Master Thesis

Organizational Transition Towards Circular Public Infrastructure- Navigating internal organizational change in the case of Dutch water authorities

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Organizational Transition towards Circular Public Infrastructure

Navigating internal organizational change in the case of Dutch water authorities

by

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Preface

This master's thesis represents the culmination of my studies in the Construction Management and Engineering master's program at TU Delft. My journey has been challenging yet rewarding, and one which has helped me to grow personally and professionally.

My interest in this research topic stemmed from a growing awareness of the urgent need for sustainable construction practices in our increasingly resource-constrained world. My previous projects in the domain of circular economy also motivated me to pursue this study. Throughout this journey, I have been fortunate to engage with a variety of professionals, academics, and practitioners whose insights have greatly enriched my understanding of the subject.

I would like to express my deepest gratitude to my thesis committee, whose guidance, expertise, and encouragement have been invaluable in shaping this work. A heartfelt thanks to Dr. ir. Ad Straub for his continuous supervision throughout the research. I am also deeply grateful to Dr. Martijn Leijten for his valuable insights and feedback in every stage. My sincere thanks go to Ir. Hanneke Veldhuis for her steadfast support from the very beginning, including connecting me with my graduation company. A special thank you to my company supervisor, Ir. Janiek Baarends, for her unwavering support and for making me feel at home at Hoogheemraadschap van Delfland.

I would like to thank all interview participants from Hoogheemraadschap van Delfland, Waterschap Vallei en Veluwe, Unie van Waterschappen, Waternet and Rijkswaterstaat for their cooperation and providing me with significant insights on the topic. I also thank my colleagues from Programma Delfland Duurzaam Circulair for their warm support.

I would like to acknowledge the support of my family, whose unwavering encouragement has uplifted me in every step of my study in the Netherlands. Their belief in my abilities has kept me focused and determined throughout this process. Moreover, my most sincere thanks to my friends both in the Netherlands and India, who have been a constant source of support for my entire masters journey.

It is my hope that this thesis not only adds to the existing body of knowledge but also inspires further research and action in the field of circular infrastructure. As we collectively work towards a more sustainable future, these insights may serve as a valuable resource for organizations to guide their transition. I wish you a pleasant read!

- Shaun Alex,
Delft, the Netherlands,
14th August, 2024.

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Executive Summary

The Dutch government has envisioned and is working towards a completely circular economy by 2050. However, studies indicate that the current progress of the transition is insufficient to achieve set ambitions. Transforming the resource intensive construction sector is vital for the transition to circular economy. Since infrastructure projects are primarily procured by public entities, these client organizations can drive the development of a circular construction economy by boosting market demand through strategic purchasing policies. Incorporating changes to transition from linear to circular way of working place significant demands on client organizations. A notable group feeling this pressure is the Dutch regional water authorities. These public organizations are responsible for water management at the regional level. The 21 water authorities, together build and manage huge numbers of infrastructure assets like flood defences, navigable water ways, pumping stations and waste water treatment plants. These organizations directly deal with the consequences of climate change such as heavier rains and prolonged periods of drought. Despite recognizing the urgency for change, the water boards struggle to progress beyond pilot projects, increase maturity levels throughout the organization, and align new policies with daily practices. For the successful implementation of such transitions, these organizations must adapt internally to support the transition. Therefore, this study addresses the pressing need for effective change strategies to adjust the internal organization of public clients to facilitate the transition to a circular way of working. The primary objective is to develop a conceptual change framework that provides recommendations on what internal changes can be implemented within the water boards, to accelerate their transition to circular public infrastructure. To achieve this objective, the following research question is formulated:

> **What changes in the internal organization of a public infrastructure client, like the Dutch Regional Water Authorities, could facilitate the transition to circular construction practices?**

Overview of research methodology

The research adopts a qualitative approach through case studies, chosen for its suitability in exploratory studies with limited existing knowledge. The first phase of the study involves exploring the organizational context of the water boards and establishing a theoretical foundation through a literature review. Initially, document reviews and exploratory interviews are used to gain a thorough understanding of the water boards' organizational environment, before developing change strategies. Subsequently, the study delves into a literature review to identify the essential components needed to create a framework for organizational change. The literature indicates that models incorporating both *process* and *content* aspects are most effective in addressing comprehensive organizational change, thus these components are integral to the conceptual framework. Additionally, to address the gap in existing literature on the functioning of a 'circular' public organization post-transition, the literature review identifies specific goals for the desired post-change state. These goals guide the determination of procedural change measures, later from interviews, forming the core of the change framework. In the second research phase, empirical data is gathered through case studies, selecting two water boards for detailed analysis. Through expert interviews the change measures required to achieve the goals

set in the previous phase are captured. The final phase involves developing an initial organizational change framework, which is then validated and refined through expert interviews. After incorporating recommended improvements from the validation phase, the final organizational change framework for the circular transition of public clients is proposed.

Proposed organizational change framework for transition to circular construction practices

The developed change framework, depicted in the figure below, serves as a guiding tool for facilitating the water boards' transition from their current state to the desired state through structured and achievable steps. This framework comprises both content and process components. It identifies four key areas of change: *People, Work Process, Structure*, and *External*. These areas highlight what needs to be changed in the organizations. For each of these four aspects, change measures are presented in the *unfreeze-transition-refreeze* steps, adopted from Lewin's change model for planned organizational change. These measures, identified through case studies, provide a roadmap for implementing change. By creating this framework, the research successfully achieves its main objective: developing an organizational change framework to support the circular transition of the water boards.

The proposed framework is developed following literature recommendations. Since the results were obtained through empirical research, these measures can be viewed as practical and attainable for organizations. The validation process, which included expert interviews, was crucial for confirming the initial findings and refining the framework, ensuring the proposed measures are both effective and feasible. This makes the proposed framework a valuable tool for circular economy change managers within the organization.

Recommendations for water boards

- Change managers, program managers, and sustainability teams should proactively implement the specified change measures for the four organizational areas, using the framework to address their unique needs and overcome significant barriers.
- Water boards should start with an internal assessment to evaluate their readiness for change. To mobilize the 'early majority,' water boards could begin by unfreezing the 'Structural' aspect, focusing on goals such as ensuring managerial commitment and fostering intra-organizational collaboration and accountability. Achieving these structural goals could then facilitate progress in the 'People' aspect, by cultivating a shared and supportive mindset among employees and fostering a culture of innovation. This, in turn, could enhance the success of the circular transition in 'Work Process.' Additionally, goals related to 'External' factors should be pursued continuously throughout all phases of the change process.
- The lead circular economy transition group should utilize this framework to initiate discussions with senior management, including the governing board, executive committee, and director's team, aiming to secure their commitment to circular economy goals.
- Traditionally, water boards prioritize technical solutions for their issues, given their technical nature. However, there is potential for further technical advancements in circular transitions beyond current practices. Therefore, water boards should prioritize managerial and organizational strategies to address human barriers to transition. The change measures outlined in the proposed framework facilitate this shift.

(proposed framework figure below after translated summary)

Samenvatting

De Nederlandse overheid wil in 2050 een volledig circulaire economie hebben. Echter, studies laten zien dat we nog niet genoeg vooruitgang boeken. Het is belangrijk om de bouwsector, die veel grondstoffen verbruikt, te veranderen voor deze transitie naar een circulaire economie. Omdat publieke instellingen vaak infrastructuurprojecten aanbesteden, kunnen zij een circulaire bouwsector stimuleren door strategisch in te kopen. Dit vraagt veel van deze organisaties. De Nederlandse waterschappen hebben hier ook een grote uitdaging aan. Zij zijn verantwoordelijk voor waterbeheer en beheren veel infrastructuur zoals dijken, waterwegen, gemalen en afvalwaterzuiveringsinstallaties. Zij hebben direct te maken met klimaatverandering, zoals zwaardere regenval en droogte. Hoewel ze begrijpen dat verandering dringend nodig is, blijven ze steken in pilots en vinden ze het lastig om nieuw beleid in de dagelijkse praktijk te integreren. Om deze transitie te laten slagen, moeten de waterschappen intern veranderingen doorvoeren. Deze studie richt zich daarom op effectieve strategieën om de interne organisatie van publieke opdrachtgevers aan te passen en de transitie naar circulair werken te ondersteunen. Het doel is een conceptueel organisatieveranderingsraamwerk te ontwikkelen dat aanbevelingen doet voor interne veranderingen binnen de waterschappen om de transitie naar een circulaire infrastructuur te versnellen. De onderzoeksvraag luidt:

> **Welke veranderingen in de interne organisatie van een publieke infrastructuuropdrachtgever, zoals de Nederlandse waterschappen, kunnen de transitie naar circulaire bouwpraktijken vergemakkelijken?**

Overzicht onderzoeksmethode

Het onderzoek hanteert een kwalitatieve benadering door middel van casestudies. Hiervoor is gekozen vanwege de geschiktheid bij verkennende studies met beperkte bestaande kennis, wat in dit onderzoek het geval is. De eerste fase van het onderzoek omvat het verkennen van de organisatorische context van de waterschappen en het opstellen van een theoretisch kader door middel van literatuuronderzoek. Eerst zijn documenten onderzocht en verkennende interviews gehouden om een grondig inzicht te krijgen in de organisatorische context van de waterschappen, voordat veranderstrategieën worden ontwikkeld. Vervolgens is een literatuuronderzoek uitgevoerd om de essentiële componenten te identificeren die nodig zijn om een raamwerk voor organisatieverandering te creëren. De literatuur geeft aan dat modellen die zowel proces- als inhoudelijke aspecten omvatten het meest effectief zijn bij het aanpakken van uitgebreide organisatieverandering, waardoor deze componenten integraal onderdeel zijn van het conceptuele raamwerk. Daarnaast, om de lacune in de bestaande literatuur over het functioneren van een 'circulaire' publieke organisatie na de transitie te adresseren, identificeert het literatuuronderzoek specifieke doelen voor de gewenste post-veranderingsstaat. Deze doelen leiden tot de bepaling van procedurele veranderingsmaatregelen, later gevalideerd in interviews, die de kern vormen van het veranderingsraamwerk. In de tweede onderzoeksfase worden empirische gegevens verzameld door middel van casestudies, waarbij twee waterschappen zijn geselecteerd voor een gedetailleerde analyse. Door middel van interviews met experts worden de veranderingsmaatregelen vastgelegd die nodig zijn om de in de vorige fase gestelde doelen te bereiken. De laatste fase omvat het ontwikkelen van een initieel organisatieveranderingsraamwerk, dat vervolgens wordt gevalideerd

en verfijnd door middel van expertinterviews. Na het opnemen van aanbevolen verbeteringen uit de validatiefase, wordt het definitieve organisatieveranderingsraamwerk voor de circulaire transitie van publieke opdrachtgevers voorgesteld.

Voorgesteld organisatieveranderingsraamwerk voor de transitie naar circulaire bouwpraktijken

Het ontwikkelde veranderingsraamwerk, hieronder afgebeeld in figuur x, dient als een leidraad om de transitie van de waterschappen van de huidige situatie naar de gewenste situatie te faciliteren door middel van gestructureerde en haalbare stappen. Dit raamwerk bestaat uit zowel inhoudelijke als procescomponenten. Het identificeert vier belangrijke verandergebieden: Mensen, Werkprocessen, Structuur en Externe omgeving. Deze gebieden benadrukken wat er in de organisaties veranderd moet worden. Voor elk van deze vier aspecten worden verandermaatregelen gepresenteerd in de stappen ontdooien-veranderen-bevriezen, afgeleid van Lewin's veranderingsmodel voor geplande organisatieverandering. Deze maatregelen, geïdentificeerd door middel van casestudies, bieden een routekaart voor het implementeren van verandering. Door dit raamwerk te creëren, heeft het onderzoek met succes zijn belangrijkste doel bereikt: het ontwikkelen van een organisatieveranderingsraamwerk ter ondersteuning van de circulaire transitie van de waterschappen. Het voorgestelde raamwerk is ontwikkeld op basis van aanbevelingen gevonden in literatuur. Aangezien de resultaten zijn verkregen door empirisch onderzoek, kunnen deze maatregelen worden beschouwd als praktisch en haalbaar voor organisaties. Het validatieproces, dat expert interviews omvatte, was cruciaal voor het bevestigen van de eerste bevindingen en het verfijnen van het raamwerk, waardoor de voorgestelde maatregelen zowel effectief als haalbaar zijn. Dit maakt het voorgestelde raamwerk tot een waardevol hulpmiddel voor managers die het realiseren van een circulaire economie als doel hebben binnen de organisatie.

Aanbevelingen voor de waterschappen

- Verandermanagers, programmamanagers en duurzaamheidsteams zouden proactief de gespecificeerde verandermaatregelen voor de vier organisatiegebieden kunnen implementeren, waarbij ze het raamwerk gebruiken om hun specifieke behoeften aan te pakken en barrières te overwinnen.
- Waterschappen zouden kunnen beginnen met een interne evaluatie om de bereidheid tot verandering van de organisatie te beoordelen. Om de 'early majority' te mobiliseren, kunnen waterschappen beginnen met het ontdooien van het 'Structuur'-aspect, met doelen zoals het waarborgen van manageriële betrokkenheid en het bevorderen van intra-organisatorische samenwerking en verantwoordelijkheid. Het behalen van deze structuurdoelen kan vooruitgang bevorderen op het 'Mensen'-aspect, door een gedeelde en ondersteunende mindset onder medewerkers te cultiveren en een cultuur van innovatie te bevorderen. Dit kan op zijn beurt de succesvolle circulaire transitie in 'Werkprocessen' verbeteren. Daarnaast moeten doelen met betrekking tot 'Externe omgeving' factoren continu worden nagestreefd gedurende alle fasen van het veranderingsproces.
- De leidende groep voor de circulaire economie transitie zou dit raamwerk kunnen gebruiken om gesprekken te starten met het middenmanagement en daarna ook met het dagelijks bestuur en het directieteam, met als doel hun betrokkenheid bij de circulaire doelen te waarborgen.
- Traditioneel geven waterschappen prioriteit aan technische oplossingen voor hun problemen, gezien hun technische aard. Er is echter potentieel voor verdere technische vooruitgang in circulaire transities buiten de huidige praktijken. Daarom zouden waterschappen prioriteit moeten geven aan management- en organisatorische strategieën om menselijke barrières voor transitie aan te pakken. De verandermaatregelen die in het voorgestelde raamwerk zijn uiteengezet faciliteren deze verschuiving.

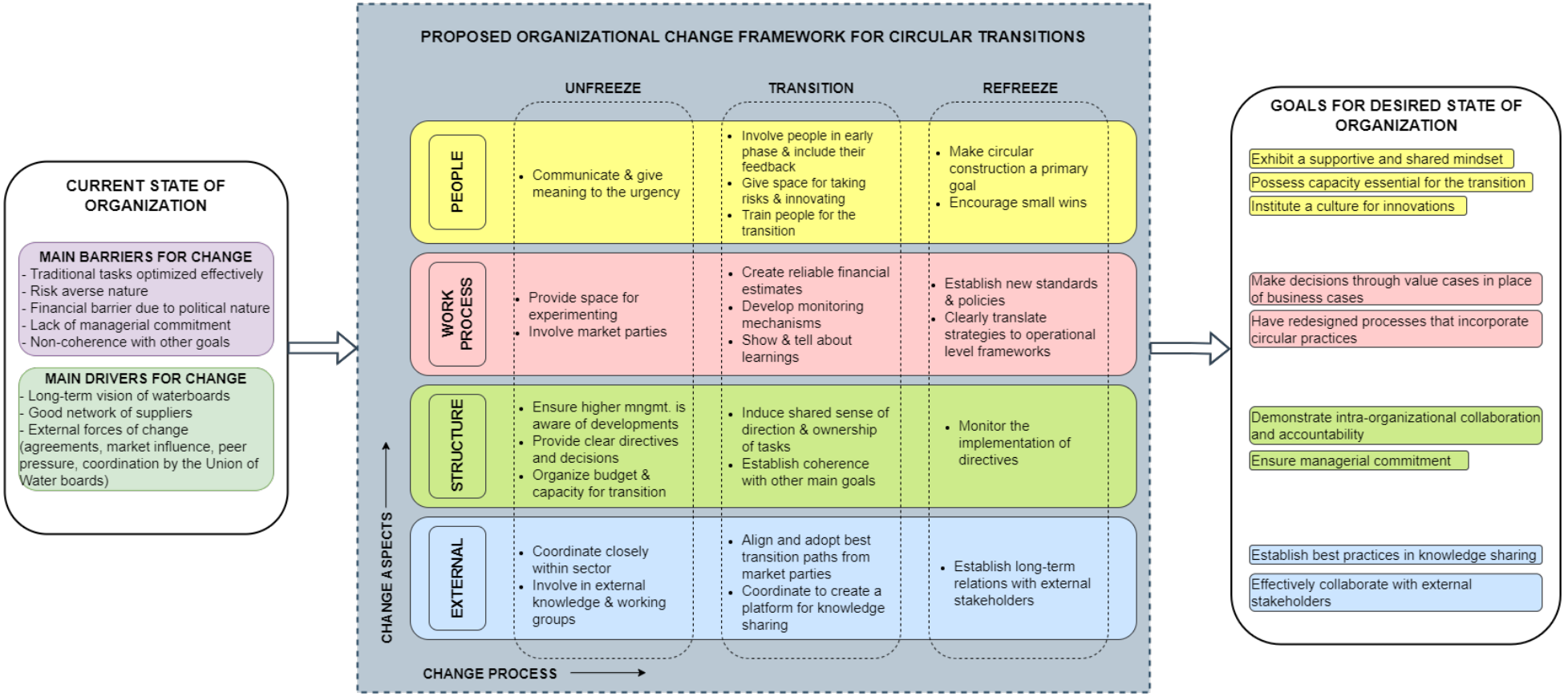

Figure 1: Proposed organizational change framework for transition to circular construction practices

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List of Abbreviations

Abbrevation	*Meaning*
HHD	Hoogheemraadschap van Delfland
KCAO	Klimaatneutraal Circulair Assetmanagement en Opdrachtgeverschap
KPI	Key Performance Indicator
SQ	Sub-research question
UvW	Unie van Waterschappen
WBP	Waterbeheerprogramma
WVV	Waterschap Vallei en Veluwe

Chapter 1

Introduction

Chapter 1 introduces and sets the tone for this research by providing background information, outlining the research context, defining the problem and identifying research gaps, specifying research objectives and questions to address these objectives, and summarizing the research methodology and design.

1.1 Background

In 2016, the Dutch government envisioned a government-wide programme and started working towards a completely circular economy by 2050, with an intermediate target of reducing 50% use of virgin material consumption by 2030 (Government of the Netherlands, n.d.). Seven years later, the Integral Circular Economy Report (ICER) 2023, a biennial study that assesses the status of the desired transition towards a circular economy in the Netherlands, suggests that the current trends and policies in place are not sufficient for achieving the set ambitions. Circular companies, for instance, still constitute only around 6% of the total number of Dutch companies, and financial support for circular activities has remained consistent for several years. The deployed policies have not accelerated the transition towards a circular economy as anticipated and are deemed insufficient to achieve the goal of halving primary abiotic resource use by 2030 (Hanemaaijer et al., 2023).

In the Netherlands, the construction sector accounts for around 50% of the raw materials used, 40% of total energy consumption and 30% of the total water consumption (The Ministry of Infrastructure & the Environment and the Ministry of Economic Affairs, 2016). The sector's current approach of "take, make and dispose of" is the major contributor to carbon emissions, energy consumption and exploitation of natural resources (Marchesi & Tweed, 2021). It is also estimated that, currently, only 8% of all construction materials consist of secondary materials (Conde et al., 2022). Transforming the construction sector is, thus, a decisive factor in the transition to the circular economy. Therefore, there needs to be a strong shift in the current practices in the construction sector to accelerate the circular economy goals. In this study, an investigation is done into how public infrastructure clients can act as drivers of this transition and how they could adjust their internal organization accordingly. To begin with, a short introduction to circular economy and its principles is provided.

1.1.1 Circular Economy

Today, the concept of a Circular Economy can be defined and interpreted in various ways, with a wide range of applications, practices, and processes to achieve its goals. According to Ellen Macarthur Foundation (n.d.), circular economy is defined as a system where materials never become waste and nature is regenerated. In a circular economy, the goal is to minimize the input of raw materials and reduce waste and emissions by various strategies. Transitioning to a circular economy can significantly address four major societal challenges: mitigating climate change, preserving biodiversity, reducing pollution, and minimizing supply risks (Hoogheemraadschap van Delfland, 2021).

Circular economy is not just about waste management at end of life but also focuses on retaining value throughout the entire supply chain and life cycle of a product or service. This approach emphasizes designing out waste and emissions from the very beginning, ensuring that resources are used efficiently and sustainably at every stage (Leffers et al., 2022). The strategies to achieve this can be further elaborated through the *R-Ladder*, proposed by PBL Netherlands Environmental Assessment Agency and the Dutch Ministry of Infrastructure and Water Management, shown in Figure 1.1. The four main goals represented by the R-ladder are (Leffers et al., 2022):

1. *Narrowing resource loops*- Reducing resource input can be achieved by avoiding product use when possible (prevention), increasing the intensity of product use, or minimizing material usage through more efficient manufacturing processes and utilization.

2. *Slowing down or elongating resource loops*- Extending the lifespan and maximizing the value of materials and products can be accomplished through practices such as reuse, repair, and re-manufacturing.

3. *Closing the loops*- Reducing material loss through waste can be achieved by recycling and recovering energy from materials when reuse, repair, and remanufacturing are no longer viable options.

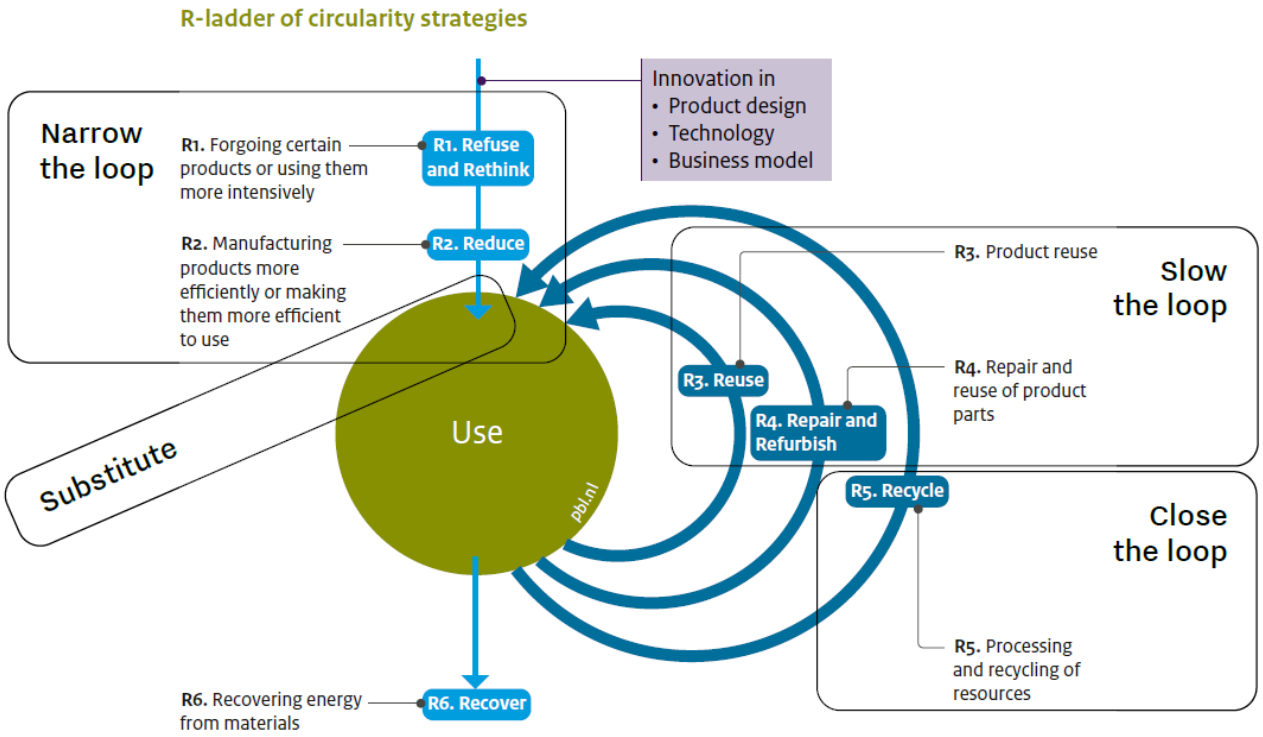

Figure 1.1: R-Ladder of Circular Strategies. (Potting & Hanemaaijer (2018) as cited in Leffers et al. (2022), p.20)

4. *Substitution*- The use of bio-based, renewable materials instead of primary abiotic materials must be promoted wherever applicable.

1.1.2 Circular Economy in Infrastructure

With the growth in the global population to 9.7 billion in 2050, it is estimated that 60% of the infrastructure required to meet the needs is non-existent today. This is akin to constructing a city the size of Paris every week for the next 30 years (Global Infrastructure Hub, 2021). In the Netherlands, in addition to the population growth, infrastructure has an imperative role to play in keeping the land dry, as almost 26% of the country lies below sea level (Gokmen, 2022). Annually, more than 20 million tons of materials are utilized for the expansion and enhancement of roads, canals, and underground infrastructure in the Netherlands (Leffers et al., 2022). In addition to new constructions, currently, over EUR 1 billion is spent every year on civil infrastructure renewal. It is forecast that this amount will gradually reach EUR 3-4 billion in 2040-2050 and EUR 4-6 billion a year thereafter. Management and maintenance of existing infrastructure will cost another EUR 7 billion annually (Bleijenberg, 2021). The demand for infrastructure is higher than ever before, coupled with far-reaching climate objectives that make development more challenging.

Adopting circular economy principles throughout the infrastructure value chain holds the potential to mitigate up to 19% of total infrastructure emissions (Leffers et al., 2022). According to The Ministry of Infrastructure & the Environment and the Ministry of Economic Affairs (2016) more than 95% of construction and demolition wastes are already reused in the Netherlands. However, these materials are not reused at the same or higher levels. For instance, construction rubble is mostly processed and reused as foundation materials in infrastructure projects like roadworks or hydraulic works. Thus, ways should be developed within the sector for the reuse of materials at the same or higher levels. In 2016, the Government-Wide Program for a Circular Economy identified 'construction' as one of the five priority areas to be addressed first, given the sector's resource-intensive nature (The Ministry of Infrastructure & the Environment and the Ministry of Economic Affairs, 2016). The transition agenda 'Circular Construction Economy,' crafted collaboratively by various public and private stakeholders, outlines the Dutch strategy to achieve full circularity in the built environment by the year 2050.

1.1.3 The Role of Public Clients

In Western European countries, public and semi-public construction clients account for around 40% of the total construction output (Vennstrom, 2008 as cited in van Zoest, Volker, and Hermans (2020)). Infrastructure projects are majorly procured by public entities. Thus, public clients can lead the development of circular products and services by actively increasing the demand for such offerings. They can directly shape market demand through the implementation of strategic purchasing policies (Hanemaaijer et al., 2021). According to Team Significant Synergy (2021), the procurement volumes of the Dutch government authorities grew by 9.2% from EUR 79.3 billion in 2017 to EUR 86.6 billion in 2019. The substantial procurement volumes associated with public works present opportunities to pave the way for an engaging market where stakeholders can develop climate-neutral and circular solutions (Leffers et al., 2022). Moreover, owing to their social responsibilities, public and semi-public construction clients are expected to play an active role in fostering innovation and improving the building sector (van Zoest et al., 2020).

Changes like the transition to circular construction practices will place great demand on client organizations. Many circular initiatives are still in their initial phases, with limited scaling up or breakthrough activities. At this point, substantial market demand for and supply of circular products and services is still lacking (Hanemaaijer et al., 2023). This might indicate that public clients have not fundamentally altered their strategic, tactical, or operational approaches to facilitate the transition.

1.2 Research Context- Dutch Regional Water Authorities

One significant group of Dutch public client organizations is the Dutch Regional Water Authorities/boards (*in Dutch: waterschap or heemraadschap*), responsible for regional water management. In the Dutch water sector, drinking water companies produce and supply drinking water, regional water boards manage water regionally and treat wastewater, municipalities handle the sewer system, Rijkswaterstaat (the implementing organization of the Ministry of Infrastructure and Water Management) manages large bodies of water, and the provinces oversee groundwater management (Vewin, n.d.).

This study involves an investigation into the regional water authorities, specifically focusing on their role as public client organizations striving to transition to circular infrastructure. The 21 Dutch Regional Water Authorities build and manage huge numbers of infrastructure works like flood defenses, navigable waterways, pumping stations, and waste water treatment plants. These authorities hold an independent position in the democratic system in the Netherlands with autonomous governance over the activities assigned to them (Havekes et al., 2017). In 2016, 2.9 billion Euros, 40% of the government expenditure on water-related activities, was allocated to the Regional Water Authorities (Rijkswaterstaat & Association of Dutch Water Authorities, 2019). In the upcoming years up to 2050, 200 dike sections totaling 1500 kilometers require to be strengthened. The Regional Water Authorities play a significant role in these activities along with safety from flooding, management of water quality and quantity, and urban wastewater treatment (Havekes et al., 2017). An overview of the infrastructure administered by these bodies is given in Table 1.1.

Given the nature of their work, water authorities are well aware that employing a linear approach to material usage is unsustainable. They directly deal with the consequences of climate change such as heavier rains and prolonged periods of drought. Being major clients in the infrastructure sector, they have the resources and opportunities to make a substantial difference in the transition to a circular economy (Unie van Waterschappen, 2021a). Unie van Waterschappen (2021a) (Union of Water Boards, UvW) indicate that the water boards have made progress in the circular economy domain. All 21 water boards have developed a circularity policy, with over 17 of them having already adopted it administratively. However, it remains largely experimental and exploratory. For the most part, the

Description	*Figures*
Length of dikes	17,100 kms.
Length of water courses	235,000 kms.
No. of pumping stations (storage basins & external water)	2940
No. of other pumping stations	3235
No. of wastewater purification plants	327
Length of roads	7500 kms.

Table 1.1: Key figures of infrastructure administered by Dutch Regional Water Authorities, 2019. (Rijkswaterstaat and Association of Dutch Water Authorities (2019))

circular approach has not yet become ingrained in the regular work of most water boards. It is currently perceived as an additional task for a select few within the organization, but rather should evolve into a norm for the entire organization of the water boards.

To better understand the types of circular initiatives undertaken by water boards, some circular infrastructure pilot projects conducted by these organizations can be explored. The main assets of the water boards, as listed in Table 1.1, include dikes, water barriers, pumping stations, wastewater treatment plants, and pipelines. Consequently, their circular initiatives primarily focus on these asset groups. For instance, when constructing or reinforcing dikes, water boards closely examine the use and origin of materials. Instead of using basalt, they now prefer concrete blocks made from recycled concrete, which are designed to minimize CO_2 emissions during production. Additionally, alternatives are being considered for the textiles applied under the stone cladding of dikes. One example of such a circular dike reinforcement is the Grebbedijk, managed by Waterschap Vallei en Veluwe (Unie van Waterschappen, n.d.-c). Another example is from Waterschap Drents Overijsselse Delta which has designed and built completely modular, prefab pumping stations that can easily be taken apart if necessary. This approach promotes standardization and reuse of elements at the end of its lifespan. They have also tested the use of cement-less concrete as a pilot for the reduction of CO_2 emissions (Unie van Waterschappen, 2021a). Although these are innovative circular strategies, they have not been scaled up and adopted as standard practices.

1.3 Problem Definition

With the transition to circular construction practices, public client organizations like the water boards can no longer continue with standardized, traditional ways of working. While the urgency for change is present, the water boards struggle to progress beyond pilot projects, increase maturity levels throughout the organization, and align new policies with daily practices. This transition brings about a change in decision-making, design, purchasing, use and logistics, among other things. Thus, for the implementation of such transitions, these organizations must adapt their internal organization to incorporate the changes.

Most studies to facilitate the transition to a circular construction economy focus on inter-organizational collaborations, rather than the internal organization of the client. The extant literature on internal organization change models for public clients, particularly within the context of circular economy is limited. Also, literature is fragmented regarding how an organization transitioning to a circular economy should function post-change. Therefore, this is the research gap that this study investigated.

1.4 Research Objectives

This study addressed the pressing need for robust strategies related to the internal organization of public clients, aiming to facilitate the transition to a circular way of working. This was achieved by examining the case of the Dutch Regional Water Authorities. The research addressed the following key objectives through its findings:

1. Develop a conceptual framework that provides insights into how internal changes can be conducted in the organization to accelerate the transition to circular construction practices.
2. Provide recommendations to the water authorities and similar public clients on how to implement changes in their daily practices to facilitate the transition.

1.5 Research Scope

As previously discussed, the water boards play a crucial role in the renovation and maintenance of flood protection infrastructure, including dikes, locks, pumping stations, canals, and ditches. Simultaneously, they are actively involved in the construction of new infrastructure such as (waste) water treatment plants and more. Consequently, this study encompassed internal organizational aspects specific to circular construction economy, considering the water boards as infrastructure client organizations. Furthermore, the organizational change framework developed in this study are tailored to the context of water boards and similar public clients. The research does not delve into a comparison of results with other businesses or organizations. Therefore, it is unknown whether the resultant change framework applies to other organizations.

1.6 Research Questions

Main research question:

What changes in the internal organization of a public infrastructure client, like the Dutch Regional Water Authorities, could facilitate the transition to circular construction practices?

Sub-research questions:

- SQ1- How are Dutch Water Boards organized as public clients, and what are their current strategies for transition to circular infrastructure?
- SQ2- What are the essentials from literature for a conceptual change framework to comprehensively address the aspects of change?
- SQ3- What are the desired outcomes post-change for a 'circular' water board across the various aspects identified for the change framework?
- SQ4- What are the change measures to achieve the desired transition to circular infrastructure, which can be identified from practice within the water boards?
- SQ5- What does a change framework look like that could assist public clients, such as water boards, in transitioning to circular infrastructure?

1.7 Research Methodology & Design

The research primarily follows a qualitative approach of an exploratory nature. Qualitative research gathers participants' experiences and perceptions to provide a deeper understanding of real-world

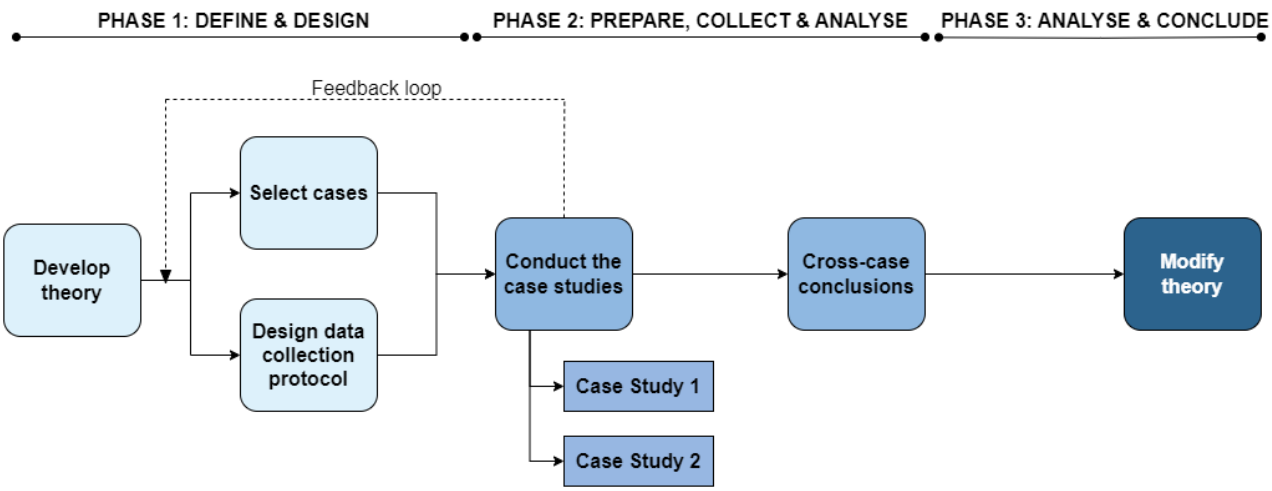

Figure 1.2: Case study methodology (Based on Yin (2017))

problems (Tenny, Brannan, & Brannan, 2023). To comprehensively gather information on varied aspects, an exploratory strategy is necessary. Empirical data forms the backbone of the study. Case studies are inherently suited for exploratory research where the research area is not well-defined or where existing knowledge is limited (Priya, 2021). Thus, the methodology of this research primarily follows the structure of multiple case study from Yin (2017) as shown in Figure 1.2. The first step, *Define & Design*, involves developing an initial theory through a literature review, selecting case studies, and defining the protocol for the data collection process. The second step, *Prepare, Collect & Analyze*, entails conducting case studies, with each one involving in-depth interviews. In the final phase, *Analyze & Conclude*, cross-case conclusions are drawn to generalize and refine the theory. A detailed research design is shown in Figure 1.3 and is elaborated below.

The research design serves as the logical sequence that links the empirical data to the initial research questions of the study and, ultimately, leads to conclusions. Figure 1.3 gives an outline of the research. The study is divided into three main phases as already mentioned.

Phase 1- Define and Design

The first phase of the study is a desk research consisting of a literature review, document review, and a few unstructured exploratory interviews. The objective of this phase is to identify the essentials for a change framework that comprehensively captures the different aspects of change that need to be addressed in the organization for circular transitions. For this purpose, it was imperative to initially understand the current ways of working at the organization under consideration. This is done by commencing with a review of documents available within the organization on governance aspects. The understanding is further solidified through some exploratory interviews. This procedure helped understand what areas of internal organization should be prioritized in the change framework in later parts of the study.

The subsequent step is to conduct a thorough literature review on available organizational change literature. Taking into account the inputs from the previous step, this step involved the identification of some components essential in a change framework. These findings form the theoretical basis for the rest of the research. Next, a specific set of goals are defined according to the desired state post-change for each organizational aspect. For this purpose, a detailed literature survey is conducted as extant literature is fragmented on how a 'circular' organization should function. The final part in this phase is the selection suitable case studies and the design of an interview protocol for conduction semi-structured interviews.

Research questions answered in this phase- SQ1, SQ2 & (partly) SQ3

Research Methods used- 1. Exploratory interviews and document review, 2. Literature Review

Outcomes-

1. Gaining insights into the current internal organization of the regional water authorities and investigating their current circular strategies.
2. Determining the essential components for the development of an effective organizational change framework for circular transition.
3. Defining the desired goals for a 'circular' water board on how it should function post-change implementation.
4. Selecting case studies and designing the data collection protocol to conduct semi-structured interviews.

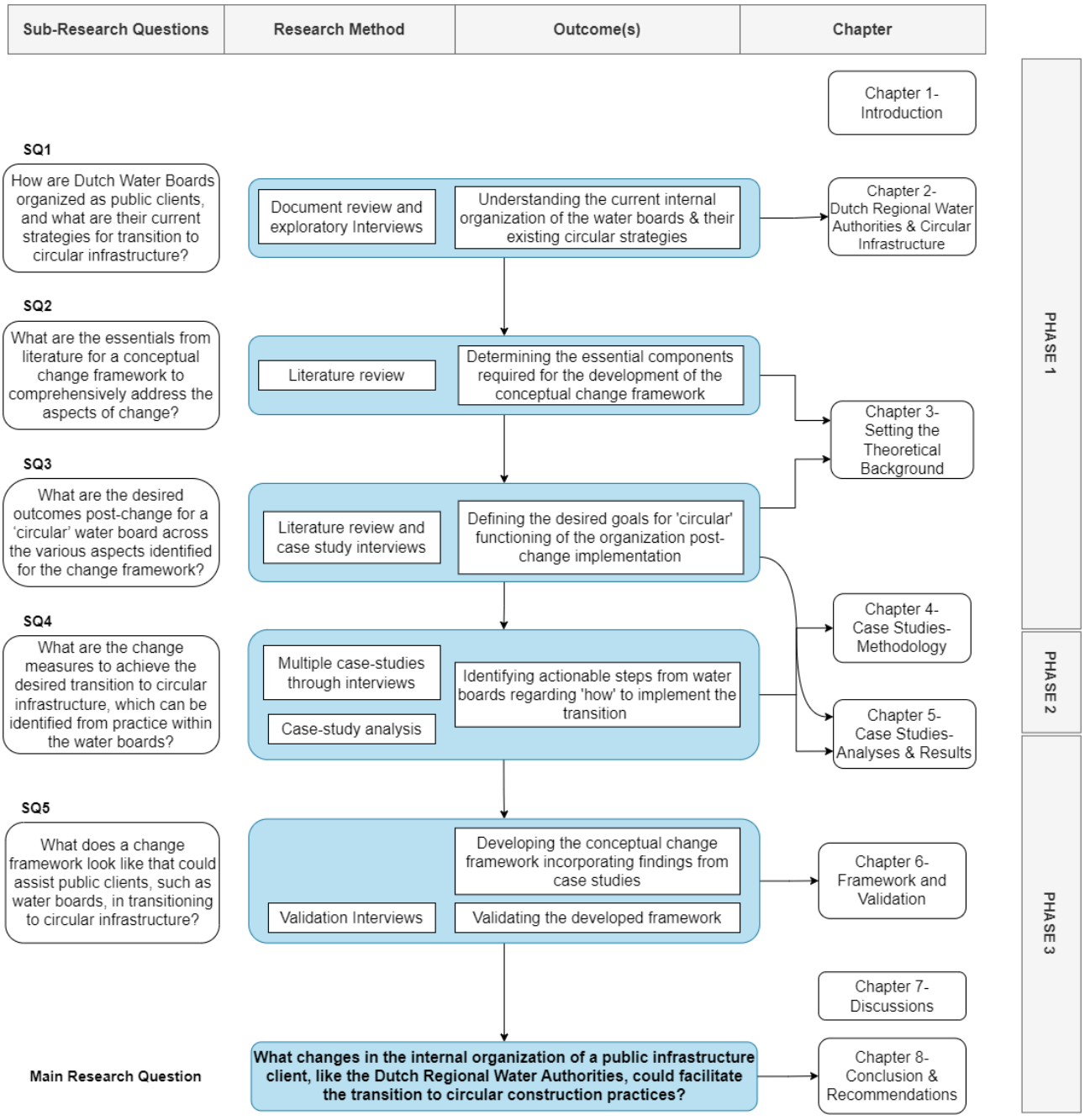

Figure 1.3: Research design

Phase 2- Prepare, Collect & Analyse

The second phase of the study focuses on empirical investigation. Since the extant literature on internal organizational change to transition to circular construction practices is scarce, analysis of multiple case studies was an apt methodology for this part. The multiple case study is a qualitative research methodology that enables us to attain substantial, contextual, and in-depth insights into the subject of focus (Yin, 2017).

The first phase, *Define & Design*, encompassed setting the theoretical background, case selection, and the formulation of a specific protocol for the data collection process. Subsequently, in second phase, the case studies are conducted. It involves treating an entire organization (such as Hoogheemraadschap van Delfland) as an individual case. Two water boards, which are at the forefront of the transition to circular economy practices, constitutes multiple cases. Each case study involves a comprehensive examination through semi-structured interviews.

Research questions answered in this phase SQ3 (fully) & SQ4

Research Method used- Multiple case-study

Outcomes-

1. Confirming the goals identified in literature for the desired state of the organization functioning in circular manner.
2. Identifying practical measures for implementing change through case studies at the the water boards.

Phase 3- Analyse and Conclude

The third phase includes analysis of the collected data and drawing conclusions from it. Cumulative conclusions are made from the multiple case studies An initial framework is developed based on the empirical findings from Phase 2. The initially developed framework is validated for improving its applicability through expert interviews. Adjustments to the initial framework are made, based on the feedback received, to produce the final framework. Finally, discussion on the findings and and recommendations are presented.

Research questions answered in this phase- SQ5

Research Method used- Validation interviews

Outcomes-

1. Developing the initial framework after analysis of collected data
2. Validating of initial framework through expert interviews and adjusting the framework.
3. Discussion on the findings and recommendations.

Chapter 2

Dutch Regional Water Authorities and Circular Infrastructure

In this chapter, the objective is to understand the current internal organizational setup of the water boards and subsequently to understand their current strategies to transition to circular infrastructure. The research question answered in this section is the following.

SQ1- How are Dutch Water Boards organized as public clients, and what are their current strategies for transition to circular infrastructure?

The research methods used are document reviews and exploratory interviews. The reviewed documents are from various sources like Unie van Waterschappen, internal documents from Hoogheemraadschap van Delfland, etc. A total of three exploratory interviews were conducted with experts from Hoogheemraadschap van Delfland and the Unie van Waterschappen.

2.1 Internal Organization of Dutch Regional Water Authorities

The regional water boards were the earliest democratic institutions established in the Netherlands. The Dutch Water Authority model, originating in the 13th century, has played a crucial role in safeguarding the Netherlands from flooding and ensuring access to clean water for its inhabitants (Havekes et al., 2017). From around 3500 water boards in 1850, their numbers have decreased through mergers, resulting in the current count of 21 water boards (Gieske, 2019). With around 6500 employees and 600 board members, they manage public infrastructure assets like primary flood defences, water-retaining structures, pumping stations, waterways and waste water treatment plants across the Netherlands (Havekes, 2023).

In this section, an effort is made to understand how the water boards function and ensure the implementation of their tasks. The findings of this section were also utilized in formulating the essentials for a change framework in Chapter 3.

2.1.1 Organization and Structure

The regional water authorities are decentralized institutions in the Dutch democratic system, with autonomous governance over the activities assigned to them. From a hierarchical standpoint, regional water authorities hold a similar level of authority as municipalities as shown in Figure 2.1. Figure 2.2 is an illustration of the common organizational structure of the Dutch water boards. The subsequent paragraphs delves into this organizational structure based on articles by Otte and Smits (2002), Havekes et al. (2017) and personal communication through interviews.

At the topmost level, the water boards have an elected governing body with members appointed for four-year periods. The governing body consists of a general council, executive committee and chairperson (also known as dijkgraaf). The general council consists of elected members representing different categories of stakeholders like residents, owners of open land (farmers), owners of nature areas and businesses. The general council holds the authority to regulate and manage tasks entrusted to the regional water boards. They also need to arrange for tasks like adopting the budget, annual accounts, water-level decisions, registers, bye-laws and levying taxes. The executive committee is appointed by and from within the general council. Policy-making and overseeing day-to-day business are the primary functions of the executive committee. The executive committee is responsible for preparing all proposals presented for decision-making by the general council. Furthermore, implementation of policies and enforcement of laws and bye-laws are also tasks of the executive committee. The chairperson is appointed by the Crown and is a member of the executive committee. The responsibilities

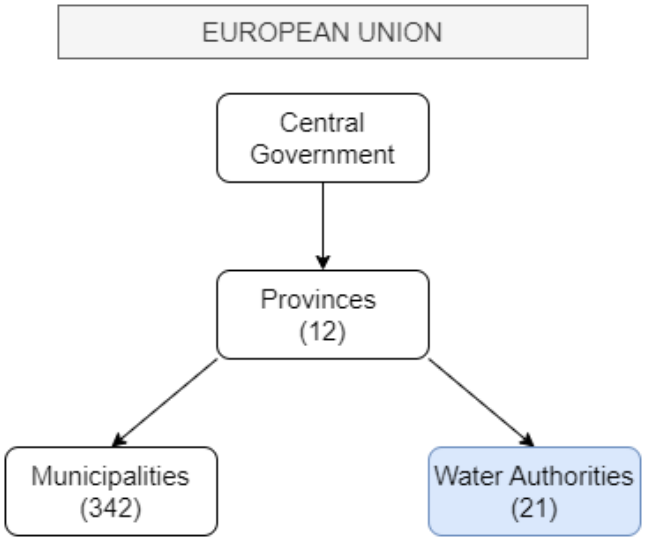

Figure 2.1: Position of water authorities in Dutch democratic system (Source: Havekes et al. (2017))

of the chairperson include proper representation of the water authority's tasks and chairing meetings of the general council and executive committee. Furthermore, the chairperson, in conjunction with the highest official of the regional water authority, signs documents issued by the general council or executive committee. In situations of urgency or imminent risk where convening the general council or executive committee is not feasible, the chairperson is empowered to enact all measures within the authority of these assemblies.

The governing body is assisted by a technical and administrative section to support the policy-making and implementation. They are tasked with the daily management of the water boards. Among the Dutch water boards, two common structures are predominantly found for this section of administration (B. Nanninga, personal communication, February 12, 2024). The first structure is task-based, with departments formed based on the tasks of the waterboards like water safety, wastewater and water quality, or managing the water system. Waterschap Rijn and Ijssel is an example of a water

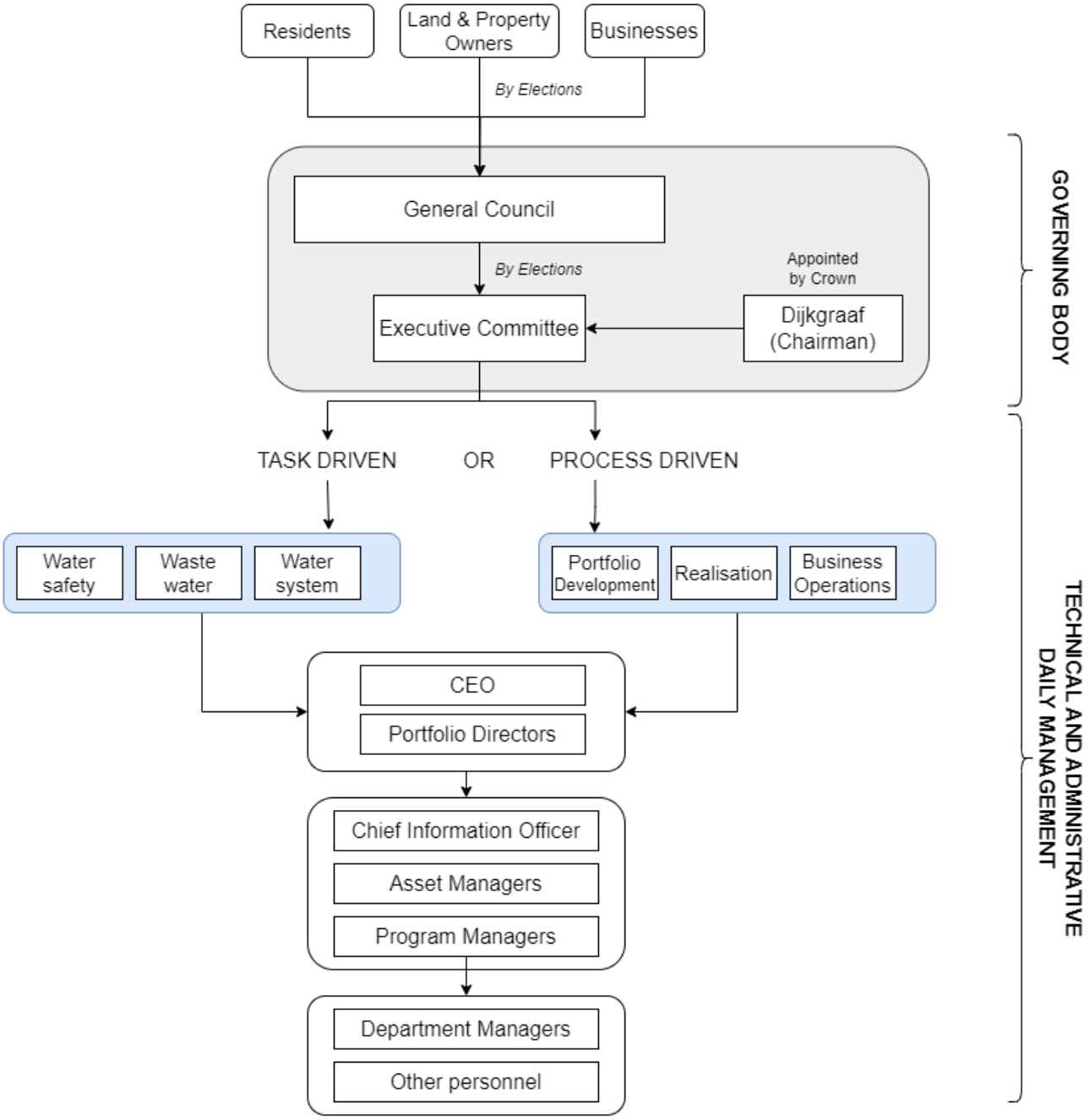

Figure 2.2: Organizational structure of Dutch regional water authorities. (Adapted from Otte and Smits (2002); Havekes et al. (2017) and personal communication)

board with this type of organizational structure. The next type of structure, more commonly found, is process-driven. Departments such as Portfolio Development, Project Realization, and Business Operations are typically part of this structure. Hoogheemraadschap van Delfland is a typical example of this type. However, there is no evidence to substantiate if one type is better than the other. While the governing body typically follows a well-defined hierarchical structure, the technical and administrative sections may offer more flexibility for implementing changes.

The technical and administrative section usually comprises a management team, including a CEO and a director for each portfolio. This core team is supported by asset and program managers, and a chief information officer followed by managers and other personnel to ensure smooth operations.

2.1.2 Strategy and Implementation

The regional water authorities, to a large extent, are financially independent since they collect taxes from the region under their administration for the assigned tasks (Havekes et al., 2017). The tasks carried out by a particular water board depend on the local circumstances of the region. Some of the main tasks carried out are discussed below. However, not all water boards perform all the tasks (Otte & Smits, 2002).

- Flood control- Protecting land against floods through dikes, dunes and canals.
- Water quantity management- Keeping water at the right levels in polders and low areas through pumping stations, etc.
- Water quality management- Improvement of quality of surface water and wastewater by means of water treatment plants.
- Other tasks- Other related aspects of water management like road and waterway management (dredging).

The administration of these fundamental tasks is done in accordance with the existing European and national laws and policies. The water boards also need to make changes according to the changing directives. A representation illustrating the transformation of legislation or policies into implementation assignments at one of the water boards, Hoogheemraadschap van Delfland, is depicted in Figure. 2.3.

The water boards develop strategies for managing the water systems they oversee based on existing and new national and European legislation. Initially, a legally mandated, six-year Water Management Programme (*in Dutch: Waterbeheerprogramma (WBP)*) is established, which outlines the broad approach and necessary measures to maintain the water system and flood defenses. It is developed in accordance with the Regional Water Programme established by the provinces under which each respective water board operates (Informatiepunt Leefomgeving, n.d.). It is interesting to note that many water boards, including Hoogheemraadschap van Delfland, have included 'circular economy' as a theme for the first time in their WBPs (Hoogheemraadschap van Delfland, 2022a). Additionally, every elected coalition prepares a Coalition Agreement (*in Dutch: Coalitieakkord*) in accordance with the WBP. This agreement outlines commitments and focus areas to which the parties are dedicated for the next four years. In this way, the external regulations and guidelines are converted into the water board's strategic objectives and ambitions.

Based on the WBP and Coalition Agreement, the core management team determines the strategic long-term direction. Through internal commissioning, they devise process strategies and prepare strategic multi-year plans for working. For instance, the governing board of Hoogheemraadschap van Delfland has detailed 'water quality' as one of the most urgent goals (Hoogheemraadschap van Delfland, 2023b). The management team, thus, will focus on improving the quality of Delfland's water system and define strategies in this direction. Next, strategic development assignments are

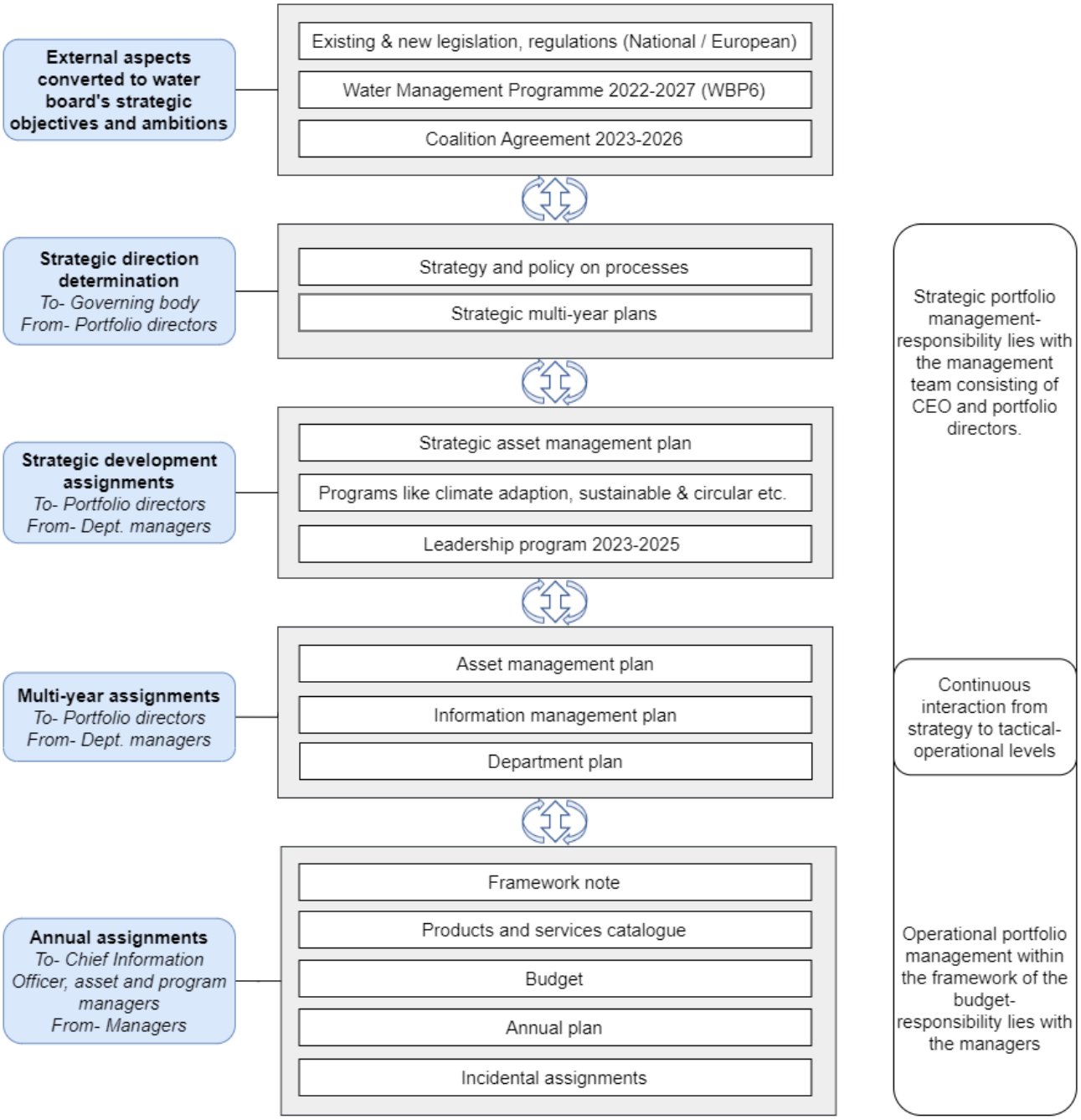

Figure 2.3: Transformation of strategy to implementation assignments at the water boards (M. de Ruiter, personal communication, January 31, 2024)

outlined by the managers including strategic asset management plans and programmes for focusing on new directions. For example, at Hoogheemraadschap van Delfland, new programmes like 'sustainable and circular' are commenced to realize the themes agreed upon in the sixth WBP. These are converted to multi-year assignments and finally into yearly assignments. At the operational level, the staff and personnel function according to the tasks laid out in annual plans, within the framework of the allocated budget (M. de Ruiter, personal communication, January 31, 2024).

2.2 Distinctive Characteristics

There are some attributes that make the Dutch regional water boards unique from some other public infrastructure client organizations (like Rijkswaterstaat, the implementing agency of Ministry of Infrastructure and Water Management) and private organizations. These distinctive characteristics are

discussed in the following sections.

2.2.1 Political Nature of Water Boards

As mentioned in Section 2.1.1, the governing body of water boards has politically elected members. In the Netherlands, water management responsibilities are divided across different tiers of the government. According to 2012 data, around EUR 7.6 billion is annually spent in water resources management. At least 80% of the annual costs are financed via local and regional levy structures (OECD, 2014). A big proportion of this comes from taxes raised by water boards. As tax-raising institutions, water boards must uphold democratic election processes.

In most public organizations, the political authorities typically formulate new policies, while the administrative apparatus is tasked with their implementation. Their mission is set by the political bodies and their working cannot easily depart from this political mandate. As a result, the core aspects of organizational identity of public entities are mostly predetermined, leaving public managers fewer degrees of freedom in developing strategy and moving the organization in alternative directions. When compared with private businesses, this stark contrast means that their adaptability to market signals and stakeholder needs is limited over time (Wæraas & Byrkjeflot, 2012). While all public organizations have this political oversight, water boards stand out because they are directly governed by a political governing board dedicated solely to the policies and tasks of these boards. This political nature of water boards is one of its most distinctive characteristics when compared to many other public organizations working in the infrastructure sector.

The political attribute could also potentially impede the pace of sustainability transitions in water boards. The water boards are responsible for some primary tasks as stipulated in Article 1 of the Regional Water Authorities Act (RWA Act). Incorporating sustainability into these primary tasks (explained in Section 2.1.2), often costs more when compared to traditional, optimized methods. The financial management of regional water authorities, however, is still guided by efficiency and lower rates. It is challenging to make this explicit and explainable to the governing boards and ensure their commitment to the change as they need to convince the residents of a tax increase. Thus, in the context of sustainable transitions, the political nature of the water boards can inhibit the speed of transitions.

2.2.2 Regional Administration

Another closely related aspect that stems from the political character is the regional nature of water boards. The governing board comprises representatives from stakeholder categories with vested interests in the authorities' tasks. Residents represent the interest in general tasks related to all residents living in the regional water authority district. Additionally, specific stakeholder groups are given representation in proportion to other specific tasks to be executed. Their focus lie in specific tasks related to the interests of groups like farmers, businesses and managers of nature areas (Havekes et al., 2017). Thus, the governing bodies typically consist of members appointed based on regional responsibilities, and the administration is oriented towards regional concerns.

In addition, the current regional water authorities are based mostly on hydrological boundaries Havekes (2023). Therefore, the main responsibilities of different water boards vary depending on their respective water districts' geography or water resources. For example, the water board Hoogheemraadschap van Delfland, located in the province of South Holland, manages coastal dikes as one of its primary assets and oversees wastewater treatment for densely populated areas such as The Hague and Rotterdam, which also host large numbers of greenhouses. In contrast, Waterschap Vallei en Veluwe, covering provinces Gelderland and Utrecht, focuses on managing primary river dikes as its main assets (J. Baarends, personal communication, 30 Jan, 2024). Therefore, the tasks of water boards are regiocentric. They are local and regional communities that make relatively independent decisions about what needs to be done and who will pay for it (Havekes, 2023). This regional perspective can pose challenges for effective collaboration and accelerating the transition to sustainable infrastructure.

2.3 Transition to Circular Infrastructure

Although water boards were once predominantly technocratic and professional organizations, in recent years they have increasingly adopted new governance approaches (Gieske, 2019). Lately, the water boards have been busy tackling climate change and shifting towards sustainability mainly in three areas- climate adaptation, energy neutrality, and circular economy (Unie van Waterschappen, n.d.-a). While the water boards have set targets of achieving 50% circularity by 2030 and 100% circularity by 2050, the specific actions required to shape these goals have not yet been completed or crystallized (Besseling, Volbeda, Koster, Sittoni, & Van Zelst, 2020).

2.3.1 National-level Strategies

Unie van Waterschappen (UvW), the association of Dutch water boards, coordinates national efforts to devise policies that align with the interests of the water boards. Based on the strategy Inkoop met Impact (translated as Purchasing with Impact), 2019 by the National Government, the UvW formulated Strategie Duurzaam Opdrachtgeverschap Waterschappen 2021-2030 (translated as Sustainable Water Board Commissioning Strategy 2021-2030). This was an effort to coordinate the sector-wide efforts and lay a solid foundation to make sustainability an integral part of water boards' assignments (Unie van Waterschappen, 2021b). While this strategy covers broader sustainability aspects, in 2021, the UvW also published 'Het verhaal van de circulaire waterschappen' (translated as 'The Story of Circular Water Boards'), outlining strategies emphasizing the circular transition of water boards. This exploration defines why circular water boards are necessary, what the goals for circular transitions are, and also delves briefly into some strategies on how the transition can be achieved. Organizational and behavioral change is identified as one of the essential lines in the strategy towards a circular economy in this publication (Unie van Waterschappen, 2021a).

In 2023, UvW published Klimaatneutraal Circulair Assetmanagement en Opdrachtgeverschap (KCAO) (translated as Climate-neutral Circular Asset management and Commissioning), collaborating with the 21 water boards and engineering consultants to translate the circularity ambitions of the water boards into concrete implementation actions (Unie van Waterchappen, n.d.-b). The KCAO's objective is to equip water boards with the necessary tools to seamlessly incorporate circularity and climate-neutral objectives into their daily work (Unie van Waterschappen, 2023). KCAO guidelines were developed in line with the national government's strategy Klimaateneutraal en Circulair Infraprojecten (KCI) (translated as Climate-neutral and Circular Infrastructure projects), which presents transition roadmaps for several infrastructure assets. The KCAO strategy provides guidelines for five main assets of the water boards, namely pumping stations, wastewater treatment plants, bank/shore structures, flood defenses, and pipes. Although initial guidelines have been established, the Unie van Waterschappen is currently developing follow-up procedures to ensure that all infrastructure projects are climate-neutral and circular by 2030.

2.3.2 Efforts at the Waterboards level

Although the UvW provides guidelines for sustainability initiatives, the water boards have the autonomy to develop their strategies to meet sustainability objectives. Most water boards combine several sustainability goals like energy transition, circular use of raw materials and fresh water, restoring biodiversity, and adopting climate adaptation measures. The sustainability department/programme takes the lead in coordinating these efforts. Sustainable commissioning is implemented in several work processes and purchases following the strategy drawn up by the UvW.

When focusing on the circular transition, it appears that efforts may be trailing behind other goals such as the energy transition. Many water boards prioritize clean energy initiatives within their CO_2 emission reduction strategies. Currently, the water boards are engaged in pilot projects and experimenting with innovative technologies to achieve closed-loop processes. The progress varies across different

water boards. For instance, some, like Waterschap Noorderzijlvest, have developed roadmaps for the circular transition in collaboration with engineering consultants. These roadmaps include baseline measurements of material flows, the application of circular principles for selecting alternatives, and guidelines for monitoring progress. Meanwhile, other water boards have identified specific projects to be executed in a circular manner. Some examples of these are already mentioned in Section 1.2. However, at a minimum, it was observed that most water boards have already established sustainability or circular economy lead team/programme and set clear goals for the transition. Additionally, individuals within the waterboards are generally familiar with the circular economy concept due to ongoing sustainable commissioning efforts. This foundational awareness provide a basis for further advancing circular economy initiatives within the water boards.

While the basis for change is present, the water boards struggle to progress beyond pilot projects, increase maturity levels throughout the organization, and align new policies with daily practices. If client organizations like water boards incorporate organizational changes to facilitate circular constructions, it could also stimulate market parties to transition faster due to accelerated demand for circular products and services.

Chapter 3

Setting the Theoretical Background

This chapter establishes the theoretical foundation for the study through literature reviews, focusing on two main aspects. First, it explores organizational change management theory to identify the essentials for developing a conceptual change framework for circular transitions (Sections 3.1). Second, it examines existing literature to understand the desired state of the organization post-implementation of change. This section seeks to determine how a public organization operates within a circular framework (Section 3.2). The research questions addressed in this section are as follows:

SQ2- What are the essentials from literature for a conceptual change framework to comprehensively address the aspects of change?

SQ3 (partly)- What are the desired outcomes post-change for a 'circular' water board across the various aspects identified for the change framework?

The research methods employed include literature surveys and document reviews. The insights from this chapter form the foundation for structuring the empirical data gathering through case studies and the subsequent development of the conceptual change framework.

3.1 Literature Review on Organizational Change Management

Organizations navigating through changing environments require sustainable organizational changes to ensure survival and success (Michel, By, & Burnes, 2013). With far-reaching climate goals, public organizations strive to transform to a circular way of working. In this study, a conceptual framework is developed that can help these public-client organizations transition. To develop such a framework, the essential components required in it need to initially be understood.

Before proceeding, it is essential to clarify the meaning of a 'conceptual framework' that we intend to develop. A conceptual framework outlines the multiple variables of a research study and the relationships between these variables to achieve the desired outcomes. These variables are coordinated to form a structure that demonstrates their interconnectedness and working patterns within a process, setting, or system (Shikalepo, 2023). Thus, in this case, a conceptual framework consists of ideas that visualize the changes to be implemented in an organization, as informed by the data and findings of the study. In this section, first, the review delves into planned organizational change theories developed over the years, followed by conclusions on the essential components identified for an effective change framework.

3.1.1 Planned Organizational Change

Organizational change is defined as the empirical transformation observed in the form, quality, or long-term state of an organizational entity. This change typically arises from the introduction of new styles of thinking, acting, or operational approaches, aimed at adapting to the environment or enhancing performance (Pardo-del Val, Martinez-Fuentes, & Roig-Dobon, 2012, p. 1845). According to Errida and Lotfi (2021), change management models support and act as guiding frameworks to facilitate change efforts by outlining specific processes or steps that can be followed. It also depicts the various factors influencing change and identifies the levers necessary for success in the change management process.

Transition to circular constructions is often initiated deliberately. Planned organizational changes are deliberate activities to move an organization from its current state to the desired state (Stouten, Rousseau, & De Cremer, 2018, p. 752). While reviewing the existing literature, it can be found that several planned organizational change models are available. For instance, Joseph Galli (2018) did a comparative analysis of five major change models and identified the advantages and disadvantages of each. Errida and Lotfi (2021) identified 37 change models through extensive literature reviews and analyzed the selected models to identify the factors influencing change management success. Planned organizational change models mainly fall into two categories- 1) processual models and 2) descriptive models (Parry, Kirsch, Carey, and Shaw (2014); Errida and Lotfi (2021)). The following sections delve deeper into these categories.

3.1.1.1 Processual Change Models

Processual change models outline the unfolding of the change process and determine the steps for conducting and managing change. Some renowned processual change models include Lewin's 3-stage model, Kotter's 8-step model, Prosci's ADKAR model etc. (Parry et al. (2014); Errida and Lotfi (2021)). While there are several other processual models available, many of them are variations of Lewin's 3-stage model, often dividing the three stages into more steps (Errida & Lotfi, 2021). Within the three most commonly used change models mentioned above, the ADKAR model focuses on an individual's change adaptation, while Lewin's and Kotter's approach guides and facilitates organization-wide change (Joseph Galli, 2018). In this study, since the focus is on organizational change, Lewin's and Kotter's models are explored further.

Lewin's 3-stage model

Lewin's 3-stage model of change is called the classical model by some authors (Talmaciu, 2014)

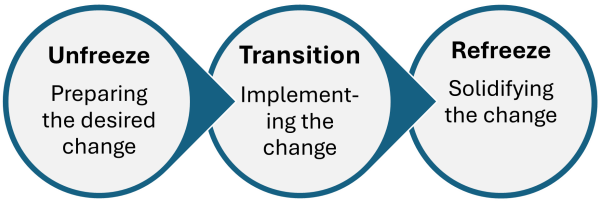

Figure 3.1: Lewin's 3-stage change model (Joseph Galli (2018); Talmaciu (2014))

and widely regarded as the cornerstone of planned change management (Errida & Lotfi, 2021). The majority of subsequent theories and models are founded on Lewin's fundamental principles (Yli-Kerttula & Varis, 2023). This model splits the process of change into three stages or phases, namely: *unfreeze, moving* and *refreeze* (Talmaciu, 2014). Figure 3.1 illustrates the basic stages in Lewin's model. The three proposed stages in the model are: (Errida and Lotfi (2021); Bekmukhambetova (2021))

1. *Unfreeze*- The first step involves destabilizing the current state of affairs by creating the need and support for change, identifying the forces pushing for and against change, and defining the desired end state. This stage aims to motivate the organization for the change and prepare for the upcoming change.
2. *Moving (transition)*- This phase entails moving towards the desired future state through active participation and involvement. During this stage, planned actions are executed in alignment with the desired changes.
3. *Refreeze*- Refreezing occurs after the change has been implemented, solidifying the new culture, behaviors, and practices within the organization. This phase involves stabilizing the new state of affairs by establishing policies, rewarding successful adaptation, and setting new standards. It includes activities aimed at consolidating the new organizational practices.

Kotter's 8-step model

The next prominent processual model is the one created by Kotter consisting of 8 steps (Kotter, 1995). Figure 3.2 shows the functioning of this model. The 8 steps are: (Kotter, 2007)

1. *Establishing a sense of urgency*- The first step is to examine the realities of the external environment. Also, to identify and discuss potential crises and opportunities.
2. *Forming a powerful guiding coalition*- Creating a strong team to lead the change and promoting teamwork among its members.

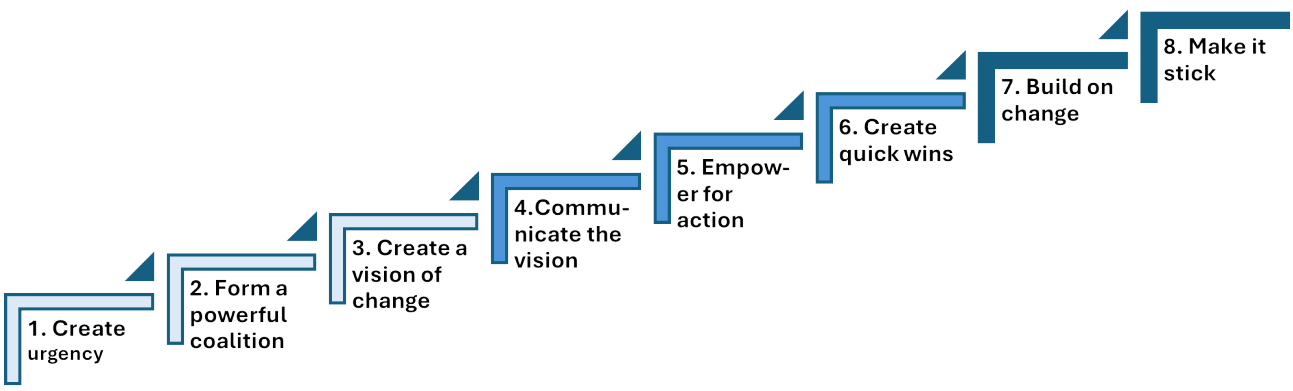

Figure 3.2: Kotter's 8-step change model (Joseph Galli (2018); Bekmukhambetova (2021))

3. *Creating a vision*- Developing a clear vision to guide the change and devising strategies to accomplish it.
4. *Communicating the vision*- Utilizing all available channels to communicate the new vision and strategies, and demonstrating new behaviors through the example set by the guiding coalition.
5. *Empowering others to act on the vision*- Removing barriers to change, altering systems or structures that hinder the vision, and encouraging risk-taking and unconventional ideas, activities, and actions.
6. *Planning for and creating short-term wins*- Planning for visible performance improvements, implementing those improvements, and acknowledging and rewarding employees who contribute to them.
7. *Consolidating improvements and producing more changes*- Leveraging enhanced credibility to change systems, structures, and policies that are not in line with the vision, promoting the growth of personnel capable of executing the vision, and rejuvenating the process with fresh initiatives, themes, and change advocates.
8. *Institutionalizing new approaches*- Clearly outlining the linkages between new behaviors and organizational achievements, and establishing mechanisms for fostering leadership development and succession.

Comparison between Lewin's and Kotter's models

Kotter's 8-Step Change Model builds upon Lewin's initial change theory, giving an expanded view to managing organizational change (Joseph Galli, 2018). A comparison of Kotter's model to corresponding phases of Lewin's model is shown in the following Table 3.1. Stage *Unfreeze* corresponds to the first three steps, namely, creating urgency, forming a powerful coalition, and creating a change vision. As for *moving*, it includes the next three steps- communicating the vision, empowerment and creating quick wins. Finally, refreezing consists of steps 7 and 8, which are building on change and making the change stable (Hamdo, 2021).

Lewin's 3-stage	Kotter's 8-step
Unfreeze	1. Establishing a sense of urgency
	2. Forming a powerful guiding coalition
	3. Creating a vision
Moving (transition)	4. Communicating the vision
	5. Empowering others to act on the vision
	6. Planning for and creating short-term wins
Refreeze	7. Consolidating improvements and producing more changes
	8. Institutionalizing new approaches

Table 3.1: Comparison between Lewin's and Kotter's models (Hamdo (2021))

3.1.1.2 Descriptive Change Models

A descriptive model defines the key variables and factors influencing the success of organizational change. While processual models refer to how change can occur, descriptive models focus on content and describe what changes in the organization. Some common descriptive change models include Burke and Litwin's model of organizational change and Nadler and Tushman's congruence model (Errida & Lotfi, 2021).

Burke and Litwin's model

The Burke-Litwin model consists of 12 dimensions, which guide us regarding what must be analyzed and changed in an organization. The change model is shown in Figure 3.3. The connections mean

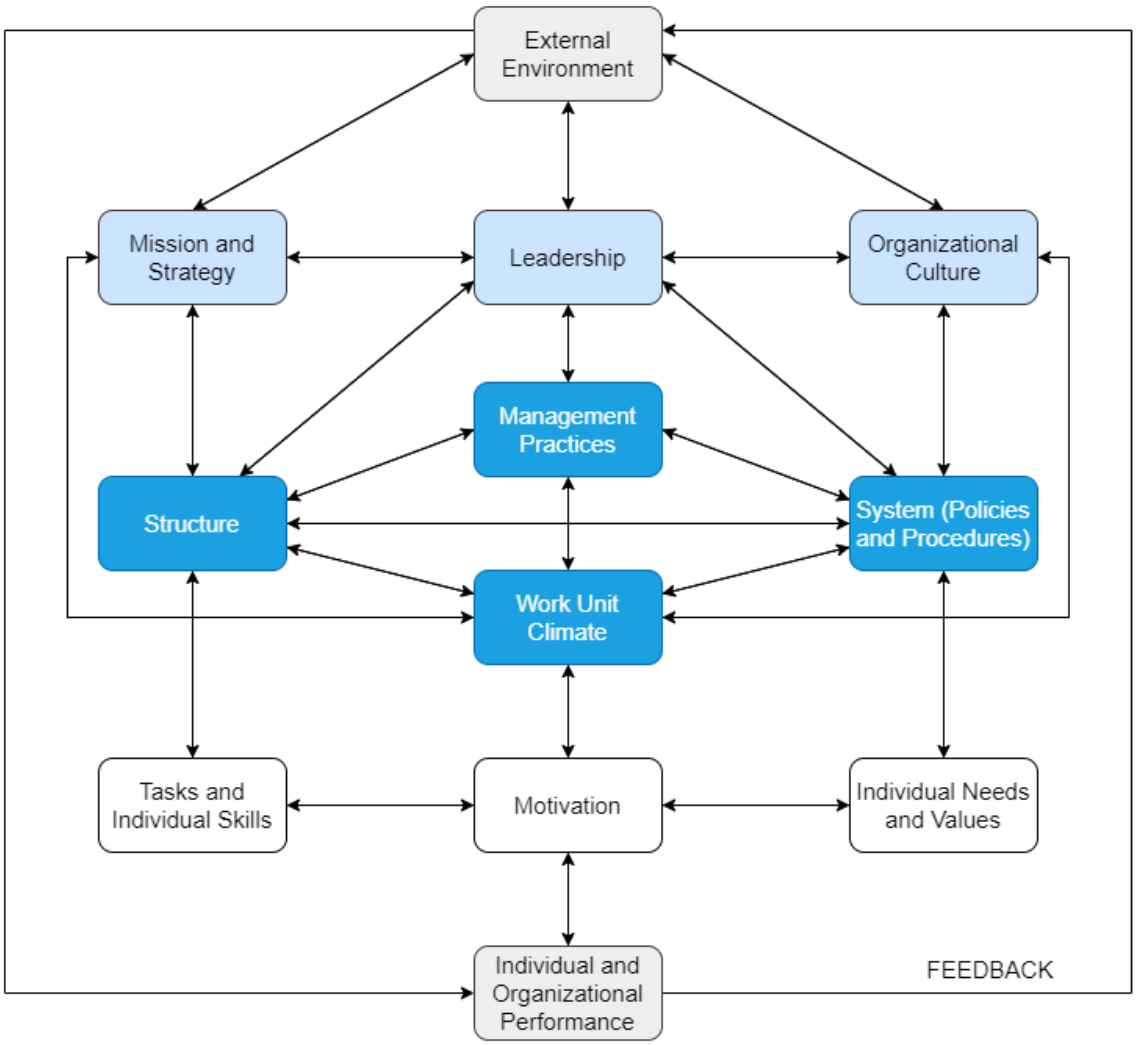

Figure 3.3: Burke-Litwin model for organizational performance and change (Burke & Litwin, 2002 as cited in Boone (2012))

that change to one element can influence other elements. In the model, the upper portion emphasizes transformational (deep structure) factors, while the lower portion pertains to transactional (day-to-day) factors. According to this model, transformational change is triggered by external factors and directly influences the organization's mission, strategy, leadership, and culture. These in turn affect the transactional factors (management practices, structure, systems and work climate) and both factors influence motivation resulting in changing individual and organizational performance (Boone (2012); Filej, Skela-Savič, Vicic, and Hudorovic (2009); Errida and Lotfi (2021)).

Nadler and Tushman's congruence model

The Nadler-Tushman congruence model has two main elements- *strategy* (decisions on deploying resources to environmental opportunities and threats) and *organization*. Organization includes four components, namely, work & tasks, people, formal structure, and informal organization. The focus of the model is the fit between these four components in an organizational transformation process. The authors explain that the effectiveness of an organizational change is the best when the organization's strategy is consistent with the environment and there is congruence among the four components (Nadler & Tushman, 1989). Figure 3.4 shows a representation of Nadler-Tushman model.

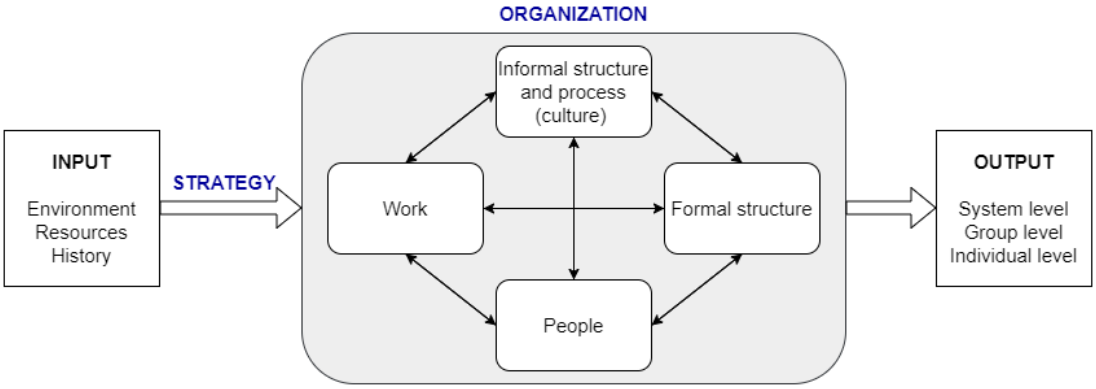

Figure 3.4: Organizational change model by Nadler and Tushman (Nadler and Tushman (1989))

3.1.2 Essentials for an Organizational Change Framework

There is disagreement in the literature regarding the selection of the most suitable model to steer change within an organization (Errida & Lotfi, 2021). Several authors think that using a single model may not provide a full description and may neglect certain important factors. Besides, one model for all cases may be inappropriate to the particularity of the change (Joseph Galli (2018); Al-Haddad and Kotnour (2015)). While literature may provide some direction, it is ultimately the organizational environment that should determine a suitable change framework that fits (Joseph Galli (2018); Al-Haddad and Kotnour (2015)). Therefore, this research intends to develop a tailor-made framework for organizational change that addresses circular transitions in public client organizations such as the Dutch regional water boards.

3.1.2.1 Guiding Theoretical Framework

Multiple change models could be combined to align with the specific needs of a change initiative or the context of an organization (Errida & Lotfi, 2021). It is found that models that incorporate both process and content aspects demonstrate the most promise in addressing the change holistically (Barnett & Carroll, 1995). Keeping this in mind, the change model for this study must include components of a processual model as well as organizational-specific variables and factors from descriptive models. This observation is also supported by a recent systematic review of literature on organizational change towards a circular economy. The scholars identify three main dimensions of organizational change: *content*, *process*, and *context* (Graessler, Guenter, de Jong, & Henning, 2024). The first two dimensions correspond to descriptive and processual change aspects, respectively. Context, however, pertains to the conditions influencing planned change and can be divided into inner context (e.g., culture, structure, and political context within the firm) and outer context (e.g., economic, social, and competitive environment). Given the scope of this study, the focus is on the internal organization, particularly the inner context. Through the first sub-research question (SQ1) the context of organizational change within the water boards has already been investigated. Additionally, interviews conducted in later stages help identify the drivers and barriers for transitioning to circular methods, thereby providing a better understanding of the context. Therefore, the conceptual organizational change framework intended to be developed requires two essential components: 1. content and 2. process.

Accordingly, Figure 3.5 provides a visual representation of these key components. This adapted theoretical model primarily consists of two parts. First, it adopts one of the most utilized processual models, namely, Lewin's 3-stage model consisting of *unfreeze-transition-refreeze* steps. The Kotter's 8-step model is often seen as a detailed version of Lewin's model (as explained in Table 3.1). With this processual model as guidance, the conceptual framework will be able to effectively determine the process or steps for conducting and managing organizational change in the context of circular transitions. The second part involves the variables or factors targeted for change within the organization as found in various descriptive change models. The four content aspects identified are *people, work process, structure* and *external*. The initial three aspects, or their modified forms, are present

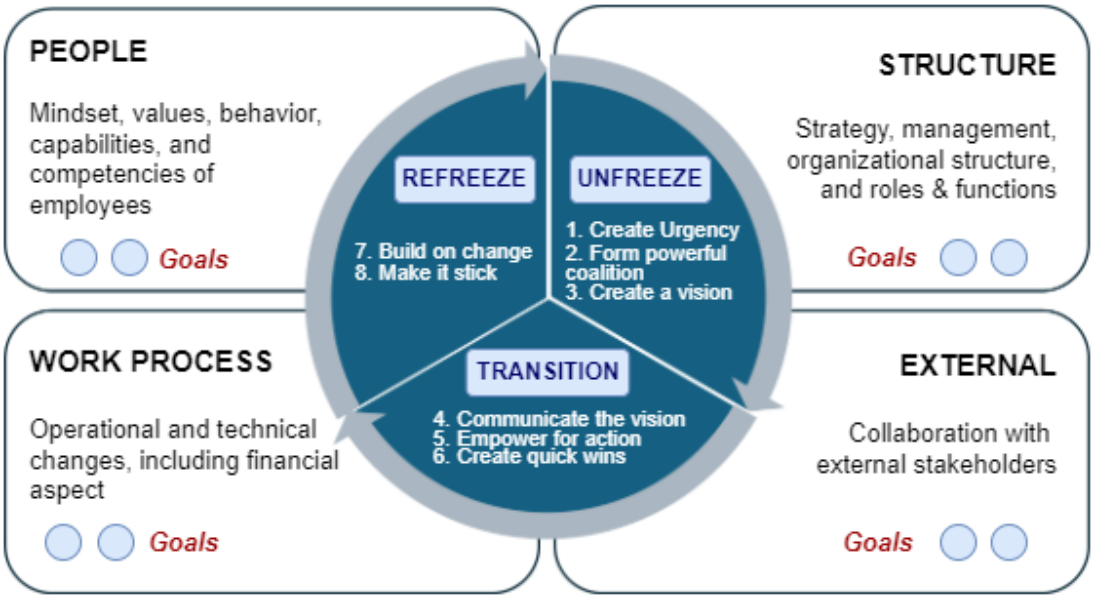

Figure 3.5: Guiding theoretical framework showing the essential components for an effective organizational change framework

in various descriptive models such as Burke-Litwin's model, Nadler-Tushman's congruence model, and McKinsey's 7S Framework. They are also consistent with the organizational context of the Dutch water authorities discussed in the preceding chapter. The fourth aspect—*external*—was identified in the validation interviews, as detailed later in this section. These four aspects are elaborated below:

- *People*- 'People' relates to the different individuals who are part of the organization. The main aspect that could be considered in this component is the organizational culture. According to Bertassini, Ometto, Severengiz, and Gerolamo (2021), organizational culture to support the transition to a circular economy consists of five building blocks- mindsets, values, behaviours, capabilities and competences.
- *Work Process*- This component relates to the operations of the organization and how they are performed. It includes aspects related to the adaptability of the processes in place and its financial management. It also includes how strategies are devised and formed into work assignments.
- *Structure*- 'Structure' refers to the way the organizational structure is set up, the span of control of the roles & functions, accountability, and management practices to name a few.
- *External*- For changing to circular ways of functioning, organizations must also learn from the external environment. Absorbing technological advancements, collaborating with external stakeholders, knowledge sharing and policy development are some crucial aspects of this component.

The illustration also shows some 'Goals' for each content-related aspect. This is further discussed in Section 3.2.

3.1.2.2 Validation of the Guiding Theoretical Framework

The proposed guiding framework is strongly rooted in organizational change theory. For instance, Lewin's and Kotter's models are the two most commonly applied methodologies for organizational change in extant healthcare literature (Harrison et al., 2021). Also, the identified content-related aspects, or their adapted versions, are found in several descriptive models such as Burke-Litwin's model, Nadler-Tushman's congruence model, and McKinsey's 7S Framework. Additionally, to ensure these components are applicable within the context of the water boards, validation was conducted through two interviews- one expert interview each at Hoogheemradschap van Delfland and Unie van Waterschappen.

A comparable theoretical framework, incorporating steps from Lewin's and Kotter's models but with distinct content-related components, has been utilized at Hoogheemraadschap van Delfland as part of an organizational restructuring program initiated in 2018. Furthermore, both experts deemed the model suitable for the context of water boards and found it to be practical. Based on received feedback, the 'external' component was introduced as the fourth content-related aspect to encompass factors such as technological advancements, knowledge sharing, and how the organization must adjust to effectively collaborate with external stakeholders. External stakeholders of the waterboards include, but not limited to, the extensive network of suppliers, government institutions like national government, provinces and municipalities, the association of the Dutch water authorities- Unie van Waterschappen, organizations within the sector like other water boards, drinking water companies and Rijkswaterstaat and academic institutions. One of the experts remarked that the guiding model embodies "the best of both worlds" by combining elements from both processual and descriptive change models.

3.2 'Circular' Water Boards

In the previous section, we determined the content aspects of change within the water boards. In figure 3.5, it can be seen that each content aspect includes a set of goals. This can be explained as follows. The conceptual framework we aim to develop also includes procedural steps that can guide water boards on how to implement the changes in these aspects. To determine the procedural steps, the initial phase involves defining the desired state of the organization after the change is implemented, i.e., what would a 'circular' water board be like in its intra-organizational functioning? Thus, for all four aspects considered, namely, work process, structure, people, and external, the goals that are necessary to guide change are establshed.

In order to do this, firstly, we delve into the existing literature. Literature is fragmented regarding how an organization transitioning to a circular economy should function post-change. Thus, it is difficult to directly define the desired outcomes for the aspects under consideration. There are a few papers that talk about the organizational transition towards circular business models for private businesses (Hofmann and Jaeger-Erben (2020); Unal, Urbinati, and Chiaroni (2019), von Kolpinski, Yazan, and Fraccascia (2023); Nujen, Kvadsheim, Mwesiumo, Reke, and Powell (2023); Graessler et al. (2024)). These articles provide some recommendations for managerial practices, insights into internal dynamics, and some other intra-organizational perspectives when organizations transition to circular business models. However, none of the articles were based on a circular construction economy or focused on public client organizations striving to transition to circular infrastructure. Therefore, these goals were discussed in the interviews to see if the practitioners identified the need for these goals in their daily practice within the water boards. As a general criterion, only goals observed in two or more sources were included in the study. Some goals, specific to the water boards, were identified from document reviews, specifically those from the Unie van Waterchappen. These goals were prioritized over other literature goals as they were specifically shaped for the water boards.

3.2.1 People

As mentioned, people aspect deals with the mindsets, values, behaviours, capabilities, and competencies of the people at the organization including governing board members, directors, managers and all subordinates. At the water boards, a circular way of working has not yet become a normal part of regular work as linear practices are ingrained in their culture. The mindset should be such that circularity is not an extra task, but a new way of thinking and working (Unie van Waterschappen, 2021a). An article by von Kolpinski et al. (2023) on the internal dynamics of startups working in the circular economy suggests that the willingness of the employees to work toward the shared vision of circular practices can overcome many barriers associated with linear industry standards and

business-as-usual. The article also points out that employees within traditional organizations (such as water boards) may exhibit a tendency towards risk aversion. This could inhibit decision-making and effective collaboration. Hence, considering the significant influence of mindset, it is crucial to provide employees with the necessary space, support, and confidence to think and work out of the box. This approach is supported by a recent study conducted in collaboration with the circular learning community at the municipality of Amsterdam, focusing on civil servants within their organization (Diercks, Flinkenflogel, & Loorbach, 2023). Furthermore, studies also highlight the need for employees' skills and competencies (von Kolpinski et al. (2023); Bertassini et al. (2021)). For the people in an organization, acquiring capabilities through development, learning, and exchange of knowledge, which are transformed into competencies is essential in the transition to a circular economy (Bertassini et al., 2021).

3.2.2 Work Process

Work process deals with the operations and technical changes in the organization. According to the report by Unie van Waterschappen (2021a), due to the political nature of the water boards, their financial management is currently determined through factors like efficiency or lower rates. With circular practices, however, the aim should be to add value to every step of the life cycle of a product or process. The water boards must thus transform to work processes based on value cases rather than business cases. Functioning with value cases ensures that not just financial costs and returns are considered, but also the environmental effects, use of secondary materials and broad social costs and benefits (Unie van Waterschappen, 2021a). This is also outlined as a guiding principle for water boards, including Hoogheemraadschap van Delfland, to become circular (Hoogheemraadschap van Delfland, 2022b). Furthermore, the ultimate goal of the organizational change is that the work processes must ensure the closing of resource loops and eliminate waste across the industrial ecosystem. To internalize circularity, many processes need to undergo redesign to facilitate reuse, recycling, and logistics. Management of processes may be impacted by reengineering efforts aimed at making them more circular or by transitioning from one set of operations to another. Thus, organizations may have to fundamentally redesign their processes in such a way that circular economy principles can be applied (Graessler et al. (2024); Barros, Salvador, do Prado, de Francisco, and Piekarski (2021)).

3.2.3 Structure

Structure includes aspects like strategies, management, organizational structure, and roles and functions. In the desired state post-change, circular economy aspects should be seamlessly integrated across different levels of the organization. The boundaries between the departments should become transparent, such that it enables collaboration and eliminate silo thinking. The aggregated expertise of individuals from diverse disciplinary backgrounds often yields more precise foresight and sustainability-oriented decisions. This interdisciplinary nature accelerates circular solutions as organizations develop new intra-organizational structures and mechanisms for mutual learning, bridging previously disparate knowledge domains (Graessler et al. (2024); Hofmann and Jaeger-Erben (2020)). Another aspect that has strategic significance in terms of aligning the resources with the circular objectives of the company is managerial commitment (Unal et al. (2019); von Kolpinski et al. (2023)). Managerial commitment towards circular practices is required to devise and implement strategies and is indispensable during short-term trade-offs between financial value and the circularity of the organization. In the context of the water boards, as discussed in section 2.1.1, the governing body holds considerable sway over managerial choices, with the political aspect of governance potentially exerting significant influence. Multi-year plans such as the WBP could help maintain commitment even amid changes in the governing body.

3.2.4 External

The external aspect was introduced to the framework as an additional content-related aspect based on exploratory interviews. The main goal, as suggested by the interviewees, of enhancing organizational

alignment for improved collaboration is also corroborated by existing literature. (Salvioni and Almici (2020); Unie van Waterschappen (2021a); Circular Economy Alliance (2023)). As discussed, the water boards as client organizations, spend around EUR 2 billion per year on purchasing and projects which creates the potential for market development towards a circular economy. However, current collaboration practices require strengthening and expansion to make the circular economy a part of regular work (Unie van Waterschappen, 2021a). The water boards must work closely with contractors and other suppliers not just to ensure the sourcing of renewable, recycled, or low-impact materials, but also to reuse the raw materials recovered from wastewater and water systems. Close collaboration with other external stakeholders like municipalities, provinces, knowledge institutions is also necessary. Additionally, the water boards also need to be learning organizations and adopt best practices in knowledge-sharing. A challenge in the circular transition is getting the employees to think about a theme in which they are not specialists in (Unie van Waterschappen, 2021a). Knowledge sharing with market parties, academic institutions, and other water boards would enable people to broaden their perspectives and gain experience in the transition. The role of Unie van Waterschappen is also crucial to stimulate knowledge exchange and cooperation (B. Nanninga, personal communication, February 12, 2024). Knowledge sharing to facilitate circular practices will improve access to technical and supply chain information, thus enabling improved organizational decision-making based on more certain economic and environmental impacts (Jäger-Roschko & Petersen, 2022).

The following Table 3.2 summarizes the various goals identified from the literature and exploratory interviews for each content-related aspect of change. These goals were further discussed in the interviews.

Code	*Goal*	*Source(s)*
People		
P1.	Exhibit a supportive and shared mindset	(1), (2), (3)
P2.	Possess competencies essential for the transition	(3), (4)
Work Process		
W1.	Make decisions through value cases in place of business cases	(3), (11)
W2.	Have redesigned processes that incorporate circular practices	(5), (6)
Structure		
S1.	Demonstrate intra-organizational transparency and collaboration	(5), (7)
S2.	Ensure managerial commitment (leadership and political)	(1), (8)
External		
E1.	Establish best practices in knowledge sharing	(3), (10)
E2.	Effectively collaborate with external stakeholders	(3), (9), (10)

(1) von Kolpinski et al. (2023), (2) Diercks et al. (2023), (3) Unie van Waterschappen (2021a), (4) Bertassini et al. (2021), (5) Graessler et al. (2024), (6) Barros et al. (2021), (7) Hofmann and Jaeger-Erben (2020), (8) Unal et al. (2019), (9) Salvioni and Almici (2020), (10) Jäger-Roschko and Petersen (2022), (11) Hoogheemraadschap van Delfland (2022b)

Table 3.2: Desired goals identified from literature

Chapter 4

Case Studies- Methodology

This chapter outlines the methodology employed for the empirical data-gathering segment of the research, which is conducted through multiple case studies. As illustrated in the research design (Figure 1.3), the theoretical framework for these case studies has been established in Chapters 2 and 3. The subsequent steps involve selecting the case studies, designing the data collection methods, and formulating the analysis methodology.

Two organizations were chosen as case studies, and a brief background of both is provided. This is followed by a detailed explanation of the data collection design, which utilizes semi-structured interviews. Finally, the chapter delves into the methodology used for analyzing the collected data.

4.1 Criteria for Selection of Cases

Multiple case studies form the backbone of empirical data gathering in this research. Thus, the selection of these cases assumes importance. An inductive approach will be followed in the development of the conceptual framework from the case studies. A minimum of two case studies are utilized for this purpose to eliminate the possibility of deductive theory confirmation. The individual case studies must predict similar results (literal replication) to allow the possibility to generalize findings (Yin, 2017). Most similar cases are thus considered to make analytical generalizations. As previously noted, an entire organization (in this instance, a water board) is treated as a single case study. It is already established that the research is carried out within the framework of the Dutch regional water authorities. Additionally, the following criteria are used to identify suitable water boards for the study:

1. *Water boards with recognizable initiatives for transitioning towards circular constructions.*
   The first and crucial criterion for selection is to check if a water board has already formulated its own goals and translated them into policies. Furthermore, it should have taken actionable steps towards achieving these ambitions like implementing pilot projects, steps for sustainable commissioning, or other ongoing initiatives. It would be challenging to gather constructive recommendations if the specific water board isn't fully committed to the transition.

2. *Water boards with an established organizational structure and process maturity.*
   This criterion emphasizes the importance of selecting water boards that possess a mature organizational structure and well-defined processes, as these characteristics are conducive to effectively implementing organizational change strategies related to transitioning to circular construction practices.

3. *Water boards of varying sizes and scope of tasks.*
   Though the 'most similar' approach is used for the selection of cases, water boards of varying sizes and scope of work could ensure a diverse range of perspectives and experiences with organizational change and circular practices. These findings can be accumulated to develop a comprehensive framework for change.

4.2 Cases Selected

Based on the criteria listed above, two Dutch regional water authorities—Hoogheemraadschap van Delfland (HHD) and Waterschap Vallei en Veluwe (WVV)—were chosen for this research study. These water boards are front-runners in sustainability transitions. Brief background descriptions are given in the following sections.

4.2.1 Hoogheemraadschap van Delfland

Hoogheemraadschap van Delfland (HHD, hereafter Delfland) undertakes water management of the area enclosed by the North Sea, the Nieuwe Waterweg (a river), and the Berkel en Rodenrijs, Zoetermeer, and Wassenaar line. The area spreads around 405 km^2 with over 1.2 million inhabitants and more than 40,000 businesses. This makes the Delfland region one of the Netherlands' most densely populated and highly industrialized areas. Additionally, the region is well-known for its extensive glasshouse horticulture (Delft Blue Water, n.d.).

Located in the province of South Holland, Delfland's significant tasks include water management to safeguard the polders, managing coastal dikes, wastewater treatment for densely populated cities such as The Hague and Rotterdam, and maintaining water levels and water quality to host the large numbers of greenhouses. Delfland has centuries of experience in managing the region's water systems and has evolved into a mature organization with an established structure and well-defined processes. As

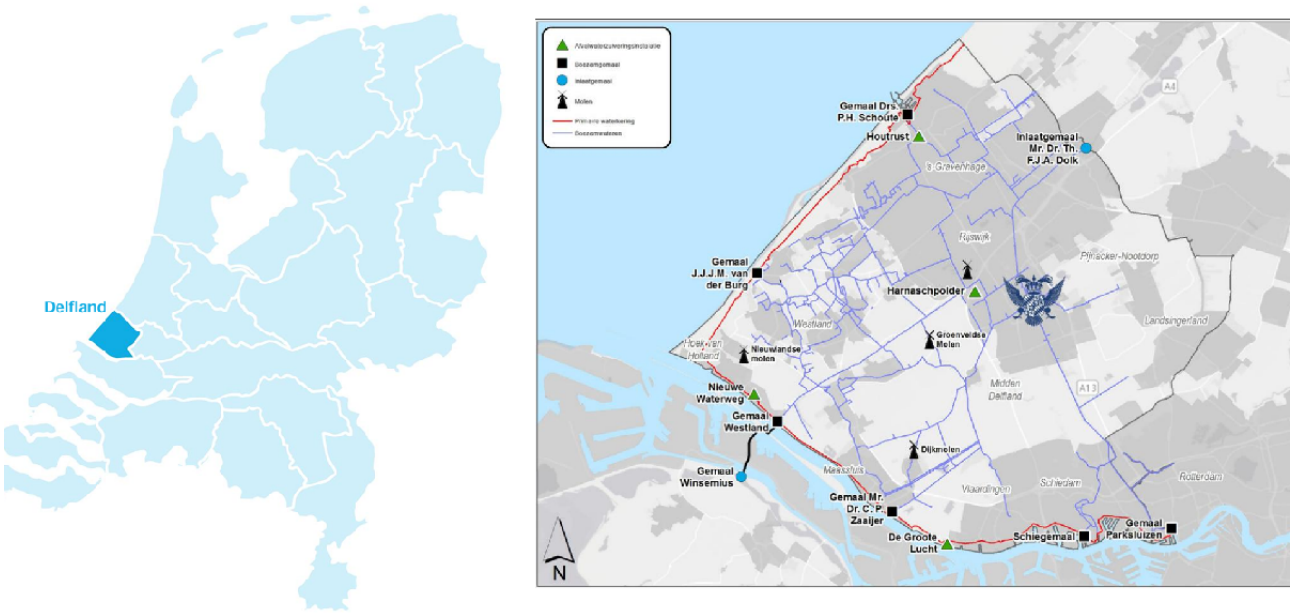

Figure 4.1: Region administered by Hoogheemraadschap van Delfland (Sources: Roelofs et al. (2022); Hoogheemraadschap van Delfland (2022a))

discussed in Section 2.1, Delfland operates with a process-based organizational structure and clearly delineated work processes to carry out its functions. For instance, Figure 2.3 gives an outline of how Delfland transforms its strategies to operational level assignments.

Circular economy is an important goal for Delfland, a theme that is included in its strategic documents like WBP and Coalition Agreement. Delfland has been one of the front runners in sustainability transitions in comparison to many water boards. The programme Sustainable-Circular was internally commissioned to provide goals and tools for bridging the gap arising in departments for sustainability implementation. On 19 May 2018, the Delfland Circular Strategy was approved, which embodies the water board's commitment to evolving towards a circular economy. (Hoogheemraadschap van Delfland, 2022b). Five principles are defined to guide the choices to become circular: 1. reduce usage and use sustainable energy and raw material, 2. reuse raw materials as high-quality as possible, 3. choose the ideal scale level, and keep the circle as small as possible, 4. conduct social costs and benefits assessment which not only looks at the financial effects (business case and payback period) but also considers the social effects (value case) and 5. ensure sufficient flexibility so that assets can easily evolve or be adapted to new insights and developments.

Delfland is actively pursuing circular initiatives to be 100% circular by 2050. As a starting point, a baseline study (CO_2 Performance Ladder) was conducted in 2021 to estimate the total CO_2 emissions. This study classified Delfland as a 'large' organization in terms of CO_2 emissions (> 2500 tonnes) (Hoogheemraadschap van Delfland, 2022b). Furthermore, a study to estimate the amount of building materials used in Delfland's assets revealed that plastics, concrete, steel and iron are the most common materials. This study also gives insights into the environmental impact of the materials and assets with flood defenses contributing the greatest impact (Roelofs et al., 2022). Currently, Delfland is actively collaborating with external stakeholders to develop knowledge and implement pilot projects. Some of the activities Delfland is undertaking include:

- Using dredged materials as a cement substitute in concrete- With this pilot initiative, Delfland focuses on the development of circular concrete and the promotion of circular applications of dredged materials. Back-filling and raising construction sites with dredged material are also undertaken for sustainable disposal (Hoogheemraadschap van Delfland, 2024a).
- Reusing residual substances from purification processes in water chain- In collaboration with

AquaMinerals®, this initiative aims to generate raw materials from waste water, which in turn can be used for manufacturing glass, fertilizers etc. (Hoogheemraadschap van Delfland (2022c); AquaMinerals (n.d.)).

- Investigation on strategies to make the new waste-water treatment plant at Vlaardingen circular- Delfland, in collaboration with engineering firms, is exploring strategies to promote circularity in the raw materials used during construction and raw materials produced during treatment processes (Hoogheemraadschap van Delfland, 2024b).

Additionally, Delfland is also working to enhance knowledge of the circular economy by leveraging and expanding the external network. The aim is to develop circular strategies for assets, products, and residual flows, leading to policies for circular purchasing, management, construction, and operations. Furthermore, with advancements in circular practices in maintenance, management, and projects, Delfland aims to translate sustainability goals into actionable policies and tools for daily operations (Hoogheemraadschap van Delfland, 2023a).

4.2.2 Waterschap Vallei en Veluwe

Waterschap Vallei en Veluwe (WVV) is located in provinces Gelderland and Utrecht, between the IJssel, Lower Rhine, Utrechtse Heuvelrug and the Randmeren. Spread over an area of around 246,000 hectares, this water district encompasses 37 municipalities and serves a population of around 1.2 million residents. The waterboard manages around 16,000 kms of waterways and the combined length of the primary and regional flood defense systems spans 248 kilometers (Waterschap Vallei en Veluwe, n.d.-b). The landscape of the region is diverse, featuring polders, fields and meadows, and the largest nature reserve in the Netherlands. The area is criss-crossed by numerous waterways, including the Weteringen, the Grift, the Apeldoorns canal and the Vallei canal, as well as the Eem, the shortest river in the Netherlands (ChristenUnie Vallei and Veluwe, n.d.). Thus, the main tasks of WVV are focused more towards managing the primary river dikes along with regular tasks like water quality management.

Since 2020, Waterschap Vallei en Veluwe has been fully energy-neutral and aims to be completely circular and climate-positive by 2050 (Waterschap Vallei en Veluwe, n.d.-c). Experts in the sector identify WVV as one of the front-runners in circular transitions. WVV conducts yearly studies for

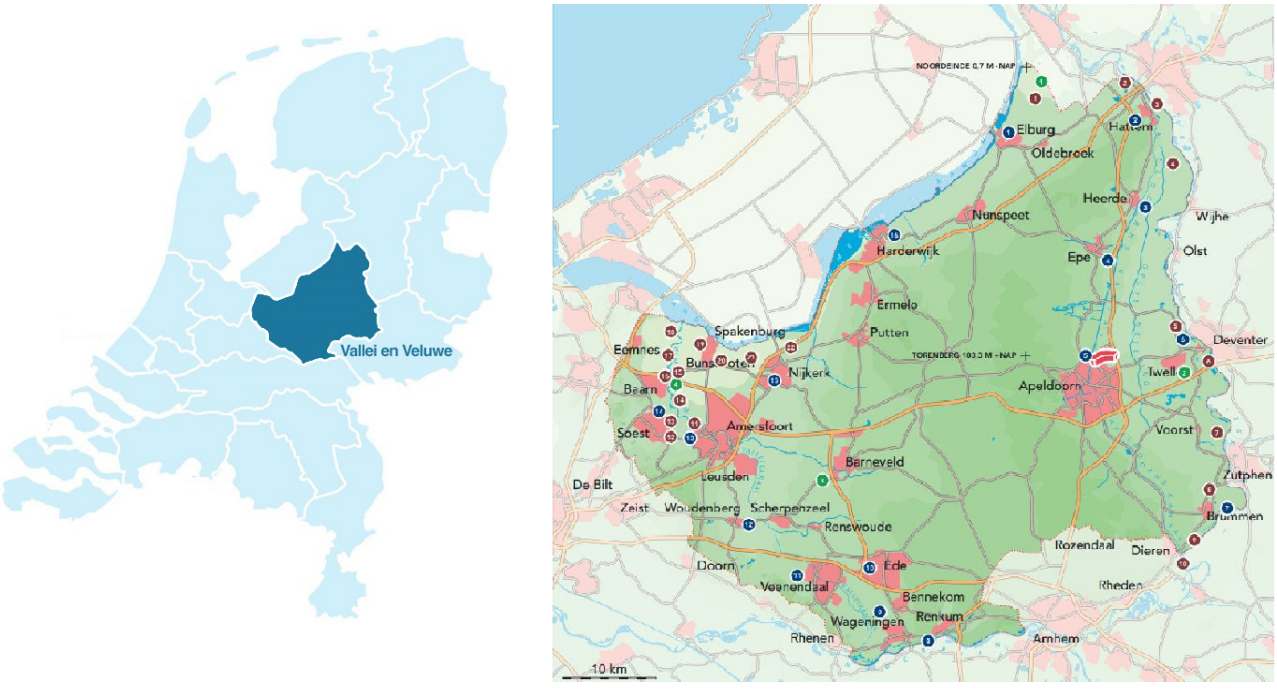

Figure 4.2: Region Administered by Waterschap Vallei en Veluwe (Source: Waterschap Vallei en Veluwe (n.d.-a)

estimating its carbon footprint through CO_2 Performance Ladder. According to 2022 estimates, the water board's CO_2 emissions footprint was 1,153 tonnes which is a significant reduction of nearly 1,500 tons compared to 2021, when emissions totaled 2,644 tonnes (Waterschap Vallei en Veluwe, n.d.-d). WVV is working internally and with the external network to achieve targets. Below are some projects with which WVV is working towards a 'circular' future:

- The circular renovation of waste-water treatment plant at Terwolde- The plant was recently renovated in a circular manner with the reuse of installations, parts and materials. Additionally, new components were made demountable, for instance using the Verdygo®, concept for the modular, standardized installation of the treatment units. Many other parts were also made for disassembly and using sustainable materials (Waterschap Vallei en Veluwe, n.d.-e).
- Disassembly and reuse of materials- Keeping circular economy in mind, WVV carefully harvests parts from older assets like treatment plants, repair if necessary and reuse them elsewhere. Additionally, WVV is collaborating with Duspot, the circular marketplace, to offer released materials in the market for other projects. As a first experiment, WVV along with drinking water company- Vitens, sourced used culverts from Dusport instead of purchasing new ones for their drinking-water extraction project (Waterschap Vallei en Veluwe, n.d.-e).
- Collaboration across the chain for biobased construction- WVV is collaborating with regional farmers to establish supply chains for biobased building materials. The cultivation of fibre crops not only enhances soil and water quality but also contributes to developing a comprehensive value and business model for the entire chain, including the farmer, the processor, and the construction sector. Furthermore, a study into biobased, circular bank protection is being conducted on behalf of waterboards Rivierenland, Zuiderzeeland and WVV, Rijkswaterstaat and Stichting Toegepast Onderzoek Waterbeheer (STOWA) (Waterschap Vallei en Veluwe, n.d.-e).

4.2.3 Selection Criteria Check

Both the cases meet the selection criteria mentioned in Section 4.1. An overview of this is provided in the following Table 4.1.

Criteria	*HHD*	*WVV*
1. Water boards with recognizable initiatives for transitioning towards circular constructions	✓	✓
2. Water boards with an established organizational structure and process maturity	✓	✓
3. Water boards of varying sizes and scope of tasks:		
a) area covered-	405 km^2	2460 km^2
b) tasks-	Safeguarding polders, managing coastal dikes, wastewater treatment for densely populated areas, facilitating horticulture	Managing primary river dikes, ensuring surface water quality, wastewater treatment

Table 4.1: Overview of selection criteria met by selected cases

4.3 Design of Data Collection: Semi-structured Interviews

The data collection from case studies was organized through semi-structured interviews with expert personnel at each selected organization. The interviews were conducted following the guidelines and ethical obligations for research on human subjects. A background study into these organizations, their working and their circular initiatives was done prior to the interviews through documents retrieved from publicly available websites.

Semi-structured interviews in qualitative research let researchers to ask open-ended questions but also allow them to explore new topics based on participants' answers. This method is good for gathering detailed information about participants' experiences, beliefs, and views, making it ideal for exploratory studies like this one (Ruslin, Mashuri, Rasak, Alhabsyi, & Syam, 2022).

4.3.1 Criteria for Selection of Interviewees

Some criteria that were set for the selection of interviewees are:

- *Role and position-* The interviewee should hold a position relevant to infrastructure management, strategic planning or change management within the organization. They must have varying positions to bring as many perspectives as possible. Some intended roles could include- Project managers, asset managers, process managers, contract / commissioning managers, sustainability / circular experts or members of governing body.
- *Experience-* Professionals with substantial experience (min. 5 years) and must have participated in completed/ongoing circular construction initiatives of the organization.
- *Availability and communication skills-* The participant should be available and willing to participate in the study and possess effective communication skills to articulate their experiences and perspectives.

Following to the above criteria, three to five interviewees were selected for each case study organization. An overview of the interviewees' profile is shown in the following Table 4.2.

Organization	*Participant's Role*	*Code*	*Interview Date*
Hoogheemraadschap van Delfland	Department Manager	HHD1	04-04-2024
	Policy Advisor (Asset Management)	HHD2	08-04-2024
	Asset Manager	HHD3	08-04-2024
	Manager (Pgm. Sustainable Circular)	HHD4	09-04-2024
	Technical Manager	HHD5	12-04-2024
Waterschap Vallei en Veluwe	Project Leader	WVV1	06-05-2024
	Advisor (Circular Economy)	WVV2	06-05-2024
	Manager (Sustainable Innovation)	WVV3	13-05-2024

Table 4.2: Overview of interviewees

4.3.2 Interview Protocol

In semi-structured interviews, researchers use an interview guide to ensure consistency while adapting questions to the interview context (Jamshed, 2014). The interview guide was designed so as to identify actionable measures for implementing changes internally within the organizations.The complete form of interview protocol used is shown in Appendix A. It is structured into five main parts:

- *Part 1-* Introduction section with a self-introduction of the researcher and introduction from the interviewee. In this section it was confirmed whether the interviewee has been a part of circular initiatives within their organization. Besides, a brief overview of the study was provided to

all interviewees to ensure that both parties are aligned on the goals and expectations for the discussion.

- *Part 2-* This section discussed the desired state of the organization post-change. The main goals for each of the four aspects (People, Work Process, Structure, and External), identified from the literature review (see Table 3.2), were reviewed with the interviewees to determine their practical necessity for accelerating the transition. Interviewees were also asked to suggest any other significant goals within each aspect. Finally, a discussion was held whether these aspects should 'unfreeze' simultaneously or sequentially during the change process.
- *Part 3-* A brief discussion of the barriers and enablers for the four aspects in the context of the water boards was conducted.
- *Part 4-* In this section, practical measures from the interviewees' experiences were discussed to implement changes within the organization, aimed at transitioning to circular construction practices. This section was guided by the theoretical framework for the essential components in a change framework as derived from the literature review (shown in Figure 3.5). In-depth discussions were conducted on how each of the eight goals (and any additional or modified goals) could be achieved using the 'unfreeze-transition-refreeze' process. This part essentially formed the backbone for developing the conceptual change framework.
- *Part 5-* Closure of the interview including closing remarks and conclusion.

4.4 Methodology for Data Analysis

Data analysis involves bringing order and structure and interpreting the collected data to derive meaningful insights (Marshall & Rossman, 1999). In-depth analyses of the data collected during the case studies were performed to identify the emerging themes and perspectives discussed. The analyses could be said to include both deductive and inductive approaches. The guiding theoretical framework (Figure 3.5) was utilized to categorize the findings into four main aspects, namely, *people, work process, structure* and *external*. The data collection and analysis within a predetermined framework gives the analysis a deductive nature. At the same time, themes and patterns within these categories emerged directly from the data through thematic analysis, without any preconceived notions, thereby giving it an inductive nature.

Thematic analysis is one of the most common methods for analyzing qualitative data from semi-structured interviews. This method involves identifying, analyzing, and reporting patterns (themes) within the data (Knott, Rao, Summers, & Teeger, 2022). The methodology followed for thematic analysis in this study, adapted from Clarke and Braun (2014), is shown in Figure 4.3.

- *Reviewing collected data-* Initially, the transcripts of the interviews were formatted to anonymize the data and to remove timestamps, filler words and repetitions. This was followed by familiarizing the data by reading it thoroughly.

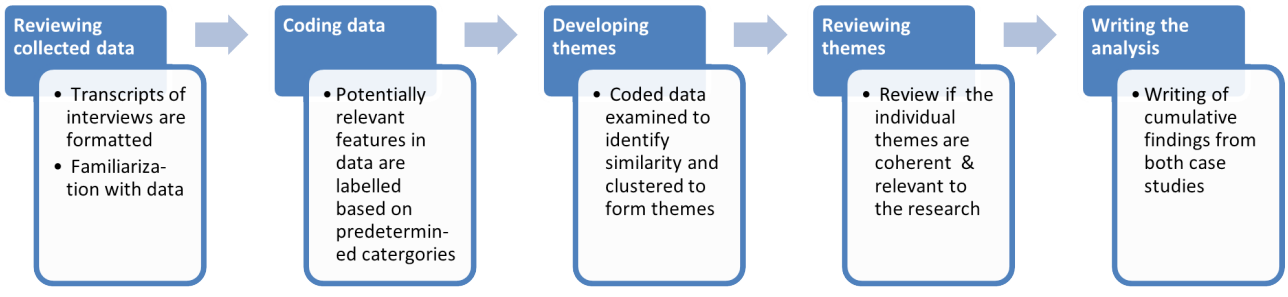

Figure 4.3: Methodology for data analysis (Adapted from Clarke and Braun (2014))

- *Coding data*- The next step was to label the features in data that were potentially relevant to the research questions. This coding was done based on the predetermined categories, namely people, work process, structure and external. Furthermore, additional labelling of data was done to capture views for other interview questions such as the goals within each category, drivers and barriers for the transition etc.
- *Developing themes*- The codes and coded data were analyzed to identify similarities and overlaps, and then clustered to form themes. Additionally, the relationships between these potential themes were considered to ensure they collectively tell a rich and complex story about the collected data.
- *Reviewing themes*- The initial themes were reviewed to ensure they were coherent and collectively addressed the research question in a meaningful way, capturing the most relevant features of the data. This review process involved revising the initial themes to enhance their clarity and relevance.
- *Writing the analysis*- The findings from the analyses were subsequently written down in the report. A cross-case comparison was not done, rather, the cumulative themes and other findings from both case studies were documented within the predetermined framework.

The next chapter details the results derived from the case studies using the aforementioned analytical methodology. An accumulative cross-case analysis approach was employed to consolidate findings from multiple case studies. This method integrates data to identify common themes and patterns across different cases, combining information from various studies to develop a broader understanding of the topic (Khan & VanWynsberghe, 2008).

Chapter 5

Case Studies- Analyses and Results

This chapter delves into the findings from analyses of the case studies. The objectives of the case studies were multi-fold. Firstly, a brief exploration of the context for change was conducted by investigating the drivers and barriers that influence 'circular' organizational change (Section 5.1). Next, the case studies were used to confirm the literature findings regarding the desired state of the organization post-change (Section 5.2). Finally, actionable measures on how to implement the transition at the water boards were investigated (Section 5.3). The research questions answered are:

SQ3 (fully)- What are the desired outcomes post-change for a 'circular' water board across the various aspects identified for the change framework?

SQ4- What are the change measures to achieve the desired transition to circular infrastructure, which can be identified from practice within the water boards?

5.1 Organizational Context for 'Circular' Change

The organizational context of the Dutch water authorities for transitioning to circular construction practices was extensively studied in Chapter 2. The interviews conducted have identified drivers and barriers for this transition, providing a better understanding of the current environment for change within the water boards,

5.1.1 Barriers for Organizational Change

The following barriers were commonly pointed out in the interviews.

- *Established traditional tasks*- A linear way of working is ingrained within the water boards' tasks. Tasks that have been performed for 40-50 years have undergone extensive optimization in design and engineering to achieve maximum effectiveness. Linear way of working, with its related processes, procedures, decision-making, information flows, responsibilities, accountabilities, etc. are established well within the primary tasks of the water boards. When tasks are required to be performed in a circular manner, it necessitates that individual employees step out of their comfort zones to accomplish them (often without knowledge of the intended results).
- *Risk-averse nature of water boards*- The tasks of the water boards are crucial to keep the inhabitants safe. When new work processes are adopted to transition to circular practices, the effects of the changes are (partly) unknown. This includes aspects such as safety requirements, quality guarantees for circular products, availability of circular materials and components, and their costs. How employees manage these risks is crucial during transitions. Traditionally, water boards have been risk-averse, and employees tend to work conservatively.
- *Financial barrier due to political nature*- As mentioned, the tasks at the water boards are optimized effectively and as a result, a change in the work processes may increase the costs. Being a public organization with an elected governing body, the water boards tend to keep the taxes they collect as low as possible. Thus, it is difficult to convince the board of an increase in expenditure for circular transitions. Besides, the politicians should also be able to explain the need for transition to the residents and other stakeholders in order to collect additional taxes. Thus, the political nature can inhibit the pace of the transition.
- *Lack of managerial commitment*- Although some agreements are signed at strategic levels, the water boards lack clear directives from governing bodies and director teams circular initiatives. The leaders are often uncertain about decision-making regarding circular assignments, leading to a lack of commitment. The monitoring of the goals is also often overlooked.
- *Non-coherence with other goals*- Circular construction is currently perceived as an additional goal within the water boards, often taking lower precedence compared to other primary goals such as water quality and water safety. Other sustainability goals, like energy transition, biodiversity and climate adaption also assume higher priority due to recent events such as congestion in electricity grids and extreme wet and dry periods. Non-coherence with the other goals is a major barrier to implementing circular practices within the waterboards.

5.1.2 Drivers for Organizational Change

The most favourable drivers identified for accelerating the transition within the context of the water boards were:

- *Long-term vision of water boards*- The people at the waterboards work with a long-term mindset. For instance, for improving dikes, installing pumps, or building a waste-water treatment plant, they look ahead for 40-50 years or beyond. This strength of the people to plan could be tapped in to facilitate circular transitions.

- *Network of suppliers open for change*- The waterboards have traditionally been collaborating with several suppliers, contractors, and subcontractors. The collaboration could act as a driver for adopting more circular practices within their assignments as the contractors themselves are on a transition path. As an example, for the dredging works under Hoogheemraadschap van Delfland, the waterboard adopted the transition path of its contractor to reduce emissions and circularly reuse the dredged materials.
- *External forces of change*- Due to the external forces, the members of the governing body have picked up the urgency to change. Some of those are:
    1. European and National agreements.
    2. Changing market dynamics like high prices of raw materials and energy.
    3. Peer pressure to align with other water boards in sustainable practices and emission reduction efforts.
    4. Effective coordination and knowledge sharing from the Union of the Water Boards (Unie van Waterschappen).

5.2 Validating 'Circular' Change Goals

In Section 3.2, the desired state of the organization post-change was defined through a comprehensive literature review, as summarized in Table 3.2. This review identified eight goals across four key aspects of change, outlining how a 'circular' water board should ideally operate. These goals, derived from academic sources on general circular business practices, were validated through the case study interviews to assess their relevance to public organizations like water boards. This section elaborates on the findings from the validation process. Interviewees were asked whether they found these goals practically necessary for accelerating the transition to circular practices. Additionally, they were invited to suggest any other significant goals within each aspect.

The validation process confirmed that all eight goals listed in Table 3.2 are relevant to the daily operations of the water baords. The participants acknowledged the importance of these goals in facilitating the organization's transition to circular practices. Furthermore, the interviewees proposed additional goals and modifications to the existing ones, which are highlighted (in yellow) in the following Table 5.1. A discussion on the modified/added goals is given below:

Code	*Goal*	*Source Interviewee*
People		
P1.	Exhibit a supportive and shared mindset	
P2.	Possess capacity essential for the transition	HHD2,HHD4,HHD5
P3.	Institute a culture for innovations	HHD1
Work Process		
W1.	Make decisions through value cases in place of business cases	
W2.	Have redesigned processes that incorporate circular practices	
Structure		
S1.	Demonstrate intra-organizational collaboration & accountability	HHD2, WVV2
S2.	Ensure managerial commitment (leadership and political)	
External		
E1.	Establish best practices in knowledge sharing	
E2.	Effectively collaborate with external stakeholders	

Table 5.1: Validated goals post-case study interviews for each change aspect

Goal P2- Provide capacity essential for the transition

The initial goal, P2- "Develop competencies essential for the transition," was deemed relevant by the interviewees. However, many noted that most technical designs and calculations at the water boards are outsourced to engineering firms. For circular transitions, additional tools required to perform tasks, such as calculating the Environmental Cost Indicator (ECI), will also be outsourced to these firms. Some competencies, such as managing the transitions, may need to be developed internally. A more significant concern raised by the interviewees was the water boards' lack of capacity, particularly the shortage of specialists and operations-level employees needed to lead the transitions. Existing employees are often preoccupied with other tasks, causing them to overlook sustainability goals. Some comments from the intreviewees were:

> "*It (circular transitions) takes a lot of time and space to do things differently. The operational levels doesn't have any capacity extra to implement it"* [HHD2]
>
> "*The biggest barrier that is there is the time available for the people. They're too busy with their normal work and since circularity is seen as an extra task, they don't have enough time to incorporate it"* [HHD4].

Therefore, Goal P2 has been revised to address these issues. Here, "capacity essential for the transition" encompasses both equipping employees with the necessary knowledge and skills for the transitions and ensuring that sufficient resources are allocated to support these efforts.

Goal P3- Develop a culture for innovation

This goal was emphasized in the People aspect, as highlighted by interviewee HHD1, who identified it as a necessary cultural element for organizational transition. All subsequent interviewees concurred, recognizing the goal's relevance to circular transitions. HHD1 stated:

> *"If your organization is strong on all eight goals but isn't keen on innovation, then it's hard to get the (circular economy) transition done.*" [HHD1]

It is crucial that, for not only circular transitions but all types of transitions, there exists a dedicated group or process within the organization where employees can innovate and integrate new insights into their work. This is particularly significant for traditional organizations, such as water boards, where employees often exhibit a risk-averse attitude.

Goal S1- Develop intra-organizational collaboration and accountability

The initial goal, S1, was to "Develop intra-organizational transparency and collaboration." While many interviewees found this goal relevant, they also emphasized the importance of employees taking accountability for their goals. This accountability is crucial for fostering effective inter-departmental collaboration. Some interviewees noted that although several strategic-level agreements are being signed, they often fail to translate into operational actions. Even when these agreements are implemented, there are no consequences for employees if the goals are not met, as no one questions why the objectives were not achieved. There should be a greater sense of accountability, especially for goals like circular transition. Therefore, in addition to promoting inter-organizational collaboration, it is essential that employees are held accountable for the implementation of sustainability tasks.

5.3 Organizational Change Measures for Circular Transition

This section presents findings from interviews on practical measures to transition to circular construction practices within organizations. Since the data was collected from experts across water boards, these measures can be considered pragmatic and feasible for implementation. Discussions were guided by the theoretical framework derived from the literature (shown in Figure 3.5). In-depth discussions explored how each goal (Table 5.1) could be achieved using the 'unfreeze-transition-refreeze' process.

Overall, the respondents found it hard to clearly outline the steps for each goal. This difficulty is likely because of the ongoing nature of circular economy transitions, which cannot yet be delineated as a straightforward, black-and-white blueprint. The impacts of different processes in these transitions are still unclear. Therefore, the key observations from all interviews were accumulated and later classified into 'unfreeze-transition-refreeze' steps considering each change aspect as a whole. In the following sections, the themes that emerged are discussed in detail for each of the four change aspects.

5.3.1 Change Measures- People

'People' relates to the mindsets, values, behaviours, capabilities and competences of the individuals who are part of the organization. Three goals were identified in this regard, 1. Exhibit a supportive and shared mindset, 2. Possess capacity essential for the transition, and 3. Institute a culture for innovations. Various internal change measures were identified to achieve these goals.

5.3.1.1 Communicate and give meaning to the urgency

Communication is one of the key themes that emerged to achieve 'people' goals. Currently, there is a lack of awareness among the employees, especially the people who are working in operations, about circular transitions and the need for it. So the first step is to communicate and raise awareness [HHD2]. Interviewee HHD1 stated:

> "*For a supportive and shared mindset, I would like to refer to the eight-step plan for transitions by Kotter. One of the things he says is you could never over-communicate your change. So, communicate, communicate. How much ever you communicate it's not enough. Still, you need to communicate more.*" [HHD1]

Effective communication is crucial for changing mindsets. By integrating circular economy tasks into daily assignments and consistently communicating their importance, it becomes a normal part of work. Over time, this approach will shift cultural perceptions and embed circular economy principles into the workplace. The sustainability team at the water boards could lead communications internally and externally by having a dedicated communications coordinator. Additionally, it is crucial to illustrate the necessity for change by providing examples. For instance, one could highlight the carbon dioxide emissions associated with different work processes or the environmental impact of construction raw materials. By showcasing the consequences, the people will be convinced about the urgency of the transition.

> "*Explain everyone, the purpose behind doing it. Make clear why we are doing it instead of just telling them (to do).*" [HHD3]

5.3.1.2 Give space for taking risks and experimenting

The risk-averse nature of water boards was identified as a significant barrier in both the literature and interviews. Overcoming this barrier is crucial for fostering an innovative culture and increasing capacity for the transition. Managers should support their team members by giving the space to take calculated risks and experiment. This will stimulate people to try innovative methods in their work [WVV1]. Providing space for risk-taking and experimentation was also observed as a theme in changing 'work process'. Interviews revealed that managers generally do not accept taking risks

without understanding the impacts of the change, but small steps are now being taken in this regard. One example of taking risks, suggested by a circularity expert, is as follows:

> *"They are changing how they do the maintenance and renovation of the assets like pumping stations, for instance. If a pumping station had life expectancy of 40 years, at the end of 40 years, we would demolish it and build a new one. That is how it worked, but now, they want to first do a check at the end of 40 years. They go to the building, do several analyses, put together data about performance, and the state of the building, and they judge based on the condition whether it should be renovated, newly built, or should be done nothing at all.... That could be saving a lot of materials. Instead of age there they're going to look at the condition, whether it is still doing the function safely and still meeting the requirements. For example, sometimes, for a pumping station, the capacity of the pump degrades with time. Say the capacity required is something like 75%, but if the condition after the check says it's 72%, they think- ohh, that's within the acceptable margin. So, you take the risk of that 3% less. The managers should encourage people think in that direction."* [HHD4]

5.3.1.3 Involve people in early phase of transitions

The next key theme identified is to involve people in the early phase of transitions. It was suggested by HHD1 that:

> *"People indeed want to change, that's (often) not a problem to them. But people don't want to want to be changed by someone else".* [HHD1]

The lead sustainability group should avoid keeping their ambitions confined within their team for too long, waiting until a fully developed plan is ready. Typically, this group consists of a small number of individuals within the water boards. Instead, they should engage all project members right from the beginning of a new process. Early involvement ensures that everyone feels included and integral to the change. Consequently, sustainability tasks become a natural part of their workflow rather than an additional goal. Moreover, specialists in their respective fields possess the most knowledge about their work processes. Engaging them early on will help develop more effective methods for facilitating the transition.

5.3.1.4 Circular working should be a primary goal

The water boards are organizations that directly address the impacts of climate change. Therefore, adopting a circular ways of working should become a primary goal. Currently, circular goals often take a backseat to other primary tasks of the water boards, such as maintaining water quality and ensuring water safety. Due to the political nature of water boards, often financial goals are also in conflict with circular economy goals. However, during the transition, circularity should evolve to become one of the primary objectives. It is essential to integrate circular principles with other requirements so that circularity is not seen as an additional step but becomes 'the new normal' for working.

5.3.1.5 Encourage small wins

It is essential to plan for smaller wins and reward individuals for achieving these milestones [HHD5]. By celebrating small successes, people will be motivated to continue working towards circular goals.

5.3.1.6 Train people for the transition

An interesting statement by interviewee WVV2 was:

> *"If you look at the transition for circularity, I think, it's about the people behaving. It is not technical (barriers), because....a lot more than what we do is already possible to do technically. It is the people that are holding back at the moment".* [WVV2]

Once everyone understands the necessity of change during the unfreeze stage, the next logical question would be how to implement it. One crucial step is to equip people with knowledge about transition management. Organizations like the water boards fundamentally have a technical nature. Therefore, it is essential to impart knowledge about transition management through training. Additionally, training could also cover the application of various new tools (like, Environmental Cost Indicator (ECI) calculations) related to circular constructions.

PEOPLE		
Themes identified	*Description*	*Source Interviewee(s)*
Communicate & give meaning to the urgency	The lead group should communicate to bridge the gap in awareness and illustrate the necessity of change through examples	HHD1, HHD2, HHD3
Give space to take risks & experiment	To overcome risk-averse nature of people, managers should give space to take calculated risks & experiment innovations	HHD4, WVV1
Involve people in early phase	Engage people from the beginning of transitions. This will ensure they are committed to the change and circularity is not seen as an extra task	HHD1, WVV1
Make circular economy a primary goal	Integrate circular principles with other primary tasks such that it has the same significance as other requirements	WVV2
Encourage small wins	Creating and rewarding short wins will serve as a motivation for people to work further towards circular goals	HHD5
Train people for the transition	Circular transition is more or less a people issue than technological. Thus, provide trainings for transition management and application of new tools	WVV2

Table 5.2: 'People' change measures identified from case studies

5.3.2 Change Measures- Work Process

'Work process' pertains to the organization's operations, encompassing process adaptability, financial management, and the formulation of strategies into work assignments. The two goals identified are: 1. Make decisions through value cases in place of business cases, and 2. Have redesigned processes that incorporate circular practices. The water boards, as previously noted, are organizations with firmly established methods and procedures for executing their core responsibilities. For this reason, HHD1 suggests that implementing changes to 'work processes' would likely be the most difficult and require a significant amount of time to accomplish. Key themes identified to achieve the goals are discussed.

5.3.2.1 Provide space for experimenting

Similar to 'people' aspect, this theme was indicated crucial also for 'work process' by the interviewees. It is essential for employees to understand the potential impacts of changes in their work processes. This understanding can be achieved through practical experimentation. Therefore, by allowing room for trying new ideas, it will be possible to redesign or modify the current work processes. The results obtained from these experimental trials will provide a foundation for establishing new work methods and developing effective monitoring mechanisms.

5.3.2.2 Create reliable financial estimates

In the context of redesigning processes and shifting the focus from traditional business cases to value-driven cases, WVV1 emphasized that.:

> *"Everything always comes down to money in the end."* [WVV1]

As tax-collecting institutions, water boards often prioritize financial goals over circular economy ambitions. To address this issue, some suggestions were put forward. Circular requirements should be incorporated in the early stages of a project, such that it becomes mandatory for everyone involved to realize them. This approach allows for budget estimates to include these circular requirements. Water boards typically prepare multi-year or annual budgets, so forecasting higher costs early on can prevent significant budget overruns. If the costs are anticipated and included in the budget, there will be fewer hiccups during implementation [HHD4].

A technical issue for transitioning to value cases that was pointed out is related to the current price tag on CO_2 emissions, which is very low. Currenltly, only EUR 100 per tonne of CO2 is used for estimations which translates to very low ECI. This was explained through an example by WVV2:

> "*For instance, now we have a more biobased polymer that you use for sludge dewatering and it costs, say 20% more to procure, but reduces CO_2 by 50%. In short, it is 50% less CO_2 for 20% more money. We went on to calculate (the ECI), but the product was so expensive that the 20% was a big amount of money when compared to price of 50% CO_2 at EUR 100 per tonne. We calculated further and we observed that only a CO_2 price of EUR 1000 per tonne would make the value case comparable. So we need to have some kind of a factor on the price of CO_2. Once we can fix this, then at the strategic level, the governing boards have signed various agreements and thus they will have to be committed to the transition."* [WVV2]

To summarize, accurate and reliable financial estimates in the early stages of changing work process can deal with financial barriers of the circular transition to some extent.

5.3.2.3 Involve market parties

Another significant theme that emerged in this context was the involvement of market participants. The primary recommendation was to focus on defining the functional requirements of the desired output rather than prescribing the specific work procedures to be followed. This approach could encourage market participants, including suppliers, contractors, and subcontractors, to innovate and optimize their processes, making them as circular as possible. By doing so, the processes become more flexible and capable of integrating circular construction practices [HHD4]. However, it is important to recognize that during this process, there is a risk of ending up with what the contractor is offering rather than obtaining exactly what is needed. This is because contractors, as stakeholders, have their own financial interests. Thus, it is advisable to involve contractors from the early stages of the project. By doing so, the objectives for the project can be collaboratively established by both the water board and the contractor. This approach not only aligns the goals of both parties but also allows contractors to introduce innovative methods in their work processes [WVV2].

5.3.2.4 Clearly translate strategies to operational frameworks

During the interviews, it was noted that while policies are established at the strategic level, their translation to the tactical and operational levels (as shown in Figure 2.3) is still in the early stages. The directors should assign tasks to managers and the respective departments need to be directed to undertake internal projects aimed at developing sustainability frameworks. These frameworks would then be used by personnel at the operational level and also during commissioning to carry out tasks. Such frameworks are crucial as they provide clear guidance and direction, facilitating the necessary changes in the work process.

5.3.2.5 Establish new standards and policies

Along with transitioning work processes, it is also important to standardize these processes over time. Without standardization, if work processes remain flexible indefinitely, efficiency cannot be achieved. Therefore, during the 'refreeze' phase of the change, processes should be fixed and optimized to standardize procedures and establish associated policies.

> *"In the new situation, you also want an efficient work process instead of thinking again a new one every year. It's too expensive and exhausting... and eventually will become a burden for the taxpayers... Fix your work process for a few years and then comes a new change, so the cycle goes around."* [HHD1]

5.3.2.6 Develop monitoring mechanisms

Mechanisms for monitoring changes in work processes should be established to facilitate transitions. These mechanisms can include the use of Key Performance Indicators (KPI's) and dashboards to track progress and ensure alignment with organizational goals. For example, monitoring CO_2 emissions within an organization can be achieved through the CO_2 Performance Ladder method, which is utilized by water boards to assess and manage environmental impact. Implementing KPIs and dashboards not only helps in tracking progress but also acts as a driver for change by creating a sense of urgency and focus. Visualization of changes through KPI's and dashboards significantly enhances awareness. These tools effectively communicate the current status, ensuring everyone, including the governing boards, are well-informed to take further actions. The transition phase should serve as a platform to establish various KPI's tailored to the nature of the work process.

WORK PROCESS		
Themes identified	*Description*	*Source Interviewee(s)*
Provide space for experimenting	Understanding the potential impacts of the change is necessary to redesign work processes; this can be achieved through experimentation	HHD4, WVV1
Create reliable financial estimates	Early and precise budget estimations can play a role in overcoming financial barriers by providing a realistic picture	HHD4, WVV1, WVV2
Involve market parties	By defining functional requirements, market parties can innovate and optimize their processes for circularity	HHD4, HHD5
Clearly translate strategies to operational level frameworks	Departments should be internally tasked to develop sustainability frameworks at the level of implementation	HHD2, HHD3, WVV1
Establish new standards and policies	To achieve efficiency, the transitioning work processes should be standardized during refreeze	HHD1
Develop monitoring mechanisms	KPI's and dashboards help in tracking transition progress, as well as act as a driver for change by creating a sense of urgency and focus	HHD5

Table 5.3: 'Work Process' change measures identified from case studies

5.3.3 Change Measures- Structure

'Structure' refers to the way the organizational structure is set up, the roles & functions, accountability, and management practices to name a few. The two goals identified in this aspect are: 1. Demonstrate intra-organizational collaboration & accountability, and 2. Ensure managerial commitment. The main themes that emerged to achieve these goals are discussed below.

5.3.3.1 Provide clear directives and decisions

The case studies revealed that a significant obstacle to the transition towards a circular economy is the lack of commitment from management. At the governing board level, there is a noticeable deficiency in prioritizing circular economy objectives over other goals. Directors, who hold a pivotal position, have the capacity to influence both the governing boards and the subordinate levels within the organization. At times when tasks are given from the boards, they fail to translate these into clear assignments for the rest of the organization. This hesitation is primarily due to the uncertainty surrounding the impact of their decisions. To effectively guide the transition and provide a clear sense of direction to the entire organization, it is imperative for these levels to issue unambiguous directives and make decisive choices- for instance, by drawing up and establishing a (circular) policy framework for the organization. Compared to the current situation, there needs to be greater clarity regarding expectations on what so that individuals can adjust accordingly.

5.3.3.2 Monitor the implementation of directives

In addition to issuing clear directives, it is also important to ensure that these directives are effectively implemented to achieve the set goals. For the higher management, this involves not only communicating expectations but also monitoring and verifying that the actions taken align with the intended outcomes. The individuals or entities in charge must be answerable for their actions. This accountability will serve as a motivating factor, encouraging them to perform their duties more effectively and they are more likely to achieve the set circular goals. On this matter, WVV2 remarked:

> *"When we miss a (circular economy) goal, we do not have the board or management complaining or asking questions about it, so we move on. And that cannot be the way. We need to have goals with stricter monitoring and if you don't achieve your goals, there must be consequences.*" [WVV2]

At the subordinate levels, it is crucial to escalate issues at the appropriate time. When individuals or teams within the organization resist adopting new methods necessary to achieve circular economy objectives, and this resistance subsequently impacts the broader strategic goals, it becomes essential to bring these issues to the attention of higher management or directors.

5.3.3.3 Induce shared sense of direction and ownership of tasks

In complex transitions such as the shift to a circular economy, it is crucial for organizational teams to work cohesively towards shared goals. When making decisions and designing processes, the entire life cycle (including the positive and negative impoacts during the period) must be taken into account. This transcends the boundaries of teams and departments. Thus, the intra-organizational boundaries must be transparent, promoting effective collaboration across the organization. This transparency ensures that tasks are integrated across departments, which is essential for closing resource loops.

However, it is important to heed the advice of HHD1, which emphasizes that while an integrated approach is beneficial, it must also maintain clear accountability for tasks. As integration increases, so does the complexity, introducing more uncertainties and variations that can become unmanageable. This complexity can lead to a situation where decision-making becomes paralyzed due to the lack of clarity. Therefore, it is essential to establish a clear division of roles and responsibilities within shared tasks. Furthermore, when individuals are working towards a common goal, there is a risk that they may assume that someone else will handle certain tasks. To mitigate this, it is necessary to make people explicitly responsible for their individual contributions to the collective objective [WVV2].

5.3.3.4 Establish coherence with other main goals

Non-coherence with other goals was observed to be a major barrier for implementing circular construction methods. Many managers expressed resistance to adopting circular practices due to uncertainties about how these methods would impact other critical objectives, such as safety, quality, and financial performance.

> *"What does it mean for the other goals and ambitions of the water board? We have multiple goals in the organization to manage, we also have goals that contradict each other. You have to take that into account when you decide on your transition. You have to take other factors in the equation for your decision, and that makes it complex."* [HHD1]

Circularity should be viewed as the standard mode of operation rather than an additional task. To achieve this, organizational strategies must evolve to integrate circularity with other objectives. This shift requires a transformation in the organization's overall strategy, where managers need to play a significant role in ensuring alignment and coherence between various goals.

5.3.3.5 Ensure higher management is aware of developments

To ensure managerial commitment, it is essential that senior management, including governing boards, remain well-informed about sector developments. This responsibility can be assigned to the lead sustainability team, which should engage in regular dialogues with the executive council to keep them updated on the potential and progress of circular initiatives.

STRUCTURE		
Themes identified	*Description*	*Source Interviewee(s)*
Provide clear directives and decisions	Prioritizing circular initiatives is required from higher management by issuing unambiguous directives and making strong choices	HHD1, HHD2, HHD4, WVV1, WVV3
Monitor the implementation of directives	Management should raise questions and individuals should be answerable for missed goals; escalate issues at appropriate time	WVV2, HHD3
Induce shared sense of direction and ownership of tasks	Share a collaborative approach towards working for the common goal, but at the same time make individuals explicitly responsible for their contribution towards the objectives	HHD1, WVV2, WVV3
Establish coherence with other main goals	Organizational strategies should be restructured to embed circularity as a standard mode of operation aligning it with other objectives	HHD1, HHD3
Ensure higher management is aware of developments	Higher management should be well-informed about the sector's developments in circular economy to ensure their commitment to new initiatives	WVV1

Table 5.4: 'Structure' change measures identified from case studies

5.3.4 Change Measures- External

Engaging with the external environment is crucial for facilitating a circular transition. The 'external' aspect focuses on enhancing the water boards' interactions and collaborations with external entities. The primary goals identified in this context include: 1. Establish best practices in knowledge sharing, and 2. Effectively collaborate with external stakeholders. Several prominent themes have emerged in this area, which are discussed in detail below.

5.3.4.1 Adopt best transition paths from market parties

As public clients, the water boards must strive to adopt best methods of working from the external market. This is important because the market parties themselves are working on transition paths, which can be aligned with the requirements of the water boards. HHD1 recommended the following strategy:

> *"Pick the waves of the transition. Don't try to figure out your transition when there is also a main transition path already happening. That's what I did with the contract for dredging. The contractors made the transition path for circular objectives. You ride along with the wave and pick the right moments to catch the wave."* [HHD1]

HHD1 illustrates this with a practical example from their organization. When drafting contracts for dredging projects, the water board set requirements and objectives that took into account the contractors' ongoing transition plans for 2030. This approach was somewhat risky because the water board was uncertain about how all contractors would respond. However, by incorporating the contractors' goals into the contracts, the water board found that all five contractors involved were more ambitious and proactive than they might have been if the water board had set the goals independently. Therefore, adopting the most effective strategies available in the market, instead of developing your own ones, can significantly accelerate the process of transitions.

5.3.4.2 Coordinate closely within sector

All 21 water boards broadly perform similar tasks, although there are some tasks unique to specific areas. This commonality presents an opportunity for mutual learning and collaboration. Innovations and advancements made by one water board can be studied and potentially adopted by others. By sharing insights and experiences, water boards can collectively assess the impact of changed work processes during transitional phases [HHD3, HHD4]. Additionally, the Unie van Waterschappen plays a crucial role in coordinating sustainability transitions at the national level. They have developed strategies aimed at making water board assets more circular, as detailed in Section 2.3. The sustainability team/programme within the respective water boards could guide other teams to relevant resources, thereby enhancing their awareness of development opportunities [HHD2].

Moreover, WVV2 highlights the importance of collaboration between water boards and regional stakeholders to facilitate the transition. For example, Waterschap Vallei en Veluwe is partnering with local farmers to cultivate hemp, a strong fiber used in bio-based construction materials. This initiative not only creates economic value and business opportunities for farmers but also provides essential materials for sustainable construction.

5.3.4.3 Involve in external knowledge and working groups

In the context of ongoing transitions, the sharing of knowledge through various channels is important. This process not only facilitates gaining of external insights but also enables the transfer of our expertise to other organizations. It is recommended that individuals engage in external platforms such as communities of practice—groups of professionals who share a common field and collaborate to exchange insights and address challenges—or working groups. Participation in these forums helps individuals stay updated of the latest developments in their field while also allowing them to contribute their own knowledge and expertise [HHD1, WVV3].

5.3.4.4 Establish long-term relations with market parties

Collaborating with market parties such as contractors and suppliers can be significantly beneficial when these parties are already familiar with your organization. Building and maintaining long-term relationships with these partners is advantageous because they develop an understanding of your specific needs and objectives. This familiarity allows them to deliver solutions that align with the organization's strategic goals. Therefore, investing in long-term partnerships with market parties is a strategic move that can accelerate circular transitions.

EXTERNAL		
Themes identified	*Description*	*Source Interviewee(s)*
Adopt best transition paths from market parties	Embrace the main market transition paths and align it with the water board's goals rather than creating entirely new strategies	HHD1, WVV1
Coordinate closely within sector	The commonality of tasks can facilitate mutual learning and innovation with other water boards. Collaboration with Unie van Waterschappen and regional stakeholders should be enhanced	HHD2, HHD3, HHD4, WVV2
Involve in external knowledge and working groups	Individuals should engage in external forums like communities of practice to stay updated of the latest developments while also contributing from their own expertise	HHD1, WVV3
Establish long-term relations with market parties	Invest in long-term partnerships with suppliers, contractors, etc. so that they develop an understanding of the organization's needs and thereby deliver strategic solutions	WVV2

Table 5.5: 'External' change measures identified from case studies

Chapter 6

Framework and Validation

This chapter delves into the development of the change framework that can guide public infrastructure organizations, such as water boards, in implementing internal organizational changes to expedite the transition to circular construction practices. The initial framework is constructed based on change measures identified through case studies. This preliminary version is then validated through expert interviews, culminating in the final change framework. The research question addressed is:

SQ5- What does a change framework look like that could assist public clients, such as water boards, in transitioning to circular infrastructure?

The chapter begins by detailing the procedure used to develop the framework. Following this, the chapter presents the findings from validation interviews, which were conducted to assess the framework's effectiveness. Finally, the chapter concludes by introducing the finalized change framework, which incorporates the insights and improvements identified during the validation phase.

6.1 Framework Development

The concept behind framework development is illustrated in the following Figure 6.1. Chapter 2 delves into the organization's current state and context for change, further investigated by identifying the barriers and drivers of the transition. The desired state of the organization is defined by establishing specific goals for each aspect of change. **The framework then acts as a guiding tool for understanding 'how' the organization can transition from its current state to the desired state.** Findings from case studies were then utilized in designing this change framework.

6.1.1 Framework Design Procedure

The procedure for developing the change framework is illustrated in Figure 6.2. Up to the current stage of the study, the initial three steps have been completed. Initially, by comprehending the organizational context and conducting an extensive literature review, a theoretical guiding framework was established (Section 3.1). This framework included the essential components necessary to develop the conceptual framework . Following this, the desired state of the organization post-change was defined by setting specific goals for each aspect present in the theoretical framework (Table 5.1). Using these as foundation, the study then moved on to empirical data collection through case studies. The analysis of these case studies presented prominent themes that emerged during the interviews, leading to the identification of several change measures across the four change aspects (elucidated in Chapter 5). In this chapter, we will delve into the subsequent three steps of the procedure, which are explained below.

1. *Creating initial organizational change framework for circular transitions*
   The previous chapter presented the findings on the organization's current state, highlighting both the barriers and drivers that influence the circular economy transition. It also confirmed the goals for the organization's desired future state. Through the analyses of case studies, the necessary change measures to achieve these goals across all four change aspects were identified. However, these measures were not organized into the sequential steps of 'unfreeze-transition-refreeze' as outlined by the guiding theoretical framework. Therefore, the first step towards creating the initial change framework is to structure these change measures according to these steps. Following this, the initial change framework is presented following the concept shown in Figure 6.1.

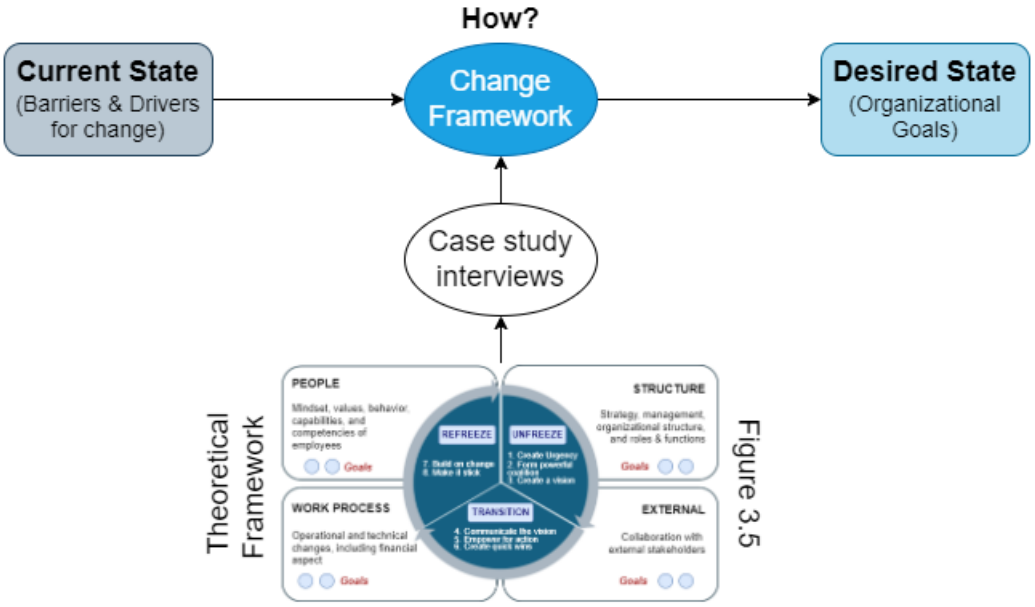

Figure 6.1: Concept of change framework to guide organizations from current state to desired state

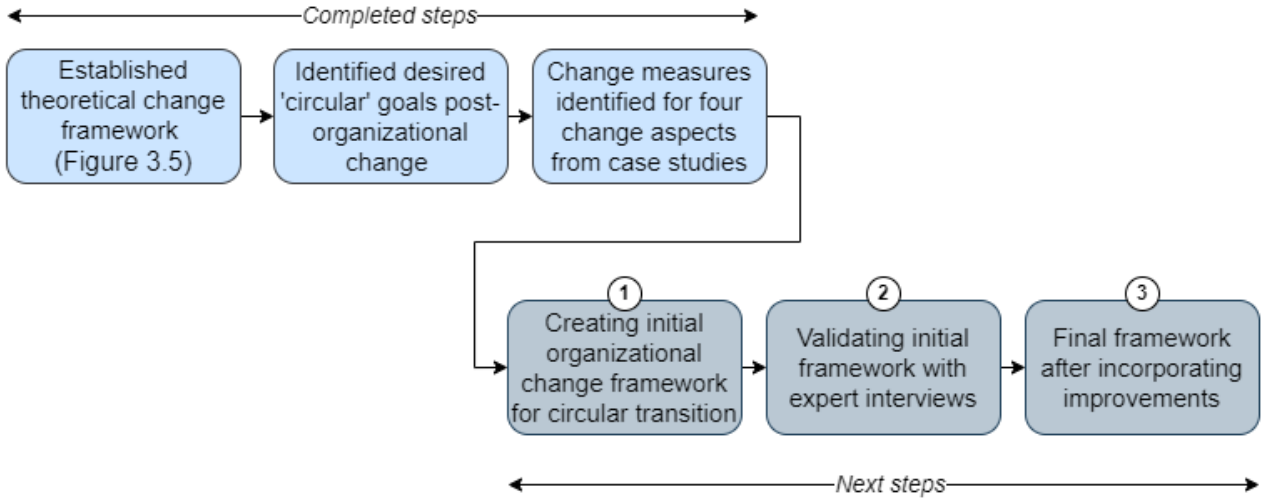

Figure 6.2: Procedure for framework development

2. *Validating initial framework with expert interviews*
   The initial framework undergoes a validation process by engaging in expert interviews to confirm initial findings as well as refine and improve the framework. Also, the categorization of the change measures into the unfreeze-transition-refreeze steps had to be verified.

3. *Final framework after incorporating improvements*
   The recommendations from the validation step is used as input is for the improvement of the framework. The final framework is then presented.

6.1.2 Initial Framework

The literature review identified two essential components for a conceptual change framework: 'content' (the areas requiring change) and 'process' (the steps to implement change). Accordingly, the developed framework integrates both these elements. Change measures for all four content aspects- *people, work process, structure* and *external*- were derived from case studies and utilized to illustrate how an organization can progress from its current state to the desired state. However, the case studies did not clearly suggest which of these measures fit into the specific process steps—unfreeze, transition, refreeze—of the selected Lewin's processual change model. Therefore, the initial step was to categorize the change measures into these three stages.

To achieve this categorization, the following methods were employed: first, any measures explicitly linked to a particular phase from interview insights were directly assigned to that phase. For instance, the recommendation- 'establish new procedures, standards, and policies'- in the change aspect 'work process' was clearly associated with the refreeze phase, as it involves consolidating the learning from experiments to establish new standards and policies (Section 5.3.2). Next, the definitions of each phase from Lewin's model were used to analyze and group each identified change measure. The context of the organizations undergoing change was also taken into account. For example, there was no need to prepare the organizations for change by introducing the concept of the circular economy, forming a lead group, or setting circular economy goals. Thus, the unfreeze step could commence with measures like 'communicating the change,' which is typically part of the transition phase in the studied Kotter's model. Through this process, all measures were classified, and the initial framework outline was prepared based on the concept shown in Figure 6.1. The preliminary framework created in this research is shown in Appendix B.

6.2 Framework Validation

This section delves into the expert validation of the developed change framework (shown in Appendix X). It begins with a brief overview of how the validation interviews were conducted, followed by an in-depth discussion of the recommendations and suggested improvements to the change framework.

6.2.1 Validation Interviews

The selected interviewees for this phase of the study were experts with close affinity to circular economy transitions within public client organizations in the infrastructure sector. All three experts have been working in sustainability or circular economy departments/programmes within their organization. E1-WTN was from Waternet, the organization that is responsible for water management for Amsterdam and surroundings. Waternet's responsibilities include the full spectrum of water management tasks, such as supplying drinking water, maintaining groundwater levels, and performing all tasks of a water board. E2-UVW was from Unie van Waterschappen, the association of the Dutch water boards, with an integrated perspective on the operations and challenges faced by all water boards. And lastly, E3-RWS was from Rijkswaterstaat, the national infrastructure organization of the Ministry of Infrastructure and Water Management, managing assets like national waterways and roads. Together, these interviews provided a thorough evaluation of the framework, leading to its refinement and enhancing its practical applicability within organizations. An overview of the interviews is shown in Table 6.1.

Code	*Role*	*Organization*	*Date of Interview*
E1-WTN	Advisor- Circular Economy	Waternet	05-06-2024
E2-UVW	Policy Advisor- Circular Economy	Unie van Waterschappen	07-06-2024
E3-RWS	Senior Advisor- Circular Economy & Innovation	Rijkswaterstaat	25-06-2024

Table 6.1: Overview of experts for validation interviews

The validation interview protocol was designed to allocate ample time for in-depth discussions on the initially developed framework. The structure of the interviews was divided into the following segments:

- *Introduction*- A concise introduction of both the interviewee and the researcher followed by a detailed explanation of the research which highlighted the key findings. This provided the interviewee an opportunity to clear any doubts regarding the findings and also ensured that the expectations and objectives of the interview were aligned.
- *Discussion of initial framework*- The framework was introduced, and four aspects of change were examined by detailing each change measure. The relevance and effectiveness of each measure were confirmed, and feedback was asked on any potential omissions. Additionally, the categorization of change measures into the 'unfreeze-transition-refreeze' steps was validated.
- *Additional discussions*- Additional conversations focused on other aspects of the framework, such as its practical implementation within organizations, identifying which levels or teams can effectively utilize the framework, and whether all aspects of change should be 'unfrozen' simultaneously or in a sequential manner throughout the change process.
- *Closure* of the interview including closing remarks and conclusion.

In addition to these points of discussion, the conversation with E3-RWS also explored the potential application of this framework to other public client organizations beyond the water boards. The discussion included a brief examination whether the measures could remain unchanged or would need to be adapted to make the framework applicable and beneficial for other public clients.

6.2.2 Recommendations from Validation

Overall, the framework was evaluated as being both 'logical' and 'applicable in practice'. It serves as a useful tool for assessing the issues faced at each stage. The measures included were suggested to be recognizable and relevant for public clients, such as water boards. The following section outlines recommendations for improving the initial framework. These discussions encompass additional change measures that experts identified as missing from the initial framework, some modifications to existing change measures, and adjustments to the 'unfreeze-transition-refreeze' categorization of measures. Each of the four aspects of change is thoroughly examined in these discussions.

People

The experts observed that all changes measures in 'people' aspect were recognizable for the transition to circular ways of working. One of the recommendations proposed was related to the change measure- 'involve people early phase'. E1-WTN suggested that within their organization, the lead sustainability team tests the changes before issuing guidelines. These evaluations are typically conducted with a group of individuals who are supportive of the transition. The feedback obtained from these evaluations is used to refine the frameworks and guidelines before they are implemented across the organization. Consequently, this recommendation is integrated into the change measure of involving people early.

Work Process

In 'work process,' the primary recommendations focused on reorganizing the measures according to the 'unfreeze-transition-refreeze' steps. The specific suggestions included the following:

- *Clearly translate strategies to operational level frameworks*- The measure initially proposed during the unfreeze phase should be reconsidered and implemented during the refreeze phase. Translating the changes into operational frameworks becomes feasible once the consolidated learning from the experiments are fully known and the impacts of the modified processes are clear. Therefore, it is only later during the refreeze phase that you can effectively translate these frameworks to an operational level.
- *Involve market parties*- Engaging market participants such as contractors and suppliers should occur during the initial stages of work processes. Their early involvement can significantly influence the structure of contracts, allowing for the integration of the highest levels of innovation. Therefore, this strategy should be considered during the initial 'unfreeze' phase of the process.
- *Develop monitoring mechanisms*- The implementation of monitoring tools, such as KPIs and monitoring dashboards, was initially included as a measure in the refreeze stage of the change process. However, in this stage, these tools serve as management steering mechanisms, ensuring that senior management remains informed about progress. The development of these monitoring tools should ideally occur during the transition phase. This is because it is crucial to determine the appropriate monitoring methods that can be aligned with the specific goals during this phase.

In addition to the aforementioned changes, another significant change measure was identified essential in this aspect. This measure involves consistently sharing and discussing the learning experiences across the entire organization [E2-UVW]. It is important to communicate not only the successes but also the failures. The insights gained from the experimental phases should be consolidated and disseminated throughout the organization. This approach will inspire other departments and encourage the adoption of circular methods on a larger scale within the organization.

Structure

The goal managerial commitment in the 'structure' aspect was reaffirmed as a critical objective within public organizations. According to observations by E2-UVW, a notable omission in the current set of measures is the lack of provisions for 'organizing budget and capacity for the transition'. To effectively set and achieve ambitions for a circular transition, it is imperative that the lead group is equipped with both the necessary budget and capacity. This should be done in conjunction with making informed decisions and issuing clear directives. Without allocating appropriate resources, the realization of new goals remains unattainable. Allocating these resources will also provide greater clarity for directors and managers, enabling them to make more informed decisions.

External

Two improvements were recommended in the 'external' aspect. First, it was about the change measure 'adopting transition paths from market parties'. It was suggested that the transition paths of market parties like contractors and suppliers must first be aligned with the requirements of the water boards and then adopt it if it still align with their goals. Though this is what was already meant by that change measure, it was necessary to make it more explicit.

The next improvement involved the introduction of the measure- 'coordinate to create a platform for knowledge sharing'. E1-WTN highlighted that while numerous interesting developments occur across the water boards, the dissemination of this information remains challenging. This difficulty arises primarily due to the regional focus of the water boards, which hinders the flow of information to other boards. Therefore, there is the need for a unified platform where all developments can be easily accessed. Although the Unie van Waterschappen (UvW) is already making efforts to coordinate transition initiatives by sharing knowledge, they could take a more proactive role in establishing a centralized platform for this purpose.

6.3 Final Framework

By incorporating the improvements identified during the validation phase into the initial framework, the final change framework was developed. This conceptual framework was designed to guide public client organizations within the infrastructure sector in adjusting their internal organization to effectively transition to circular construction practices. The complete form of the change framework is shown in Figure 6.3.

The proposed organizational change framework assist organizations to transition from its current linear working to a desired state of circular working by addressing the four key aspects. By including both the areas of change and the process for change, the framework becomes an effective tool to negotiate change as supported by literature studies. For a thorough understanding, this framework should be studied alongside the detailed explanation of each change measure provided in Section 5.3. To facilitate ease of reference for readers, a brief explanation of all change measures as they appear in the proposed change framework is summarized in Table 6.2.

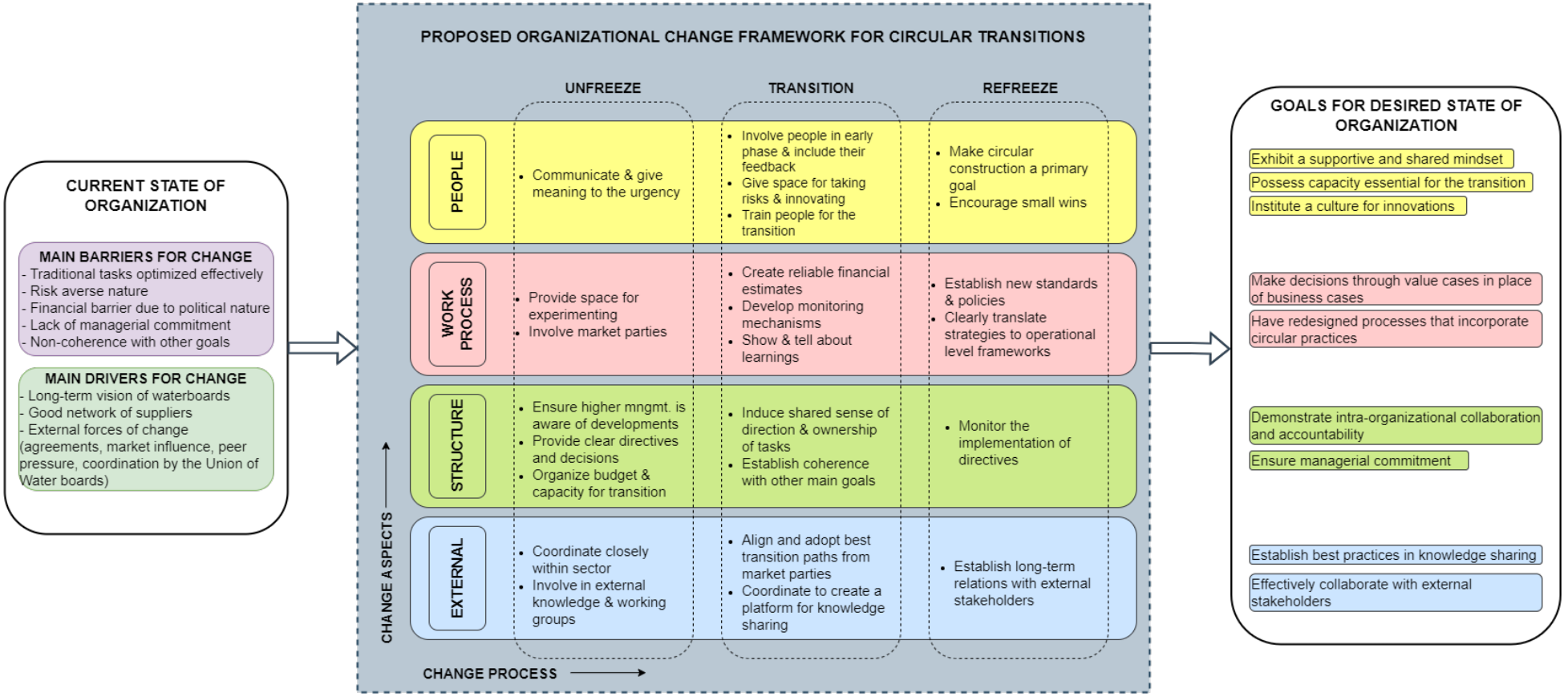

Figure 6.3: Proposed organizational change framework for transition to circular construction practices

Unfreeze	*Transition*	*Refreeze*
	PEOPLE	
Communicate and give meaning to the urgency The lead group should communicate to bridge the gap in awareness & illustrate the necessity of change through examples	**Involve people in early phase and include their feedback** Engaging people from the beginning of transitions will ensure they are committed to the change & circularity is not seen as an extra task. Also include their feedback in shaping guidelines & frameworks	**Make circular construction a primary goal** Integrate circular principles with other primary tasks such that it has the same significance as other requirements
	Give space for taking risks & innovating To overcome risk-averse nature of people, managers should give space to take calcu- lated risks & experiment innovations	**Encourage small wins** Creating and rewarding short wins will serve as a motivation for people to work further towards circular goals
	Train people for the transition Circular transition is more or less a people issue than technological. Thus, provide trainings for transition management and application of new tools	
	WORK PROCESS	
Provide space for experimenting Understanding the potential impacts of the change is necessary to redesign work processes; this can be achieved through experimentation	**Create reliable financial estimates** Early and precise budget estimations can play a role in overcoming financial barriers by providing a realistic picture	**Establish new standards & policies** To achieve efficiency, the transitioning work processes should be standardized during refreeze
Involve market parties By defining functional requirements, market parties can design their processes for circularity. Involving them in the early stages allows integration of highest levels of innovation.	**Develop monitoring mechanisms** KPI's and dashboards help in tracking transition progress, as well as act as a driver for change by creating a sense of urgency and focus	**Clearly translate strategies to operational level frameworks** Departments should be internally tasked to develop sustainability frameworks at the level of implementation once the impacts of changes are known.

	Show & tell about learnings Consistently share & discuss the learning experiences across the entire organization	
STRUCTURE		
Ensure higher management is aware of developments Higher management should be well-informed about the sector's developments in circular economy to ensure their commitment to new initiatives	**Induce shared sense of direction & ownership of tasks** Share a collaborative approach towards working for the common goal, but at the same time make individuals explicitly responsible for their contribution towards the objectives	**Monitor the implementation of directives** Management should raise questions and individuals should be answerable for missed goals; escalate issues at appropriate time
Provide clear directives & decisions Prioritizing circular initiatives is required from higher management by issuing unambiguous directives and making strong choice	**Establish coherence with other main goals** Organizational strategies should be restructured to embed circularity as a standard mode of operation aligning it with other objectives	
Organize budget & capacity for transition In conjunction with giving clear directives, the lead groups should be allocated necessary budget and personnel		
EXTERNAL		
Coordinate closely within sector The commonality of tasks can facilitate mutual learning and innovation with other water boards. Collaboration with Unie van Waterschappen and regional stakeholders should be enhanced	**Align and adopt best transition paths from market parties** Embrace the main market transition paths and align it with the water board's goals rather than creating entirely new strategies	**Establish long-term relations with market parties** Invest in long-term partnerships with suppliers, contractors, etc. so that they develop an understanding of the organization's needs and thereby deliver strategic solutions
Involve in external knowledge & working groups	**Coordinate to create a platform for knowledge sharing**	

Individuals should engage in external forums like communities of practice to stay updated of the latest developments while also contributing from their own expertise	To overcome barriers in knowledge dissemination, the water boards should coordinate with Unie van Waterschappen to establish a unified platform for information sharing	

Table 6.2: Description of change measures in the developed framework for organizational transition to circular construction practices

Chapter 7

Discussions

This chapter presents a discussion on the research findings and includes additional considerations related to the proposed framework. It covers the practical applicability aspects observed during the case studies and validation interviews, such as who can utilize the framework, and briefly discusses the merits of the framework. Additionally, the chapter addresses the limitations of this research.

7.1 Additional Discussion on Findings

Merits of the proposed change framework

The proposed change framework, as mentioned, can serve as a guiding tool for public client organizations in infrastructure, facilitating their transition to circular construction practices by altering their internal functioning. The developed framework offers several merits. Firstly, it is designed following literature recommendations. As noted in the literature (Joseph Galli (2018); Al-Haddad and Kotnour (2015)), the proposed framework strongly considers the organizational environment for change, making it a suitable fit for Dutch water boards and similar public client organizations. Additionally, literature recommends that change models incorporating both process and content aspects are most promising in addressing change, which is also true for circular economy transitions (Barnett and Carroll (1995); Graessler et al. (2024)). The developed framework follows this principle by including four change areas, most commonly found in descriptive change models (content) and Lewin's processual model, a cornerstone of planned change management (process). These factors make the model both theoretically sound and practically efficient.

Secondly, the proposed framework also delves into the current state of the water boards by presenting significant barriers and drivers for circular transition. Additionally, it outlines the desired state of such organizations post-transition through specific goals. Extant literature does not provide a clear depiction of what a 'circular' public organization would be like in its intra-organizational functioning. Therefore, through a literature review and subsequent validation via case studies, a clear picture of the desired goals for transitioning from linear to circular ways of working is established. These goals are crucial for providing a more defined vision of how organizations should operate. They also guided interviewees in identifying change measures to achieve these goals based on their practical experience. In essence, the proposed framework diagram contains elements of a roadmap for water boards to transition from a linear to a circular economy, highlighting the barriers and drivers they may encounter and outlining clear and achievable goals.

Theoretical contribution

The proposed framework makes a significant scientific contribution by focusing on change management specifically for public organizations aiming to transition to a circular economy, a focus that is absent in existing change management models. The study's focus on organizational change aspects that can be integrated into the daily operations of water boards makes it particularly novel. Internal organizational dynamics of circular economy transitions for public clients have been less explored but are now recognized as a high-priority issue. When it comes to circular economy transitions, the challenges or end-goals are not always clear-cut. This framework provides a structured approach to navigating these organizational complexities, addressing a critical gap in existing research.

Discussion on the desired goals for 'circular' water boards

The goals set for the change management process were not standalone or isolated from one another but were interconnected across different aspects of change. For example, achieving the goal of 'cultivating a supportive and shared mindset' often required 'managerial commitment,' which highlights the interdependence of these goals. Similarly, certain change measures, such as 'providing space for experimenting and innovating,' were suggested to achieve separate goals in different change aspects. This interconnections might explain the respondents' difficulty in outlining distinct 'unfreeze-transition-refreeze' steps for each goal.

It can also be observed that not all goals were specifically focused on transitioning to circular construction but included generic goals applicable to various types of transitions. However, these generic

goals are still significant and relevant for facilitating circular transitions. 'Ensure managerial commitment' emerged as one of the most frequently mentioned goals by the respondents. Both case studies highlight that a lack of managerial commitment is a major challenge that needs to be addressed within the organizations.

Discussions on practical implementation of proposed framework

To gain insights on how the framework can be implemented, interviewees were asked if they see a sequential order in which the four aspects—people, work process, structure, or external—should begin unfreezing. Different opinions were observed, leading to a lack of conclusive results. However, some prominent observations were made. The majority of respondents agreed that the 'Structure' aspect should unfreeze first. They believed that achieving goals related to managerial commitment and intra-organizational collaboration and accountability should be prioritized. Managerial commitment can then assist the 'People' aspect in cultivating a shared and supportive mindset among employees and developing a culture of innovation. This, in turn, can lead to greater success in achieving goals related to 'Work Process'. Goals related to 'External' factors should be pursued throughout all phases of the change process. Such a change order could be utilized to move the 'early majority,' as suggested by the Diffusion of Innovation Theory. However, some respondents noted that this is not a linear process where one aspect follows another sequentially. Instead, the aspects and goals are iterative and interconnected. For instance, an initial innovation in work processes might change some people-related aspects, involving more individuals over time. Eventually, structural aspects would adjust to the new ways of working.

The next discussion on implementation focuses on identifying the groups or levels of people within the organization for whom this framework is most suitable. The interviewees agreed that the framework could serve as a general guide across various levels within the organization. Specifically, the framework is well-suited for the lead sustainability group, programme managers, and change managers who are spearheading circular transitions within the organization. In other words, the framework is most suitable for the tactical level within organizations. These leaders can utilize the framework to engage in discussions with higher management, including directors and governing boards, about the circular transitions [E2-UVW].

As an additional tip during implementation, the lead groups at the water boards could first assess their organization's readiness for the transition. Conducting an internal study can provide valuable insights into the current state of the organization, enabling you to implement measures from the framework more effectively. For example, Waternet's Sustainability team has conducted such internal assessments to guide their transition efforts [E1-WTN].

Applicability of framework for other (public) organizations

Only one interview was conducted with an expert from a public client organization outside the water authorities- E3-RWS from Rijkswaterstaat. Rijkswaterstaat is a large public client in the Netherlands that manages infrastructure assets such as roads, bridges, and national waterways. The interviewee was asked whether the measures in the framework could remain unchanged or would need modifications to be applicable and beneficial for other public clients beyond the water boards. According to the response, the elements in the framework are about 80% adaptable, just that the organization use different terminology or framing. This framework can function as a checklist, indicating necessary actions for a transition plan. However, Rijkswaterstaat, being larger with various regions and ways of working, requires a greater emphasis on the division of roles and expectations from each individual. Therefore, while the core elements remain relevant, the specific application might need adjustments to account for organizational differences in size and structure.

Reflection on research methodology

Another significant merit of this research is the methodology used to develop the framework. The case study approach is particularly well-suited for exploratory research, where there is a lack of existing literature on the topic and limited knowledge in the field. This is especially relevant in the context of this study, as the internal organizational change processes for circular economy transitions within public organizations have not been extensively studied before. Therefore, the case study methodology was an apt choice for this research, allowing for an in-depth examination of the phenomenon. Furthermore, the two organizations chosen for the case studies—Hoogheemraadschap van Delfland and Waterschap Vallei en Veluwe—proved to be excellent selections. This was confirmed by E2-UVW during the validation phase, as these water boards were among the earliest to venture into sustainable and circular construction initiatives and have the longest working experience in the transition. This selection has undoubtedly benefited the study by capturing effective organizational change measures that these organizations have been implementing to facilitate the transition.

Lack of managerial commitment as a major barrier

In politically headed organizations like the water boards, much of the final decision-making authority rests with the elected board. The case studies in this research were primarily based on interviews with employees at the tactical level of the organization. Many of these employees identified a 'lack of managerial commitment' as a significant barrier that slows the pace of the circular economy transition. Often, political governing bodies prioritize other objectives over circular economy goals. While interviews with political members could not be conducted within the timeframe of this study, the research includes a discussion on potential steps to secure stronger commitment from higher management for the transition.

To ensure commitment from management, it is crucial that they remain informed about the ongoing developments in the circular economy transition. They must be able to issue clear directives and decisions and follow up to ensure these directives are properly implemented. The findings and framework from this study can serve as a valuable starting point for engaging in conversations with higher management, increasing their awareness of the transition. Circular economy goals are often sidelined by management due to the prioritization of other objectives. For example, a strong focus on water quality can sometimes overshadow circular goals, or sometimes be in conflict with circular objectives. In such cases, the tactical level of the organization needs to present solutions that balance these competing goals and offer meaningful answers to management. Leaders at the director level have a pivotal role in this process. They act as mediators, convincing board members to commit to circular economy initiatives, while also translating that commitment into clear directives and decisions for the rest of the organization. The leadership of the directors then becomes pivotal. Additionally, UvW can contribute by influencing board members, acting as a platform to lobby governing board members from different water boards and unify them in support of circular economy goals.

In addition, several external drivers could encourage stronger commitment from the political board toward circular economy initiatives. For instance, there is a growing national momentum for circular economy practices in construction, spanning various levels of government and organizations. Peer pressure to align with other water boards and advance in sustainable practices, including emission reduction efforts, serves as a significant driver. National regulations and policy directives also play a crucial role in steering these transitions. Market dynamics, such as rising prices of raw materials and energy, further reinforce the need for circular strategies. The political board closely monitors these external developments, which can act as catalysts for their commitment to circular infrastructure..

7.2 Limitations of Study

While the study was conducted using the best methods, it is essential to acknowledge its limitations, which are discussed below:

- The case study interviews were conducted with experts ranging from advisors to department managers (i.e., mainly the tactical level within organizations). Due to availability issues, it was not possible to interview higher management, such as members of governing bodies or the directors' team. As a result, the framework does not fully capture insights from the strategic levels of management.
- Given that water boards are primarily technical organizations, most of the respondents selected have a technical background. Despite this, they possess several years of experience in managerial roles. However, their technical expertise might influence their interpretation of organizational questions, potentially causing a bias that undervalues non-technical factors and hinders the capture of broader organizational aspects.
- Due to the limited time frame of the research, only two case studies were conducted. Consequently, the identified change measures and findings may differ in other organizations.
- Triangulation of findings was not possible due to the absence of additional data sources to cross-verify the interview results. Nonetheless, a validation phase served as a form of triangulation.
- A sufficient number of interviews could not be conducted to assess the applicability of the framework to public organizations beyond water boards. Further evaluation is needed to identify the similarities and differences in the framework to ensure its suitability for other organizations.

Chapter 8

Conclusion and Recommendations

This chapter presents the recap and final conclusions of the research study. It discusses the findings from each phase by answering the sub-research questions. Subsequently, it answers the main research question. The chapter also includes recommendations for both practice and further scientific inquiry.

8.1 Conclusion

To deal with climate change, the Dutch government aims to achieve a completely circular economy by 2050, placing significant demands on public organizations. For infrastructure clients like the Dutch regional water authorities, addressing climate change is even more urgent because they directly confront its consequences such as extreme weather conditions. Also, public clients can drive the development of circular products and services in the market by actively increasing demand through strategic purchasing policies. Thus, the need to transition to circular public infrastructure is pressing. To bring about this transition, these organizations can no longer rely on their traditional, linear methods of operation and must adopt new ways of working. Currently, with respect to circular transitions, they struggle to progress beyond the experimental stages and achieve higher maturity levels in their organizations. The circular approach is often viewed as an additional responsibility or the duty of a select few within the organization. To make this the new normal standard of working for the entire organization, the water boards need to reorganize their internal arrangements. This study, therefore, investigated what internal organizational changes could be implemented in the water boards to accelerate their transition to circular construction practices, thereby contributing to sustainable infrastructure.

The study addressed this by conducting case studies that identified practical measures employees across various departments and organizations adopted to make their work more circular. These findings were compiled into a change framework designed to help employees at water boards modify their approaches and implement circular practices more effectively. Unlike the current unorganized processes, this framework serves as a guide or checklist, providing structured support for leading circular economy transition efforts within the water boards. Circular economy transition leaders or team managers can utilize the recommendations in this framework whenever they introduce new initiatives within their teams or organizations. By following the recommended measures, they can overcome many of the barriers they currently face, thereby increasing the likelihood of success for their initiatives. In the context of circular economy transitions, where the ultimate goal is often a distant target, this change framework offers valuable guidance, helping employees implement necessary changes and effectively facilitate the transitions.

The proposed organizational change framework is firmly grounded in scientific literature and closely aligned with practical realities, due to the research methodology employed. In developing the framework, careful consideration was given to the organizational context of water boards, making it well-suited for tactical levels within these organizations to implement circular initiatives. However, it does not encompass the perspectives of the strategic levels within organizations.

Answering the Research Questions

The objectives of the study have been achieved by answering the following research questions. The section also provides a recap into the process followed in the research.

> **SQ1- How are Dutch Water Boards organized as public clients, and what are their current strategies for transition to circular infrastructure?**

This sub-question was addressed in Chapter 2 of the study through exploratory interviews and document reviews. The first goal of the study was to gain a comprehensive understanding of the organizational context of the water boards before devising change strategies. The chapter examined aspects such as the typical organizational structures at water boards, and how policies at strategic levels are translated into operational assignments.

The water boards are governed by politically elected members, who form the decisive governing bod-

ies, followed by directors and other administrative levels. Legislation or policies at the strategic level are transformed into multi-year and annual plans, and finally into operational frameworks through internal assignments involving managers and advisors. Additionally, the study outlined the distinctive characteristics of water boards that set them apart from many other public and private organizations. Their political nature and region-specific administration could sometimes act as inhibitors to the water boards' efforts to transition to a circular economy. Understanding these organizational dynamics provided a solid foundation while establishing the theoretical framework and identifying suitable change strategies in this study.

The second part of the chapter analyzed the current progress of circular transitions at the water boards. The water boards have set ambitious targets: achieving 50% circularity by 2030 and 100% by 2050. However, there is a lack of specific measures to reach these goals. At the national level, the Unie van Waterschappen coordinates efforts to align national policies with the interests of the water boards. Individual water boards exhibit varying levels of progress. Some are engaged in pilot projects, while others have developed road maps to guide their transitions. Most water boards integrate other sustainability goals—such as energy transition, biodiversity, and climate adaptation—with their circular economy objectives. Although the basis for the transition exists, most water boards struggle to embed the circular approach as the standard way of working across all organizational levels and to align new policies with daily practices.

SQ2- What are the essentials from literature for a conceptual change framework to comprehensively address the aspects of change?

Since the primary objective of the study was to develop a framework for organizational change the next step was to identify the essential components required to create such a framework. To achieve this, the study first explored the literature on planned organizational change, examining several models that outline the change process (processual models) and those that define key areas of change (descriptive models). The literature suggested that models integrating both process and content aspects are most effective in addressing organizational change comprehensively. Therefore, the conceptual framework to be developed needed to include these two key components. Firstly, the framework adopted one of the most widely used processual models in planned change management: Lewin's model, which consists of three stages - *unfreeze, transition,* and *refreeze*. This model is considered a cornerstone of planned change management. Secondly, the study identified four content aspects from various descriptive models, tailored to the organizational context. These aspects were: *people, work process, structure,* and *external*. These essential components were validated through interviews and were deemed suitable for inclusion in the conceptual change framework in the organizational context of water boards. A theoretical framework including these essential elements was created as shown in Figure 3.5 to guide the empirical research and provide a structured approach to developing the conceptual framework.

SQ3- What are the desired outcomes post-change for a 'circular' water board across the various aspects identified for the change framework?

A crucial gap in the existing literature was the lack of information on what a 'circular' public organization would look like in terms of its internal functioning. This sub-question addressed this gap by conducting a comprehensive literature review and validating the findings through case studies. Identifying change goals were required to determine the procedural change measures to achieve the desired state of the organization. The sub-question was answered in two parts. First, Chapter 3 presented a literature review of desired goals, leading to the identification of eight goals across four change aspects. Some of these goals were obtained from academic sources discussing general circular business transitions. Subsequently, these eight goals from the literature were validated through case study

interviews (Table 5.1). This validation process assessed their relevance to public organizations like water boards. Additional goals were identified, and modifications were made to the initial set of goals.

SQ4- What are the change measures to achieve the desired transition to circular infrastructure, which can be identified from practice within the water boards?

This sub-question was answered in Section 5.3 of the study. Through case study interviews, this empirical portion of the research primarily explored how the desired goals identified in the previous sub-question could be practically achieved. Two water boards- Hoogheemraadschap van Delfland and Waterschap Vallei en Veluwe were selected as case studies for this purpose. These water boards were among the earliest to start working on sustainable and circular construction initiatives and have the longest working experience in the transition. Interviewees, drawing on their experience with circular initiatives, were asked how each goal could be achieved using the unfreeze-transition-refreeze steps. However, respondents found it challenging to delineate clear steps for each phase for the goals. Therefore, key observations from all interviews were consolidated and later classified into unfreeze-transition-refreeze steps, considering each change aspect as a whole. These change measures are summarized in tables at the end of the discussion for each aspect in Section 5.3. Additionally, a brief study was conducted to identify the prominent barriers and drivers for change, providing a better understanding of the organizational context for change.

SQ5- What does a change framework look like that could assist public clients, such as water boards, in transitioning to circular infrastructure?

By answering this sub-question, the main objective of the research—to develop an organizational change framework for facilitating circular transition at the water boards—is achieved. Chapter 6 elaborates on how the change framework was developed. Once the change measures were identified from case studies, an initial framework was created by organizing the change measures into the stages of unfreeze, transition, and refreeze, as guided by the theoretical framework. This initial framework underwent a validation process through expert interviews. The purpose of these interviews was to confirm the initial findings and to refine and improve the framework. The final framework, which is then presented, is the proposed framework for organizational transition towards circular infrastructure for public organizations like the water boards (shown in Figure 6.3).

The proposed framework consists of change measures that the organization can adopt, explained through the steps of unfreeze, transition, and refreeze across four change areas: people, work processes, structure, and external factors. This framework acts as a guiding tool for understanding how the water boards can transition from their current state to the desired state through structured and achievable steps.

Main research question:

What changes in the internal organization of a public infrastructure client, like the Dutch Regional Water Authorities, could facilitate the transition to circular construction practices?

The overarching objective of this research was to develop measures for adjusting the internal functioning of a public client, such as the Dutch regional water board, to enable the integration of circular construction practices in the management of their infrastructure assets. By employing a set of logical and structured sub-research questions, this study successfully addressed the main research question. The proposed change framework (Figure 6.3) outlines the internal organizational changes that public infrastructure clients like the water boards, can implement. These changes measures, if implemented

proactively, are intended to facilitate the transition to circular infrastructure. Since the results were obtained through empirical research, these measures can be viewed as practical and attainable for organizations. The validation process, which included expert interviews, was crucial for confirming the initial findings and refining the framework, ensuring the proposed measures are both effective and feasible. This makes the proposed framework a valuable tool for circular economy change managers within the organization.

8.2 Recommendations

In this section some recommendations are put forward for the water boards, UvW and for further research.

8.2.1 Recommendations for Dutch Regional Water Authorities

As prominent clients, the water boards together have purchasing power to stimulate the market towards circular products and services. The proposed framework can serve as a guiding tool or roadmap for spearheading circular transitions within the water boards. Some recommendations for the water boards are:

- It is recommended that the change measures specified for the four areas within the organization be proactively implemented by change managers, programme managers, and/or the lead sustainability team. The framework enables them to adopt change measures to meet the specific needs of their organizational environment by considering the most significant barriers faced by their team or organization.
- The water boards can initially perform an internal assessment to evaluate their organization's readiness for change. To mobilize the 'early majority,' water boards could begin by unfreezing the 'Structural' aspect, focusing on goals such as ensuring managerial commitment and fostering intra-organizational collaboration and accountability. Achieving these structural goals could then facilitate progress in the 'People' aspect, by cultivating a shared and supportive mindset among employees and fostering a culture of innovation. This, in turn, could enhance the success of the circular transition in 'Work Process.' Additionally, goals related to 'External' factors should be pursued continuously throughout all phases of the change process.
- It is recommended that the lead circular economy transition group use this framework as a starting point for engaging in discussions with higher management, including the governing board, executive committee and the director's team, to secure their commitment to circular economy goals.
- Traditionally, water boards focus on technical solutions for issues due to their technical nature. However, further technical advancements in circular transitions are already possible than what is currently incorporated in the water boards. Therefore, water boards should emphasize managerial and organizational strategies to overcome human barriers to transition. The proposed framework's change measures support this shift.

8.2.2 Recommendations for Further Research

Lastly, some suggestions for further research in this direction are:

- Further research is necessary to evaluate how well the developed framework can be applied to public organizations beyond the water boards. The framework could be adapted for use in organizations like municipalities, provinces, national infrastructure organizations like Rijkswaterstaat, ProRail etc. It could also be assessed whether the framework can be adapted for use beyond infrastructure sector.

- When public clients adjust their internal work processes, external stakeholders, particularly contractors and suppliers, must also adapt their ways of working to align with these new methods. A study could be conducted to examine how these changes in client organizations impact other stakeholders and what are necessary change measures these parties need to adopt for continued effective collaboration.
- Building on the elements within the proposed framework, there is potential to explore the development of a maturity model that assesses an organization's readiness and progress toward circular transitions.

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Appendix A

Interview Protocol

To conduct the semi-structured interviews, an overview of the research was sent to each participant a few days before their scheduled interview. This provided them with background information and an introduction to the research ahead of time. Additionally, an interview protocol was designed to guide the interviews, which was regularly updated based on feedback.

Below are the screenshots of the initial versions of the research overview and interview protocol. These documents were updated over time based on feedback loops, leading to the addition or modification of goals as new insights were identified.

A.1 Overview of Research

Master Thesis

Organizatonal Transition Towards Circular Public Infrastructure

Shaun Alex
Construction Management & Engineering,
TU Delft.

Overview of the research

Transforming the construction sector is a decisive factor in the transition to the circular economy. With the transition to circular construction practices, public client organizations like the water boards can no longer continue with traditional ways of working. While the urgency for change is present, the water boards struggle to progress beyond pilot projects, increase maturity levels throughout the organization, and align new policies with daily practices. In order to shift from linear to circular functioning, they may need to fundamentally rethink and restructure their internal organization. Therefore, the objective of this research is **to develop a conceptual framework** for implementing internal changes in public infrastructure client organizations to accelerate the transition to circular construction practices. This study stands at the intersection of circular economy and organizational change. The main research question is:

What changes in the internal organization of a public infrastructure client, like the Dutch Regional Water Authorities, could facilitate the transition to circular construction practices?

Developing the conceptual framework

Initially, some essential components for a conceptual framework for organizational change towards a circular economy are identified. The conceptual framework developed should consist of both process and content aspects. Process describes 'how' the change could be brought about and 'content' relates to 'what' needs to be transformed. After a preliminary study on how the water boards function and a comprehensive literature review, it was concluded that the following content-related aspects are necessary for the conceptual framework:

Figure: Essential 'content' aspects

Four content-related aspects of the internal organization are identified- People, Work process, Structure and External. The conceptual framework also includes procedural steps that could direct water boards on how to implement the changes in these essential aspects. To determine the procedural steps, we utilize a processual change model- Unfreeze, Transition, and Refreeze.

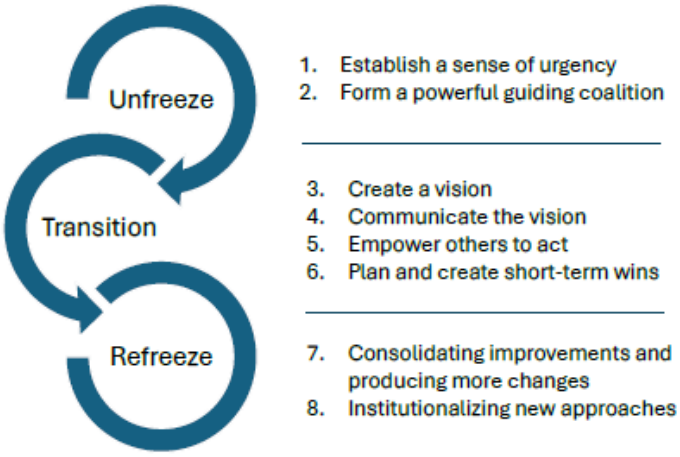

Figure: Identified 'process' of change

Furthermore, from literature review and document analysis, the **desired state** of the organization post-change is defined, i.e., what would a 'circular' water board be like in its intra-organizational functioning? Thus, for all four aspects considered, namely, work process, structure, people, and external context, we try to establish the goals that are necessary to guide change.

Goals
People
P1. Cultivate a supportive and shared mindset.
P2. Develop competencies essential for the transition
Work Process
W1. Business case to value case
W2. Redesign processes to incorporate circular practices
Structure
S1. Intra-organizational transparency and collaboration.
S2. Managerial commitment (leadership and political)
External
E1. Best practices in knowledge sharing
E2. Effective collaboration with external stakeholders

Table: Desired state of organization post-change

Case Study and Interviews

The interviews are aimed at understanding practitioners' perspectives on how the desired changes can be achieved in the water boards. Based on the literature findings outlined above, semi-structured interviews will be conducted to gather participants' experiences and opinions to achieve the desired outcomes. The interviews are part of a multiple-case study analysis, where a water board, for instance, Delfland, is considered as an individual case. Multiple water boards will be studied, and the results will be subjected to a cross-case analysis. The findings from the case studies will help in formulating a conceptual

framework which answers 'how' the desired changes can be achieved to transition towards circular construction.

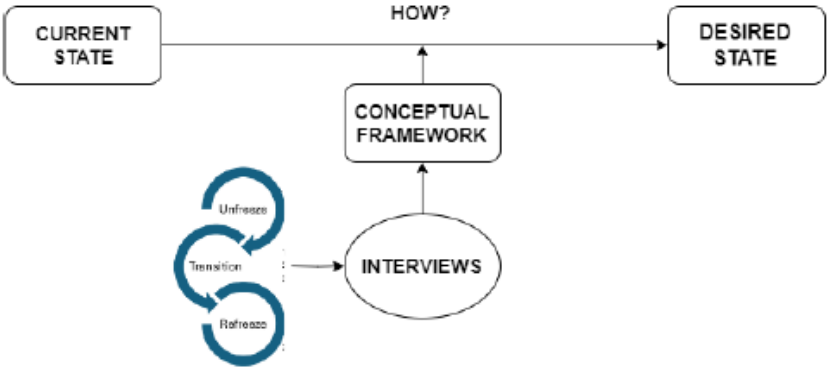

Figure: Research concept

If you have queries or need additional information, kindly contact:

Shaun Alex
E. [redacted]nl
M. [redacted]7

A.2 Protocol for semi-structured interviews

Organizational Transition Towards Circular Public Infrastructure

Scroll down for English

Interviewvragenlijst

Dit interview bestaat uit vijf delen en zal ongeveer 60 minuten in beslag nemen. Een overzicht van het onderzoek is te vinden in het document getiteld 'Overview of Research'. U kunt met mij contact opnemen via e-mail [redacted] of via mobiel [redacted], mocht u aanvullende informatie nodig hebben of om eventuele vragen te verduidelijken.

Part 1: Kennismaking (~5 min.)

Q1.1. *Zelfintroductie van de onderzoeker*

Hallo, ik ben Shaun Alex, een masterstudent Construction Management & Engineering aan de TU Delft. Momenteel bevind ik me in de laatste fase van mijn studie waarin ik mijn afstudeeronderzoek doe naar het bovengenoemde onderwerp. Ik ben geïnteresseerd in duurzaamheidsthema's in de gebouwde omgeving, zoals circulaire economie en energietransitie, en daarom heb ik besloten om samen met het Hoogheemraadschap van Delfland dit onderzoek te doen. In mijn vrije tijd geniet ik van kaartspelen of werk ik me in het zweet tijdens een potje badminton of voetbal.

Q1.2. *Introductie van de geïnterviewde:*

- Naam:
- Functie binnen de organisatie:
- Jaren werkervaring t.a.v. circulariteit?:
- Heeft u gewerkt aan circulaire initiatieven? Zo ja, aan welk(e) project(en)?

Q1.3. Introductie van het onderzoek - Raadpleeg het bijgevoegde document getiteld 'Overview of Research', wat verduidelijking kan geven tijdens het beantwoorden van de volgende vragen.

Part 2: Gewenste staat van de organisatie na verandering (~10 min.)

Q2.1. Uit literatuurstudies heb ik een reeks doelstellingen voor de gewenste staat van de organisatie na de verandering afgeleid. Deze doelstellingen worden voor elk aspect (namelijk People, Work Process, Structure en External) hieronder vermeld. Herkent u in uw dagelijkse praktijk de noodzaak van deze doelstellingen voor de organisatie om de transitie naar circulair te versnellen?

Doelstellingen
People
P1. Het creëren van een ondersteunende en gedeelde mindset.
P2. Het ontwikkelen van competenties die essentieel zijn voor de circulaire transitie.
Work Process
W1. Het werken met een valuecase in plaats van een businesscase
W2. Het herontwerpen van (werk)processen om de circulaire werkwijze te borgen in de organisatie.
Structure
S1. Intra-organisatorische transparantie en samenwerking.
S2. Betrokkenheid en sturing door management (leiderschap en politiek).
External
E1. Best practices en kennisdeling.
E2. Effectieve samenwerking met externe stakeholders.

Q2.2. Heeft u nog andere suggesties voor andere belangrijke doelstellingen die u binnen uw organisatie herkent op elk van de vier aspecten?

Q2.3. Denkt u dat al deze aspecten tegelijkertijd moeten 'unfreezen' of 'in transition' moeten zijn, of de één na de ander? Geef alstublieft de volgorde aan als u denkt dat het sequentieel moet zijn.

Part 3: Barrières/versnellers binnen de waterschappen (~10 min.)

Q3.1. Wat zijn de cruciale barrières en versnellers die u heeft waargenomen op elk van de vier aspecten binnen uw organisatie, of voor waterschappen in het algemeen?

Part 4: Processtappen voor organisatorische verandering (~30 min.)

Q4.1. Kunt u met behulp van het Unfreeze-Transition-Refreeze procesmodel stappen suggereren die de interne organisatie van de waterschappen zouden moeten zetten om het doel van een circulaire economie in de infra te bereiken?

PEOPLE:

- ***P1- Het creëren van een ondersteunende en gedeelde mindset***- Momenteel is de lineaire cultuur diepgeworteld in de manier van werken. De mindset is dat circulariteit een aanvullende taak is, maar het zou eerder een nieuwe manier van denken en werken moeten zijn. Bovendien bestaat er in traditionele organisaties, zoals waterschappen, een neiging tot risicomijdend gedrag. Geldt dit voor de waterschappen? Hoe kunnen we dit veranderen?

- ***P2- Het ontwikkelen van competenties die essentieel zijn voor de circulaire transitie-*** Studies benadrukken de noodzaak van vaardigheden en competenties van werknemers. Denkt u dat de waterschappen voldoende middelen en competenties hebben om de transitie mogelijk te maken? Wat zou er kunnen worden gedaan om de huidige situatie te veranderen?

WORK PROCESS:

- ***W1- Het werken met een valuecase in plaats van een businesscase -*** Vanwege de politieke aard van waterschappen wordt financieel beheer momenteel gedaan aan de hand van factoren zoals efficiëntie of lagere tarieven. Met circulaire praktijken zou het doel echter moeten zijn om waarde toe te voegen aan elke stap van de levenscyclus van een proces. Wat vindt u hiervan? Wat kan er worden gedaan om een overgang te bewerkstelligen naar het bekijken van projecten vanuit een waardecase perspectief?

- **W2- Het herontwerpen van (werk)processen om circulaire werkwijzen te borgen in de organisatie-** Om (grondstof)kringlopen te sluiten, moeten we wellicht werkprocessen flexibeler maken en werkproces(sen) opnieuw ontwerpen. Hoe kunnen we veranderingen opnemen om werkprocessen flexibeler te maken?

STRUCTURE:

- **S1- Intra-organisatorische transparantie en samenwerking-** Om circulaire praktijken naadloos te integreren, moeten intra-organisatorische grenzen tussen afdelingen transparant zijn en het alleen werken aan de doelen van de eigen afdeling worden geëlimineerd. Ook moet er een duidelijk onderscheid zijn tussen rollen en verantwoordelijkheden binnen circulaire projecten. Heeft u suggesties vanuit uw ervaring over hoe dit bereikt kan worden voor een circulaire manier van samenwerken?

- **S2- Betrokkenheid en sturing door management (leiderschap en politiek)-** In de context van waterschappen is de leiderschaps- en politieke betrokkenheid van het bestuur cruciaal. Hoe kunnen we ervoor zorgen dat het management zich inzet voor de politieke agenda's en financiële beperkingen? Wat kan er worden gedaan om hun betrokkenheid en commitment in de circulaire transitie te verbeteren?

EXTERNAL:

- **E1- Best practices en kennisdeling-** Hoe kunnen we ervoor zorgen dat we kennis en technologie uit marktontwikkelingen absorberen? Hoe kunnen we onze interne organisatie hier beter op afstemmen?

- **E2- Effectieve samenwerking met externe belanghebbenden-** Valuecreatie voor allen in het netwerk.

Part 5: Afsluiting (~5 min.)

Q5.1. Denkt u dat er nog andere personen van uw afdeling zijn met wie ik zou moeten praten om meer inzichten te verkrijgen?

Als u geïnteresseerd bent in de definitieve versie van het onderzoek, kunt u me dit laten weten en zal ik graag het rapport delen zodra deze is goedgekeurd door de universiteit.

Dank u voor uw waardevolle tijd! Ik vraag u ook vriendelijk het toestemmingsformulier te ondertekenen om uw gegevens veilig te houden en ervoor te zorgen dat de gegevens alleen voor dit onderzoek worden gebruikt.

Met vriendelijke groet,

Shaun Alex,

MSc- Construction Management & Engineering, TU Delft.
Afstudeerstagiair bij Hoogheemraadschap van Delfland.

(ENGLISH VERSION)

INTERVIEW QUESTIONNAIRE

This interview consists of five parts and will take ~60 minutes to complete. An overview of the research can be found in the document titled 'Overview of Research'. You could contact me via email at [redacted] or via mobile at +31[redacted] in case you need additional information or to clarify any doubts.

Part 1: Introduction (~5 min.)

Q1.1. *Self-introduction of the researcher*

Hello, I am Shaun Alex, a master's student in Construction Management & Engineering at TU Delft. Currently, I am in the last phase of my studies pursuing my graduation research in the above-mentioned topic. I am interested in sustainability topics in the built environment like circular economy and energy transition and thus, in collaboration with Hoogheemraadschap van Delfland, I decided to pursue this research. In my free time, I enjoy playing cards or sweating it out playing badminton or football.

Q1.2. *Introduction of the interviewee:*

- Name-
- Role at the organization-
- Years of experience-
- Have you worked in circular initiatives? If yes, which project(s)-

Q1.3. *Introduction to the research*- Please refer to the attached document titled 'Overview of research' which is useful in answering the questions that follow.

Part 2: Desired state of organization post-change (~10 min.)

Q2.1. From literature reviews, I have arrived at a set of goals for the desired state of the organization post-change. These goals for each aspect (namely, People, Work Process, Structure, and External) are listed below. In your daily practice, do you recognize the need for these goals for the organization to accelerate the transition?

Goals
People
P1. Cultivate a supportive and shared mindset.
P2. Develop competencies essential for the transition
Work Process
W1. Business case to value case
W2. Redesign processes to incorporate circular practices
Structure
S1. Intra-organizational transparency and collaboration.
S2. Managerial commitment (leadership and political)
External
E1. Best practices in knowledge sharing
E2. Effective collaboration with external stakeholders

Q2.2. Do you have any other suggestions on other important goals that you recognize within your organization in each of the four aspects?

Q2.3. Do you think all these aspects have to 'unfreeze' or 'transition' simultaneously or one after the other? Please indicate the order if you think it should be sequential.

Part 3: Barriers/enablers within water boards (~10 min.)

Q3.1. What are the crucial barriers and enablers that you have observed in each of the four aspects within your organization, or for water boards in general?

Part 4: Process steps for organizational change (~30 min.)

Q4.1. Using the Unfreeze-Transition-Refreeze process, could you suggest steps that could better align the internal organization of water boards to achieve circular infrastructure?

PEOPLE:

- ***P1- Cultivate a supportive and shared mindset-*** Currently, linear culture is ingrained in ways of working. The mindset is that circularity is an additional task, but rather

should be a new way of thinking and working. In addition, in traditional organizations like water boards, there is a risk-averse tendency. Is that true for the water boards? How can we change?

- ***P2- Develop competencies essential for the transition-*** Studies highlight the need for employees' skills and competencies. Do you think the water boards have enough resources and competencies within to enable the transition? What could be done to change the current situation?

WORK PROCESS:

- ***W1- Business case to value case-*** Due to the political nature of water boards, currently, financial management is through factors like efficiency or lower rates. With circular practices, however, the aim should be to add value to every step of the life cycle of a process. What do you think of this? What could be done to bring about a transition to start considering projects from a value case perspective?

- ***W2- Redesign processes to incorporate circular practices-*** To close resource loops, we may have to make work processes more flexible and redesign the process. How could we incorporate changes to make work processes more flexible?

STRUCTURE:

- ***S1- Intra-organizational transparency and collaboration-*** To seamlessly integrate circular practices, intra-organizational boundaries between departments should be transparent and eliminate silo-thinking. Also, there needs to be a clear distinction between roles and accountability of actions. Do you have suggestions from your experience on how to achieve this for circular transitions?

- ***S2- Managerial commitment-*** In the context of water boards, leadership and political commitment of the governing body becomes crucial. How can we ensure the commitment of the management body over political agendas and financial constraints? What could be done to improve their commitment towards circular transitions?

EXTERNAL:

- ***E1- Best practices in knowledge sharing-*** How can we ensure that we absorb knowledge and technology from market developments? How can we better align our internal organization for this?

- ***E2- Effective collaboration with external stakeholders***- Value creation for all in the network.

PART 5: Closing (~5 min.)

Q5.1. Do you consider that there is any other person from your department I should talk with to obtain more insights?

If the interviewees are interested in the final version of the research, they can let me know and I will gladly share the report once approved by the university. Thank you for your valuable time! I also request you to kindly sign the consent form to keep your data safe and ensure that the data will only be used for this research.

Thanks and regards,

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Appendix B

Initial Change Framework

The following Figure B.1 shows the initially developed framework before including the improvements from validation phase.

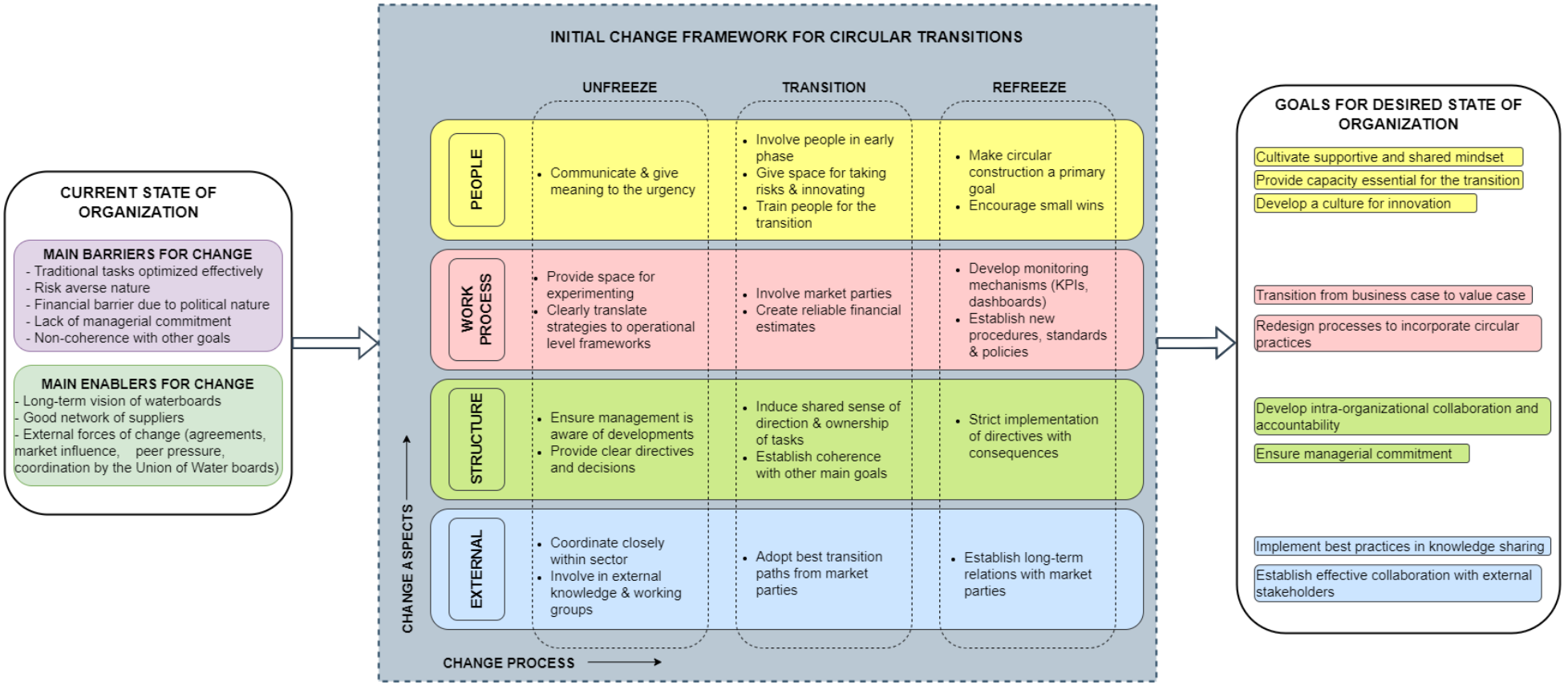

Figure B.1: Developed initial change framework before validation

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