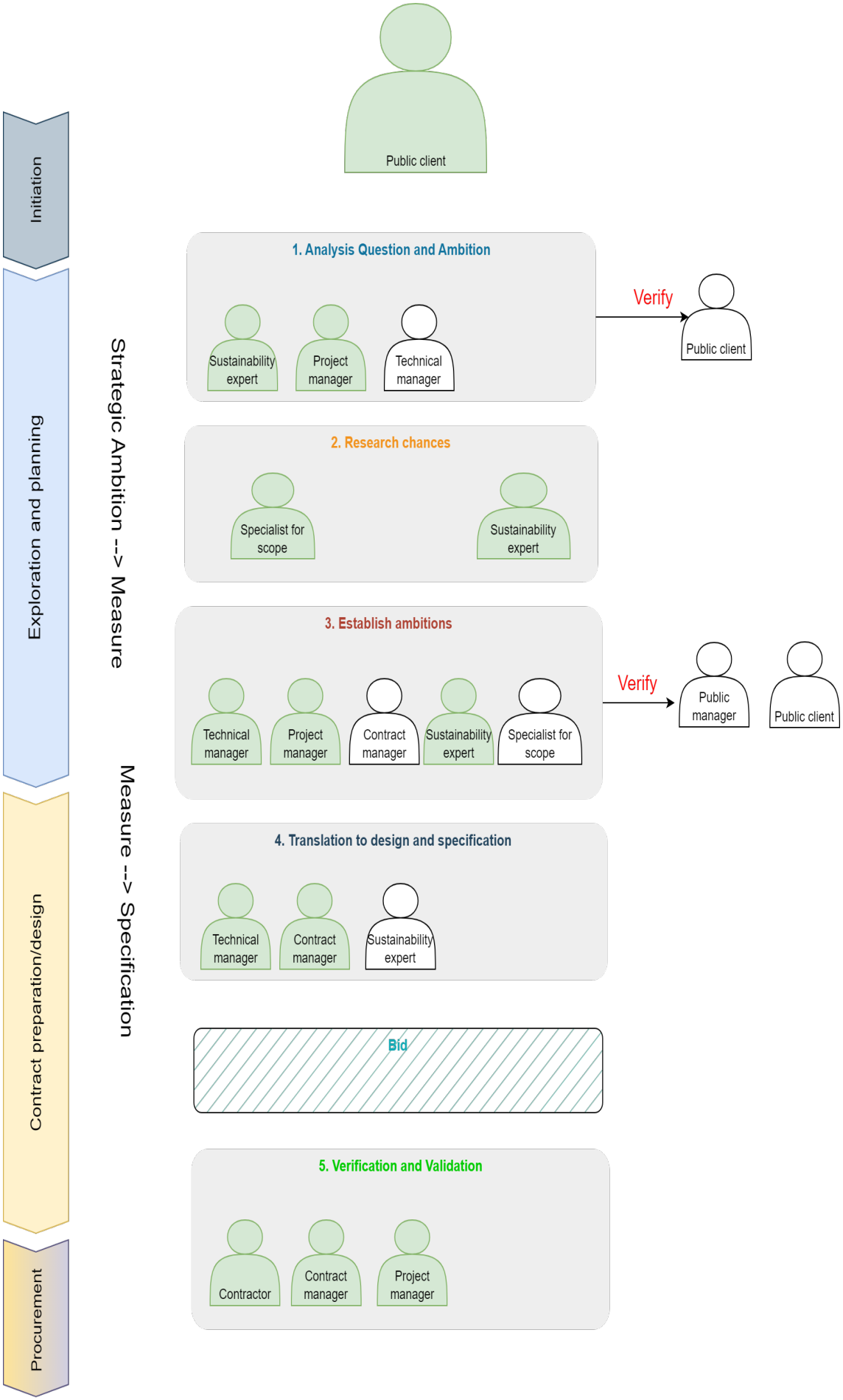

Figure 5.4: Collaboration Framework

Overall, the suggested process fosters awareness, the dissemination of knowledge, an increase of intrinsic motivation, a sense of responsibility, the correct interpretation and definition of the initial ambition, and a shared vision amongst the relevant individuals. By stimulating these efforts and involvement, collaboration has the potential to steer a meaningful and lasting change toward a sustainable transition within the sector.

5.5. Mitigation of barriers in process

In order to realise strategic ambitions to operational specifications, the impact of the identified barriers needs to be reduced. The empirical and theoretical research provides actions that can be taken by a consultancy engineering firm to mitigate these barriers. Moreover, the case study provides insight into the process and when these actions should be taken resulting in a policy and empirical-oriented process. Table 5.1 presents each step that needs to be taken during the exploration phase to define and translate strategic ambitions to operational specification without ambition erosion and mitigate the indicated barriers. The required actions are based on the analysis of the occurrence and mitigation of the barrier in Chapter 3 and 4, and are integrated into the case of 5.2.

collaboration framework	• Lack of awareness • Lack of communication • Willingness to change • Lack of knowledge • Lack of awareness • Power of an actor • Lack of intrinsic motivation • Interpretation of an ambition • Definition of sustainability
0.0 Set precondition of sustainability component in general	• Lack of precondition
1.1 Set a clear definition of sustainability for the scope of the project	• Definition of sustainability
1.2 Verify understanding of sustainability	• Lack of communication • Definition of sustainability
1.3 Use tools such as omgevingswijzer to understand sustainability scope	• Definition of sustainability
2.1 Use ambitieweb to define level of ambition and how to achieve it	• Interpretation of ambition
2.2 Create and distribute database with measures relevant to an ambition	• Lack of knowledge on the implementation of measures and tools • Experience
2.3 Collaboration with other functions to exchange knowledge	• Responsibility • Lack of knowledge on the implementation of measures and tools

3.1 Create an overview of the ambitions with their measures ■ Create an overview of the ambitions with their measures ■ Needs to be measurable ■ Possible within scope	• Measurability • Project specificity • Contrasting law and policy • Lack of information • Scope
3.3 Session for first cut of ambitions can be done through a trade-off matrix or the placement of high value/high investment	
3.2 Set minimum level of ambition to be achieved	• Lack of precondition • Priority
3.4 Investigate costs of the measures	• Costs
3.5 Collaboration with contract manager to analyse functionality of measures to specifications	• Interpretation of ambition • Measurability of measure or demand
3.6 Discussion with client and manager to establish agreed ambitions	• Interpretation of ambition
4.1 Translate the minimum level of ambition to a functional requirement	• Lack of precondition
4.2 Determine weight of sustainability component in tender	• Lack of weight in tender
4.3 Translate measure to specification in two ways (BPQV criteria or contractual requirement) Conditions: ■ Criteria cannot fall under the same measurement ■ Information for measurement needs to be available or trustworthy assumption ■ All measures need to align with the specification, cannot contradict one and another ■ Qualitative criteria must have a scale for score or pass/-fail ■ SMART formulation through use of expertise and database	• Overarching measurements • Trade-off measures • Measurability of measure and demand • Vague specification of measure and requirements
4.4 Use of Dubocalc, norms and regulations	• Measurability of measure or demand
5.1 Set mandatory demonstration rules between contractor and client	• Lack of demonstration
5.2 Update the information for calculations	• Lack of information

Table 5.1: Overview of steps and relevant barriers

5.5.1. Unsolved barriers

The model strives to place each barrier and solve its complexity within the process. Despite the best efforts of the model, three barriers remain unresolved. A fast-changing environment and competition are barriers that can be classified as external factors. Sustainability is a rising concept within the infrastructure sector as climate change and its regulations become more pressing leasing to a fast-changing environment. Despite the increase of tools, research, and regulations in the sector, stakeholders struggle to keep up to date and implement accordingly. Additionally, competition is another externally driven barrier that cannot fully be mitigated in the suggested model. The level of competition raises the question of the right method of procurement which is further discussed in the discussion in Section 7.1. The last unsolved barrier is short-term focus, this is a mindset that cannot be changed through collaboration and the mitigation steps in the process. A short-term focus exists within project teams. Even though, policy urges to look at the long term sustainability goals it has set, within organisations a short term focus still exists.

5.6. Conclusion

From the case study, it can be concluded that most barriers occur during the translation process in the exploration phase which is distinguished into sub-processes: defining, establishing, specifying, and validating. The integrated process from the case study provides a foundation for the implementation of necessary actions to mitigate the placed barriers. Two types of actions have been implemented: (1) a collaboration framework and (2) mitigation steps/conditions. However, the barriers fast-changing environment, competition and short-term focus cannot be solved within the process as they are seen as external factors that cannot be influenced. The final process is visually presented in Figure 5.5.

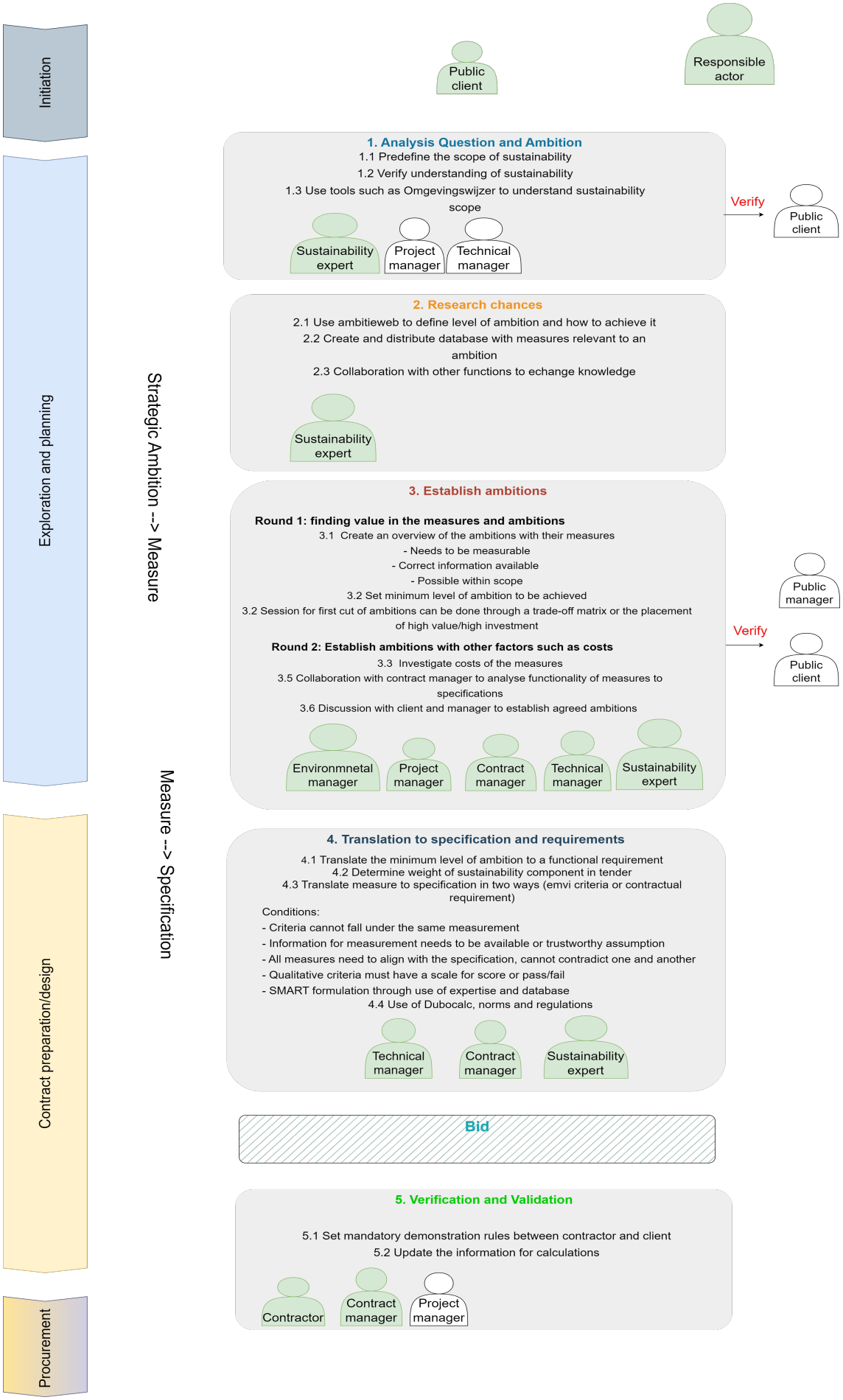

Figure 5.5: Framework for reducing ambition erosion

6

Validation

The validation of the redesigned process for the framework and this research is conducted through expert interviews. In the interview the expert of a certain function feedback or suggestions to the framework from the research. The main points are elaborated in this chapter and potentially further described and implemented in the framework.

6.1. Validation Protocol

The validation of this research was performed through four expert interviews with a contract manager, sustainability coordinator, project manager from RHDHV, and a sustainability/contract manager from BAM (contractor). These specific functions were selected due to their relevance in the empirical research and their understanding of the process. The inclusion of these parties ensures that each perspective is taken into account considering that each party perceives ambitions at diverse levels and approaches their implementation differently. By conducting interviews with these different experts, information on their specific function but also opinion on the overall framework is gathered. This approach facilitates obtaining valuable feedback, including suggestions for potential modifications, and reaching a consensus on the framework.

Each interview had an average of 50 minutes and was conducted through an online meeting with a PowerPoint with the following structure:

1. Introduction to research: goal and scope of research were discussed
2. Clusters of barriers and an overview was shown
3. Introduction of case study
4. Duurzaam GWW
    (a) Alteration based on interviews
    (b) Walk through the steps with the identified barriers and suggested actions
5. Feedback on each step
    (a) Agreements
    (b) Suggested changes
6. Suggestions on overall research

6.2. Validation Results

Each interview discussed each step specifically. During the interviews, Figure 5.3, Figure 5.4, and Figure 5.5 were shown and discussed each time to see if all perspectives align or contrast each other. Suggestions made by previous experts were discussed in other interviews if the subject arose. The validation results will be discussed by addressing each step.

6.2.1. Feedback Step 1

- The definition of sustainability remains a challenge as there is tension between different aspects, so it is important to verify its meaning for the project early in the process which is added to the process.
- Tools like “omgevingswijzer” are useful, but require a predefined scope to make sure ambitions are understood. Thus, the public client needs to establish a clear scope during initiation and the framework should not rely on these tools.
- Experts agree with the identified barriers and add that the barrier ’scope’ is also apparent in this step which should be mitigated.
- Collaboration and verification of the understanding of sustainability with the client will help and is possible, which indicates a valid framework
- Prerequisites need to be defined on all levels. There is a strategy from the highest level, but it should also be set within the project, company, and requirements. By setting preconditions on all levels, sustainability will be safeguarded from on an organisational, governmental, project based and individual level. Indicating more specific awarding of preconditions in the framework.

6.2.2. Feedback Step 2

- All experts agree on the identified barriers, which indicates a feasible framework.
- Database limitation: a database might not be the answer to spreading knowledge. It allows for an analysis on data that was used in older projects which might not align with the current practice, hindering the achievement of ambitions such as CO2 neutrality by 2030 for which innovation is needed. Thus, the framework should not rely on a database to solve the lack of information.
- Innovation-trajectories (knowledge pathways to stimulate innovation within RHDHV) should be incorporated in the step. Standard practices already exist, but in this step, innovation should also be taken into account through market consultation and partnering so that information can stay up to date and knowledge is spread resulting in the mitigation of ’lack of information’ and ’lack of knowledge and awareness’. This could be implemented in the framework but would need further research.
- The collaboration process is not complete. Sustainable implementations involve specific knowledge, thus specialists on the topic should be incorporated. For example, if there would be a high level of ambition in ecology and a possible measure would be to implement a lot of indigenous plants. An ecology expert is needed to provide expertise on the matter. A project manager or environmental manager is important, but the experts are the ones with the knowledge and motivation which are needed to find feasible measures for the scope of the project.

6.2.3. Feedback Step 3

- The suggested steps are valid and will help clarify the process and help realise the strategic sustainability ambitions but also increase awareness for sustainability practices, indicating a valid framework.
- Round 1 represents the long list of measures, this should be clarified to optimise the process.
- Round 2 represents the short list of measures, this should be clarified to optimise the process.
- The impact of the measure in relation to ambition can not always be measured but can prove value and impact. For example, the impact of the implementation of certain plants cannot be measured but it can have a high impact. Suggestion to add to the framwework: incorporate impact in this step through an implicit impact analysis, so that it is possible to consider qualitative measures that can make a big difference.

- Costs should be taken into account in step 1 as they add to the trade-off matrix. Creating a long list with values, benefits, and costs helps determine the scope which will help discuss it with the client. Added to the framework.
- Experts agree that it's important to assess measurability and available information in this step in the process to make sure measures can be implemented before establishing the final list of measures and cutting them due to high costs later in the process. Indicating a valid framework.
- The barrier scope should be moved to this step as the scope causes ambitions and measures to be lost when it does not fit within the scope or there are other ambitions that have a higher priority in the scope due to which sustainability is neglected.
- In this step the definition of sustainability needs to be assessed with a feedback loop to ensure it is aligned with the initial definition to verify that the strategic ambition is being realised and safeguarded.
- Collaboration: The responsibility of the functions needs to be defined more clearly. It is important that a sustainability advisor is existent in this process as are other specialists so that they can help establish feasible measures for the ambitions. Moreover, the RACI framework should be implemented to clarify the division of what is expected of a function or role within the project team. Experts indicate that experts guard the process and are the ones to make the changes, not the managers. The prioritisation of the functions should be more clear as they cannot all be responsible. For example, a sustainability advisor is supportive and informative in step 4, while the project manager is responsible but not always accountable. Multiple administrators may overlook certain risks, so it's important to involve them in the process and establish standards to ensure consistent consideration.
- Experts suggest implementing a solution before exploration starts from the public client. Consultancy engineering firms and contractors would benefit from a clarification on the priority of the ambition. The public client should clarify if they give more priority to the costs or the sustainability ambition or the maintainability versus the sustainability ambition. As a result, consultancy-engineering firms and contractors will be able to find measures that fit within the public client's priorities. Example: Costs vs sustainability ambition. If costs has a higher priority than achieving high sustainability ambitions, then the consultancy-engineering firm and contractor will find measures that align with the priority of cost to ensure that the measure is not cut due to budget constraints. This can be implemented in the framework, though requires further research.

6.2.4. Feedback Step 4

- Experts agree with the placement of barriers except for 'scope' which is suggested to be placed in step 3 as the scope causes ambitions and measures to be lost when it does not fit within the scope or there are other ambitions that have a higher priority in the scope due to which sustainability is neglected.
- There are various tools for measuring circularity, but Life Cycle Analysis remains the most widely used and fairest method. Qualitative aspects of circularity can be included as requirements or BPQV criteria so that there is more of a balance between qualitative and quantitative criteria and requirements which is added to the framework.
- It is important to ensure a clear definition of what is asked in a requirement or criteria such as secondary materials. Thus, validation and verification with the internal team, but also with the client is necessary to ensure that the sustainability vision of the client is fulfilled which is added to the process. For example: What is meant by secondary materials? Which is necessary in the framework.
- The client needs to consider the complexity for the contractor during contract execution, so that the contractor can deliver a feasible proposal while upholding the sustainability ambitions. This action is harder to implement in the framework, as it can be biased.
- Suggested step to take is to standardise knowledge through expertise centres, and governmental policy should take more control in standardising the process. However, this process does not align with that feedback as empirical data showed that standardisation is difficult due to project specificity and competition, thus hard to implement.

- Pre-conditional ambitions and requirements are crucial in this step as the enforce the realisation of the sustainability ambitions and force actors to consider them.
- In this step the different possibilities for formulation should be addressed: BPQV criteria, process requirements, and contract requirements which is already stated in the process to explore the different opportunities of formulating the sustainability measures on paper.
- Specialists should be involved in this step as they can make the changes.
- Sustainability experts are not responsible for this step anymore which is changed in the process.
- Suggestion that the name of the step should be changed to the sole specification of criteria and requirements. It indicates the design of the object, but this process focuses on a contract level which will help clarify the goal of the designed framework.
- Sustainable solutions can be more expensive, and the bidding process should reward ambitious and innovative approaches to maintain high sustainability standards. This can result in more motivation for the contractor to deliver high sustainability practices in their proposal.
- Lack of intrinsic motivation is a problem, and setting clear requirements and incentives would help drive engagement and impact which is validated with the framework.
- Suggestion of the implementation and stimulation of the BPQV criteria tool by Duurzaam GWW to guarantee the measurability of requirements and criteria which will help with the specification of measures for contract design.

6.2.5. Feedback Step 5

- Demonstration is crucial in this step. Experts agree to have a mandatory demonstration formulated to ensure the traceability of the requirements aligning with the existing framework.
- Penalties could be imposed for not meeting sustainability requirements, even when time constraints could arise. This should be more clearly defined in the step to ensure the realisation of the ambitions.
- Involving a sustainability advisor in for the calculations of the ECI and circularity assessments is crucial for quality control and assurance which will lead to a better assessment of the performed practices. However, the framework mentions ECI, but does not consider its reliability or efficiency.
- Emphasise that the focus is on formulating and validating contract requirements, including a back loop to sustainability definitions and collaboration moments with both the client and internal teams to ensure that the vision and strategic sustainability have been and are being realised.

6.2.6. Overall feedback on research

The experts see the value in the research and describe its impact on the different functions related to the model. They agree that taking these steps in a more standard manner would reduce ambition erosion and help clarify the process of how strategic ambitions should be defined and safeguarded into realisation. However, they do express that each project and its team is different, and often steps are skipped depending on how people work together and how they approach their individual work. It is urged that the sustainability component should be made pre-conditional from the highest level of policy as the earlier it is touched upon in the process, the more impact it can have on the project which is further discussed in the discussion in Chapter 7.

6.3. Validated Process

Based on the validation there were changes made in both the collaboration process and the process. In the collaboration process, the RACI framework was added to define the roles in more detail. The final framework was changed based on the suggestions described in Section 6.2.

6.3.1. RACI Framework

The RACI framework is a tool used in project management and organisational processes. The aim of the framework is to clarify and define the role, function, and task execution of each stakeholder. Within

the framework, there are four key roles that represent the letter of RACI shown in 6.1 (Rahmad Dwi Putra Suhanda et al., 2021).

- Responsible: Provides information and is the person who is responsible for carrying out a task until it is completed.
- Accountable: Members of this team are responsible for all tasks delegated.
- Consulted: Are responsible to provide information on the subject as these roles have the expertise.
- Informed: This role is always informed on the process and must be notified when changes are made.

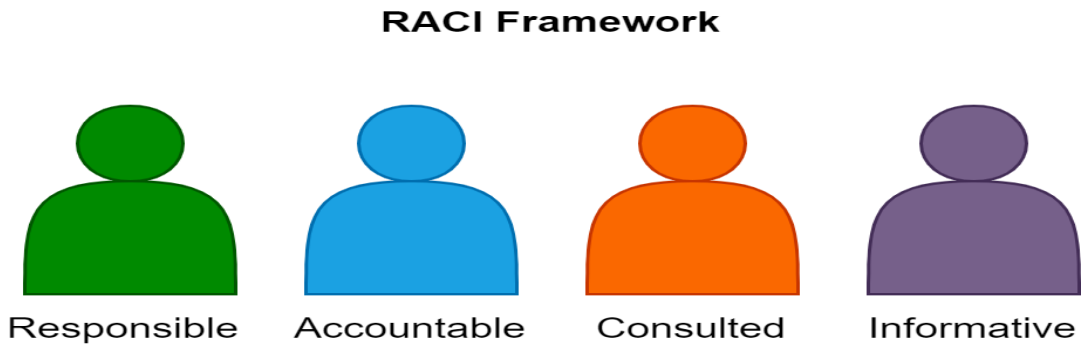

Figure 6.1: Structure of RACI Framework

By utilising the framework, the mapped actors can be prioritised and present the role they take in the step. It can provide insight into which actor is expected to uphold the sustainability ambition. Through RACI, the collaboration model in Chapter 5 can become more detailed thus collaboration can be stimulated. This framework is adapted in the collaboration model based on feedback from the validation and empirical interviews. The framework adds value as the accountability, informative and consultation division becomes clear. By distinguishing these roles, barriers are even more mitigated than with only allocating responsibility. For example, if certain roles are appointed as informative, the team will be aware of who to reach out to and what to trust thus knowledge will more easily be exchanged. Another example is if certain roles are set to be accountable or consulted, there is no mistreatment of power, and a shared vision is created to reach the ambition. The RACI allocation is based on empirical data from the interviews and is shown in Figure 6.2.

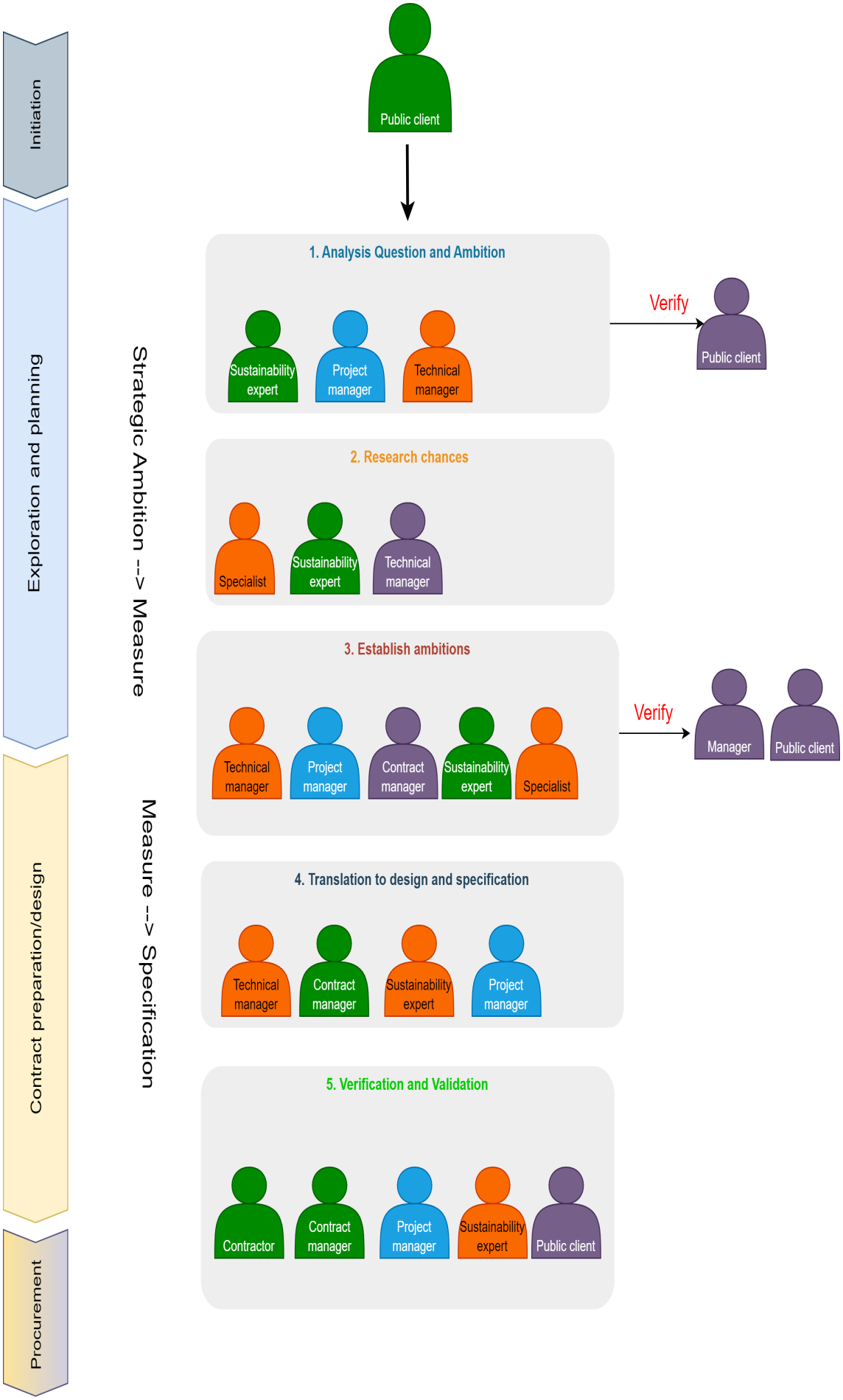

Figure 6.2: RACI implemented in collaboration framework

6.3.2. Approach with placed barriers

The following barriers were moved to a different step based on feedback in 6.2. They are described in Table 6.1 as added or removed.

Step 1	Added: “Scope”
Step 2	Added: “Project Specificity”
Step 3	Removed: “Project Specificity”
Step 4	Removed: “Scope”
Bid	Phase skipped, lack of communication is existent in the overall process and is not a component in this translation process.
Step 5	Remains

Table 6.1: Overview changes in placed barriers

6.4. Framework

The designed process aims to answer the main research question and its sub-questions. Based on theoretical research, an empirical analysis, and a case study, a process was designed and altered based on the validation and feedback of expert interviews resulting in a final model shown in Figure 6.3. This process is to be used to define, establish, specify, and validate strategic sustainability ambitions to operational requirements and criteria for contract design. The process has considered 28 barriers that occur during the steps and has implemented conditions and actions to mitigate these barriers. The process considers two main aspects: (1) the internal and external collaboration between the stakeholders and within the project team of the consultancy-engineering firm and (2) actions and steps that should be performed or considered when conducting the steps in the exploration phase. By following the steps in the process, ambition erosion is reduced and strategic sustainability ambitions can be safeguarded and realised.

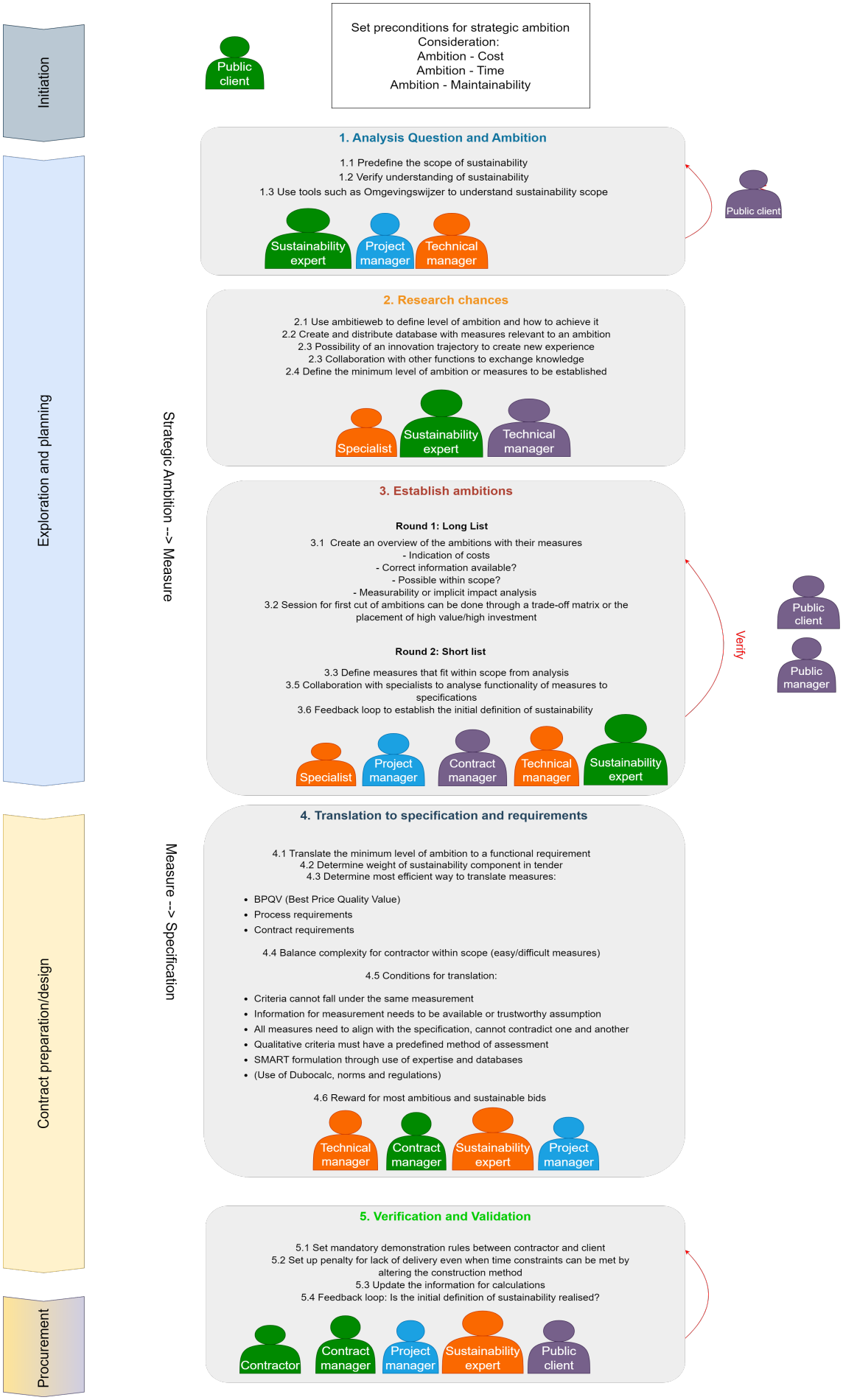

Figure 6.3: Final framework for reducing ambition erosion

7

Discussion and Limitations

7.1. Discussion

This research aims to provide insight into the realisation of strategic sustainability ambitions and the reduction of ambition erosion by conducting a combination of theoretical research, thematic analysis and a case study. This qualitative analysis tries to answer the following research objectives:

- To define the meaning of sustainability within the infrastructure sector.
- To clarify the different levels of formulated ambitions and what information is required to define and establish these ambitions.
- To identify the barriers that cause ambition erosion in the infrastructure sector and to investigate how they can be mitigated.
- To map the current exploration phase and to examine improvement to reduce ambition erosion in the process.

7.1.1. Theoretical Research findings

The theoretical research addresses several research objectives and presents several key findings. One of the outcomes is establishing a definition of sustainability within the infrastructure sector. While there are various perspectives on what sustainability entails, it is argued that it does not only include the environmental aspect such as carbon emissions and pollution but also includes a social and economic dimension. When all three aspects overlap, the maximum level of sustainability can be achieved (Tennakoon and Janadari, 2022). The derived definition for this research emphasises the inclusiveness of each aspect and urges to achieve a balance between environmental protection, well-being, and economic viability (Reddy and Thomson,2015, Munyasya and Chileshe, 2018). Furthermore, the theoretical analysis provides insight into the origin of ambitions and what ambitions exist within the infrastructure sector, more specifically the Ground, Road, and Hydraulic Engineering (GRH) sector. The analysis highlights the crucial role of government policy and regulations as they often shape and guide frameworks such as the 'klimaatwet'. These policies and instruments urge consultancy engineering firms and contractors to develop and include sustainability within their project works. Moreover, these policies form a foundation for stimulating sustainability within the sector to achieve the overall stated goals by the Dutch government. Also, organisational, and individual ambitions are origins to sustainability ambitions and form the vision that an ambition will follow within the process. Additionally, other information sources such as guidelines, building codes and EU standards play a role in the creation and realisation of a sustainability ambition. It is important to note that these sustainability ambitions originate from the highest levels of the government and thus are mere strategies. To realise these strategic sustainability ambitions, they have to be formulated at a tactical level and operational level for project implementation.

In addition, the theoretical research has given insight into the theoretical knowledge of the barriers

to (sustainability) ambitions within both management and the infrastructure sector. Literature defines twelve barriers that cause ambition erosion and are categorised into four groups: (1) knowledge and awareness related barriers, (2) finance related barriers, (3) process related barriers, and (4) organisational barriers. These four groups of barriers hinder the translation and implementation of strategic sustainability ambitions into operational requirements for project implementation. This gap between strategically formulated sustainability ambitions and their practical implementation is a significant challenge as the formulation of tactical and operational and the continuation of the ambition is often hindered by the identified barriers. The theoretical research has highlighted barriers that need to be addressed to mitigate ambition erosion and bridge the gap between strategic intent and practical implementation.

7.1.2. Empirical Research findings

The empirical research in this study employed a thematic analysis based on Braun and Clarke's (2021) framework. This framework allows the analysis to conduct a systematic exploration of empirical data collected through semi-structured interviews. By conducting a thematic analysis, the identification of key themes and barriers related to the ambition erosion of sustainability within the infrastructure sector was performed. The results of the analysis were presented by utilising quotes from the codes to illustrate the identified themes. This methodology enabled the combination of the interviewee's experience and perspective, gaining insight into the barriers and the exploration phase in practice. Through the identification of the barriers and the exploration phase, valuable insights for practitioners and policymakers can be drawn and help understand the challenge of the realisation of strategic sustainability ambitions.

From the empirical data and the thematic analysis, 25 barriers were identified which were then categorised into four themes:

1. **Capacity building related barriers:**
   The infrastructure sector faces seven barriers to implementing sustainable practices. One of the biggest challenges is the perception that sustainability is difficult, expensive, and a burden on projects. This attitude can lead to a lack of prioritisation for sustainable measures, especially when budgets are limited, and project managers are juggling multiple priorities. Another barrier is the competition for contractors, which can lead to a lack of investment in sustainable practices as they fear they will not win the proposal with a high price. Additionally, contractors may face challenges as the question is not a viable investment for themselves. Despite these challenges, there is a growing recognition of the need to promote sustainability in the infrastructure sector. The definition of sustainability is broad and encompasses various aspects of environmental, social, and economic impact. As such, there is a need for collaboration and innovation to find new ways of implementing sustainable practices that work within the constraints of the industry.

2. **Motivational related barriers:**
   The analysis suggests that there is a lack of intrinsic motivation. Addressing the challenges for the industry requires a change in mindset as it cannot be fulfilled by a few motivated individuals. It requires actors to become intrinsically motivated yet also willing to change and adapt to this new priority. Unfortunately, many actors within the process lack the motivation and willingness to put sustainability as an important ambition. To overcome this barrier, there is a need to improve and stimulate intrinsic motivation and promote its importance among stakeholders within the industry.

3. **Collaboration related barriers:**
   Collaboration is a key driver for the implementation of sustainability ambitions. One of the main barriers is the late involvement of functions within the project team due to which opportunities are missed or formulations are unclear in the early stages of the project. Moreover, the lack of communication leads to misinterpretation of the initial ambitions due to which different levels of the goal are realised and knowledge is lacking on a general level. Furthermore, the lack of responsibility among the stakeholders and internally within the project team limits the chances of implementing sustainability. These barriers highlight the need for better collaboration between the stakeholders and internally within the project team of the consultancy-engineering firm and a

clear division of the responsibility to uphold and implement the ambitions to ensure the realisation and safeguarding of the initial sustainability ambitions.

4. **Process related barriers:**
   There are ten process-related barriers that the infrastructure sector faces in terms of sustainability. One of the main barriers is the difficulty in measuring sustainability, which leads to a lack of understanding and appreciation for its importance. Additionally, vague specifications and complex trade-offs make it challenging for construction companies to prioritise sustainable measures. Furthermore, the lack of information, demonstration, and weight in tenders also hinders the implementation of sustainable measures. Project specificity and interpretation of ambitions also play a significant role in the construction industry, as different projects have varying requirements and priorities. In addition to these factors, the infrastructure sector also faces challenges due to contrasting laws and policies, which can create confusion and a lack of consistency in sustainability standards. Finally, the lack of preconditions in projects can make it difficult to implement sustainable measures effectively. Collaboration between stakeholders, clearer specifications and requirements, and standard conditions for sustainability measures could help address these challenges and enable the construction industry to become more sustainable.

The identification of the barriers and their occurrence within the exploration phase of the construction process is necessary to investigate as scientific literature is lacking on this aspect. The problem definition and empirical data show that ambition erosion of sustainability ambitions occurs during the exploration phase of the construction process as strategic ambitions need to be formulated on a project level to work with during the elaboration/construction phase. Stimulation of internal and external collaboration moments and the implementation of certain mitigation actions within the process would reduce the ambition erosion. Therefore, the identification of the empirical barriers aligns and expands upon the identified theoretical barriers. Moreover, empiricism shows that there are more barriers to the realisation of sustainability ambitions than theoretical research identifies. The theoretical barriers are added to the categories from the empirical research, resulting in a comprehensive categorisation of both theoretical and empirical barriers. It is important to note that the empirical barriers describe more detailed barriers to the process of sustainability ambitions and the necessity to reach them as the theoretical barriers tend to describe the human factor and organisational nature of ambition erosion. Therefore, combining these two identifications creates an extensive overview of all barriers occurring in general and within the exploration phase of the construction process.

7.1.3. Contradictions during analysis

It is important to note, that the thematic analysis specifically investigates the barriers of sustainability ambitions and how they should be translated to operational requirements. However, some discussion points emerged as interviewees contradicted one and another. From the interviews, the debate of the liability of the ECI implementation was discussed as multiple interviewees do not find it a solid basis to measure sustainability. Though other interviewees find it to be a solid foundation for measuring sustainability. Moreover, the actual tender process was taken into debate as some interviewees view this method as a barrier itself to sustainability ambitions. Specifically for the formulation of 'Best Price Quality Value' criteria and contract requirements, there is a lack of clarity on what type of formulation is best for the realisation of the initial sustainability ambition. While contract managers view its best to formulate measures and specifications strictly into requirements, contractors want to have the space to produce innovative ideas which is not possible with strict contract requirements.

There is a need for communication and collaboration between these stakeholders and roles as consultancy engineering firms and contractors want the public client to be more specific on their wishes and vision for the project instead of formulating vague ambitions such as 'sustainable and effective'. However, the governmental authorities rely on the knowledge of contractors, consultancy engineers, and sustainability platforms to specify and investigate possible sustainability practices as they do not have the knowledge on these implementations. Therefore, this can be seen as a dilemma as both parties want something from each other yet have a hard time to deliver due to their inability or capacity.

Furthermore, the barrier 'lack of demonstration' can be mitigated by setting mandatory demonstration

between the contractor and the client. However, the optimal method of demonstration is not determined. This mitigation action would help solve the barrier, however, precise knowledge of the best method for implementation lacks consensus. Demonstration of the implemented measures requires much administrative work due to which it can become quite complex. Contractors view demonstration as an initiative from the client side, yet consultancy engineers believe that demonstration should be initiated by the contractor. Further research should be conducted on what actor should be responsible for the initiation of the demonstration.

7.1.4. Case-study findings

The case study conducted in this research builds upon the approach developed by Duurzaam GWW, which outlines the necessary steps to be taken during the exploration phase to define and translate strategic ambitions into operational ambitions at the project level. This case is relevant to the research as it can help place barriers and implement mitigation actions to reduce ambition erosion. Moreover, it serves as a solid foundation to redesign the exploration process as this approach is supported by the Dutch government. By comparing and integrating the empirical process and the approach from the case study, an optimal framework is formulated that aligns with governmental policy and practical experience.

The findings of this case study show that even though Duurzaam GWW has provided a solid approach to define, establish, and specify sustainability ambitions there are various considerations and gaps that need to be addressed based on the empirical process and the existing barriers. The approach of Duurzaam GWW is an ideal method that misses the component of collaboration within the process, feedback loops, and sub-steps within a step. Moreover, the placement of the identified empirical and theoretical barriers reveals deficiencies in the current process. The case study provides the opportunity to redesign the process and implement mitigation steps that will reduce the impact of the placed barriers and stimulate collaboration that will support the realisation of the strategic sustainability ambitions.

7.1.5. Integration of methods

The integration of the theoretical, empirical research, and the case study provides a final framework that involves mitigation steps and a collaboration model that will reduce the barriers and challenges identified in each research. By combining these three approaches, the framework includes the scientific, human, and policy perspectives. While all three sources of data in this research highlight the persistent challenges surrounding sustainability in the infrastructure sector, they also reveal distinct pathways to achieving sustainability. The sources of the data vary within this research as some are scientifically peer-reviewed, while other data is based on the experience and opinions of an individual within the infrastructure sector. Despite the diverse origins of the data, their combination results in a comprehensive view of sustainability ambitions, their barriers and occurrence, and how to realise them.

7.1.6. Implications and Practical Applications

Through the identification of the existing barriers both in theoretical and practical contexts and by investigating their occurrence within the exploration phase, the main goal of this research can be achieved. The collective findings of theory, practice, and the case study contribute to the development of a process that incorporates targeted actions to mitigate the impact of these barriers. This process can be applied within consultancy-engineering firms to translate strategic sustainability ambitions to operational specifications on a project level.

Significantly, this research contributes on a scientific level by addressing a crucial gap in the existing literature. While previous research, mostly focuses on identifying barriers to sustainability within the sector, the specific occurrence of these barriers within the process of defining, establishing, specifying, and validating within the exploration phase has not been extensively investigated. The inclusion of this investigation enhances our scientific understanding by shedding light on the specific points at which barriers arise in the process.

Furthermore, a combination of practice, theory, and policy has not been used to investigate ambition erosion and the realisation of strategic ambitions thus adding comprehensive knowledge to both the scientific and practical fields. Consequently, this framework enriches the scientific field and provides practical guidance, particularly for roles and functions within consultancy-engineering firms, by clari-

fying the considerations necessary for effectively translating strategic ambitions from the public client into operational requirements for the contractor.

7.2. Limitations

The limitation of this research was defined during the scope of the research but also made throughout the research. Even though there are limitations to the research, the research was conducted in such a way that it provides answers to the research question. This section discusses certain limitations that are important to consider.

7.2.1. Scope of process

This research investigates the realisation of strategic ambitions within the construction process. However, due to time constraints, the research does not include the design process of an object within the exploration phase. Nevertheless, the research provides solid answers to the reduction of ambition erosion and the realisation of strategic sustainability ambitions. The research shows that many barriers exist during defining, establishing, specifying, and validating of the translation process within the exploration phase. Collaborative dynamics and barriers occurring before and after this process are not extensively examined. Therefore, the generalisability of the findings to the broader context of sustainability implementation in the infrastructure sector may be limited. Despite these limitations, this research provides valuable insights into reducing ambition erosion and realising strategic sustainability ambitions within the examined phases of the construction process.

7.2.2. Scope for procurement

For this research, a specific type of contractual agreement and procurement was the main beginning point. The research assumes an integrated contract agreement 'UAV-GC' and tendering process which allows an consultancy engineering firm to represent a public client where the responsibility of the design and engineering can be for both the contractor and consultancy engineering firm. Due to the complexity of the process and period of the research, the design phase was left out to ensure clarity first on the definition, establishment, specification, and validation of the ambitions for a contract level. Furthermore, this research does not investigate the importance of a traditional or two-phase contract and does not analyse these ambitions on a Temporary Design (VO) and Definitive Design (DO) level. These focus points were not considered as they would have narrowed the scope and not provided a comprehensive view of the various existing barriers and overall implementation.

7.2.3. Interviewee sampling

The selection of participants for the semi-structured interviews in the empirical research consisted of twelve individuals representing both a market perspective and a client perspective. The participants were chosen based on expertise and affiliation with sustainability within their line of work. Specifically, individuals with expertise in sustainability, contract management and roles associated with the exploration phase were included. However, there are various methods elaborated on in research that discuss suitable options for the choice of participants. Due to time constraints and the scope of the research, these research methods were not incorporated. Nonetheless, the current empirical data sample does include both the market perspective from the contractor and the client's perspective of a consultancy engineering firm. However, the consultancy engineering interviewees are mostly from Royal HaskoningDHV which could influence their view on the implementation of strategic sustainability ambitions due to organisational ambitions. It is worth noting that the perspective of the public client, who initiates the project, was not included in the interviews due to time constraints. Their perspective primarily pertains to strategy and policy, which falls outside the scope of this research.

7.2.4. Choice of focus on Ground, Road, Hydraulic engineering

The infrastructure sector encompasses a wide range of objects and projects, each with its own unique complexities. In this research, the Ground, Road, and Hydraulic engineering sector was selected as it is considered to have significant sustainability challenges due to its impacts on the environment. The research excluded the main rail network from this sector as rail construction projects aim at facilitating train transportation for which construction, expansion, renovation, and maintenance of the railways

is necessary and procurement can be conducted differently. Other types of infrastructure focus on the construction, maintenance, renovation, and improvement of transport ad water infrastructure. The purpose for these objects is to increase mobility, accessibility, and the living environment, while rail construction focuses on ensuring the safety and efficiency of the rail network. If the railway sector was considered for this research, the scope for the time span of the research would have been too broad. This decision was made to avoid the involvement of additional stakeholders and to maintain a focused approach. Moreover, other sectors such as the building environment were left out of the scope as they have different instruments and sustainability platforms to guide and assess sustainability in the projects. Another limitation to note is that the process developed in this research does not differentiate between the realisation of new infrastructure objects and renovation projects. The framework's applicability to both scenarios has not been specifically explored. It is worth considering that the challenges and considerations may differ between these two types of projects, and future research could delve deeper into this distinction.

7.2.5. Public client

The limitation of the empirical research and validation in this study is that it primarily focuses on the perspective of multiple contractors and the consultancy engineering firm, Royal HaskoningDHV. While these perspectives provide valuable insights into the barriers encountered during the exploration phase, the research does not incorporate the perspective of public client who initiate the projects and set high-level strategic ambitions. This research aims to understand the barriers that occur between the consultancy engineer and the contractor from strategy to operationalisation. Furthermore, it is important to acknowledge that the final framework in this research has not been validated by experts from a governmental point of view or by Duurzaam GWW, a platform supported by government authorities. Due to time constraints and logistical challenges, it was not possible to convene the necessary experts for validation within the scope of this study. Therefore, it is crucial to note that the final result, while based on extensive research, lacks formal validation and approval from governmental experts or Duurzaam GWW.

As a result, the validity and feasibility of the research findings and the proposed framework may be subject to different perspectives and opinions from those experts who were not directly involved in this study. Future research should consider incorporating the perspectives of public clients and seeking validation from relevant governmental and industry stakeholders to enhance the robustness and applicability of the research outcomes.

8

Conclusion

8.1. Conclusion Sub-Questions

1) Sub-question A: What is the scope and meaning of sustainability within the infrastructure sector?

As sustainability is a broad term that is often used within the infrastructure sector, clarity lacks on the definition of this term in the research context. The term is defined in scientific literature in different ways, some considering all three pillars of sustainability and others focusing on one pillar. Various research reviews the different aspects of sustainability to find a suitable definition to form a basis for the definition of sustainable ambitions within the Ground, Road, Hydraulic Engineering sector. The theoretical research concluded the following definition of sustainability that set the context for the research:

"The adoption of principles of sustainable development in infrastructure development projects execution, by striking a balance between environmental protection, well-being and economic prosperity for the benefits of both the present and future generations."(Munyasya and Chileshe, 2018)

Moreover, this definition aligns with the practical aspects of instruments that are provided by Duurzaam GWW and the Dutch government to define and translate strategic ambitions in Chapter 5. 'Ambitieweb'and 'Omgevingswijzer' are urged to be used to define sustainability for a specific project and consider all three pillars of sustainability (People, Planet, Profit) when defining and establishing ambitions. It can be concluded that both theoretically and empirically it is proved that within the Ground, Road, and Hydraulic Engineering sector of the civil engineering sector, sustainability can consider all three aspects for its definition.

2) Sub-question B: On what levels can ambitions be defined and what information is necessary to define and set ambitions?

In conclusion, ambitions are established at various levels and influenced by a range of factors. At the organisational level, executives set ambitions to address social responsibility, ecological responsibility, and economic competitiveness. These ambitions are driven by the recognition of social and environmental impacts and are formulated through programs and goals that consider the triple bottom line. Stakeholder pressures and environmental movements further shape ambitions by promoting accountability, ethical practices, and advocating for sustainability initiatives. Additionally, personal ambitions stemming from individual motivations and cultural influences play a role in shaping organizational direction and fostering engagement. Moreover, policies and regulations at the government level provide a framework for sustainability efforts, guiding decision-making and promoting sustainable practices. Theoretical research indicates that sustainability ambitions in the Ground, Road and Hydraulic engineering

sector require a clear definition of sustainability and are based on government policy and regulation. To understand these strategic ambitions, knowledge of regulation, policy, and innovation is necessary. Ambitions are established from policies and regulations such as euro standards, “the Klimaat Wet” and global policies. The Environmental Cost indicator and other laws provide the opportunity to guide the infrastructure sector and assess its impact. Building codes, standards, and policies ensure strategic ambitions to align and stimulate sustainable implementation throughout the sector. Moreover, the empirical research adds other topics that are necessary to define and establish ambitions. From the interviews and case study, it can be concluded that it is important to know the market for the given project. Also, reference projects and already implemented measures are required to be able to translate strategic ambitions into tactical measures and operational criteria and requirements. Moreover, the guidelines from the specific public client and consultancy engineering firm are required to translate the tactical measures into operational requirements. If sustainability ambitions want to be achieved, it is crucial to consider all necessary steps and actions when establishing and defining strategic ambitions, tactical measures, and operational requirements.

3) Sub-question C: What are the barriers to the continuation of ambition in the infrastructure sector and how can they be mitigated?

The identification of the barriers to sustainability ambitions was conducted through theoretical research and empirical research. Scientific research discusses twelve barriers that were grouped into four categories being. Next to the theoretical identification of barriers, empirical research shows that there are more barriers existent in practice. The empirical data adds fourteen more barriers. When integrating the empirical data and theoretical data, it was concluded that there are four main categories that are visually presented in Figure 4.2:

- Capacity building barriers: Fast-changing environment, competition, experience, priority, costs, lack of knowledge, lack of knowledge on the implementation of tools and measures, lack of awareness, and the definition of sustainability.
- Motivational-related barriers: Lack of willingness for implementation, Lack of intrinsic motivation, power of an actor, short-term focus and lack of willingness for change.
- Collaboration-related barriers: Responsibility, lack of communication, and late collaboration with certain roles within the project team.
- Process-related barriers: Overarching measurement, lack of weight in tender, measurability of measure or demand, lack of demonstration of measure, vague specification of measure or requirement, trade-off measures, project specificity, lack of information, scope, interpretation of ambition, lack of precondition, and contrasting law and policy.

Through empirical research, the occurrence of these barriers was analysed as scientific literature has not thoroughly investigated this yet. Interviews show that most barriers occur early on in a construction process, more specifically after initiation until the validation of the contract before elaboration starts.

4) Sub-question D: How do consultancy engineering firms working for public clients define sustainability ambitions during the exploration phase and how can it be improved?

The current process is drawn from empirical data and involves three different parties. The public client, the consultancy engineering firm, and the contractor. Distinct roles are engaged in the process to define, establish, specify, and validate an ambition and its formulated specifications. Figure 6.3, shows the process based on empirical data. The case study of Duurzaam GWW offers a reference to the viability of the empirical process as the case study provides an approach that is supported by the Dutch government. The integration of both approaches provides a realisable process that can be improved with actions to mitigate the previously identified barriers. The main improvements are the addition of instruments, conditions, collaboration moments, and the division of tasks.

- Instruments: ECI values, DuboCalc, Ambitieweb, Omgevingswijzer, reference database, EMVI criteria tool

- Conditions: For example, availability of information, measurability of measures and requirements, and the balance of qualitative and quantitative requirements. A full overview of the improvements of the process and the barriers it solves can be found in Table 5.1 in Chapter 5.

Next to instrument and conditions, collaboration moments and the allocation of roles are implemented to improve the process. Within the infrastructure sector, multiple parties participate in the construction process. For a UAV-GC contract, there are three main stakeholders involved in this research: the contractor, the consultancy engineering firm, and the public client. Collaboration and engagement between these stakeholders and internally within the project team of the consultancy engineering firm is analysed through interviews. More specifically, collaboration can be improved by allocating responsibility to certain roles to uphold sustainability ambitions. Verification sessions and feedback loops between the public client, contractor, and consultancy engineering firm provides insight into the definition of sustainability and the interpretation of the inquiry. By implementing standard verification of the definition of sustainability for the ambition and implemented measure, a shared vision is created, and the initial level of ambition can be realised. Through external and internal collaboration, a sense of purpose and a shared understanding arises which increases the motivation and willingness to uphold the ambitions. On top of allocating responsibility to certain roles within the designed process, the RACI framework is implemented. By awarding four specific roles: responsibility, accountability, consulted, and informative, the division of tasks is clear and the priority and what role is crucial are clarified. As each role has its own task yet still involved in the process, communication is enforced, and knowledge is shared. Moreover, actors cannot misuse their power as it might not be their role within the framework. The improved version of the collaboration between the three stakeholders and the internal project team solves the following barriers:

- Lack of communication
- Lack of knowledge
- Power of an actor
- Lack of intrinsic motivation
- Lack of willingness to change
- Responsibility
- Interpretation of an ambition
- Definition of sustainability

To conclude, the process can be improved by implementing two overall changes: (1) allocating and awarding roles certain tasks within the process, implementing feedback sessions with the relevant parties to verify and create a shared sustainability vision. (2) implementing steps and actions that mitigate the other barriers.

8.2. Conclusion Research Question

This graduation thesis aims to answer the following research question:

How can ambition erosion be reduced and strategic ambitions be safeguarded into realisation?

To answer the main research question, multiple methods of research were conducted. The combination of theoretical and empirical research, investigated in a case study led to an improvement of the exploration phase in which actions are incorporated that mitigate barriers that cause ambition erosion. Getting to the final process, required investigating various aspects to understand how a strategic ambition is continued within the process and results in a clear operational requirement.

In conclusion, reducing ambition erosion and realising strategic sustainability ambitions requires several steps to be taken. Firstly, within the infrastructure sector sustainability is a broad term. Therefore, the definition of sustainability needs to be clear, comprehensive, and incorporate all three pillars (people, planet, profit) to reach improvements for future generations.

It is vital for successful realisation to have a clear continuation from a strategic ambition to a tactical and operational ambition. However, translating high-level ambitions initiated by governmental authorities

into project-level is challenging due to several barriers. Theoretical research and empirical research reveal twenty-eight barriers that can be grouped into the following four categories: capacity-building barriers, motivational-related barriers, collaboration-related barriers, and process-related barriers. To reduce ambition erosion, understanding these barriers and their occurrence when defining, establishing, specifying, and validating is crucial. The occurrence of these barriers is early in the construction process, more specifically from initiation until contract preparation and design as strategic ambitions are continued into operational requirements and criteria for the realisation. Recognizing these barriers in these processes, can help understand the complexity in practice for consultancy engineering firms and overcome these barriers by actions.

Ambitions can be continued into realisation by mitigating the identified barriers and redesigning the process of defining, establishing, translating, and validating an ambition within the exploration phase of the construction process. There are two aspects of improvement to continue ambitions into realisation. Through collaboration and role allocation, the involved stakeholders can create a shared understanding of the sustainability component, increase knowledge, and stimulate each other to implement sustainability within their daily tasks and projects. To uphold the initial sustainability ambitions, it is crucial to allocate the tasks responsibility, accountability, consulted and informative to the roles involved in defining, establishing, specifying, and validating the ambitions to requirements. The RACI framework was implemented into the collaboration model to clarify which role is crucial in each step.

The second aspect of improving the process so that strategic ambitions can be continued in realisation is by implementing actions in the form of conditions, steps, and instruments to mitigate the barriers and reduce ambition erosion. Enhancements can be made through the implementation of instruments (such as ECI values, DuboCalc, Ambitieweb, Omgevingswijzer, EMVI criteria tool) and conditions/steps that ensure the mitigation of a barrier, for example: the availability of information, measurability of measures, and a balance between qualitative and quantitative requirements, but also cost indication, scope of a minimal achievement of sustainability and mandatory demonstration of the realised measures. These improvements can contribute to the realisation of strategic sustainability ambitions and the reduction of ambition erosion.

9

Recommendations

Future research could expand upon this analysis by exploring potential strategies and interventions to address the realisation of strategic sustainability ambitions.

9.1. Recommendations for further research

It is recommended to further explore the barriers that exist throughout the initiation, design, demolition, and transportation phases in order to broaden the scope of the current framework. By researching these additional phases of the construction process, the framework can cover a wider range of barriers. Given the complexity of the various stakeholders involved, it is also advised to investigate whether this complexity affects the feasibility of the suggested external and internal collaboration in the process. Furthermore, it is recommended to research whether a distinction between different types of construction projects would have an impact on the feasibility of the Framework. This research specifically focuses on the Ground, Road, and Hydraulic Engineering sectors, excluding rail construction and renovation, as these projects have distinct objectives related to train transportation and rail network safety and efficiency, which involve different environmental considerations within the GRH sector. It would be worthwhile to explore the adaptability of this process to other sectors such as the built environment. Additionally, within the infrastructure sector, a distinction should be made between renovation projects and new constructions. Exploring the specific challenges and considerations associated with these two types of projects could be a valuable for future research.

During the theoretical research, one of the definitions of sustainability emphasises the importance of accountability as an additional pillar alongside the existing three (People, Planet, Profit). While the collaboration aspect of the framework developed in this study addresses responsibility, the concept of accountability is minimally addressed. However, during the validation phase, the author was made aware of the RACI framework, which highlights the significance of accountability. It would be interesting to investigate how accountability specifically impacts the achievement of sustainability and whether it can be integrated into the definition of sustainability.

In relation to the procurement process, there are several topics that warrant further research. Although this study focuses on UAV-GC contracts, exploring the possibilities and gaps of strategic sustainability ambitions within other types of contracts and external collaborations would be of interesting. Additionally, expanding the process to include a step that examines the consideration of bids and determines the most suitable criteria (such as BPQV or requirements) would add significant value. Furthermore, as the topic of tendering and procurement methods emerged multiple times during the empirical research, it could be worthwhile to investigate the feasibility of tendering as procurement to achieve sustainability within the infrastructure sector.

Furthermore, the public client plays a significant role in upholding sustainability ambitions within the infrastructure sector. While the public client was not directly interviewed in this study as the focus was not on the initiation phase, it is crucial to consider the way in which the public client determines their

strategic sustainability ambitions and formulates them. Further research on barriers and this particular aspect of the process should be explored. It is recommended to interview public clients to explore additional barriers and sustainability-related topics. Additionally, extending the validation of this research by conducting expert interviews with sustainability platforms and public clients, such as Rijkswaterstaat, would provide valuable insights. The perspectives of these stakeholders are currently missing, and their inclusion in future research is essential to gain a comprehensive understanding of the topic and the governmental implications of the designed process.

At last, the empirical research in this study is based on nine interviews conducted with employees from Royal HaskoningDHV and Witteveen and Bos and three interviews with contractors. To further enhance and ensure the quality of the data, it is recommended to conduct additional interviews with professionals from other consultancy engineering firms to assess whether they face similar challenges with sustainability ambitions. Moreover, conducting more expert interviews involving different roles within consultancy-engineering firms would help validate the designed process. The topic of collaboration, both internally and externally, should also be further investigated to identify the types of collaboration that exist and how different role divisions can influence the realisation and protection of strategic sustainability ambitions. Collaboration can be improved by allocating and assigning specific tasks to roles within the process and implementing feedback sessions with relevant parties to verify and create a shared sustainability vision.

9.2. Recommendations for consultancy engineering firm

The aim of this research was to understand how strategic sustainability ambitions can be translated into operational requirements by a consultancy engineering firm representing the public client towards the contractor. The designed framework is intended for use by various professionals within consultancy engineering firms, including project managers, technical managers, environmental managers, project controllers, contract managers, sustainability advisors, and experts within the project team. These roles can utilise this framework to overcome existing barriers to sustainability ambitions and utilise it to define, establish, specify, and validate sustainability requirements during the exploration phase for the contract design phase. The framework suggests two aspects for the realisation of sustainability ambitions: (1) steps and actions within the process and (2) the implementation of collaboration moments internally and externally. It is recommended that the project team of the consultancy engineering firm allocates roles according to the RACI framework and communicates to improve the internal collaboration. Furthermore, it is recommended that external collaboration is necessary to implement to ensure a shared understanding of the sustainability ambitions, to increase the knowledge and stimulate the overall vision.

By employing the framework found in in Figure D.1 in Appendix D, not only can strategic sustainability ambitions be realised, but it can also foster increased knowledge, participation, and motivation among the team members. The framework serves as a guideline for the different conditions that these professionals should be aware of in order to effectively achieve sustainability within their project.

9.3. Recommendations for public client

The designed framework outlines specific conditions or steps that should be taken into account by the public client during the initiation phase. While this framework is intended for use by a consultancy engineering firm to achieve the strategic sustainability ambitions of the client, it is important for the public client to consider the implemented conditions during the initiation process and be made aware of the challenges for the other stakeholders. Clear expression of the public client's priorities will facilitate the realisation and safeguarding of strategic ambitions. For example, if maintainability of the construction is of higher priority than the sustainability level, this should be explicitly stated. Additionally, the public client should explore the possibility of integrating sustainability as a pre-condition in its regulations, programs, and policies. Research and the framework suggest that the greatest impact can be achieved when sustainability is emphasised at the highest level. Therefore, by incorporating sustainability requirements from the outset, the public client can drive significant changes in construction practices.

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A

Set up Interviews (in Dutch)

Deze vragen kunnen variëren per persoon die geïnterviewd wordt. Er zullen met verschillende instanties interviews plaatsvinden

Deel 1: Introductie

Ik leg mijn onderzoek uit, het doel van het interview en wie ik ben. Hier zal ik wegens privacy regels vragen aan voor toestemming om het gesprek op te nemen. Deze zal vervolgens naar de geïnterviewden gestuurd worden en zal alleen toegepast worden met toestemming. Eens de geschreven versie goedgekeurd is, zal de geluidsopname en video verwijderd worden. De naam van de geïnterviewde zal niet worden gedeeld in het onderzoek, slechts de functie zal toegelicht worden om het perspectief te kunnen gebruiken.

Deel 2: Thema's Thema 1: Expertise en functie van geïnterviewde in relatie tot het onderzoek *Het doel van dit thema is om de expertise en functie van de geïnterviewde te schetsen. Mogelijke projecten/ ervaringen kunnen naar boven komen die relevantie tot het onderzoek kunnen tonen*

De volgende vragen zullen vooral gaan over uw functie en kennis op gebied van duurzaamheidsambities, VR opgaves, het beheren en opstellen van de contractfase en realisatie met de aannemer.

- Betrokkenheid bij VR opgaven of rond duurzaamheid, beheer en opstellen van contracten en samenwerking met andere instanties?
- Welke projecten in het verleden aan gewerkt?
- Hoeveel jaar ervaring heeft u?

Thema 2: Duurzaamheidsambities in de constructie *Dit onderdeel doelt op het schetsen van de huidige situatie rond duurzaamheidsambities in de constructiesector. Hier zal duurzaamheid als definitie, de drempels voor de ambities en de ervaring met duurzaamheid binnen de functie van de geïnterviewden behandeld worden.*

- Hoe gaat het huidige proces wanneer een aanbesteding is gewonnen van de publieke instantie?
- Hoe komt duurzaamheid anders te passen bij een VR dan bij een nieuwe constructie?
- Hoe ziet u duurzaamheid terugkomen in contracten?
- Hoe worden ambities afgewogen en vervolgens meegenomen in het proces

- De rijksoverheid heeft veel ambities gezet tegen 2030 en 2050 omtrent duurzaamheid. Waarom is het lastig om duurzaamheidsambities hard/ specifiek te krijgen?
- Wanneer is een duurzaamheidsambitie duidelijk en specifiek geformuleerd?
- Wat voor rol speelt u in het vertalen van ambities naar eisen (zo ja, thema 3)
- Hoe kan duurzaamheid standaard geïmplementeerd worden op tactisch en operationeel niveau?

Thema 3: Duurzaamheidsambities in de contractfase

Dit onderdeel focust op duurzaamheidsambities binnen de contractfase en hoe dit proces in werking gaat los van de literatuur. Hieruit zullen verschillende voorwaarden, eisen, indicatoren naar voren komen die gebruikt kunnen worden om het raamwerk te ontwerpen en duidelijk zullen maken welke vragen er moeten gesteld worden om tijdens een V&R opgave duurzaamheidsambities te vertalen.

- Van wie zijn dat de verantwoordelijkheden in de contractfase en het aanbestedingsproces?
- Met welke voorwaarden moet je rekening houden tijdens het opstellen van eisen en criteria?
- Wanneer is een eis specifiek?
- Wanneer is een eis meetbaar?
- Wanneer is een eis betrouwbaar?
- Wanneer is een duurzaamheidsambitie duidelijk en specifiek geformuleerd?
- Wat voor input heb je nodig om een ambitie te kunnen vertalen tot iets specifieks?
- Hoe spelen jullie in op criteria? (Aannemer)
- Wanneer zijn eisen makkelijk in te vullen?(Aannemer)
- Welke duurzaamheidsambities kunnen jullie het makkelijkste laten waarmaken? (Aannemer)
- Wat doet u als een indicator moeilijk meetbaar is? (Aannemer)

Thema 4: Bespreken van verschillende duurzaamheidsdoelstellingen en hun meetbaarheid
CROW en de overheid willen graag de volgende indicatoren standaard hanteren om duurzaamheid te monitoren. Welke van deze zijn makkelijk te implementeren en waarom? Welke zijn dat niet en waarom?

KPI's	**Unit**	**Calculation Method**	**Description**
Greenhouse gases	C02 equivalent	CO2-equivalents total life span and the year emissions	Greenhouse emissions that are released during construction, use, demolition and recycling for the full life span and per year.
ECI	Euro	ECI-value of total project for all phases	ECI value is calculated with DuboCalc for the construction, use, demolition and recycling of ERW projects
Nitrogen emissions	NOx	Usage in litres of fossil fuels for transport and working hours.	Fossil fuels that are being used for use of materials during construction, use and demolition and are recalculated to NOx.
Energy use	kWh	Usage of kWh per year for installations and machinery.	Amount of kWh used during the lifespan of the used installation.

Circularity	%kg	Input primary % kg, secondary and renewable materials. Output % kg based on re-use, recycle and landfilling	• Quantities of input streams during construction, using phase, demolition and recycling. They are to be distincted by primary, secondary and renewable materials. • Quantities of output streams during construction, using phase, demolition and recycling. They are to be distincted by primary, secondary and renewable materials.
Biodiversity	Score ambition web	Score on ecology and biodiversity from ambition web	The average 'ambitieweb'-score for all projects for ecological structure and biodiversity

Table A.1: KPI Dashboard by Duurzaam GWW

Deel 3: Toekomstperspectief
Zijn er nog opmerkingen of vragen over dit onderwerp/onderzoek?

Dankuwel voor uw tijd en de moeite om mijn vragen te beantwoorden.

B

Overview Data Analysis

Each theme is disscussed in a different section.

B.1. Theme 1

Barrier	Occurrence and **Mitigation**
Fast changing environment	This is an external barrier that sets the tone of the environment ambitions exist in.**Action: As this is an external barrier, it cannot be mitigated.**
Competition/Market	This barrier can impact the decision-making to incorporate sustainability measures for both client and contractor or not consider a bid as a contractor as there is no even-level playing field. **Action: Setting sustainability as a pre-conditional component requires every actor to take it into account.**
Costs	This barrier occurs when defining the ambitions and deciding what measures to take. Often the costs of the measures are taken into account later in the process or are seen as high investments early due to which they are cut from the measures to be realised. **Action: Set the investigation of costs early on in the process so it can be considered before choosing measures from the whole list.**
Lack of knowledge on implementation of measures and tools	This barrier occurs mostly during the selection of measures to achieve ambitions as not every role has the knowledge of its implementation. Moreover, this barrier also occurs during the translation of the measures to specifications as it is not always known how they should be clearly formulated. **Action: Through collaboration and knowledge sharing this barrier can be mitigated. For example, a shared database within the consultancy-engineering company could provide more insight into the implementation of certain measures.**
Experience	This barrier occurs during the exploration and definition of the ambitions and measures. As the consultancy-engineering firm does not always have the experience for a specific project. Moreover, a contractor sometimes does not have the right experience to deliver on the set ambition, therefore,e are not taken into consideration. **Action: Through knowledge sharing this barrier can be mitigated. For example, a shared database within the consultancy-engineering company could provide more insight into the implementation of certain measures.**
Definition of sustainability	This barrier causes the difficulty of prioritising different sustainability goals, the lack of consensus on what sustainability means in practice, and the potential for conflicting interests and values during the initiation of the project. If the public client does not clearly specify what is meant with sustainability for the project, the consultancy-engineering firm can merely guess at what is meant. **Action: Through collaboration, these two actors can verify each other's understanding of the definition of sustainability for the given project.**

Table B.1: Overview capacity building related barriers their occurrence and mitigation

B.2. Theme 2

Barrier	Occurrence and **Mitigation**
Lack of willingness to change (conservative)	This barrier occurs the most in this step as the final cut of ambitions is made within the second round of this step. If one of the actors within the team, the public client or the manager does not agree with the suggested measures as they are too innovative or complex to implement, they are easily cut from the ambitions that will be translated during contract preparation. **Action: Through collaboration the willingness to change can be mitigated.**
Lack of intrinsic motivation	This barrier occurs throughout the entire process. If actors are not internally motivated, they will not pursue sustainability as an ambition in the project. **Action: Through collaboration the level of motivation can be increased as it creates a shared vision and purpose.**

Table B.2: Overview motivational related barriers their occurrence and mitigation

B.3. Theme 3

Barrier	Occurrence and **Mitigation**
Responsibility	This barrier occurs throughout the process. Not every actor feels responsible to uphold the initial sustainability ambitions due to which is moved to an actor later in the process. **Action: Through collaboration and defining which roles should be responsible, clarity on who is responsible and stimulation to sense it will be increased.**
Lack of communication	This barrier occurs internally within the consultancy engineering firm, but also between the contractor, public client and consultancy-engineering firm. **Action: This barrier can be mitigated by enforcing collaboration between the parties and different roles.**
Late collaboration with functions	This barrier occurs throughout the whole process. Functions such as a contract manager or sustainability expert are often not involved in certain steps. **Action: Therefore, it is important to include all functions in the second round of establishing the ambitions to assure that these ambitions can effectively be translated to contractual requirements and criteria, but also to create space for a range of measures before a design is finalised. This barrier can be solved through collaboration.**

Table B.3: Overview collaboration related barriers their occurrence and mitigation

B.4. Theme 4

Barrier	Occurrence and **Mitigation**
Lack of precondition in project	This barrier occurs throughout the entire process and is rooted within each actor involved in the process. However, most specifically it impacts the initiation of the project from the public client's point of view and hinders the most when establishing the measures to be taken. If sustainability is not pre-conditional from the initiation and on, it will less likely to be realised at the end. **Action: The lack of precondition can be reduced by making a level of sustainability pre-conditional from all stakeholders' perspectives, for instance, a functional requirement in a tender. The public client, the engineering-consultancy firm and the contractor all need to have it as a mandatory aspect of their way of working. By making sustainability a standard part of the proposal, the commitment to the ambition is shown and cannot be neglected. Setting a minimum level of sustainability as a requirement when choosing ambitions and translating that requirement into the contract will reduce the barrier.**
Contrasting law and policy	This barrier can occur during the translation of the measures to specifications. **Action: This barrier can be mitigated by setting a condition to verify the scope and law and policy before deciding which measures will be implemented.**

Table B.4: Overview initiation and policy barriers their occurrence and mitigation

Barrier	Occurrence and **Mitigation**
Vague specification of measure and requirement	One of the reasons the translation is complex is that the ambitions or measures are vaguely specified. This makes the overall translation from ambition to specification complex as it can become subjective. When an ambition or measure is vaguely specified it creates space for interpretation but also increases the chance of a low-level achieved ambition as knowledge and intrinsic motivation play a part in the implementation of the measure. **Action: This barrier can be reduced if the ambition is clearly defined in the beginning or if a minimal level of sustainability can be discussed. This barrier can also be reduced through collaboration as the contractor or engineering consultancy firm can ask for clarification.**
Complex trade-off measures	This barrier occurs once ambitions and measures have been established and they need to be translated to specifications. Sometimes, the different measures do not align or complicate each other. When too many sustainability ambitions are established, more measures can be created and can contrast each other. **Action: Make it a condition when choosing measures that they need to be vetted beforehand and cannot contradict one another.**
Project specificity	This barrier occurs during the exploration, definition and translation of an ambition to a measure and specification. Each team member is hindered by this barrier. **Action: This barrier's impact could be influenced if a database with each measure is made available to not only the sustainability expert but each actor within the team. Project specificity is linked to not enough knowledge which could be improved by providing the necessary information across a company and each actor.**
Scope	This barrier decreases the level and amount of ambitions during the process. As the scope often narrows, it limits the possibility of ambition implementation and translation. Also, a lot of measures such as energy use and nitrogen are broadly used. However, depending on the scope of these terms they need to be defined and measured differently. **Action: Validate the scope early on and take into account the scoping when establishing the measures to be taken for the project.**
Interpretation of ambitions	This barrier occurs when the project team of the engineering consultancy firm is choosing what measures to implement to achieve the sustainability ambition. Due to multiple roles, ambition can be misinterpreted. **Action: A misinterpretation of ambition can be reduced by the mandatory use of the ambition web and validation with the public client to discuss the interpretation of the expected ambition.**

Table B.5: Overview planning and specification barriers and their occurrence and mitigation

Barrier	Occurrence and **Mitigation**
Overarching measurement/Dependence	Occurs during the validation of a measure, as increases the complexity of assessing the realised measure. **Action: setting it as a condition to take into account when formulating the contract requirement or criteria.**
Lack of weight in tender	Occurs during the contract preparation. If the sustainability component would be given more weight in the tender, it would give more priority. **Action: Setting the weight as the first step.**
Measurability of measure or demand	Formulated measures or demands are often hard to measure which are usually discovered during the assessment of a measure. This is caused by multiple causes: • Qualitative criteria which have no measurability therefore no standard way of verification. Thus, a different level of ambition can be realised in the end. • Qualitative criteria which have no measurability therefore no standard way of verification. Thus, a different level of ambition can be realised in the end. • The information necessary to measure, may sometimes be based on assumption instead of real data or can be based on outdated data. Therefore, leading to a different outcome. • Sustainability components often use a broad term but are more complex to be measured. For instance, energy use occurs in multiple phases of the construction process but also in different places and for different products, so it becomes quite complex to measure • Setting a realistic measurement in an early stage is hard to do as you don't know if it is feasible. • Qualitative criteria are often seen as subjective measurements • Balance of qualitative and quantitative • Scale or clear score for qualitative • Preconditions: set a measuring method for the specific requirement so demonstration is required. • **Action: Setting the causes above as conditions when translating measures into contract requirements and criteria and support the use of instruments such as DuboCalc.**
Lack of demonstration of measures	Occurs once the contractor is designing and implementing their bid. Demonstration occurs during and after realisation. **Action: It is necessary to formulate a mandatory demonstration to ensure that the promised measures are realised and contractors stay motivated.**
Lack of information	Occurs throughout the process, however most specifically when drawing up and researching potential measures and aiming to assess the measures. **Action: This could be solved by updating the database accordingly and making it a precondition to check the available data during the translation to specifications.**

Table B.6: Overview implementation and performance barriers their occurrence and mitigation

C

Meaning of Empirical Barriers

Barrier	Meaning
Experience	refers to the challenges associated with the lack of experience and expertise in implementing sustainable solutions, technologies, and practices in the construction sector.
Contrasting law and policy	refers to inconsistent regulations across different regions or jurisdictions create confusion and uncertainty, making it challenging to implement uniform sustainability practices. This lack of clarity hampers progress, inhibits innovation, and can lead to legal and contractual complications, ultimately impeding the achievement of sustainability goals in the construction industry.
Competition	refers to the competitive pressures through tenders and market forces that can impact the decision to incorporate sustainability measures or not consider a bid.
Costs	refers to the financial challenges associated with sustainable construction projects, such as the higher upfront costs of sustainable materials, technologies, and practices, and the potential for lower returns on investment.
Fast changing environment	refers to the dynamic and constantly evolving conditions in which construction projects operate, such as changes in regulations, market trends, and technological advancements
Interpretation of ambition	As the definition of sustainability can sometimes be unclear, the interpretation of the ambition can alter the scope sustainability wise. A sustainable ambition can be translated to different measures, depending on the person and their interpretation, and understanding of the term sustainable, an ambition is implemented. This can result in a loss of ambition if the interpretation takes the minimum or zero level of ambition.
Lack of information:	Due to innovation of the infrastructure and methods, using tools such as MKI that provide measurability for a measure is not always possible as the information to quantify them is not available. If the information is non-existent, actors can make an assumption or lose the requirement. There is a lack of correct information to verify the information or make the correct assumptions.
Lack of knowledge on implementation of measures and tools	refers to the challenges associated with applying sustainable measures, technologies, and practices in real-world construction projects, such as the lack of technical expertise, the difficulty of integrating new solutions with existing systems, and the lack of awareness and training.
Lack of weight in tender	Currently, sustainability only plays a small factor in the tender from the engineering-consultancy firm to the contractor. Therefore, sustainability is sometimes neglected as it does not provide the opportunity to obtain a better bid or distinguish itself.

Measurability of demand or measure	Formulated measures or demands are often hard to measure which are usually discovered during the assessment of a measure. This is caused by multiple causes: • Qualitative criteria which have no measurability therefore no standard way of verification. Thus, a different level of ambition can be realised in the end. • Qualitative criteria which have no measurability therefore no standard way of verification. Thus, a different level of ambition can be realised in the end. • The information necessary to measure, may sometimes be based on assumption instead of real data or can be based on outdated data. Therefore, leading to a different outcome. • Sustainability components often use a broad term but are more complex to be measured. For instance, energy use occurs in multiple phases of the construction process but also in different places and for different products, so it becomes quite complex to measure • Setting a realistic measurement in an early stage is hard to do as you don't know if it is feasible. • Qualitative criteria are often seen as subjective measurements • Balance of qualitative and quantitative • Scale or clear score for qualitative • Preconditions: set a measuring method for the specific requirement so demonstration is required.
Overarching measures	Measures are often overarching in the form or requirement or criteria. This can become a barrier for ambition erosion, as certain sustainability aspects cannot be verified separately. When this occurs, a measure cannot easily be validated which may result in a different end-product then initially presumed. This barrier occurs in step 5, but can be mitigated in step 4. Certain preconditions that need to be checked before putting the requirement or criteria in procurement are necessary. In order to prevent an overarching measurement, it is necessary for the criteria and requirements to be independent. If they both cover the same qualitative measurement, they need to be taken into account together as otherwise there would be a higher score for less achievement. It is important to take this into account, when formulating criteria and requirements
Lack of demonstration of measures	This barrier causes the contractor to feel less motivated to implement and strive for the highest level of ambition, but also provides opportunity to deliver a low level of ambition on purpose. It can be seen as an external trigger to increase the willingness to change and intrinsic motivation.
Late collaboration	Knowledge of sustainability measures is not widely spread across an engineering consultancy firm, but this goes vice versa for other specific functions.
Lack of communication	Both internally and externally communication is lacking. Often roles and actors do not communicate due to which knowledge and awareness is not spread but also a shared vision on what is to be achieved is missing.
Lack of intrinsic motivation	Refers to the mindset of the actor. Not every involved actor is motivated to pursue high level sustainability ambition, thus can block them or not uphold them through the process.
Lack of pre-condition	This barrier indicates that sustainability is not a mandatory component and can often be neglected if not set as a standard component within the process and contract.
Lack of willingness to change	Refers to the conservative mindset of an actor. Within the construction sector, change is necessary but not every actor sees the importance of it and is not willing to make it a priority instead of other factors.

Project specificity:	Each project is specific; therefore each measure needs to be applied in a different way. There is no standardised way to find the correct measure and its implementation
Responsibility	Responsibility refers to the sense of feeling the need to uphold sustainable ambitions. Often roles do not feel responsible for its implementation and will move the responsibility further down the line from public client to contractor. However, later in the process sustainability is more complex to incorporate thus ambition erosion occurs.
Scope	This barrier decreases the level and number of ambitions during translation. As the scope often narrows, it limits the possibility of ambition implementation and translation. Also, a lot of measures such as energy use and nitrogen are broadly used. However, depending on the scope of these terms they need to be defined and measured differently.
Trade-off measures	Different sustainability measures that do not align or complicate each other. When too many sustainability ambitions are established, more measures can be created and can contrast each other. Therefore, the chosen measures need to be aligned and not cause a discussion for which measure is more important to implement as this causes ambition erosion.
Vague specification	One of the reasons the translation is complex is that the ambitions or measures are vaguely specified. This makes the overall translation from ambition to specification complex as it can become subjective. When an ambition or measure is vaguely specified it creates space for interpretation but also increases the chance of a low level achieved ambition as the knowledge and intrinsic motivation play part in the implementation of the measure. This barrier can be reduced if the ambition is clearly defined in the beginning or if a minimal level of sustainability can be discussed. This barrier can also be reduced through collaboration as the contractor or engineering-consultancy firm can ask for clarification.

Table C.1: Meaning of barriers

D

Final Framework

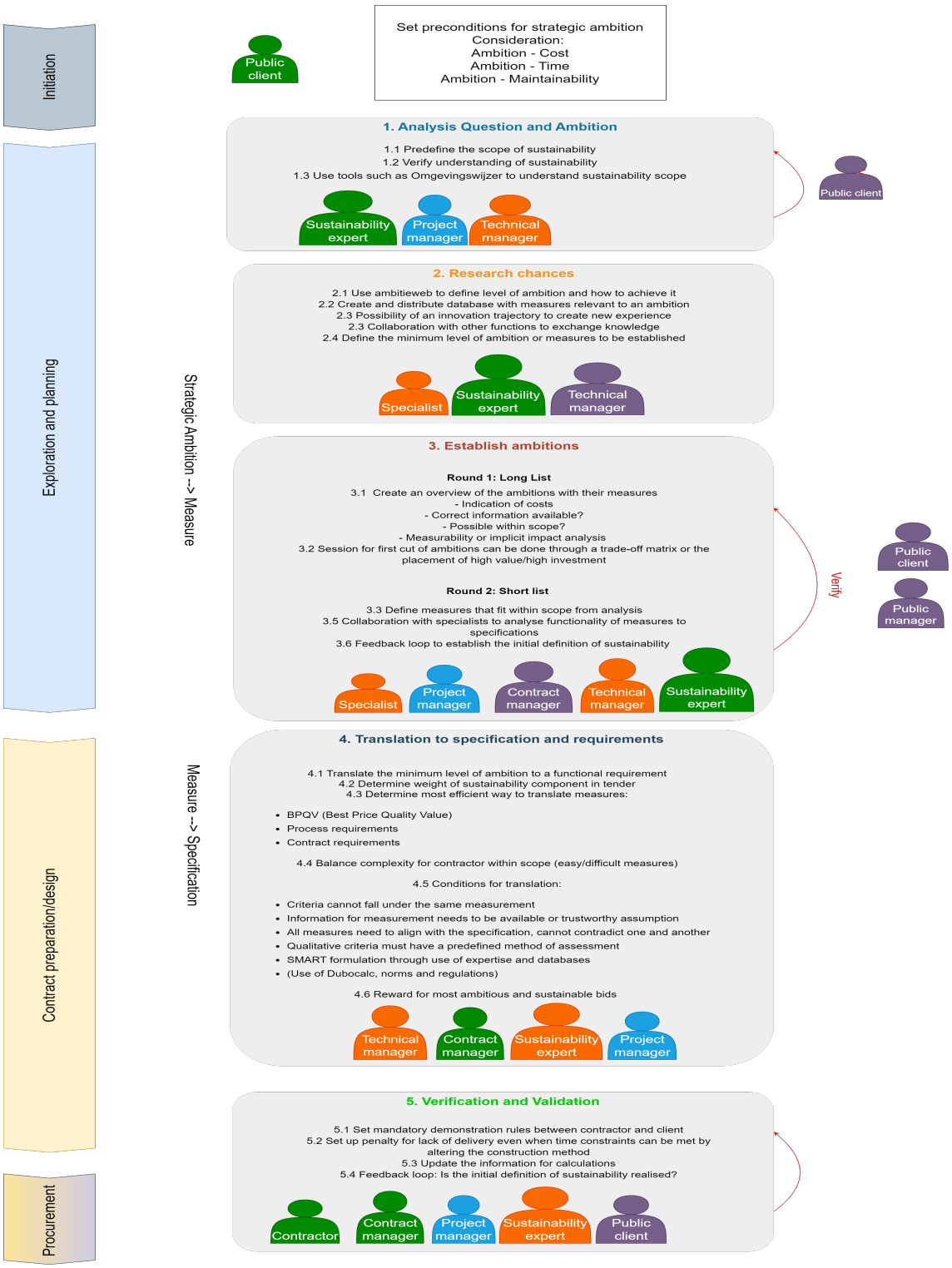

Figure D.1: Final framework for the mitigation of barriers