Delft University of Technology
Faculty of Civil Engineering and Geosciences
MSc Construction Management and Engineering (CME)

MSc Thesis

Investigating Governance of Circular Infrastructure Projects

Proposing a governance framework to counter challenges in the inter-organizational collaboration for circular infrastructure projects

Ioannis Pantelidis

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on the subject of

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By

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Acknowledgements

Writing a thesis, is always a challenging and demanding process. The one that you are holding in your hands (or maybe reading through your screen) was not an exception. I cannot even recount the days and nights (mostly nights) that I have went through trying to understand what governance is, how it is related to the concept of circular infrastructure, and, in the bottom line, how can circular infrastructure projects become the "new normal". I feel, however, lucky that I chose this fascinating subject as my graduation theme. Through this research, I became familiar with principles of circular economy, and the challenges that the infrastructure sector is about to face in the near future. Now, that I have completed my thesis, I can say that I have become a firm believer in Circular Economy, and I can understand the need for a new, circular way of building and managing infrastructure. With that being said, I would like to thank all the people that have contributed to this research, and without them, this thesis could not be completed.

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Giannis

Abstract

Circular Economy (CE) is a new economic development paradigm that is proposed as a counterweight to the traditional "take, make, use and dispose" model, known as Linear Economy (LE). To cope with the increasingly environmental impact of construction, a transition towards CE can be the solution. To that direction, several circular initiatives in the Netherlands, have provided an array of circular infrastructure projects that have been completed or are near completion. Scholars and practitioners alike have pinpointed the significance of inter-organizational collaboration, in the development of circular projects. However, this field is inadequately researched. This research investigates collaboration, under the prism of *governance*, defined as the set of rules and procedures, that govern the collaboration in the project environment. The aim of this study is to identify the governance arrangements that are in place in circular infrastructure projects and provide a framework of governance that could resolve known collaboration challenges. To that direction, first a literature review is conducted, to identify governance arrangements, based on the literature on *inter-organizational, network and collaborative governance* and *collaboration in the circular economy.* The findings are utilized to develop a research framework. This framework is validated through a multiple case study, where 14 participants across 3 circular infrastructure projects are interviewed regarding the governance arrangements that are in place. As a result, an elaborated framework of governance for circular infrastructure projects is proposed. The framework contains governance arrangements across 7 different dimensions of governance, namely *Goal Setting, Rewarding, Monitoring, Capability Building, Roles and Decision Making, Coordination* and *Motivation.* Lastly, through this research recommendations towards practitioners on the field of circular infrastructure are given. Those include: *Making a clear distinction between circular project and circular sector, Developing circular projects as a way to alter the sector, Generating and sharing knowledge, Investigate the capabilities of actors and select partners based on their skills and motivation, Utilize traditional forms of collaboration when the necessary capabilities are absent, Consider reputation and future business opportunities as the main incentive for participation in circular infrastructure projects,* and *Achieve external support through cultivating an intra-organizational circular mindset, showcasing results and achieving positive reputation.*

Executive Summary

Introduction

Circular Economy (CE) is a new economic development paradigm that is proposed as a counterweight to the traditional "take, make, use and dispose" model, known as Linear Economy (LE). It promotes maximum reuse and recycling of materials to radically decrease waste generation, through innovating the entire chain of production, distribution, and recovery of useful materials. with respect to the ecological constraints of the planet (Ghisellini et al., 2018). The built environment contributes significantly to environmental problems such as resource depletion, climate change and pollution (Van Bueren, 2012). In the Netherlands, the construction sector uses annually more than half of all raw materials. Furthermore, it is responsible for 40% of the total energy consumption, 30% of the total water consumption as well as for about 35% of the CO_2 emission (Circulair Construction Economy, 2018).

To cope with the increasingly environmental impact of construction, a transition towards CE can be the solution. This can be observed in the initiatives of public entities and organizations such as the Ministry of Directorate-General for Public Works and Water Management (Rijkswaterstaat) that aim to work in a circular and climate-neutral way by 2030 (Rijkswaterstaat, 2019). Circular infrastructure is aimed to replace the traditional way of developing infrastructure in the Netherlands. To that direction, several circular initiatives in the Netherlands have provided an array of circular infrastructure projects that have been completed or are near completion. Circular projects are performed outside the boundaries of a single organization or party, and therefore they can be initially characterized as interorganizational projects. Although the importance of collaboration for achieving circular objectives, is noted by scholars and practitioners alike (Leising et al., 2017; Circulair Construction Economy, 2018; Brown et al., 2020; Kooter et al., 2021), collaboration under CE principles for infrastructure projects is not yet systematically investigated (Hanemaaijer et al., 2021; Korhonen et al., 2018; Brown et al., 2021).

Setting the problem

As mentioned above, collaboration between actors in circular infrastructure projects is inadequately researched. Moreover, scholars agree that collaboration of involved parties is critical for the accomplishment of circular objectives (Brown et al., 2021). Consequently, it is of scientific value to investigate the collaboration process. On the context of this research, collaboration is examined under the prism of governance. Governance is defined as *the set of rules and procedures, that are utilized to coordinate, adapt, and safeguard economic exchanges among actors on the project environment.* This set of rules, processes and procedures are named governance mechanisms or governance arrangements. They can be grouped into key dimensions. The combination of specific governance arrangements constitutes the governance of a project. The specific research gap that this research aims to resolve, is the identification of the governance arrangements that are imposed in circular infrastructure projects, and how they relate to collaboration challenges.

Based on the above, the aim of this study is twofold. First, to investigate how interorganizational collaborations for circular infrastructure projects are governed, by identifying the governance arrangements that are utilized, and second to identify collaboration challenges and propose governance arrangements that can resolve these challenges. Therefore, the research question that is formulated is the following:

Research Question: How are inter-organizational collaborations for circular infrastructure projects governed, which challenges relate to governance and how could the associated governance challenges be tackled?

Methodology

To answer the research question, a combination of a literature review and a multiple case study was utilized. First, through a literature review the theoretical framework of the research was established. Then a qualitative multiple case study (multi-case study) was selected as the research method of choice. The data gathering method was semi structured interviews, and as a secondary method, project documentation, to validate the claims of interviewees and describe the collaboration procedure. Through these, the theoretical research framework was transformed into a governance framework for

circular infrastructure projects. This was achieved by identifying which governance mechanisms were relevant, with elements added or removed accordingly.

As a first step, the theoretical framework was set, through a literature review. It regarded the concept of governance in the project environment. Based on the conceptualization presented in the previous chapters, this was simplified to identifying governance arrangements or mechanisms and the factors that affect them. The three relevant terms that are investigated were *interorganizational governance, network governance and collaborative governance*. The next step regarded the adaption of the framework to the unique characteristics of circularity. First, collaboration characteristics were identified based on a literature review. Scholars have identified several elements that are apparent in a circular building environment (Brown et al., 2020; Kooter et al., 2021). Based on their work, the theoretical framework was adapted for circularity.

After setting the theoretical framework, a multiple case study, was conducted. Regarding the cases, three cases of circular infrastructure projects were selected based on five different criteria, namely *circular infrastructure projects, circularity as a core objective, public and private parties are involved, recently completed or ongoing projects, and availability of information*. As a data gathering method, a combination of semi-structured interviews with project participants, and project documentation was selected. Regarding the interviewees, 14 participants were selected from public and private parties with roles ranging from, project leaders, project managers and circularity advisors to contractors and suppliers. The case study aimed to identify similarities and differences across governance arrangements in each case, as well as identifying project specific challenges.

Theoretical framework

Based on a literature review, a framework of governance was designed. The framework was a follow-up from the work of Kujala et. al., (2020) on project network governance, however, it was enriched based on other works regarding *inter-organizational governance* and *collaborative governance.* It was also adapted based on the literature for circular infrastructure projects. The initial research framework can be seen bellow.

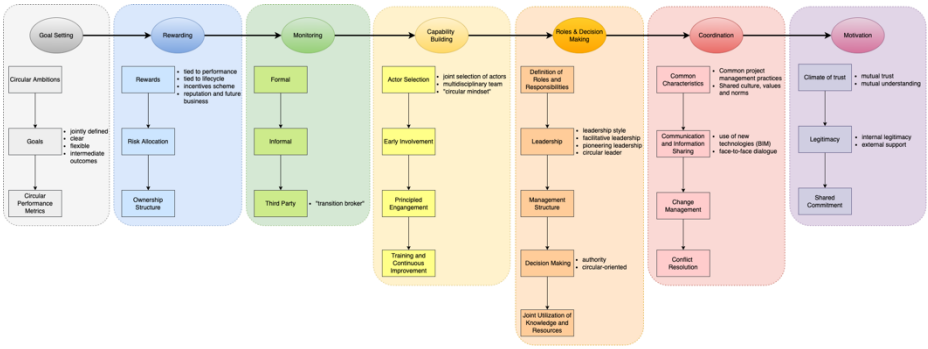

Figure 1: Research Framework of Governance for Circular Infrastructure Projects. Own work.

Multiple case study and results

Based on the multiple case study, an elaborated framework of governance was proposed, in order to cater for collaborative challenges in the context of circular infrastructure projects. The framework is explained bellow, following the categorization of governance dimensions.

In *Goal setting* it is observed that *circular ambitions are introduced before the project commences,* and the *introduction party is on principal the public client.* However, in order to materialize these ambitions into concrete circularity goals, a *collaboration between public and private parties* is needed. Another observation that relates to a known challenge, regard the *clarity of circularity ambitions*. Furthermore, *goals are jointly defined,* while an observation is that those projects leave room for private parties to achieve their *personal and organizational goals.* Intermediate outcomes that regard *knowledge*

generation and share, are apparent across the cases. Goals are also *clear* among project participants. Regarding flexibility, *initial goals are inflexible* but there is *flexibility* in achieving sub-goals. Lastly, regarding goals, *focusing on few goals, instead of having diverse or contradicting goals* can also be regarded as a governance mechanism. For performance metrics, a *combination of different metrics* is utilized, while *consensus on metrics selection* is also noted as important. This can be achieved by *joint definition of circular performance metrics.*

For *Rewarding*, it is observed that there are (*small) financial incentives for participation in circular initiatives,* before the project commences. However, there are no financial incentives during the tendering, for circular solutions. Therefore, another proposed governance mechanism regards *financial incentives in the tendering*. An additional incentive concerns *experience and knowledge on circular projects.* Across the cases, it is noted that *future business opportunities and (positive) reputation* is the main incentive for participation in a circular project. *Risks* are *jointly allocated,* however, *each participating party is accumulating different types of risks* based on their role and capabilities, in order to manage it better. For innovative solutions, *testing and certification* is utilized *as a risk mitigation measure,* both internally and from external parties. Lastly, regarding *ownership*, it is observed that *projects are owned by the public client*, however other *secondary outcomes are jointly owned by all parties.*

For *Monitoring*, there are three *different layers of monitoring, internal, external, and intra-organizational,* observed. Furthermore, monitoring is in principled performed *informally, as a consequence of collaborative approach* and through *third-party auditing for certification of innovative solutions. Formal monitoring and control by the public client* are proposed as a measure to resolve challenges that refer to compromise on the circularity of the selected solution. Furthermore, *Internal financial monitoring by project participants* can also contribute to trust and legitimacy among partners.

In the *Capability Building* dimension, it is observed that parties are selected to participate based on *non-traditional selection criteria,* that could include quality, circularity and sustainability. Furthermore, actors are selected *based on expertise and past relations.* However, it is also proposed to *select actors based on their capabilities*, especially regarding functioning in a collaborative environment. *Multidisciplinary teams* are also noted as a governance mechanism, particularly *the involvement of actors that are not traditionally participate in collaborations,* such as demolition experts and recycling companies. Regarding *involvement*, actors are *early involved through the circularity initiatives.* However, *involvement of private actors during the requirements phase,* can potentially resolve challenges that regard contradicting requirements, or unclear vision. *Continuous involvement of actors, across project phases*, is also noted as important. Lastly, regarding training and improvement, it is observed that *training of actors* took place *during their participation in circularity initiatives,* while *improvement of capabilities* during the project, regards both *circularity and interorganizational collaboration*. It is also noticed that *public actors need to improve their capabilities* in order to participate equally in circular projects.

In the *Roles and Decision-Making* dimension, *clarity of roles and responsibilities* is a common mechanism. An additional mechanism, regard the *participation of public and private actors in the same role*, as due to their differences in power and responsibilities, the role is enormously strengthened by dual participation. Furthermore, it is observed that *traditional roles and responsibilities* change in circular infrastructure projects. For instance, *private actors are needed to be more willing to share*. The *establishment of a common competencies environment,* also facilitates the *acknowledgement of role changes* and acquisition of the required capabilities. Lastly, it is implied that to account for challenges regarding collaboration, a change to the *traditional role of client-contractor during the project implementation,* is preferred. In *decision making, three different layers* are acknowledged, namely the project level, were *decisions are taken jointly,* the *higher level* (or the steering group), were *important decisions are taken*, and the *external level*, where usually *political decisions* that affect the project are taken. However, it is noted that *public actors need to be more actively involved in the decision-making*, so that there is no compromise on the solution. The *differences in the decision-making models of project parties* are also noted, and it can potentially lead to problems, such as miscommunications or delays. Therefore, an *alignment between the decision-making models of external and project organizations* is proposed. Lastly, *regarding utilization of knowledge and resources*, it is noted that there is *joint*

utilization by public and private parties in the project level, however *private parties can also utilize knowledge among themselves*, or they can *utilize knowledge and resources themselves, intra-organizationally.* Another common observation regards the *differences in the attitude towards knowledge sharing* by the project actors. This can be explained based on their role within the project. A last governance mechanism relates to *joint utilization of resources across public clients,* something that can possibly enhance the possibilities of circular infrastructure projects.

In the next dimension, *Coordination,* first it is observed a *diversity in the characteristics and practices of involved parties*, something that stem from the *multidisciplinary* character of the projects, and the *collaborative approach* in the development. However, actors not necessarily see that as a difficulty, as they acknowledge the power of diversity, in achieving circular objectives. The next observation regards, the *cultivation of a shared culture, based on early involvement in circularity initiatives,* as participation in similar initiatives is indicating a (positive) change on mindset towards circularity. *A common vision towards the project, that stems through a clear communication* is also observed, as a way to resolve challenges regarding scope change. Regarding *communication*, *personal meetings and applications* are utilized, while for *information sharing*, a *common environment* is noted as important. This common environment should be ideally *established jointly* by all project participants. Changes, regard the *scope*, the *goals* and the *specific solutions*, and they are *managed in accordance with the decision-making structure*. The same applies for *conflicts*. They are resolved both *internally in the project level, based on dialogue and negotiations*, and *externally*, in the *higher level,* when they *regard budgeting and other important decisions*.

For the last dimension, *Motivation,* actors acknowledge the need to *cultivate a climate of trust*. They proposed a plethora of ways to achieve that, with the similar ways being, *accepting responsibilities*, creating *common goals and interests* and being *open* and *transparent*. Concerning *legitimacy*, it is observed that *internal legitimacy is closely connected to trust.* Furthermore, frequent *communication*, *intrinsic motivation* for circularity, *showcasing results*, and *having a clear division of roles and responsibilities*, are all mechanisms that cultivate internal legitimacy. *Transparency in financial issues* also enhances internal legitimacy. For *external support, communicating results, achieving a positive reputation* and *showcasing profitability* is considered important. Furthermore, *a positive stance of the parent organizations towards circularity,* is considered equally important to achieve support. Lastly, engagement of project participants is achieved based on *intrinsic motivation* on circularity, and by having *common goals and rewards.* The proposed framework of governance for circular infrastructure projects is illustrated bellow.

Figure 2: Proposed Governance Framework for Circular Infrastructure Projects. Own work.

Discussion

It is observed that there is a large correlation, between arrangements identified in the literature, and arrangements that are identified through the case study. However, some of the mechanisms are in practice, expressed differently than literature suggests.

Based on the analysis, several interactions are suspected between the different governance arrangements. Those include arrangements that are expressing the same condition, such as *Room for personal and organizational goals* in the goal setting dimension, and *Experience and knowledge on circular projects as incentive,* that can be adjoined when referring to private parties. Another possible connection regards arrangements that are prerequisites of one another, such as the *Involvement of private actors in the requirement phase* and the *Materialization of ambitions through collaboration between public and private parties,* as the latter is a direct prerequisite of the former. A third possible connection refers to arrangements that are sub- or hyper sets of the other. For instance, the two mechanisms *Multidisciplinary teams* and *Involvement of actors that are not traditionally involved in collaborations,* are related, as the latter is a subset of the former.

A third discussion subject is the acknowledgment of project participants that standardization of circular infrastructure projects, as the main challenge. Circular infrastructure projects are seen as "isolated islands of innovation", in a traditionally rigid infrastructure sector. To achieve this standardization, three individual steps are identified. They relate to 1) willingness on behalf of the participants to pursue circular projects, 2) establishment of a circular supply chain, and 3) systematic gathering and sharing of knowledge regarding circularity.

Limitations

- A multiple case study was selected as the method of choice. It consisted of three cases of infrastructure projects. A different combination of cases could provide different results, regarding the identified governance arrangements.
- All cases concerned the development of circular bridges, therefore other type of infrastructure projects, such as roads or water and sewage treatment plants can showcase different governance arrangements.
- Two of the selected cases were atypical of standard infrastructure projects in the Netherlands. Case A was developed in an "innovative environment" and Case C considered more the development of a business case for reusing girders that the construction of an actual viaduct. Moreover, Case C, was developed on a non-profit basis. Therefore, those cases didn't indicate typical challenges regarding financial and permitting issues.
- The initial research framework is based on *inter-organizational governance, project network governance and collaborative governance*. However, circular infrastructure projects in practice are developed as innovative projects. Therefore, the concept of innovation is relevant, and through a literature review on *innovative collaboration* other governance arrangements could be identified. For instance, the concept of *intellectual property management* is absent from the current framework.
- As a data gathering method, a combination of semi-structured interviews and project documentation was selected. However, sensitive documents such as contracts were not available. Furthermore, the available documentation was not showcasing any relevant information on governance arrangements, and therefore it was utilized only to support the claims on the interviews and describe the process in the projects.
- Semi-structured interviews were conducted with project participants. However, some critical actors, such as circularity advisors and contract managers were not available for an interview. Moreover, the interviews were conducted remotely, with a specified timeslot. Therefore, some critical information regarding the selection of governance arrangements could be omitted.
- The extensiveness of the research framework poses a limit to the depth of the analysis and the level of detail that was permitted during the interviews. Therefore, governance arrangements could have been omitted, or not given the proper attention.
- Information regarding relevant governance arrangements, such as *circular leadership*, or *new competencies* was limited. Therefore, although those elements are considered important for a governance framework for circular infrastructure projects, they were omitted on the basis of availability of information.
- As an outcome, a framework of governance for circular infrastructure projects is presented. Although the framework illustrates the governance arrangements on each case, generalization across circular infrastructure projects cannot be claimed.

- The governance framework, as presented in the previous chapters, can be utilized to systematically examine circular infrastructure cases, and not as a guideline regarding the appropriate governance arrangements that should be utilized in circular infrastructure projects.

Recommendations for practitioners

- Make a clear distinction between what is a circular infrastructure project and what entails a circular infrastructure sector.
- Circular projects as a way of changing the construction sector.
- Knowledge generation and information sharing are important to standardize circular infrastructure projects.
- Early collaboration between public and private parties is important, to capitalize on knowledge and experience of private actors and authority of public actors.
- Investigate the capabilities of actors for collaboration, select actors based on their skills and intrinsic motivation.
- If an organization lacks the capabilities to collaborate, a traditional approach should be preferred.
- Positive reputation and future business opportunities, as the main incentive for participation in circular infrastructure projects.
- Engage and achieve the support of external actors, through cultivating an intra-organizational circular mindset, showcasing results and achieving positive reputation.

Recommendations for future research

- Enrich the framework with governance arrangements and antecedents that are stemming from literature on collaboration for innovative projects and perform a multiple case study with the new framework.
- Validate the framework through a multiple-case study concerning a combination of different circular infrastructure projects.
- Perform a Qualitative Comparative Analysis (QCA) in order to identify which configuration of governance mechanisms lead to successful circular infrastructure projects.
- Investigate the connection between governance antecedents, or pre-existing, external factors, and specific governance mechanisms in the context of circular infrastructure projects.
- Identify possible interactions between the different governance arrangements, for circular infrastructure projects.

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1 Introduction

In this chapter, an overview of the main research themes is presented. First, the concept of the circular economy is discussed, and an elaborated definition is given. Then, the importance of circular economy in the building sector is noted, and the strategies that are utilized to achieve circular objectives are presented. In the next sub-chapter, the concept of circular infrastructure is presented, and a definition of the term is given. In the two final sub-chapters the main research themes of the research are presented, namely collaboration and governance of circular projects. In those sub-chapters, the importance of interorganizational collaboration to meet circular goals is noted, and governance is proposed as a concept to understand and investigate collaboration in the (circular) project environment. Consequently, a definition of governance is given, along with a conceptual illustration.

1.1 The concept of circular economy

Circular Economy (CE) is a new economic development paradigm that is proposed as a counterweight to the traditional "take, make, use and dispose" model, known as Linear Economy (LE). It promotes maximum reuse and recycling of materials to radically decrease waste generation, through innovating the entire chain of production, distribution, and recovery of useful materials, with respect to the ecological constraints of the planet (Ghisellini et al., 2018). In a CE environment, the original concept of waste is reversed, with products being designed for reuse and recycle at the end of their life, thus creating loops of production and consumption. (Ghisellini et al., 2016). The creation and sustain of material loops are highlighted by Ellen MacArthur Foundation (EMF), a pioneering organization regarding CE. Based on EMF, *"a Circular Economy is an economic and industrial system where material loops are closed and slowed, and value creation is aimed for at every chain in the system"*. Pollice and Batocchio (2018) define CE as a synthesis of ideas (C2C, natural capitalism, performance economy etc.) aiming by design to provide an environment that is restorative and regenerative.

As indicated above, many definitions of CE exist in the literature. This can be partly attributed to the fact that organizations prefer to define CE, according to their own standards, instead of changing their businesses (Nobre & Tavares, 2021). Perhaps the most elaborative definition of CE, can be derived by the work of Nobre and Tavares. In their paper, *the quest for a circular economy final definition: A scientific perspective (2021)* they propose an elaborated definition of circular economy, by following the 5W1H concept - *What, Where, Why, When, Who and How*. Consequently, they define CE as *"an economic system that targets zero waste and pollution throughout materials lifecycles, from environment extraction to industrial transformation, and to final consumers, applying to all involved ecosystems. Upon its lifetime end, materials return to either an industrial process or, in case of a treated organic residual, safely back to the environment as in a natural regenerating cycle. It operates creating value at the macro, meso and micro levels and exploits to the fullest the sustainability nested concept. Used energy sources are clean and renewable. Resources use and consumption are efficient. Government agencies and responsible consumers play an active role ensuring correct system long-term operation*" (Nobre & Tavares, 2021, p.10). The authors aim to decouple the concept of CE -an economic model- from known enablers, techniques and tools that are utilized to achieve it, as well as from other applied or relevant concepts. Towards that direction, they developed a CE framework. The framework is presented on Figure 1. On the context of this analysis, their framework of CE is relevant and consequently the definition of Nobre & Tavares (2021) is adopted. Emphasis is given on the different enablers of CE, including the adoption of new business models and knowledge sharing, as well as the different levels in which CE can be implemented. Furthermore, basic CE principles, such as the 9R framework, are also relevant and thus they are presented below.

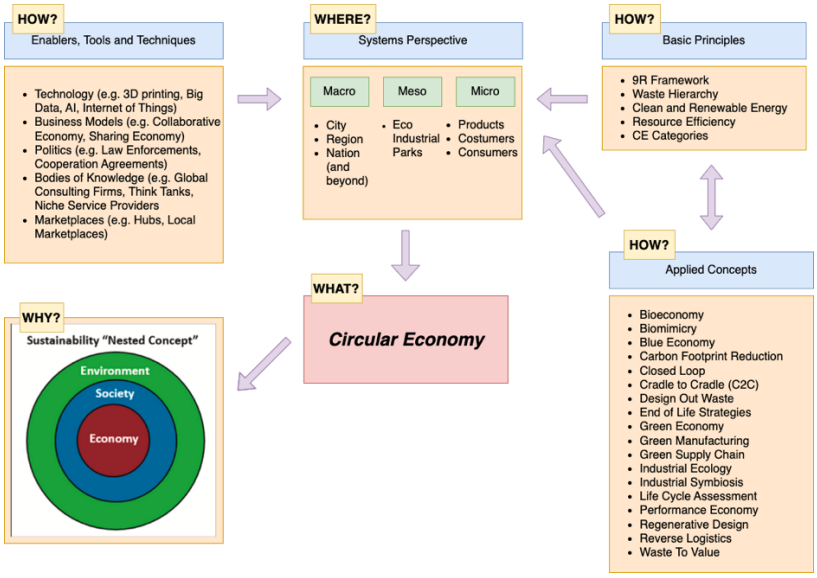

Figure 3: The Circular Economy Framework (Nobre & Tavares, 2021)

1.2 Principles of the circular economy

As explained, CE aims at minimizing natural (finite) resources usage and waste generation along the value chain. To accomplish it, different strategies can be utilized. Those strategies known as R-strategies, can be often found in elaborated R-lists. Several such lists exist in the literature; however, they resemble each other, and their main differences lie in the number of circular strategies included in each list (Potting, et al., 2017). For this research, the conceptual framework of 9Rs, adopted by PBL Netherlands Environmental Assessment Agency, is presented. The conceptual framework of 9Rs identifies 9 different strategies to promote circularity (Potting et al., 2017) clustered into three general categories referring to smarter product use and manufacture, extension of product lifespan and useful application of materials. Strategies are generally ordered from high circularity (low R-number) to low circularity (high R-number) (Potting et al., 2017), with high circularity strategies generally perceived as better to achieve CE aims. The different strategies and their categorization can be seen in Figure 2. CE strategies can be implemented in various fields and industries, including the construction sector.

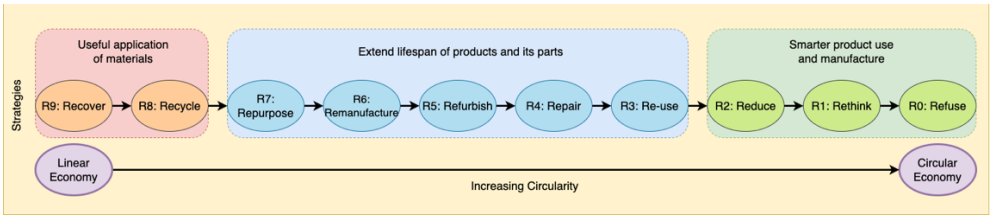

Figure 4: The Concept of 9Rs - Circularity Strategies in the production chain (Potting et al., 2017)

1.3 Circular economy in the building sector

The built environment contributes significantly to environmental problems such as resource depletion, climate change and pollution (Van Bueren, 2012). Construction requires a vast amount of extracted materials (about 50% in the European Union (EU)) and is responsible for over 35% of the EU's total waste generation. At the same time, greenhouse gas (GHG) emissions from material extraction, manufacturing of construction products and construction of buildings accounts to 5-12% of the total national GHG emissions. (European Commission, 2020).

In the Netherlands, the situation is similar. According to *Circular economy in the Dutch construction sector: A perspective for the market and government* (2015) the construction sector uses more than

half of all raw materials in the Netherlands. Furthermore, it is responsible for 40% of the total energy consumption, 30% of the total water consumption as well as for about 35% of the CO_2 emission (Circulair Construction Economy, 2018). Additionally, large waste flows, more than three times as much as household waste, are created through construction, demolition and renovation (Circulair Construction Economy, 2018). Construction materials aren't generally scarce and therefore scarcity cannot be perceived as an issue. However, waste flows constitute in recent years the main concern, regarding the environmental impact of construction (Schut et al., 2015). Furthermore, environmental pollution and excessive use of fossil fuels are all byproducts of the construction industry (Circulair Construction Economy, 2018).

A unique characteristic of the Dutch construction sector is that most construction and demolition waste (97%) is reused, alas in low grade applications for infrastructure projects (Circulair Construction Economy, 2018). Specifically, demolition material is treated as a secondary raw material, often used as a road base or filler material (Schut et al., 2015). This is partly for feasibility and financial reasons, due to lack of locally harvested raw materials such as quarry stone (Schut et al., 2015). Even though, recycling doesn't apply to all different subsectors of the construction industry. For instance, in the building sector, hardly any secondary material is utilized (3-4%) (Schut et al., 2015). This uneven field between supply and demand pose a future risk of oversupply of secondary materials that would end up as waste as there would be no need for them in the construction chain (Schut et al., 2015).

Based on the aforementioned, the construction sector in the Netherlands, can be perceived as almost circular. However, this is far from the truth (Schut et al., 2015). As indicated in the previous paragraph, recycling of demolition materials hardly constitutes CE. Recycling can be characterized as a "low" circular strategy based on the 9R's framework. A truly circular construction sector would require other higher- circulation strategies to be implemented. However, such strategies are not yet universally adopted.

To cope with the increasingly environmental impact of construction, a transition towards CE can be the solution. This can be observed in the initiatives of public entities and organizations such as the Ministry of Directorate-General for Public Works and Water Management (Rijkswaterstaat) that aim to work in a circular and climate-neutral way by 2030 (Rijkswaterstaat, 2019) and ultimately have a nationwide circular environment by 2050 (Circulair Construction Economy, 2018, Rijkswaterstaat, 2019). Furthermore, researchers and organizations alike, have identified that circularity principles aim to significantly reduce the environmental impact of buildings (Norouzi et al., 2021; Rijkswaterstaat, 2019). The European commission actively promotes the adoption of circularity principles by, among others, recycled content requirements for construction products, promotion of digital logbooks for buildings and integration of life cycle assessment in public procurement (European Commission, 2020). Scholars have identified other incubators of CE activity within construction industry, such as, supplier take-back systems, use of recyclable and recycled materials and product-as-a-service (Paas) systems (Jones et al., 2017). Organizations emphasize the need for circular procurement and tendering, circular design, cooperation between the involved parties and adoption of new business models as well as pilot projects that can kickstart the transition (Schut et al., 2015; Circulair Construction Economy, 2018)

Although in the construction sector, innovation diffuses rather slow (Fernie et al., 2006), public and private initiatives have led to a collection of projects, where circular initiatives were taken (SPP Regions, 2017). An example of circular infrastructure is the case of the first circular viaduct in the Netherlands as presented by Leffers J., Moustafa A. & Voorstman, C. (2022). The recently completed project, was designed according to circular principles. It could be dismantled and then re-used or re-purposed in another location. The project was utilized through a partnership agreement among a small group of organizations, including Rijkswaterstaat and private parties. Other organizations followed with infrastructure projects that adopted circular principles. To name a few, Circular City, a combination of 18 trial projects across 9 Dutch Municipalities, the Circular Road, a partner program where the business model of infra-as-a-service is examined through seven pilot projects and the Bruggencampus, an initiative that entails the construction of four circular and sustainable bridges in Almere. Other public parties, such as Dutch municipalities, have individually developed circular infrastructure projects. Projects such as the replacement of the quays in Merwedekanaal, Utrecht, the renovation of the Cruquiusbrug bridge and the Terwolde water treatment plant are developed on circular principles.

1.4 Circular infrastructure

Regarding infrastructure, it is observed that there is no unanimous definition of the term across the different academic fields. This is partly because several definitions of infrastructure are related to attributes and specific functions (Torrisi, 2009). Infrastructure is distinguished between *personal*, related to human capital, *institutional*, related to norms, institutions and procedures and *material* infrastructure (Jochimsen, 1966; Buhr, 2003). Material infrastructure refers to interrelated systems of physical components that are designed to address a social need (Fulmer, 2009). In the context of this research, material infrastructure is relevant. Therefore, infrastructure can be defined as "*the physical components of interrelated systems providing commodities and services essential to enable, sustain, or enhance societal living conditions*." (Fulmer, 2009 p. 32.)

As to what infrastructure entails, it is observed in literature that infrastructure is perceived as an umbrella term that includes a variety of systems, ranging from transportation systems such as roads or ports, to communication and energy grids. For example, Fulmer (2009) names five separate sectors of infrastructure, regarding *electric power, oil and gas, potable and wastewater, transportation, and communications*. According to Buhr (2003), material infrastructure can also include *education and health facilities, equipment of energy and water provision, facilities for sewage, garbage disposal, and air purification, building and housing stock, facilities for administrative purposes and for the conservation of natural resources*. However, on the context of this research the Rijkswaterstaat's categorization regarding infrastructure is followed. As a result, *buildings*, such as schools and hospitals and *networks* such as waste treatment and energy grids are excluded. Therefore, infrastructure entails systems relating to two broad categories. *Roadworks*, such as roads, tunnel and bridges, and *waterworks* such as dikes, dunes and water treatment plants.

The role of infrastructure as an enabler of CE activity is noted based on their economic and social significance and its long-term nature (Global Infrastructure Hub, 2021). However, systemic change and innovation are needed to advance the opportunities of circular infrastructure. (Global Infrastructure Hub, 2021). Organizations and networks such as Holland Circular Hotspot, Global Infrastructure Hub (GI Hub) and The Netherlands Organization for Applied Scientific Research (TNO) are acknowledging the potential of circular infrastructure to tackle environmental problems, such as resource depletion and climate change. Circular infrastructure is a relatively new and innovative concept that aims to incorporate circular principles in the infrastructure lifecycle. It stands on the cross-section between infrastructure and circular economy (Global Infrastructure Hub, 2021). A clear definition for circular infrastructure is lacking. However, on the context of this research and based on the previous paragraphs, circular infrastructure is interpreted *as a system of interrelated physical components, designed according to circular economy principles, that aim to address a social need while minimizing material consumption and waste generation.*

1.5 Collaboration in circular construction projects

Circular projects are performed outside the boundaries of a single organization or party, and therefore they can be initially characterized as interorganizational projects. This is noted by scholar and practitioners alike. (Global Infrastructure Hub, 2021; Kooter et al., 2021). *Interorganizational projects involve two or more organizational actors from distinct organizations working jointly to create a tangible product or service in a limited time period* (Jones & Lichtenstein, 2009). In this sense, there are two main characteristics that define interorganizational projects and distinguish them from other forms of collaboration. First, as stated above, they are performed outside the boundaries of one organization. Second, they are temporary organizations. In contrast to other interorganizational entities such as strategic alliances, interorganizational projects coordinate activities only for the lifespan of the project (Jones & Lichtenstein, 2009). In interorganizational projects, collaboration is needed between the involved parties. According to Galaskiewicz (1985) this happens for three main reasons: to obtain and to allocate resources, to form coalitions to enhance power, and to achieve community acceptance or legitimacy. This is apparent also in circular infrastructure projects. For instance, interorganizational co-operation is required between the supplier and the contractor as well as between the producer (client) and consumer (user) to manage the physical flows of materials and energy (Korhonen et al., 2018). In

practice, in at least one case, due to financial and procurement restrictions, a partnership between public and private actors was utilized, aiming to achieve legitimacy and power enhancement (Leffers J., Moustafa A. & Voorstman, C., 2022).

Moreover, in circular projects a network of participants is established. This network includes *public parties*, such as public clients, academic institutes and governmental bodies and *private parties*, such as contractors, suppliers, consultants and users. Those actors may have different agendas, but they need to collaborate to achieve circular objectives. The role of the public sector is especially noted throughout literature, as an enabler for circular projects. It acts not only as a regulator and policymaker, but also as a major economic actor, with a significant purchasing power (Klein et al., 2020). Furthermore, the public sector can act as a facilitator to the supply-chain coordination (Rijkswaterstaat, 2019), by bringing parties together and creating and sustaining circular networks. This critical process is referred here as *"matchmaking"*. The establishment of networks consisting of business companies and public authorities, can stimulate CE-type collaboration by sharing materials and co-utilizing energy (Korhonen et al., 2018). In "Netherlands Integral Circular Economy Report 2021" it is noted that the pace of transition towards a Circular Economy is influenced by policy (Hanemaaijer et al., 2021). This transition can be accelerated by the establishment of new business models and forms of collaboration between private and public parties. Scholars agree that collaboration of involved parties is critical for the accomplishment of circular objectives (Brown et al., 2021). Effective and comprehensive collaborations between scientists, policymakers, government, and companies is a prerequisite to achieve circular objectives (Ghaffar et al., 2020).

Although the importance of collaboration for achieving circular objectives, is noted by scholars and practitioners alike (Leising et al., 2017; Circulair Construction Economy, 2018; Brown et al., 2020; Kooter et al., 2021), collaboration under CE principles for infrastructure projects is not yet systematically investigated (Hanemaaijer et al., 2021; Korhonen et al., 2018; Brown et al., 2021). On the one hand, there are questions about the leadership on a circular network, the organization structure, and the decision-making processes, as well as questions about risk and profit sharing (Korhonen et al., 2018). On the other hand, the underlying collaborative processes are not clearly defined (Brown et al., 2021) and the significance of collaboration characteristics towards the achievement of circular objectives is not measured.

1.6 Governance as a mean to investigate collaboration

To understand collaboration in circular projects, the concept of governance is utilized. According to Bryson et al. (2015), governance stands on the intersection of collaboration processes and structures in cross-sector collaborations. In this sense, governance can be regarded as an integral part of interorganizational collaborations. In the next paragraphs, a conceptualization and a definition of governance is given.

Governance in the project environment, or project governance, is a concept that has gathered attention by researchers and practitioners alike (Ahola et al., 2014; Kujala et al., 2020). However, there is no unanimous consent on what constitutes project governance (Ahola et al., 2014). Some scholars associate project governance with the type of contract used in a project (Turner & Simister, 2001) while others identify the need to enrich the concept with stakeholder management and documentation procedures and communication (Ruuska et al., 2009), as well as decision making processes (Abednego & Ogunlana, 2006) and mechanisms regarding coordination and safeguarding of exchanges between partners (Ahola et al., 2014).

Regarding project governance, there are two relevant streams of literature. Project governance can be viewed as external or internal to the project organization (Ahola et al., 2014). In external governance the focus is intra-organizational. Principal agent theory is relevant and applied in the relationship between the project owner and the project. The interests of the owner lie in the strategic alignment and efficient execution of the project while project manager's interests are project-based or even personal, giving rise to agency issues. To align the interests of both parties, reporting practices, roles and monitoring structures are defined. (Ahola et al., 2014). Therefore, governance is defined in the

literature as a method for external control of projects, either by a single organization or a public client (Kujala et al., 2020). On the contrary, the focus in internal governance is inter-organizational. Projects are defined as a network of independent economic transactions, directed by a common goal. In the project environment, goals of the participating actors may differ or even contradict. Consequently, interorganizational governance refers to the establishment of a common set of rules and procedures that all project participants are expected to follow (Ahola et al., 2014).

As discussed, circular infrastructure projects are inherently interorganizational projects, and therefore the concept of interorganizational governance is relevant. Consequently, governance on the context of this research is defined as *the set of rules and procedures, that are utilized to coordinate, adapt, and safeguard economic exchanges among actors on the project environment.* This set of rules, processes and procedures are named governance mechanisms or governance arrangements. They can be grouped into key dimensions. The combination of specific governance arrangements constitutes the governance of a project. The selection of governance mechanisms is affected by pre-existing environmental factors or antecedents and imposes performance implications or outcomes (Roehrich et al. 2020). Consequently, by investigating the governance of a circular infrastructure project, the inter-organizational collaboration between the different actors involved can be explained. A conceptualization of governance is given below. The conceptualization is based on the works of Roehrich et al. (2019) and Kujala et al. (2020).

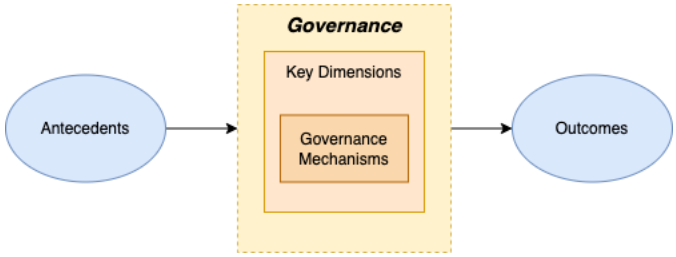

Figure 5: Conceptualization of Governance. Adapted by Roehrich et al., (2019) and Kujala et al., (2020)

2 Setting the Problem

In this chapter, the problem that this research aims to resolve is presented. First, the research gap is highlighted, and the research problem is set. It regards the absence of a complete framework of governance that aimed at facilitating collaboration in circular infrastructure projects. Next, the research question and sub-questions are formulated, and the objectives of this research are noted. The aim is to investigate collaboration on the basis of governance. This can be simplified by investigating the implemented governance arrangements and how can they be utilized to resolve potential challenges. The research design is also presented considering the way that the problem is aimed to be addressed. Specifically, a combination of a literature review and a multiple case study is utilized. Finally, a thesis outline is presented.

2.1 Problem statement

In the previous chapter, an introduction to the status quo of circular infrastructure projects in the Netherlands was made. As seen, Rijkswaterstaat aims to be circular by 2050 (Rijkswaterstaat, 2019) and consequently the infrastructure sector needs to be adapted to cater for circular demands. To that direction, several circular initiatives in the Netherlands have provided an array of circular infrastructure projects that have been completed or are near completion. Each project has started from a different basis, developed on a different (project) environment, and is governed on a different manner. Different organizations and people were also involved. Since collaboration is highlighted as a key aspect in circular projects, it is of scientific value to gather the experiences and knowledge of project participants regarding the collaboration procedure. This knowledge can be systematically investigated under the prism of governance. By investigating which governance arrangements are utilized in each project and the reasoning behind their selection, the governance framework of each case can be constructed. Furthermore, collaboration challenges can be identified and coupled with specific governance arrangements. Lastly, by comparing different cases and investigating similarities and differences, conclusions can be drawn about an optimal governance framework for circular infrastructure projects. As circular infrastructure is aimed to replace the traditional way of developing infrastructure in the Netherlands, a governance framework should be designed to set the rules of the collaboration between the different actors involved. This framework can provide the basis for reform of institutions to accomplish circular objectives. In this sense, the research problem can be regarded as the absence of a unanimous project governance framework that can facilitate circularity objectives. As mentioned above, collaboration between actors in circular infrastructure projects is inadequately researched. This gap in the literature is highlighted by scholars and practitioners alike (Hanemaaijer et al., 2021; Korhonen et al., 2018; Brown et al., 2021). Governance is equally under-researched. In this sense, this absence of knowledge can also be regarded as a research gap. The research gap can be schematically presented in Figure 4.

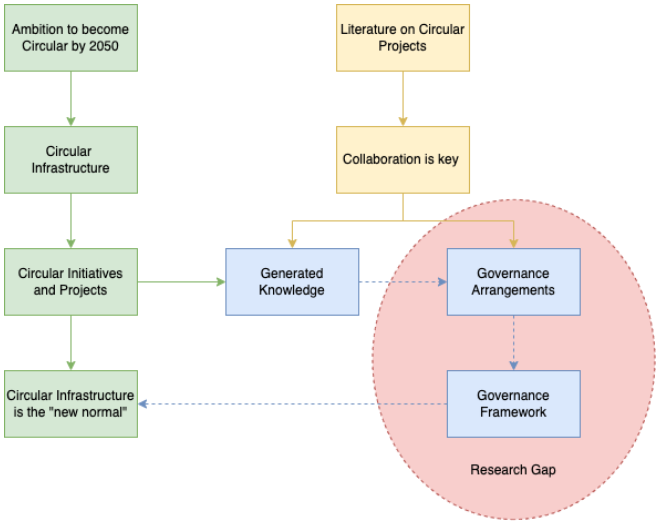

Figure 6: Research Gap. Own Work.

2.2 Research question

Based on the problem statement, the aim of this study is to investigate the governance arrangements and the associated challenges in interorganizational collaborations for circular infrastructure projects. Therefore, the research question that is formulated is the following:

Research Question: How are inter-organizational collaborations for circular infrastructure projects governed, which challenges relate to governance and how could the associated governance challenges be tackled?

To answer this question, several sub-questions are also defined. They emerge from the reasoning behind answering the main research question. Those are:

Sub-question 1: What is governance, and which are its dimensions, antecedents and mechanisms?

Sub-question 2: What additional requirements does circularity impose in the governance of circular infrastructure projects?

Sub-question 3: What are the dimensions and mechanisms of governance of different circular infrastructure projects, which external factors influence the selection of mechanisms, and what are the main challenges that occur in the collaboration?

Sub-question 4: What are the similarities and differences that can be identified in the governance of different circular infrastructure projects?

Sub-question 5: What are the main challenges that occur in circular infrastructure projects, and how they relate to the implementation or absence of governance mechanisms?

2.3 Objectives and deliverables

The aim of this research is to capitalize on generated knowledge gathered from circular infrastructure projects and provide a basic framework of governance that can be utilized in future circular infrastructure project iterations. That is realized by identifying the relevant governance arrangements that apparent in the inter-organizational collaboration. Using a multi-case study and a series of semi-structured interviews, those factors are acknowledged and can be synthesized into a governance framework. Consequently, the objective of this research is to investigate which governance arrangements cater for circular infrastructure projects. Answering this question can provide useful insight to researchers regarding CE and inter-organizational collaboration for infrastructure projects. The final deliverable of this research is expected to be a governance framework for circular infrastructure projects. Moreover, based on the findings of the research, recommendations can be provided, aimed towards practitioners in the field of procurement for circular infrastructure projects.

2.4 Research design

To research how circular infrastructure projects are governed, first the relevant governance arrangements are identified based on the literature. Then they are adapted for circularity and lastly, they are validated by the means of a case study. Therefore, the research is conducted in three steps, namely, *Investigate, Adapt,* and *Validate.*

In the first step the theoretical framework is set, by the means of a literature review. The concepts of *inter-organizational governance*, *project network governance* and *collaborative governance* are relevant and hence, the framework is a direct synthesis of the literature on those topics. In the second step, the framework is enriched based in the literature of *collaboration* and *governance* for *circular*

infrastructure projects. In this way, the relevant governance arrangements for circular infrastructure projects are acknowledged. In the third step, the governance framework is validated and expanded through the means of a *multiple case study*. The case study consists of three different cases, or circular infrastructure projects. The cases are analyzed on two different levels, namely the strategic and the implementation level. This is due to the differences in the scope and the goals on each level, as well as the knowledge and expertise of the involved people. More specifically, to identify prescribed governance arrangements and the reasoning behind their selection, the strategic level is critical. For identifying which governance arrangements were utilized in practice, and the exact way that they were implemented, the implementation level is relevant. Since the selected circular projects are implemented as part of a circularity program, the *strategic* level is the equivalent of the *program*, while the *implementation* level is the equivalent of the *project*. As a data gathering method, a combination of project documentation and semi-structured interviews is utilized. The outline of the research design is illustrated below. In the next chapter, the research methodology is thoroughly described.

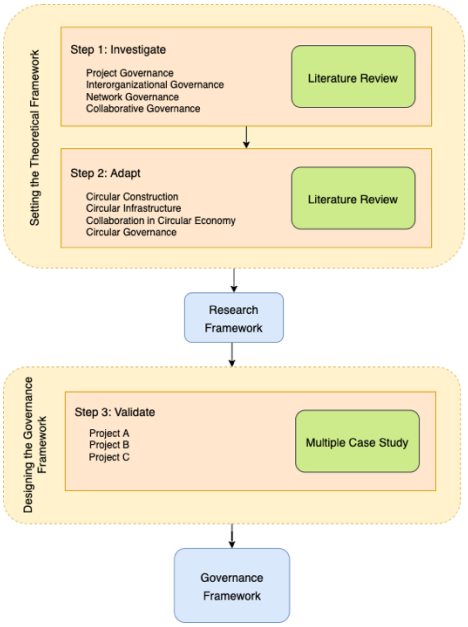

Figure 7: Research Design. Own work

2.5 Thesis outline

In *Chapter 1*, a brief introduction to the relevant themes is given, in order to set up the basis for the research. *In Chapter 2* the research problem is presented, along the research question and sub-questions the objectives and deliverables, and the proposed design of the research. In *Chapter 3*, the methodology is described. First the reasoning behind the selection of the multiple case study as the method of choice is given, then the research steps are described, along with the data gathering method and the case selection. In the next chapter*, Chapter 4*, the theoretical framework is constructed based on a literature review. In *Chapter 5*, the multiple case study is conducted, the governance framework and the associated challenges are presented for each case. In *Chapter 6*, the analysis is conducted. First, through a cross-case analysis, the similarities and differences are presented. Then, governance arrangements are linked with the associated challenges that were identified in the previous chapter. In *Chapter 7*, the results are discussed. Specifically, a redesign of the research framework is proposed and the differences regarding the governance mechanisms in theory and in practice and the identified interactions between governance arrangements are presented. Furthermore, the challenges that concern the standardization of circular infrastructure are discussed, and the limitations of the research are noted. In the final chapter, *Chapter 8*, the conclusions of the research are presented, by answering the research question, and recommendations towards participants on the field, and future researchers are given. Based on the aforementioned, an outline of the thesis is schematically illustrated bellow.

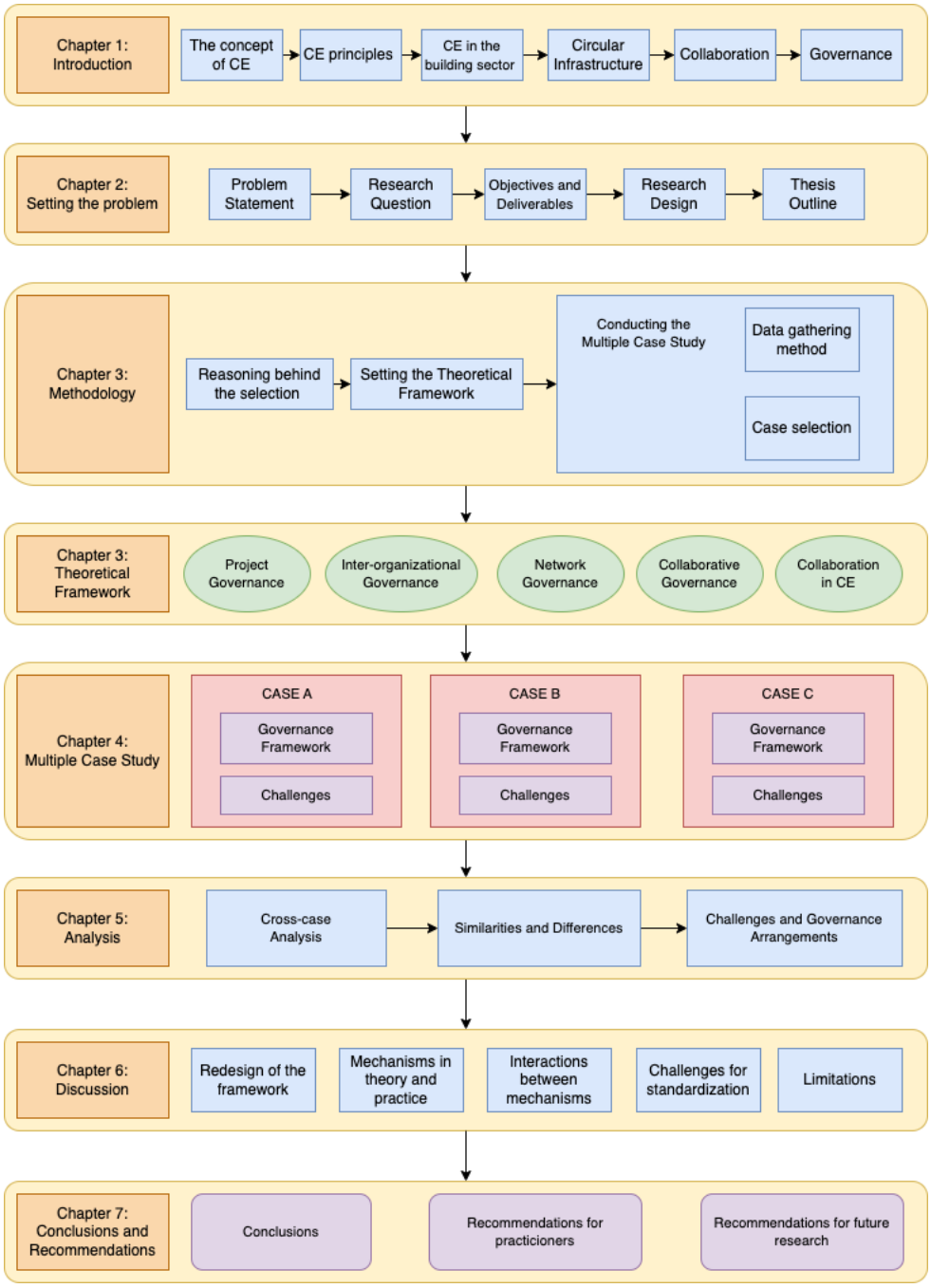

Figure 8: Thesis Outline

3 Methodology

To answer the research question, a combination of literature review and a multiple case study was utilized. First, through a literature review the theoretical framework of the research was established. Then a qualitative multiple case study (multi-case study) was selected as the research method of choice. The data gathering method was project documentation and semi structured interviews. Through these, the theoretical research framework was transformed into a governance framework for circular infrastructure projects. This was achieved by identifying which antecedents and governance mechanisms are relevant, with elements added or removed accordingly.

3.1 Reasoning for the selection of the methodology

Creswell (2013) defines case study as the method that explores a real-life, contemporary bounded system (case) or multiple bounded systems (cases) over time, through detailed, in- depth data collection involving multiple sources of information. Yin (2013), defines case study research twofold, based on the scope of the research and its technical specifications. Regarding the scope, case study aims to investigate in depth a contemporary phenomenon within its real-life context. Moreover, case study is aimed towards problems where more variables of interests than data points are present, relies on multiple (converging) sources of evidence and is based on prior theoretic developments to guide data collection and analysis (Yin, 2013). Case studies are particularly used in sociological studies, to thoroughly investigate complex phenomena (Telis, 1997). “How” and “Why” questions are likely to favor case studies, experiments, or histories as the methods of choice (Yin, 1993). Moreover, as Yin (1993) states, case study is preferred in examining contemporary events and when relevant behaviors cannot be manipulated. In this study, the research question is a “How” question. Moreover, the aim of the research is to identify governance arrangements in circular infrastructure projects. Circular projects are contemporary events, while governance cannot be manipulated by the researcher. Therefore, case study was the preferred method of choice.

Case study research includes both single- and multiple-case studies. Multiple case study, or multi-case study, cover multiple cases to draw a single set of “cross-case solutions” (Yin, 2013). Through analyzing different cases, the researcher identifies and understands similarities and differences between the cases. Multi-case study is utilized to identify contrasting or similar results across the cases (Yin, 2013). Lastly, this method creates a more convincing theory as the generated results are more intensely grounded in several empirical evidence (Gustafsson, 2017). In general, a multiple case study should be preferred when resources allow, as multiple case studies provide more compelling evidence (Yin, 1993). Since there are several circular infrastructure projects in the Netherlands, a multiple case study was preferred.

3.2 Implementation of the methodology

As illustrated in Figure 5, this research was conducted in three steps, namely *Investigate, Adapt,* and *Validate,* divided in two different parts, regarding the establishment of the theoretical framework and the validation of it by the means of a multiple case study. For the former, a literature review is utilized, while the latter is performed through a multiple case study. In the following sub chapters, the two parts are thoroughly described.

3.3 Setting the theoretical framework

As a first step, the theoretical framework was set. This was achieved through a literature review. It regarded the concept of governance in the project environment. Based on the conceptualization presented in the previous chapters, this was simplified to identifying governance arrangements or mechanisms that define the collaboration. The three relevant terms investigated were *interorganizational governance, network governance* and *collaborative governance*. The selection was made based on the characteristics of collaboration in circular construction projects, as presented on

the available guidelines (Circulair construction economy, 2018; Rijkswaterstaat, 2019; Global Infrastructure Hub, 2021). These factors, served as the basis for the next steps in the analysis. It is the first step *"Investigate"* in the research design. Through this process the first research sub-question: **"*What is governance, and which are its dimensions, antecedents and mechanisms?*"** was answered.

The next step regarded the adaption of the framework to the unique characteristics of circularity. It is the second step or *"Adapt"* in the research design. First, collaboration characteristics needed to be identified based on a literature review. Scholars have identified several elements that are apparent in a circular building environment (Brown et al., 2020; Kooter et al., 2021). Therefore, the theoretical framework was adapted to cater for circularity. Upon completion, the second sub-question **"*What additional requirements does circularity impose in the governance of circular infrastructure projects?*"** was resolved and the research framework was structured.

As explained, the theoretical framework was established by the means of a literature review. Yin (2013) states that the purpose of a literature review, in case study research, is not to determine the answers about what is known on a topic but to review previous research to develop sharper and more insightful questions about the topic. Therefore, this preparatory process cannot stand alone, but acted as the basis for the multiple case study, which is discussed in the following sub chapter.

3.4 Conducting the multiple case study

After the theoretical framework was set, a *multiple case study*, as presented by Yin in *Case Study Research: Design and Methods* (2013) and demonstrated by Tellis in *Application of a Case Study Methodology* (1997) was conducted. The methodology includes 4 stages, concerning the *design of a case study protoco*l, *the conduction of the case study*, *the analysis of the data* and the *conclusions and recommendations*. The case study aimed to provide answer to the next sub-question: "***What are the dimensions and mechanisms of governance of different circular infrastructure projects, which external factors influence the selection of mechanisms, and what are the main challenges that occur in the collaboration?"***

3.4.1 Designing the case study protocol

The first step of the research concerned the design of the case study protocol. The main activities in this step were to *determine the required skills* and *develop the protocol for the case study*. Regarding the skills, Yin (2013) suggests that a researcher should *have the ability to ask good questions*, be *flexible* and *unbiased* and *have a good understanding of the issues being studied*. On the context of this research, the ability to ask good questions related to the understanding of the issues being studied and was achieved by studying relevant literature and gaining experiences regarding project governance. Especially, in terminology and common project practices in the Netherlands. In other words, being well-educated about relevant aspects that might occur during the interviews, is important. Furthermore, the ability to ask good questions, relates to general experience in interview procedures and personality traits. To overcome those issues introductory meetings with interviewees were arranged to explain the procedure and ask their opinion regarding the research theme. Developing a *case study protocol* should include according to Yin (2013), *an overview of the case study project*, *the field procedures, the case study questions* and *a guide for the case study report.* The *overview of case study project* covers the background information about the research project, the substantive issues being investigated, and the relevant readings about the issues. On the context of a MSc Thesis, this was already presented in the previous chapters. *Field procedures* contain the presentation of credentials regarding the access to the case study data sources. The procedures need to emphasize to the major tasks concerning data collections. They include, gaining access to key organizations or interviewees, having sufficient resources, developing procedures for assistance and guidance, scheduling the data collection activities, and providing for anticipating events. On the context of a MSc Thesis, this was achieved in collaboration with the supervisors. The *case study questions*, are the heart of the case study protocol. They refer to

the questions that the investigator should keep in mind during the data collection and potential sources of information for answering each question. For this research, these questions are presented in the following chapters. Developing a *guide for the case study report* includes the outline of the research and the format for the report, as well as an overview of how the findings will be presented. For this research, the case study report followed the outline of an MSc Thesis.

3.4.2 Conducting the case study

The second stage of the analysis concerned the actual execution of the case study. In this phase the primary activity was that of data collection. The main activities are according to Yin (2013), the *preparation for data collection, design and distribution of the questionnaire* and the *conducting of interviews*. As a first step, the cases analyzed were selected. The selection was made from the pool of circular infrastructure projects, that are developed in the Netherlands. Regarding the number of the cases, there is no general rule of thumb. However, Yin (2013) proposes the replication logic in contrast to sampling logic to deal with this problem. Replication logic, prerequisites the development of a rich theoretical framework. The framework needs to state the conditions or factors under which a particular phenomenon is likely to be found (a literal replication) as well as the conditions when it is not likely to be found (a theoretical replication). For this research the phenomenon is the implementation of a circular infrastructure project, and the factors are the governance arrangements. Then each case should be selected so that it either predicts similar results (literal replication) or predicts contrasting results (theoretical replication). In a theoretical 6-10 cases sample, 2-3 should be literal replications whereas 4-6 should be selected to pursue two different patterns of theoretical replications (Yin, 2013). Therefore, a deep understanding of the available cases was a prerequisite before the final case selection was made. In the following subchapter, the case selection in thoroughly described.

3.4.2.a Case selection logic and case selection

Regarding the case selection logic, there were five relevant criteria. Those were:

1) **Circular Infrastructure Projects:** The first selection criterion regards the nature of the infrastructure project. Based on the definition of circular infrastructure projects given in the previous chapters the selected projects should be designed according to circular economy principles, that aim to address a social need while minimizing material consumption and waste generation. Furthermore, the Rijkswaterstaat approach towards circularity is adopted and therefore the main categories that examined are *roadworks* and *waterworks*.
2) **Circularity as a core objective.** The selected project should have circularity as a core objective. This can be validated through documentation, by examining the scope and the vision of the project. An indicator is how many "higher" circular strategies are followed, based on the framework of 9Rs.
3) **Public and Private parties are involved.** To research governance on the context of circular infrastructure projects, it is vital to acquire multiple viewpoints, so that both public and private parties are represented. Since those projects are interorganizational and the public sector is heavily involved during the initial phases, either as initiator, policymaker and as a major economic actor, this criterion is easily achieved.
4) **Recently completed or ongoing projects.** This research is conducted through interviews. It is therefore important to select projects that are recently completed or ongoing, so that the interviewees have a clear opinion on the subject.
5) **Availability of information.** Information, both by means of case documentation and interviewing project participants, should be available to conduct this research. Therefore, availability is the final case selection criterion.

A collection of possible cases was identified. They are presented in the form of a table, in Appendix A. Based on the criteria, three cases were selected. The reasoning behind the selection and rejection of specific projects came on the basis of confirmation with the selection criteria.

3.4.2.b Sources of evidence - data gathering method

As a data gathering method, a combination of semi-structured interviews with project participants and project documentation was utilized. A semi-structured interview is a type of interview in which a few predetermined questions are asked, while the rest of the questions are asked based on the interviewee's answers and their insight on the situation. Project documentation regards contracts, ambition documents and detailed "lessons learned" documents. In practice, available documentation was scarce and irrelevant to governance arrangements. Therefore, it was utilized primarily to describe the collaboration in the project and secondary to identify governance mechanisms. Interviews were utilized to extract detailed information from few people, as opposed to surveys that are utilized to identify general patterns from many people. The reasoning behind choosing interviews instead of a survey, was based on the nature of the research. The target group of interest was project participants, and the expected result was to validate the existence of certain governance arrangements and how they were utilized in the project environment. Regarding the interviewees, case study methodology requires several participants from different backgrounds. For this research, project participants were questioned regarding their involvement in a circular infrastructure project. The interviewees were selected from both the public and private parties since their views on governance were different or even contradicting. Regarding the number of interviewees, at least three participants were needed to be questioned for triangulation of data. Furthermore, the interviews were conducted on two different levels, namely the *strategic* and the *implementation* level. Project participants were different in each level and had a different understanding of the collaboration process. Therefore, six interviews (three on each level) were conducted per case. Project roles that were important towards that research included, *project leaders, project managers, contract managers, sustainability advisors, initiators, strategists, policy makers, procurers, and suppliers*. An overview of the data gathering process for a typical project is seen bellow.

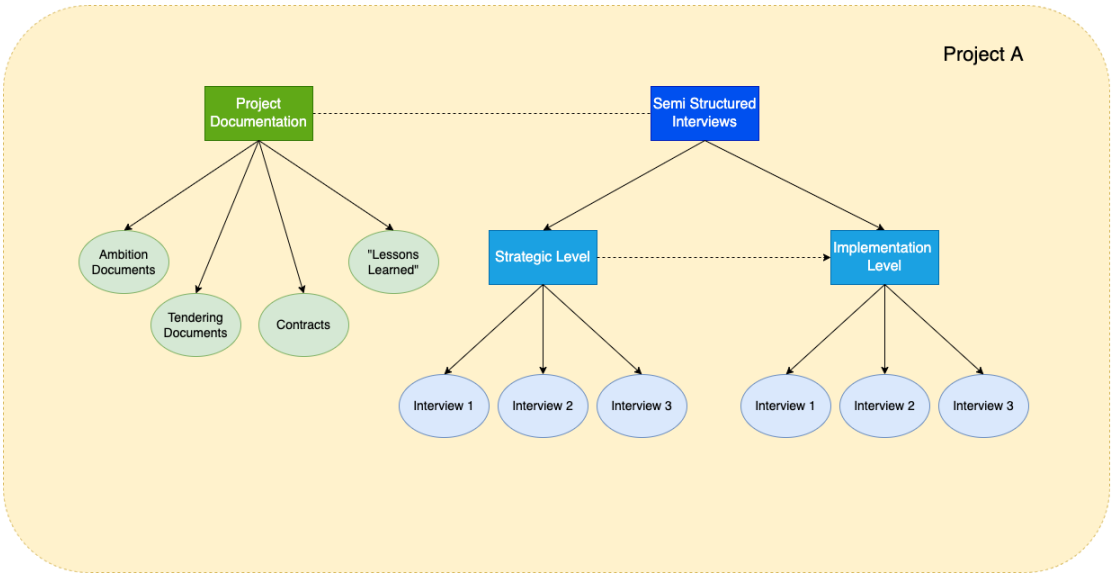

Figure 9: Data gathering method. Own work

The aim of these interviews was twofold. Regarding governance arrangements, on the one hand, the aim was to identify which of the predefined governance mechanisms were present in each case. On the other hand, case-specific arrangements that might have been omitted or considered as irrelevant during the previous steps, were reintroduced in the analysis. In this sense, the interviews were utilized to correct and enrich the established theoretical framework of the research. Secondarily, the interviewees were asked to justify the selection of governance arrangements, based on external factors (or antecedents), so that arrangements were coupled with specific antecedents. However, the gathered information about it was inconclusive, and the findings about the antecedents were omitted from the final report.

3.4.2.c Design of interview protocol

The next step was to design the interview protocol. This action refers to selecting the appropriate questions to ask project participants. Naturally, designing an interview protocol is a process of trial and error. For this research, the questions set were changed after consultation with interviewees and through the experience gained in the process of conducting interviews. Regarding the initial set of questions, it was a written representation of the theoretical (research) framework that was developed during the earlier stages of the research. More specifically, the governance arrangements acknowledged were transformed into question form, in order to identify their presence into the project environment. As far as antecedent factors are concerned, those could be identified by asking "why" questions.

3.4.3 Analyze the case study evidence

After gathering the data, in form of documentation and interview transcripts, the case study documents were analyzed. At a first level, each case was analyzed separately. The aim of this step was to define the governance arrangements that are implemented in each project, and the specific challenges that were acknowledged. The cases were analyzed with ATLAS.ti, a qualitative data analysis software. The acknowledged governance mechanisms were noted as codes and specific quotes about their presence were identified in the interview transcripts. By combining the codes across the transcripts, a governance framework of each project was created. At a second level, the selected cases were compared to each other, by comparing the different frameworks, through a *cross case analysis*. An analytic strategy, based on *pattern-matching* was utilized to analyze the data. It provided insight on similarities and differences between case-specific governance arrangements. The outcome of this step was a collection of common governance arrangements for all projects, and a presentation of the differences regarding governance arrangements. Furthermore, the case specific challenges were compared across the cases. Therefore, through this procedure, the last 2 sub-questions ***"What are the similarities and differences that can be identified in the governance of different circular infrastructure projects?"*** and "***What are the main challenges that occur in circular infrastructure projects, and how they relate to the implementation or absence of governance mechanisms?"***. The findings of the analysis were presented and then discussed in the respective chapters.

3.4.4 Develop conclusions and recommendations

The conclusions drawn from the case study research were case-specific. This means that the identified governance arrangements were relevant to the corresponding circular infrastructure project. Generalization of the conclusions for all circular infrastructure projects is a significant issue. In fact, as Yin (2013) states "a common concern about case studies is that they provide little basis for scientific generalization". He also states that the ultimate goal of a case study is to expand the findings and generalize to theories, a process called analytic generalization. In this mode of generalization, a previously developed theory is used as a template to compare the empirical results of the case study. If two or more cases are shown to support the same theory, replication may be claimed. The empirical results may be considered yet more potent if two or more cases support the same theory but do not support an equally plausible, rival theory. (Yin, 2013). Generalization can occur if the findings are aligned with theory and no contradictive findings occur. Another way to generalize the findings, is through an expert panel. Experts on the field of circularity and infrastructure could potentially validate or reject the empirical findings. On the context of this research, generalization was not actively pursued. However, governance arrangements that were apparent across all cases, and governance arrangements that could potentially resolve challenges, were combined in a proposed governance framework. This framework aimed to address the main research question, **"How are inter-organizational collaborations for circular infrastructure projects governed, which challenges relate to governance and how could the associated governance challenges be tackled?"**

4 Theoretical Framework

In this chapter the theoretical framework of the research is set. This acts as the basis for the research framework of the thesis. First the characteristics of relevant modes of governance are identified based on the literature. The relevant governance arrangements *regard interorganizational governance, project network governance* and *collaborative governance*. As a second step, the governance arrangements that are relevant to circular economy and can cater to circular principles are identified based on the literature. Based on that, a governance framework is designed as a synthesis of the aforementioned concepts.

4.1 Defining Governance

As discussed, circular infrastructure projects are inherently interorganizational projects, and therefore the concept of interorganizational governance is relevant. Roerich et al. (2019) have identified antecedents, mechanisms, and implications of interorganizational governance, based on the literature. Furthermore, circular infrastructure projects are implemented in the context of a network of organizations. Therefore, the concept of governance of project networks is introduced. Provan & Kenis (2008) have identified three separate network governance forms, along with contingencies and network tensions, while Kujala et al., (2020) have identified key dimensions and governance mechanisms, based on the literature. Lastly, collaboration is a key factor in circular infrastructure projects, as actors across the supply chain are involved early in the process. Therefore, collaborative governance as defined by Emerson et al., (2011) and adopted by Bryson et al., (2015) is also relevant. The authors have identified contingencies and drivers of collaborative governance as well as, collaborative dynamics. The framework of Ansell & Gash (2007) is also presented here, as it includes starting conditions and collaboration stages for implementing a collaborative governance approach.

4.1.1 Interorganizational Governance

Interorganizational governance refer to both formal and informal rules of exchange between actors (Roehrich et al., 2019). Therefore, two main types of governance mechanisms are distinguished. Those are economic strategies such as contracts and relational governance that which is based on trust and social norms (Griffith & Myers, 2005; Vandaele et al., 2007). Contractual governance is applied through explicit, formal, and usually written contracts (Griffith & Myers, 2005) while relational governance is based on more socially derived arrangements that are more informal in nature (Vandaele et al., 2007). Roehrich et al. (2019), present two different lines of thought regarding formal and informal governance. Earlier studies suggested that formal governance by the means of contracts, can potentially damage the effect of relational governance, since they can be perceived as a lack of trust. Furthermore, relational norms such as trust can make the contracts redundant, as an organization that is based in long-term trust will favor more informal modes of governance. However, in the recent years, scholars imply that contractual and relational governance are complementary to each other. This is based on the argument that formal contracts can facilitate trust, which in turn, can be utilized to jointly design better contracts.

Roehrich et al. (2019), identify several external factors, or antecedents, that influence governance. They refer to uncertainty, prior ties and length of previous relationships, asset specificity, power-dependency structure, legal/institutional framework, and the type of relationship/organization. As outcomes of the governance procedure, the authors acknowledge the various performance implications that governance imposes on the interorganizational relationship. Those are implications regarding exchange/relationship performance, opportunistic behavior, learning/ joint problem solving and the overall satisfaction of the involved parties. An overview of Roehrich et al., (2019) framework of interorganizational governance is provided in Appendix B.

As a closing remark, Roehrich et al., (2019) analysis has a dyadic focus, that is, they examine inter-organizational governance in dyadic relationships. In the context of circular infrastructure projects, dyadic relations are developed between the client and the contractor. However, as mentioned above,

in circular projects the early involvement of contractors and suppliers, as well the involvement of other actors (namely decommissioners and maintainers) creates a network of project participants and consequently, project network governance is also relevant.

4.1.2 Network Governance

Provan & Kenis (2008) examine the governance of organizational networks. They argue that network governance involves the use of institutions and structures of authority and collaboration to allocate resources and to coordinate and control joint action across the network. They identify three basic forms of network governance, namely participant-governed networks, where members jointly govern the network, lead-organization governed networks, where all governance is centralized and conducted through a single party, and network administrative organization, where a separate administrative entity, or network broker, is utilized. Furthermore, the identify four key structural and relational contingencies, based on which a successful adoption of a particular form of governance can be performed. Those are trust, size referring to the number of network participants, goal consensus and the nature of the task or the need for network-level competencies. They provide the characteristics of each form of governance, on the basis of the four aforementioned contingencies. Those contingencies can be regarded as external factors, or antecedents to the governance process. Lastly, they identify three basic network-level tensions that can occur in networks. Those regard Efficiency versus Inclusiveness, Internal versus External legitimacy, and Flexibility versus Stability.

Interorganizational projects are implemented in the context of a network of organizations, where no single authority has power to control the procedure. (Kujala et al., 2020). Therefore, the concept of governance of project networks is relevant. Kujala et al. (2020) focus on the internal perspective of project governance. Network governance is perceived as the internal coordination, adaptation and safeguarding mechanisms that enable multiple network actors to work toward shared goals (Kujala et al., 2020). The authors have developed a framework to analyze how interorganizational governance can achieve its goal, that is to coordinate, adapt and safeguard economic exchanges among actors. They identify six key dimensions of governance, namely Goal setting, Rewarding, Monitoring, Coordination, Roles and Decision Making and Capability Building. Each dimension encloses several mechanisms of governance that are utilized in interorganizational project networks. The dimensions and the relevant mechanisms are further elaborated below. They are schematically shown in Figure 7.

Goal setting refers to the establishment of shared performance goals, understood by all project participants. Those goals should be jointly defined, clear for all actors and flexible to cater non-anticipated risks and opportunities. The goals mentioned here refer to both short-term and long-term goals. The mechanisms acknowledged by the authors regard the establishment of *joint performance goals*, *clarity*, and *flexibility* of goals. Early involvement of project actors is significant towards establishing joint performance goals, as in this way an optimal project solution that can be identified. Clarity leads to a common interpretation of the objectives for all project actors, while flexibility is important to respond to risks and opportunities that are not anticipated.

Rewarding regards the incentives given to project participants to align with project goals. Those incentives can be monetary rewards related to joint performance goals, or conditional future gains, such as bonus payments or good reputation and continuity in business. Risk allocation is also tied to rewarding, as project participants are willing to accept risks in return of gains. Risk can be transferred to a single organization or can be divided between participants. Since all possible contingencies cannot be accounted for in advance, relational governance is also needed, as a complement to traditional contracting. The authors suggest a shared ownership structure, in which key project actors own part of the project organization. Therefore, the acknowledged governance mechanisms relate to *performance rewards, risk allocation, ownership structure* and *reputation and future business.*

Monitoring concerns the actions that are taken to ensure that all actors are behaving as expected. Monitoring is important to enable performance-based incentives for a project. Monitoring can be formal, with procedures specified on the contract, or informal based on trust, personal relationships, and collective action by project participants. In cases where the client lacks the technical competencies

to supervise and monitor the project, third party agents can be utilized to monitor and auditing the project on their behalf. Therefore, three governance mechanisms are related to monitoring, namely, *formal control and monitoring, informal monitoring and third-party monitoring and auditing.*

Coordination regards the alignment of each actors' behavior so that can effectively work together. Effective coordination requires standardized common tools and work processes across the project, that are formally defined in project contracts. However informal coordination mechanisms such as culture, values and norms are equally important. Behavioral norms and values can be also included in the contract. Information sharing and communication is another important aspect of coordination. It can be ensured by both formal and informal practices, and it can be achieved using tools such as BIM or online repositories. The final component of coordination refers to change management and conflict resolution. Change management relates to the process followed when changes are imposed upon the project, while conflict resolution relates to the process of solving issues between project participants. Those issues can be resolved either internally through discussion or through a legal process, where independent external actors making decisions. The mechanisms regarding coordination are *common project management practices, shared culture, values and norms communication and information sharing change management* and *conflict resolution.*

Roles and decision-making refer to project participants acquiring the necessary information to make appropriate decisions. Roles and responsibilities are generally formally defined on the contract, but effective governance requires also suitable management structures and appropriately distributed decision-making power among key actors. The authors pinpoint the need for a clear definition of each actor's role and responsibilities and a solid management structure for the project that is separate from parent organizations. They also emphasize the power of relational governance and shared decision making on creating a climate of trust and confidence among project participants. The three main mechanisms that the authors are acknowledging are *definition of roles and responsibilities*, *management structure* and *authority for decision-making.*

Capability building concerns the involvement of capable actors in the project. The involved actors should have the necessary skills and expertise to meet the expectations. Therefore, competitive tendering processes and selection criteria play an important role. Another mechanism to enhance capability regards the training and improvement of existing actors, to meet project's demands, although for projects this can be proved uneconomic due to the temporariness of the relations. The two identified governance mechanisms are *actor selection* and *training and continuous improvement.*

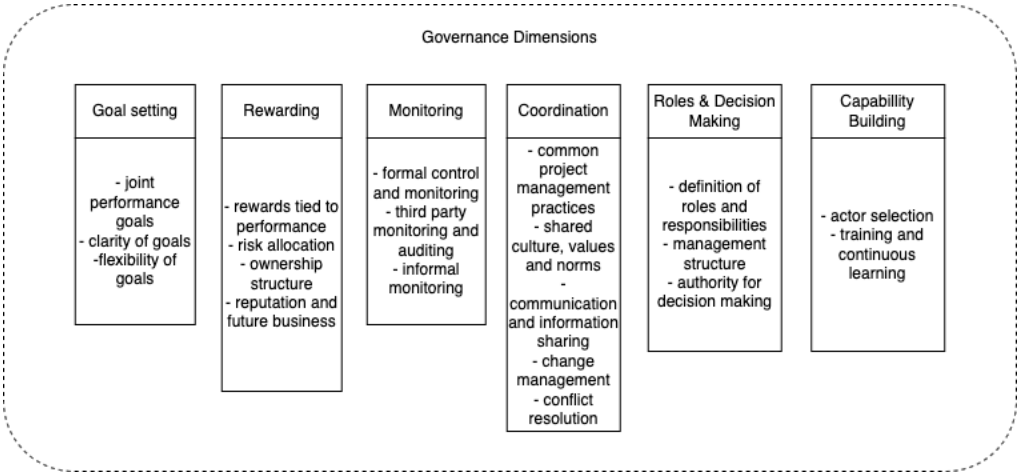

Figure 10: Dimensions and mechanisms of project network governance (Kujala et al., 2020).

4.1.3 Collaborative Governance

Governance of networks or collaborations is distinguished between collaborative governance (governance applied by public agents and non-state actors) and governance of collaboration, as in

structures and processes for decision making (Bryson et al., 2015). Vangen et al. (2014) state that "the governance of a collaborative entity entails the design and use of a structure and processes that enable actors to direct, coordinate, and allocate resources for the collaboration as a whole and to account for its activities" (Vangen et al, 2014, p.8).

Collaborative governance is defined as the process and structures of public decision making and management that engage people constructively across the boundaries of public agencies, levels of government, and/or the public, private and civic spheres to carry out a public purpose that could not otherwise be accomplished. (Emerson et al., 2011, p.3). Collaborative governance is determined by the system context or external factors. Those are resource conditions, policy and legal frameworks, political dynamics and power relations, prior failures to address the issue, network connectedness, conflicts versus trust and socioeconomic and cultural health and diversity. Emerson et al., (2011) identify also essential drivers for collaboration. Those are leadership, referring to the presence of an identified leader who initiate and help secure resources and support, consequential incentives both internal (such as a problem or a need for resources) and external (such as a threat or an opportunity), interdependency between actors meaning that actors cannot accomplish their goals alone, and lastly uncertainty as a driving force behind collaborations to mitigate risks. The authors, identify three main collaborative dynamics that constitute a Collaborative Governance Regime, or a system for public decision making in a collaborative environment. Those three interactive components are principled engagement, shared motivation, and capacity for joint action and are performed iterative to produce certain collaborative actions, such as adapting new management practices, enacting policy, or enforcing compliance. The authors acknowledge certain steps, or elements incorporated in each dynamic. An adaption of the framework is presented in Appendix B.

Principled engagement refers to involving "the right" people from a heterogenous group of actors with individual interests and skillset that take collective actions to solve a problem. It is an iterative process consisted of four elements, namely discovery of shared interests, concerns, values and other relevant information, definition of purpose and objectives, tasks and expectations of each other, deliberation as reasoned communication between participants and determination as in taking procedural and substantive decisions. The second dynamic concerns the establishment of shared motivation between participants. Four elements are relevant, starting with the development of mutual trust. Trust stems from the frequent contacts of participants and is a direct consequence of principled engagement. Trust is the basis of the second element mutual understanding referring to people expressing and appreciating their differences. In turn, that leads to creation of internal legitimacy, a validation of the trustworthiness and credibility of participants, facilitating collaboration. The final element is shared commitment to the process, that enables participants to overcome their boundaries and commit to a shared vision. Capacity for joint action refers to enabling the participants to solve problems that they couldn't solve individually. The authors conceptualize it as a combination of four elements, namely procedural and institutional arrangements, leadership, knowledge, and resources. The first element refers to protocols and structures necessary to manage participants interactions. Those protocols can be formal or informal and should be defined on intra- and interorganizational level. Leadership is an essential ingredient of collaborative governance as it can facilitates collaboration. Multiple leadership roles are needed across the development of the collaboration. Knowledge and resources are the final elements of capacity for joint action. Knowledge is introduced by participants and after processing shared knowledge is generated. Resources may include funding, time, technical skills, and expertise. In a collaboration, the way that resources are utilized can be a critical factor of success.

Bryson et al. (2015) adopt the collaborative governance regime as presented by Emerson et al. (2011). Moreover, they identify that governance in cross-sector collaborations is influenced by contextual elements as well as internal contingencies. Key external factors include policy and mandates and pre-existing relationships between members. Policies and mandates can affect the power/dependency structure of collaborations leading to powerful parties that ignore other actors and hinder the collaboration process. Previous relations can affect collaboration governance, with positive prior experiences harnessing a climate of trust and commitment. Internal contingencies, such as network size, collaborative task and degree of trust among members, also affect collaborative governance. Lastly, the authors acknowledge the influence of paradoxical tensions. Those include tensions around

control versus trust, inclusivity versus efficiency, congruent versus divergent goals and unity versus diversity.

Ansell and Gash (2007) define collaborative governance as *the governing arrangement where one or more public agencies directly engage non-state stakeholders in a collective decision-making process that is formal, consensus-oriented, and deliberative and that aims to make or implement public policy or manage public programs or assets* (Ansell & Gash, 2007, p.544). This definition implies a formally organized forum initiated by a public agency and consisted by public and private actors where decisions are taken collectively and consensually. The authors acknowledge several factors that influence the collaborative process. Those include starting conditions, namely *Power-Resource- Knowledge Asymmetries, Incentives for and Constraints on Participation* and *Prehistory of Cooperation or Conflict (initial trust level).* Moreover, they mention facilitative leadership and institutional design as critical ingredients towards the collaborative process. The collaborative process itself, is described as developing in stages. Those stages regard face to face dialogue between stakeholders, trust-building, commitment to the process, shared understanding or "common mission" between all involved and intermediate outcomes or "small wins". The framework of Ansell and Gash can be seen on the Appendix B.

4.2 Investigating Circular Projects

As mentioned above, although collaboration plays a key role in circular construction projects, the subject is inadequately researched in the literature. However, a few scholars have provided a theoretical basis of collaboration for circularity. Moreover, practitioners in the field have provided guidelines towards implementation of circular economy principles in construction projects. In this chapter, the main lessons learned from circular projects are discussed. First, the factors that differentiate circular from traditional construction projects are presented. Those factors are examined on the basis of project management practices. As explained in previous chapters, for circular initiatives action is needed earlier on. Therefore, the concept of procurement for circularity, or circular procurement is presented, along with its characteristics. Then, collaboration, a critical factor in circular economy environment, is investigated. Furthermore, an attempt to link collaboration and governance in circular networks is presented. Governance arrangements and guiding principles for circularity are noted. Lastly, the common barriers and enablers for circular economy are acknowledged.

4.2.1 Differences between circular and traditional project

Versteeg (2019) in her Master Thesis acknowledges that the transition to circular construction projects requires a change on project management practices. She identified changes, based on a cross-case analysis of four circular construction projects in the Netherlands. Her study acknowledges several project management practices that need to be altered in order to cater for circularity. To name a few, circular initiatives should be taken from the start of the project. In terms of scope, the initiator should define ambitions, instead of detailed requirements. The requirements should be jointly defined by the project team. Transparency and trust are vital ingredients for circular projects, so that resources and knowledge are freely accessible by all parties. All participants should share the same commitment, vision, and philosophy towards circular economy. The involvement of the whole supply chain early in the project is also significant, as well as the attention to end-of-life management of the project. Project partners should be selected jointly by all members. A non-hierarchical and cooperative organizational structure is utilized to ensure teamwork, shared responsibility, and creativity. Responsibilities and risks should be distributed among the involved parties. Challenges on circular construction projects arise only partly due to technicalities. The main complications regard the process of circular construction, such as partner identification and selection, cooperation, procurement, and alignment on a common cause. The identified characteristics can be seen on the table in Appendix B.

4.2.2 Procurement for circularity

Police & Batocchio (2018), explored the role of procurement in the circular economy by utilizing a case study. They argue that successful implementation of circular economy principles is merely a subject of technicalities. Partnerships with designers, suppliers and developers are important so that "closed" material loops are created, managed, and sustained for an extended time. To that direction, circular mindset, new performance metrics and new skills and competencies are required along the supply chain. This is the basis of, *circular procurement,* or procurement in accordance with circular economy principles. Circular procurement requires a change of thinking regarding three main aspects; Changing to *service-oriented* business models instead of traditional product-oriented ones, *product design* to cater for use and end of life phase, and *market engagement* to identify circular solutions. Market engagement is particularly important as it can lead to new, collaborative business models. Early embedment of circularity principles in the procurement strategy can create business synergies that lead to the establishment of networks of companies providing circular solutions. Therefore, collaboration becomes a key driver of success for circular procurement.

Witjes and Lozano (2016) proposed a theoretical framework to link procurement and supply practices, in a circular economy environment. As other scholars, they proposed a change from product to service-oriented business models, as it will better caters the needs of circular economy, that is minimizing use of raw materials and waste generation. Collaboration is a vital element in their model. Experience and generated knowledge are utilized to expand the skills of involved parties, while securing their economic benefits. Although transaction costs can rise, the relationships between procurers and suppliers tend to be stronger and last longer.

Their framework, *ProBiz4CE,* is based on closing material loops through *recovery* of materials while utilizing a payment scheme, where social and environmental aspects are taken under consideration. They propose a switch from price per product to *price per delivered service.* This *service-oriented approach* leads to *closing material loops* and improving resource efficiencies through *recovery*. Furthermore, collaboration between procurer-supplier is established at the beginning of the tender. Long term collaboration requires an enrichment of the traditional *technical specifications* set up by the procurer, with *non-technical specifications* and *socio-cultural specifications* such as beliefs and attitudes, that motivate parties to involve motivated personnel with a circular mindset. *Shared responsibility* expressed through shared ownership structure, is also an element of their framework. Their framework is illustrated in the Appendix B.

4.2.3 Collaboration within Circular Economy

Leising et al. (2017) investigated supply chain collaboration for a circular building sector in the Netherlands. Based on a literature review, they identify four relevant concepts, that concern *visions of the future, actor learning, network dynamics and business model innovation.* Vision development concerns the definition of needs that aimed to be fulfilled instead of detailed requirements. It contributes to collaboration between stakeholders to refine circular ambitions. Actor learning is essential, as actors need to broaden their scope to include life-cycle approach and establish a multidisciplinary way to jointly deal with problems. Network dynamics also play a pivotal role, as different parties (suppliers, contractors, demolishers) are involved in the process. Therefore, trust among members is an essential factor of success. Lastly, new business and ownership models that are based on supply chain collaboration across the building's lifecycle are proposed. A new process design which integrates a variety of disciplines across the supply chain, collaborating with client from the earlier stages is proposed.

Then, based on a multiple case study, they develop a collaboration tool to support CE in the building sector, across five different phases and provide guidelines to reach specific outcomes. Starting with *preparation and vision development,* a circular vision is created by the client. Instead of detailed requirements, the client proposes ambitions. This requires leadership and organizational support to create new collaboration processes across the supply chain. Moving to *market and supply chain involvement,* the aim here is to create a multidisciplinary team with participants across the supply chain.

The focus here is on disciplines instead of companies. It is assured that selected parties are creating value for the project and the supply chain by considering the overall lifecycle of the building. Personal connection is essential, and trust can be achieved through showing vulnerability. In the next phase, *process design and collaboration,* collaboration between partners is formalized by utilizing non-traditional contracting, since collective goals are key, and responsibilities are evenly distributed. Trust is essential and it is assured by transparency and assurance of members about their involvement in later stages. Technical support, by the means of Building Integrated Modelling (BIM) is also proposed. In the *business model and implementation* phase the building activities take place. Different strategies are proposed, such as utilizing buildings as material banks and using material passports. Shared financial incentives for circular goals are also included in the business model. The last phase concerns the *usage and preparation for next use.* The authors pinpoint the importance of showing the financial benefits of reuse of materials. Those can be reused either by establishing a material marketplace, for long-lived products, or by utilizing supplier take-back schemes (such us leasing) for materials or products with short lifespan. The framework of Leising et. al., can be seen in the Appendix B.

Kooter et al. (2021) aimed to understand the *dynamics* of circular construction projects and how those projects contribute towards the transition to a circular economy. They argue that circular projects are developed through interorganizational initiatives. Those initiatives act beneficially towards the emergence and adoption of new practices, relating to roles and responsibilities, in the traditionally rigid construction sector. As *dynamics* they refer to the patterns of continuity or change of interorganizational practices through time, and the factors that produce them. Through a series of semi-structured interviews with members of the interorganizational initiative Accelerating Together, the authors identify three clusters of dynamics relevant to circular construction projects namely *prerequisites*, *temporal dynamics in interorganizational projects*, and *contextual influences*.

Prerequisites refer to actions or characteristics needed for achieving circular characteristics in construction projects. The authors first mention *Top-Down Support*. They argue that support from higher levels is a prerequisite for realizing circular ambitions. The management team should be open to the possibility of change and support circular ambitions both formally and informally. Lastly, support for circular construction should be entrenched in the whole organization, with ideas and policies implemented even on the lower levels. Secondly, they refer to *Partnership Based on Increased Equality,* meaning a more equal relationship between client and contractor. A partnership is needed, as early involvement of the contractor benefits the knowledge of the client and mutual dependency is higher as circular projects are uncertain and prone to change. The next prerequisite regard *Shared Circular Goals.* The authors claim that an explicit shared goal or vision is a prerequisite towards realizing circular ambitions. Although visions are the starting point of projects, it is important to formulate clear and concrete goals, so that they are clear to all project members. The last prerequisite regards the *Involvement of Intrinsically Motivated People.* They refer to people *thinking out of the box* and *going beyond the beaten track*, while expressing a strong interest in the subject. Furthermore, they recognize that people of similar mentalities in circular projects can aid in circularity.

Temporal dynamics refer to the dynamics that play an important role in the context of the interorganizational project. They relate to *Transparency and Trust* as an enhancer of collaboration, *Flexibility* in terms of budget and planning, to cater for the uncertainty, *Reciprocal Relationships,* referring to mutual contributions to circularity, creating a shared *Project Team Identity,* based on a common circular vision, *Struggle for New Roles* as opposed to the traditional construction processes, *Pioneering Leadership* to increase awareness and inspire other project members and *Continuity in Staffing* on an intra- and inter-organizational level to enhance trust and capitalize on prior knowledge.

The final cluster concerns *Contextual Influences on Circular Construction Projects.* The authors recognize the importance of *Sector and Organization Cultures*, as an influencing factor of construction projects. They identify two cultural issues influencing the dynamics in projects with circular ambitions, namely the traditional construction sector culture that is technology oriented and is characterized by distrust among members, and the differences in circular mindsets between organizations, meaning that different organizations have different perceptions of circularity, and they translate differently circular ambitions to circular goals. Secondly, they refer to *Knowledge Flows*. Circular construction is an emerging field, where practical knowledge is lacking. This poses challenges to relevant parties, such as

clients and contractors. Challenges could refer to new forms of tendering for circular initiatives for the client party and technical expertise on emerging technologies for the contractor. Furthermore, knowledge is often case specific, and this poses problems with intra- and inter-organizational sharing. Therefore, monitoring knowledge and integrating it to existing reference frames is an important feature to capitalize on the "circular lessons" learned from each project. Lastly, the authors refer to *Power and Tensions* issues, namely dominance of clients and tension between permanent and temporary organizations. The former refers to clients having a leading role on the projects, aiming at their personal short-term goals and occasionally changing the scope, while simultaneously lacking the power to realize them alone. The later refers to the struggle for balance between the standardized procedures in permanent organizations and the innovative circular solutions that temporary organizations such as circular projects have to offer. The interplay of the dynamics can be seen on the figure bellow.

Brown et al. (2020) have attempted to understand how companies collaborate to pursue circular oriented innovation (COI). The authors have identified several collaborative process phases that act as "building blocks" for circular oriented innovation, based on the literature, and adapted them to meet circular objectives based on a case study. Their process model starts with the decision to pursue circular innovation and ends with collaborative action. Towards that direction, 5 collaborative processes are identified, namely *formulation of* a clear *initial circular proposition*, *involvement of the "right" people* to focus on circular vision and motivation, *alignment upon a shared circular purpose*, *development of circular oriented government and decision making* and *development of a circular oriented value capture model*. Those processes can be regarded as different phases in the collaboration for circular processes.

Regarding collaborative governance, the authors, pinpoint the existence of formal and informal governance mechanisms such as multilateral agreements and norms and rules respectively. These mechanisms regard network management tasks such as coordination of interactions, common rules for communication and transparency as well as joint decision making. Challenges in the sustainability context can arise due to the potential high diversity and number of partners involved. Therefore, governance mechanisms that deal with differences in opinions need to be established. Their research also indicates that traditional commercial and individualist thinking need to be altered to arrive at a collaborative circular oriented mindset. This mindset is vital for risk sharing, overcoming uncertainty and ambiguity and overcoming issues regarding to data vulnerability and cost transparency. Governance decisions, in particular, seem to be linked to risk sharing among participants.

4.2.4 Governance of Circular projects

Arfaoui et al. (2022) acknowledge that understanding governance arrangements is conductive for successful implementation of CE. Governance arrangements represent how actors interact to apply, form, and reform rules to organize activities for the development of a CE environment. Through a case study, they examine five methanation projects in France and based on their findings they propose a model of governance arrangements for CE development. Their analysis accounts for three different governance dimensions, namely the characteristics of *actors*, their *interactions*, and the related *rules*. They also describe how those dimensions are related to each other.

Regarding *actors*, the authors pinpoint the diversity of stakeholders and suggest including all relevant stakeholders in the local level. In particular, the inclusion of local residents is fundamental, to achieve public awareness and consensus. However, a high number of stakeholders could add complexity in the process. Therefore, the stakeholders should be thoroughly selected. They also observed that change of participating actors hinders project's progress and therefore they suggest avoiding it. Facilitative leadership to ensure integrity and enhance trust, and sufficient technological expertise of relevant stakeholders, are also noted as factors of importance. Regarding *interactions,* the authors pinpoint the importance of regular information sharing as an enhancer of CE activity. They also propose the utilization of collaborative self-organizing activities, especially with local inhabitants, that can facilitate collaboration and collective decision making. Regarding *rules*, actors should collectively apply and form rules that govern their interactions. This enables a collaborative approach to governance. The constitutional rules, or the legal framework should be respected. It acts both as a constraining and an enabling influence on CE and therefore it should be fully integrated into the conception and

development of the CE. Lastly, regarding *policy implications*, the authors claim that the government should encourage collaborative governance for CE and provide funding and technological support. Also, sectoral policies based on local actors are necessary for feasibility of CE.

Cramer (2020) highlights the importance of network governance to achieve circular objectives, based on her ten years' engagement on circular economy initiatives in the Netherlands. She argues that network governance is key in the transformation to a circular economy, not as a replacement of traditional public governance, but rather as a complement. She has provided ten guiding principles towards circular initiatives, categorized into three sectors concerning *the foundations of the transition*, *the context* of this transformational change and the *successful implementation* of a circular initiative.

The first principle refers to starting with *a shared sense of urgency* to change the system. Urgency is created by the clear policy goals of the government, through societal pressure or market threats and opportunities. Urgency should be felt by all participants, since this can lead to collective action. If this is not the case, the government can enforce it by pressurizing key actors. The second principle concerns the implementation of a circular initiative which occurs in *four sequential cyclic phases.* Those phases refer to the *preparation of a circular initiative*, the *development of a joint business case,* the *upscaling* of a successful initiative and lastly the *mainstreaming* of the initiative. The next guiding principle regards the *tasks to be performed in each phase.* The author claims that they are generally the same for each case, although the focus changes according to case-specific characteristics. The tasks can be seen on the table below.

The fourth guiding principle refers to circular economy "*being a journey with a clear destination yet no predetermined path",* implying that there is no predetermined set of activities that need to be followed. Developing circular initiatives is process requiring flexibility and continuous adaptations. However, a step-by-step plan is often utilized with clear steps regarding the formulation of a clear vision, gaining insight in the current situation and demands, definition of long-term goals which will define the short-term actions, drawing up of a strategy including priority points, intermediate and final targets, developing tools and adapting procedures, monitor and evaluation of progress to formulate next steps and implementation of offline/online communication strategy.

The next set of principles refers to the context. Starting by *focusing on the most promising and disrupting innovations*, *mapping the key drivers and preconditions for successful implementation,* and *identifying the relevant actors and assess their willingness to join forces*. To select the most promising innovation, the current situation is assessed, and innovative options are identified. Then through market consultation, investors are selected, and a consortium is created to jointly develop the circular initiative. Drivers and barriers can be case or sector-specific, but they generally can be of economic, financial, legal or social nature. Collaboration and trustworthy relations can be seen as a significant driver, while commitment and internal resources are seen as preconditions. Regarding actors, it might be difficult to determine which actors are prime actors for change. This can be assessed only later, through the process.

The last three principles regard the successful implementation. The author notes that new *circular business models should benefit all network partners*, so that actors are aligned on a common effort. Furthermore, she notes that *transition brokers*, independent actors orchestrating the process and the content of the circular initiative, can accelerate the progress. They can be utilized in various roles in each phase, from initiators to negotiators between the parties and communicators of the results. The last principle highlights the importance of transparency in division of labor among the participants. Each actor is responsible for certain activities and has a role in the system, and therefore it is crucial that each actor knows upfront its function and the subsequent activities he is involved with.

4.2.5 Barriers and Enablers

Hart et al. (2019) identified barriers and enablers for circular economy, within the built environment, based on a literature review. They identify four broad categories, concerning *Cultural*, *Regulatory*, *Financial* and *Sectoral* barriers and enablers. An overview of them can be seen on the table below.

Table 1: Barriers and Enablers of Circular Economy (Hart et al., 2019)

Categorization	Barriers	Enablers
Cultural	• Lack of interest, knowledge/ skills and engagement throughout the value chain • Operating in linear economy • Lack of vertical and horizontal collaboration • Lack of collaboration between business functions – silo	• Leadership • Sustainability/environmental drivers • Stimulate demand • Value chain engagement • Longer term relationships and partnerships • Systems thinking
Regulatory	• Lack of consistent regulatory framework • Obstructing laws and regulations • Lack of incentives for CE	• Policy support & public procurement • Regulatory reform • Fiscal support • Producer responsibility
Financial	• Short-term blinkers – CAPEX prioritized over OPEX • High upfront investment costs. • Low virgin material prices • Poor business case / unconvincing case studies • Limited funding	• Whole life costing • Easy wins • CBMs • Scale
Sectoral	• Lack of bandwidth compounded by no coherent vision • Complexity / confused incentives • Long product lifecycles (buildings and materials) • Technical challenges regarding material recovery • Lacking standardization • Insufficient use or development of CE-focused design and collaboration tools, information and metrics • The industry itself – conservative, uncollaborative, risk-averse	• Clearer vision for CE in the built environment • Better evidence base • Collaboration and design tools and strategies • R&D, innovation • Develop standards and assurance schemes • Develop reverse logistics infrastructure

4.3 Towards a Governance Framework

In this chapter, the different approaches to governance presented above, are adapted into a single framework of governance for collaborative networks. The framework consists of the mechanisms that constitute governance, grouped into relevant dimensions and the antecedent factors that affect mechanisms' selection and implementation. A schematic approach to the framework is seen bellow.

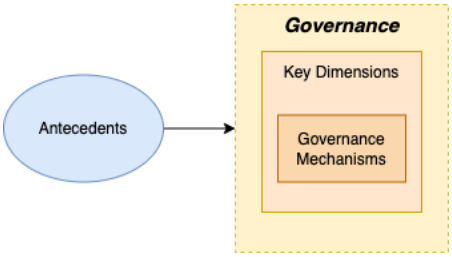

Figure 11: Scheme of Governance Framework. Own Work.

4.3.1 Governance Antecedents

Based on the literature review, several antecedents or factors that affect governance are acknowledged. The compilation of those factors is presented in Appendix C. The identified factors can be grouped into seven different categories, that act as the governance antecedents for this research. The categories are presented below.

The network size (Bryson et al., 2015) and the number of participants (Provan & Kenis, 2008) can be grouped in a category regarding the ***Size*** of the project. The network of participants can be relatively described as small or big. The paradoxical tension of inclusivity versus efficiency is also relevant here (Bryson et al., 2015), as including many actors in the project can benefit the project but it can also make it less efficient. Preexisting relationships (Bryson et al., 2015), prior ties between project participants and relationship length (Roehrich et al., 2020), pre-history of cooperation or conflicts (Ansell & Gash, 2007) and prior failure to address the subject (Emerson et al., 2011) are grouped into a single category ***Past relations and perceptions.*** It refers to whether the actors have collaborated before and their experiences regarding past collaborations. Prior relations are also affecting the initial level of trust and control (Bryson et al., 2015) and the level of trust or conflict (Emerson et al., 2011) between participants. Governance mechanisms can be affected by -positive or negative- past experiences of the initiating actor or organization. ***Policy/Legal framework*** refers to the legal framework and policies behind the project (Bryson et al.,2015; Emerson et al., 2011; Roehrich et al., 2020). Each project is subject to the legal framework and the policy or mandates that the governmental agencies impose. Therefore, governance mechanisms are affected by legislation and sectoral policies. ***Power-Dependency structure*** is also considered as an antecedent. It refers to the dependency on certain resources, expertise, and knowledge (Ansell & Gash, 2007) and the subsequent power dynamics that are developed (Roehrich et al., 2020). Based on those, actors can be either willing to collaborate or forced to do so, due to the circumstances. It can also refer to the interconnectedness of the network (Provan & Kenis, 2008), meaning how dependent are the network actors. ***Uncertainty*** (Roehrich et al., 2020), is the next factor under consideration. All forms of uncertainty (environmental, market and behavioral) are considered since they can affect the governance mechanisms on various ways. ***Type of project*** refer to the unique characteristics of each project type. This factor concerns the type of relationship (Roehrich et al., 2020) and the (collaborative) task (Bryson et al.,2015) that the actors are undertaking, as well as the nature of the project under consideration. Different projects are subject to different governance types and mechanisms. The last factor regards similarities or differences between organizational cultures of the actors (Bryson et al., 2015; Emerson et al., 2011). ***Unity/Diversity*** in practices, culture, values and roles among project participants can play a significant role on defining governance mechanisms. It is worth noting here, that factors such as *goal consensus, facilitative leadership* and *incentives or constrains on participation* are not considered as antecedent factors, as they are perceived as governance mechanisms on the context of this research.

4.3.2 Dimensions and Mechanisms of Governance

For governance to fulfil its function, that is to coordinate, adapt and safeguard economic exchanges among actors, governance mechanisms are utilized. Based on Kujala et al. (2020) those mechanisms are categorized to six key dimensions, namely *Goal setting, Rewarding, Monitoring, Coordination, Roles and decision-making* and *Capability building.* Those dimensions are the basis for the analysis. However, other authors (Emerson et al., 2011; Ansell & Gash, 2007) have identified other characteristics of governance that are relevant in a network or a collaboration. Therefore, the framework of Kujala et al. (2020) is enriched based on the literature review.

Emerson et al. (2011) identified three main collaboration dynamics of collaborative governance. These dynamics are *principled engagement*, *shared motivation* and *capacity for joint action*. Principled engagement regards engaging participants to a common purpose. Shared motivation refers to jointly motivating the participants through a climate of trust and understanding and by creating legitimacy and shared commitment. Capacity for joint action relates to the elements, namely institutional arrangements, leadership, knowledge, and resources, that cultivate the collaborative solution of a problem. Principled engagement can be regarded as a mechanism for capability building and therefore can be added on that dimension. Capacity for joint action encompasses the elements needed to "expand the space" of the collaboration. In other words, it can be perceived as the necessary structures and characteristics that actors need to achieve their shared objectives. The *procedural and institutional arrangements* refer to protocols and structures necessary to manage participants interactions, that is the core of governance mechanisms in the context of this research. *knowledge* and *resources* refer to actors bringing their expertise on the project, utilizing resources jointly and ultimately generating new knowledge and resources. Therefore, those elements are reflected in this model through mechanisms such as *information sharing, training and continuous learning* and *rewarding*. However, the joint utilization of knowledge and resources within the project environment is not expressed in the model. Therefore, *joint utilization of knowledge and resources* can be added as a governance mechanism in the dimension of *Roles & Decision Making.* Regarding *shared motivation*, this dynamic can be perceived as a separate dimension of governance, with the identified elements acting as governance mechanisms. Motivating network participants is important for governance to fulfil its function. Therefore, the dimensions of governance as presented by Kujala et al. (2019) are enriched with a new dimension named *Motivation.*

The concept of leadership, although relevant to governance can be treated outside its boundaries (Bryson et al., 2015). In the framework of Kujala et al. (2019) leadership is largely absent, with the exceptions of a reference of leadership as a facilitator in conflict resolution and the role of the leadership team in decision making. However other, scholars have identified its importance in collaborative governance (Emerson et al., 2011). Facilitative leadership is seen as an important ingredient to bring stakeholders together and engage them in a collaborative environment (Ansell & Gash, 2007). The style of leadership, the skillset of a collaborative leader and the actions taken towards empowerment and representation of different views (Ansell & Gash, 2007) are all significant aspects that need to be investigated, in relation to governance. On the context of this analysis, leadership can be seen as an integral part of different governance mechanisms. *Leadership type* and *Leader skillset* is best fitted in the mechanism regarding *roles and responsibilities*, while *empowerment* refers to *authority for decision making*.

Lastly, on the model of collaborative governance of Ansell & Gash (2007), the authors acknowledge five steps in the collaboration process, regarding *face-to-face dialogue, trust building, commitment, shared understanding,* and *intermediate outcomes*. Face-to-face dialogue can be regarded as a governance mechanism fitting to the *Coordination* dimension, while *intermediate outcomes* refer to the *goal setting* dimension. Consequently, those mechanisms can be added to the corresponding dimensions. The other steps are closely related to the elements needed for achieving *shared motivation* according to the model of Emerson et al., (2011). Therefore, they can be included in the analysis in the dimension of motivation. The dimensions and the subsequent governance mechanisms can be seen on the figure below.

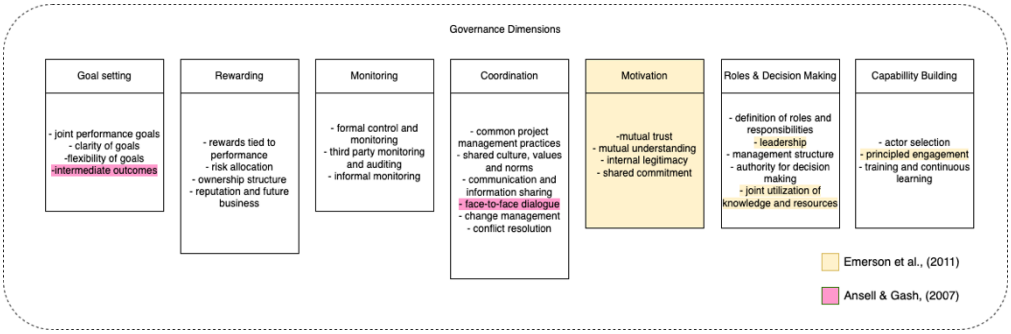

Figure 12: New Governance Dimensions and Mechanisms. Adapted by Kujala et al. (2020), Emerson et al. (2011) and Ansell & Gash (2007).

4.4 Adapting the Framework for Circular Infrastructure Projects

By incorporating the unique characteristics that circularity imposes on infrastructure projects in the conceptual framework of governance, a circular governance framework can be developed. Based on the literature, the relevant factors that differentiate circular from traditional -linear- infrastructure projects and should be considered in the analysis are presented below.

The first point concerns the creation of a shared circular vision (Leising et al., 2017; Brown et al., 2020), expressing the *circular ambitions* (Versteeg, A., 2019; Leising et al., 2017) for the project. When developing circular initiatives, this ambition acts as the starting point. Based on it, detailed requirements will be jointly defined by the project participants during the implementation. Therefore, in the key dimension of goal setting, the governance mechanism of *circular ambitions* is added. Another challenge that occurs when setting circular goals, concerns how to measure those goals. For this reason, new *circular performance metrics* (Police & Batocchio, 2018) need to be introduced.

Furthermore, authors claim that non-traditional contracting (Leising et al., 2017) should be implemented on circular projects. This is partly because, such projects are developed with collective goals in mind and partly because of the equal distribution between risks and responsibilities. This has an impact on *rewarding*, as *risk allocation* and the *ownership structure* are inherently different. Therefore, the governance mechanisms remain the same although they are expressed differently. However, a new mechanism that can be added in this dimension, refers to the establishment of *shared* (financial) *incentive*s (Leising et al., 2017) for circular goals. Circularity can be often seen as financially burdening for certain parties, such as contractors and therefore, shared incentives can be utilized to overcome this challenge and align partners' interests.

For *monitoring*, a new governance mechanism is introduced. It refers to utilizing circularity experts, or "*Transition Brokers"* (Cramer, J., 2020), as a control and monitoring structure. Their role could be procedural, but also, they could be responsible for content-specific issues in the project.

Regarding *coordination* of activities, the use of information technology and more specific Building Information Modelling (BIM) (Leising et al., 2017), is noted as an enabler of circular economy. Therefore, a new governance mechanism can be *Use of new technologies*.

Top-down support (Kooter et al., 2021) and *external support* (Leising et al., 2017; Cramer, J., 2020) from the parent organizations is also seen as an important factor in the implementation of circular projects. This factor is particularly important for reciprocity of successful results in future circular projects. Therefore, *external support* can be added as a mechanism in the dimension of *Motivation.*

Regarding *leadership*, it is perceived as an important factor by many scholars (Leising et al., 2017; Kooter et al., 2021; Hart et al., 2019). A leader with a strong circular mindset can enhance the motivation of project participants and facilitate the creation of a circular vision (Leising et al., 2017). *Pioneering leadership* (Kooter et al., 2021) inspires project participants and create awareness towards

circular initiatives while *facilitative leadership* (Arfaoui et al., 2022) ensure integrity and trust. Therefore, those leadership characteristics can be added in the same dimension. Further, on *roles and decision making*, it is noted that in circular projects all parties should have a clear understanding of their roles and responsibilities (Cramer, J., 2020). However, in practice this is easier said than done. Therefore, governance mechanisms should be introduced to safeguard that each actor knows upfront their function and its activities. This mechanism is expressed in the framework as *definition of roles and responsibilities*. Another challenge regards decision making. Traditional approaches of single-party decision making should be altered to a *collaborative circular-oriented decision making* (Brown et al., 2020), so that risks and profits are adequately shared, uncertainty and ambiguity are managed, and transparency and trust are safeguarded. Therefore, a new governance mechanism regards the *circular-oriented decision making* in the project.

Another characteristic of circular project, that is often discussed in the literature, concerns the *early involvement of the supply chain* (Versteeg, A., 2019) in the project. Naturally, this should be reflected on the governance structure, on dimensions such as *goal setting*, by taking into consideration the goals of the participants, *motivation* by establishing a climate of trust among all project participants and *capability building*, where actor selection is inherently more important due to the length of the relationship. When combined with the *life-cycle approach* that circular projects follow, and particularly the attention to *end-of-life management* (Versteeg, A., 2019), a time-dynamic dimension for governance in circular projects is apparent. Therefore, in this framework it should be taken into consideration that the relationship length between the involved parties is elongated and should be managed earlier on.

A subsequent effect of involving the supply chain earlier on, is that to achieve legitimacy the project partners should be jointly selected. Furthermore, those partners should have a "*circular mindset*" (Police & Batocchio, 2018; Witjes & Lozano, 2016; Kooter et al., 2021; Brown et al., 2020) and should be intrinsically motivated towards the common cause. Those *non-technical specifications* (Witjes & Lozano, 2016) for circularity are added on the *capability building* dimension. Another aspect added here, is the multidisciplinary character of the project team (Leising et al., 2017). Successful implementation of circular projects requires collaboration of a plethora of actors ranging from procurers and developers to maintainers and demolishers. Therefore, a *multidisciplinary project team* is a prerequisite. The circular elements included in the governance framework are illustrated bellow.

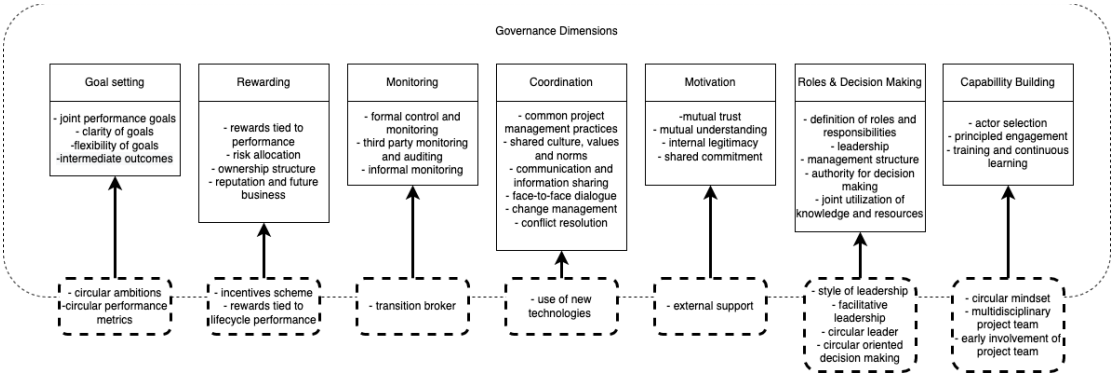

Figure 13: Governance Mechanisms included in the Governance Framework, based on the literature. Own work.

Based on the aforementioned notes, the governance framework for circular infrastructure projects is presented below.

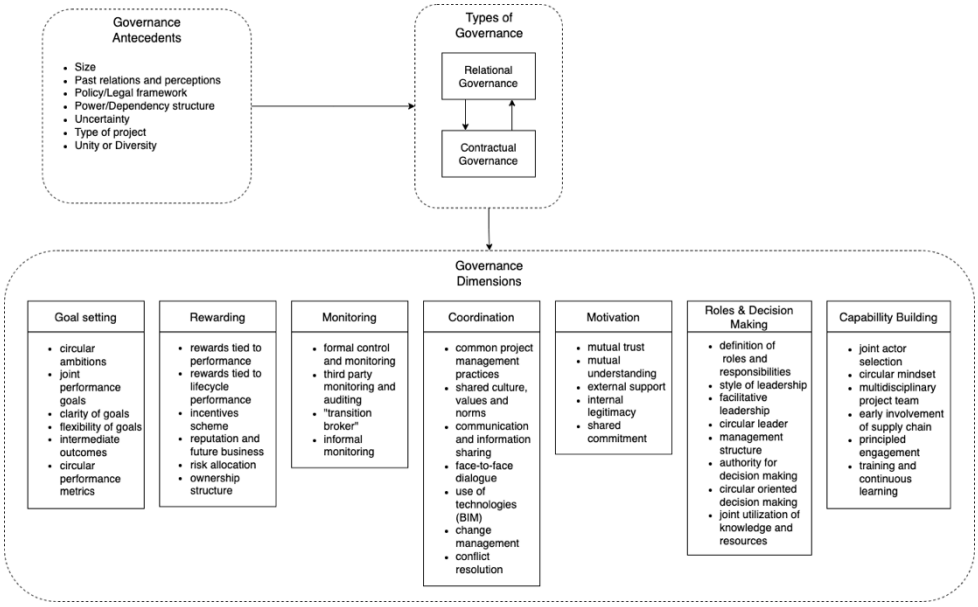

Figure 14: Governance Framework for Circular Infrastructure Projects. Own work.

By combining the governance mechanisms into groups and re-arranging the governance dimensions to reflect the traditional cognitive management structure of a construction project, a simplification of the governance dimensions is illustrated bellow.

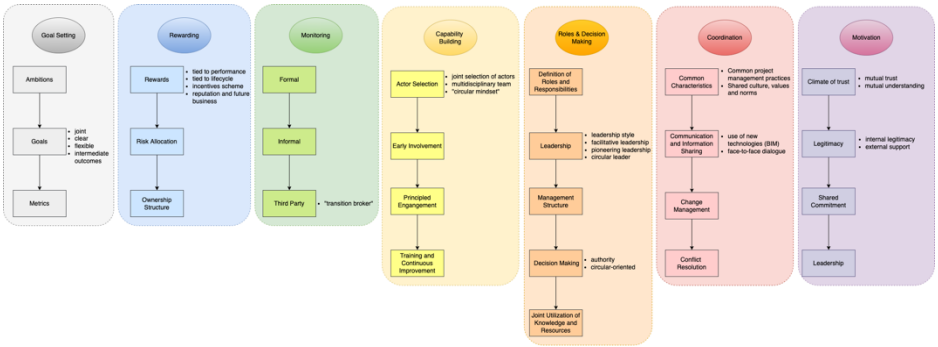

Figure 15: Research Framework of Governance for Circular Infrastructure Projects. Own work.

Based on the research framework, several interview questions can be written down. The questions are following the structure of the framework and revolve around the seven governance dimensions. The questions regard governance mechanisms in the project, the reasoning behind their selection and the challenges that relate to the different dimensions. An analytic version of the questionnaire can be found in Appendix D.

5 Multiple Case Study

In this chapter the multiple case study analysis is conducted, First, the analysis procedure is presented, subsequently, each case is analyzed, based upon the research framework. The selected cases are schematically presented bellow.

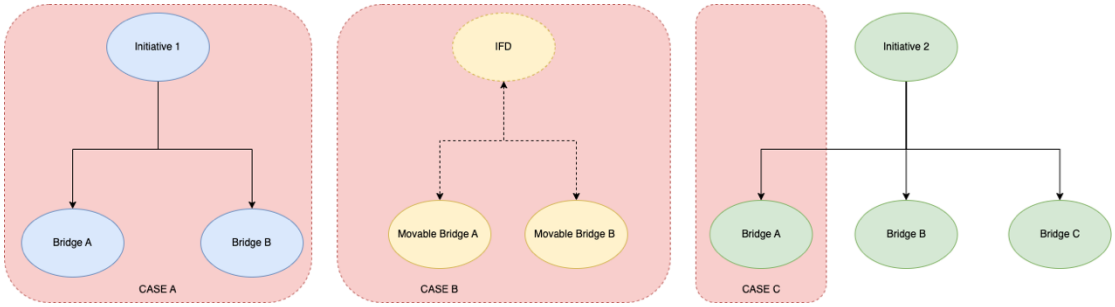

Figure 16: Case selection diagram. Own work.

5.1 The analysis procedure

As stated above, on the context of this analysis three cases are selected. Those cases regard different circular infrastructure projects in the Netherlands. Each project has as a starting point, a different circular initiative. In this way, it is interesting to compare how different initiatives define circularity, how they cope with circularity principles, how they prescribe collaboration in the project environment and consequently how they define project governance, through the governance mechanisms.

The analysis starts, with a brief description of the case, followed by a presentation of the interorganizational collaboration in the context of the project. Then, through an elaborated analysis of the interviews, the governance arrangements for each case are noted, along with factors that affect their selection. They are presented schematically, based on the research framework as explained in the previous chapters. The analysis concludes with the main challenges that were acknowledged for each case. The challenges are divided into project specific challenges and challenges that regard the adoption and standardization of circularity principles, in the Dutch infrastructure sector.

5.2 Case A: Circular pedestrian bridge and circular road bridge

Case A concerns the development of two bridges, where circular economy principles are followed. The project took place in a world expo, an incubator of innovation aimed at showcasing sustainable “green” solutions. As of 2022, the project is completed. The bridges remain on site and will be utilized as part of an urban area development.

Bridge A is a bicycle pedestrian bridge. It is constructed with cement-free concrete and includes materials from processed urban residual flows. In addition, reusable materials are also used, including wood for the handrails and tubular piles for the foundations. All materials were harvested locally, which also contributes to lowering logistics and transport costs and CO_2 emissions. Bridge B is an 80 meters long road bridge, designed for the heaviest traffic class. This bridge is constructed also from cementless concrete. It uses this type of concrete even for the structural parts, a unique characteristic in Europe. Furthermore, this bridge is completely reusable. Another characteristic of this bridge is that is constructed using a “green strip” that absorbs water, CO_2 and particles that can be found on the water.

The project is derived from a public-private initiative that aims to counter the problem of bridge renewal and renovation in the Netherlands. Specifically, around 85.000 bridges in the Netherlands are needed to be replaced in the following years, because their lifecycle expectancy is nearing its end. Therefore, the problem that arise concerns how can those bridges be replaced in a sustainable yet cost-

effective manner. In total, 4 bridges are constructed based on this initiative. However, bridge A and B are part of the same project, developed by the same group of actors, and have a common contract. Therefore, they constitute one case, Case A.

5.2.1 Interorganizational collaboration in Case A

Towards that direction, two public clients, a province, and a municipality, came together to attempt answering this question. Their initial aim was to produce sustainable bridges that can be regarded as an example for similar future projects. In that direction the generated knowledge was also a secondary goal for this initiative. To better cope with the problem, they asked a plethora of actors from the market, education and science institutes to participate in a series of dialogues, or "sprints", to translate sustainable ambitions into concrete goals. Circularity principles were introduced in the project, during this process.

Actors in the initiative were judged by an independent committee on the basis of their ideas and their proposals. The best proposal was awarded with a Design & Construct contract to materialize their ideas. The companies created a consortium to work closely together, in what was described as a "soft", or "informal" alliance. The consortium consisted of participants by the public client side, the contractor, the architect, the supplier of the cement-less concrete, and the recycling company responsible for harvesting, processing and supplying with second-hand materials. Furthermore, a common data environment was utilized during the project, and therefore the company that was responsible for the operation of this environment also constitutes an actor. The process was facilitated by three factors, mainly a decision to innovate, the availability of funding on behalf of the province, and the "room for innovation", or the availability of space to pursue innovation. Interorganizational collaboration was utilized both in the initiation and the development phase. The different actors across each phase can be seen at the next diagram.

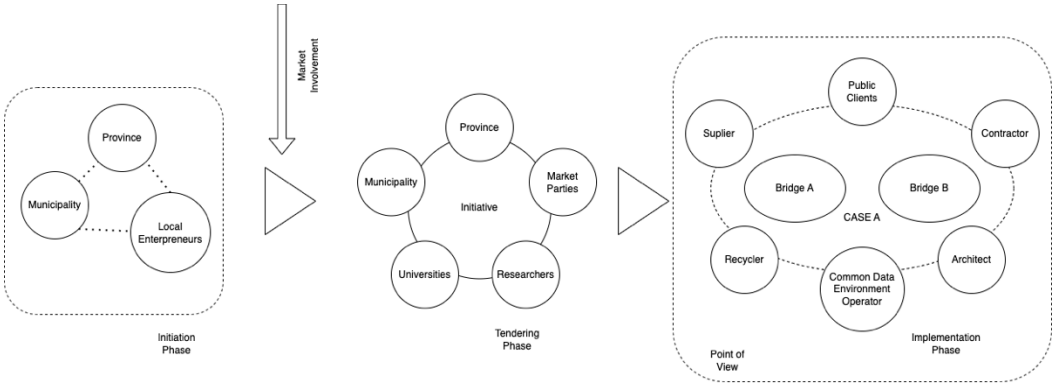

Figure 17: Inter-organizational collaboration in Case A

5.2.2 Governance arrangements in Case A

In this chapter, the governance arrangements for Case A are presented, following the categorization of the governance research framework, as presented in the previous paragraphs. Each statement, is supported using a quote, based on the interviews. An extensive table with the identified governance mechanisms, the factor that affected their selection, and the corresponding quotes based on the interviews, can be found in Appendix E.

5.2.2.a Goal setting

5.2.2.a.a Circular Ambitions

Circular ambitions were not involved during the initial phase, as initially the main objective was innovation. Circularity was introduced through the consultation with the market parties, and it was facilitated by their knowledge and expertise on the subject. The questions surrounding circularity, were

resolved in a collaborative way, jointly by the different actors, in the initial “sprints” dialogue. Actors provided different solutions regarding circularity, according to their expertise. Those regarded the adoption of circularity principles such as reuse or recycle, and more technical issues, such the use of a cementless concrete. The adoption of circularity principles was also facilitated by other governmental bodies. The reason behind that, was absence of knowledge on behalf of the initiators, regarding circularity.

5.2.2.a.b Goals

The circular ambitions were translated into specific goals during the dialogue. Initially, regarding circularity no concrete goals were set. During the tendering, requirements were set by the public parties and the private parties would set their questions, to clarify the goals. The goals were jointly set by the actors, and this was indicated by both public and private parties. Another important element was the possibility for private parties to pursue their personal/organizational goals. The goal setting process led to the shaping of concrete goals. Clarity is noted as important for the project. Once the goals were set, there was no flexibility, in terms of changing the goals.

The specific goal of this project was to deliver bridges until a specific timeslot, that was the opening of the world expo. In addition, other goals concerned learning for the future, regarding circular projects. In fact, this learning is considered as an equally important goal for the project. The main areas considered how to improve circular infrastructure projects and how to improve public-private collaboration. This knowledge was utilized internally, by the public parties. Actors identified that, in order to transform the infrastructure sector into a circular sector, developing circular projects is important. During the project implementation, new goals were introduced. For instance, knowledge generation and sharing, initially an outcome of the project, was later upgraded to a direct goal of the project.

5.2.2.a.c Performance Metrics

Regarding performance metrics, MKI and LCA were selected. However, during the tendering procedure there was not unanimous consent on the use of said metrics, as parties claimed that different considerations on the tender phase could lead to different results. Considering performance metrics in the tendering phase, clarity is considered as important. Furthermore, focusing on a single metric can exclude options that can potentially enhance circularity. Closing, although performance metrics can be informative regarding circularity, the question of what exactly entails a circular project remained.

5.2.2.b Rewarding

5.2.2.b.a Rewards

Considering the rewarding scheme for the project, it was quite traditional. There were small financial incentives for people to join in the earlier stages of the dialogue, but the main incentive was to be able to participate in this unique project. There was an absence of financial incentives or performance-based incentives in the project implementation. Knowledge and experience in circular projects, was considered an incentive for all parties involved. This can lead to future business opportunities for the private parties.

5.2.2.b.b Risk Allocation

Regarding risks, although Case A was an innovative project, it doesn’t mean that safety was compromised. Financial risks were divided between the public and the private parties, and construction risks, were divided among private parties. However, most of the construction risks were undertaken by the contractor, as his role traditionally implies. In order to mitigate construction and innovation risks, the contractor had to perform tests and involve external certification agencies. This has caused a delay in the project. It is also noted that risk related to the confidence that the contractor had on the product. Another risk in the project, concerns the behavior of people, regarding their openness to innovation and risk. A risk mitigation measure can be having close contacts with project participants. Lastly, a common data environment can also act as a risk management tool, meaning that openness and sharing of information can enhance risk management in the project.

5.2.2.b.c Ownership Structure

Lastly, considering the ownership structure of the project, its ownership was on the organization that managed the world expo, but it had since reverted into the municipality.

5.2.2.c Monitoring

Monitoring was jointly performed through the progress team. It was early-on decided to follow a "soft approach" on the collaboration, something that also affected the austerity of the monitoring. This was implemented because actors felt it could facilitate the collaboration. Third-party monitoring was also utilized for licensing purposes. Monitoring was also performed through the common data environment, and this is considered as a strong point of it. In the project, monitoring is also relevant to examining and learning about the process, one of the initial goals of the project. In this sense, monitoring is still performed today, for certain parts of the project.

5.2.2.d Capability Building

5.2.2.d.a Actor Selection

Regarding actor selection, the initial team was established through a collaboration between the municipality and the province. Initially the project leaders who were brought together in this initiative, could select their partners within their organizations but they couldn't influence actor selection outside their organizational boundaries. This team organized a series of dialogues, or "sprints", to come up with innovating solutions regarding bridges. Following, the tendering process was constructed in collaboration with an external agency. Three contractors were invited, and teams were constructed around them. The teams consisted of people that had previously collaborated in the initial dialogues. The selection of the contractor was based on specific criteria and the decision to award the contract was taken from an independent committee. Clarity in the actor selection proved to be a challenge due to differences in circularity performance metrics.

Expertise and experience played an important role during the selection. Teams were involving multiple disciplinaries. In fact, that was one of the differences with traditional projects. The multidisciplinary character of the project team derived from the fact that single parties cannot achieve their objectives alone. What was also considered important, is that people from the permitting department were also involved, so that there were no authority issues later on in the process.

5.2.2.d.b Involvement

Most actors in the project, were involved during the earlier stages of development, and they were continuously involved throughout the process. The involvement of the actors was designed from the initial phases of development, by providing an experimental yet friendly environment to innovate and achieve personal goals. Involvement was also facilitated by creating a common sense of urgency.

5.2.2.d.c Training and Continuous Improvement

A last thing about capability building refers to training and continuous improvement. Training was provided through the initial dialogues, or "sprints", through a series of questions that were collaboratively answered. Training regarded both technical aspects, but also processes, as actors weren't familiar with this kind of collaboration. Regarding the common data environment, no organized training was provided as actors were already familiar with similar systems, and for more complex issues the CDE operator was responsible.

5.2.2.e Roles & Decision Making

5.2.2.e.a Definition of Roles and Responsibilities

Regarding roles and responsibilities, the actors have specifically defined roles and responsibilities. An important thing noted by practitioners, was that actors needed to be aware of their role, and what their role entails. Another key element was that, in the project team, there were participants with the same role from both public and private parties. Regarding responsibilities, it was noted that accepting responsibilities can be the basis of being trustworthy, and therefore could enhance trust between participants. In this project the process was different and therefore actors had different roles and responsibilities in comparison with traditional projects. Project participants, in general, need to adapt

their roles, in circular infrastructure projects. Regarding the public party, it abandoned its usual passive role, and actively participated in the collaboration. Other public actors, such as the actors responsible for the licensing and the permitting, had to chance their stance, because they were confronted with innovative solutions. Changes of roles wasn't easy, as actors are facing an internal struggle between being innovative and achieving organizational goals. Private parties, such as the contractor, were also forced to change their role, and this was also noted as challenging. The differences for private parties, regarded the testing of innovative solutions, and the acquisition of permits. Another difference concerned data management and sharing as actors weren't accustomed to work on a common data environment.

Especially regarding the change in skills and competencies, this is an open field of research. Towards that direction a common competence environment was established, where the ideal roles and responsibilities were investigated. New competencies regard information management and digital skills. Digital competencies are necessary in the construction industry to cope with modern problems. Regarding leadership, the circular leader's profile is currently investigated through a circular leadership program. Although the importance of a "circular leader" is noted, no further conclusions can be made regarding it.

5.2.2.e.b Decision Making and Management Structure

Regarding decision making and management structure, decisions were taken in multiple levels. The project level acted as the incubator of information, in order for decisions to be taken in the above strategical level. Important decisions were taken also outside the project boundaries and therefore, a dependency on external actors was noted. Persuading external actors with decision making powers was noted as a challenge. Inside the project boundaries decision making was straightforward, and private actors were also able to get involved. Important for decision making was also the moment of intervention, as well as transparency. The common data environment was also a facilitator of decision making, and it was utilized to achieve consensus among project participants and facilitate political decisions. Information, or input, was important for decision making and therefore a common data environment could lead to more grounded decisions.

5.2.2.e.c Joint Utilization of Knowledge and Resources

Knowledge gathering and sharing, was a goal of the project. Interviewees considered it an important initiative. The public party aimed to internally capitalize on generated knowledge, and also share it with other public parties. This would improve the process of building circular and promote circularity. Knowledge sharing regarded circular concepts, such as the cementless concrete. Joint utilization of resources was considered important inside the project team. Private parties were contributing to co-utilizing resources with public parties, but also with other collaborating private parties. Lastly, the common data environment facilitated joint utilization of generated knowledge and sharing between project participants. There was a specific procedure that was followed, that included applying proposed changes, making comments and visualize inconsistencies.

5.2.2.f Coordination

5.2.2.f.a Common Characteristics

Common characteristics in the project team was important, however in the context of the project, there weren't common characteristics between project participants. Regardless, there was a way of common thinking in the team. This was important, though difficult to achieve. A common (positive) attitude towards circularity was apparent, and a significant facilitator for the project team. In the common data environment, actors were not obliged to follow the same procedure, or keeping the same standards. In this environment, actors could function according to their needs, by following and trusting the process.

5.2.2.f.b Communication and Information Sharing

Communication was straightforward between the project participants. Different dialogues took place among the parties. An important issue concerned understanding actors' different perspectives. And effective communication was considered important towards that direction. Communication inside the project, was performed through applications and personal meetings. Face-to-face communication was a challenge due to circumstances, and the absence of it led to problems. However, it also proved that

questions can be resolved through the use of remote communication. Information was shared in the common data environment. Information sharing in the project level is described by the operator as having four different statuses, work in progress, shared, published and final. Lastly, new technologies such as BIM were introduced.

5.2.2.f.c Change Management

Regarding change management, there was flexibility as long as the initial project requirements were not compromised.

5.2.2.f.d Conflicts

Conflicts were inevitably a part of the project. They concerned financial and operational issues. Another point was the internal conflicting goals in some participants, between innovation and organizational goals. Conflicts also arose due to misunderstandings. However, not all project participants agreed on the severity of conflicts. Some have downgraded the conflicts in the project, mainly because of the good relations inside the project team. In the project, conflicts were resolved through negotiations. They were resolved jointly, informally, and in a friendly manner. Dialogue was a key factor, in resolving conflicts. No other specific conflict resolution mechanism was noted.

5.2.2.g Motivation

5.2.2.g.a Trust

Trust was an integral part of the project. It was influenced by the informality in the relations between partners. Previous positive experiences in the "sprints" greatly influenced trust. Trust was also influenced by undertaking responsibilities. The development of the common data environment also influenced trust, due to, accountability for each party's action, regarding information sharing.

5.2.2.g.b Legitimacy

Internal legitimacy was achieved through constant communication. Previous successes in innovation projects enhanced legitimacy. Enthusiasm and common interest in circularity were also important, as well as the unique character of the project. Other factors include, working on something tangible and feeling proud about the common accomplishments. External support was achieved by communicating with superiors and explaining the details of the project, but also by "fighting your own battles" or by not excessively involving external actors, when that is not necessary. Support was also achieved through the positive reputation of the project, and because of the environmentally friendly solution that was ultimately selected. It was noted that even initial opposition could be transformed to support by providing tangible results.

5.2.2.g.c Engagement

Engagement of project participants was considered important. It was achieved through workshops and team building activities.

5.2.3 Challenges

The challenges encountered on this project, refer to both circularity as a concept, as well as project specific challenges.

In the project level, the first challenge refers to measuring how circular a concept is. The participants have identified challenges regarding measuring circularity. This also relates to the fact that circularity as a process is still largely unknown, as people have a product-centric approach to circularity. Specifically for the project, that relates to all the other activities that take place outside the building of the bridges. Collaboration was also a challenge, especially achieving consensus, while sometimes mutual understanding was also a challenge. Furthermore, this collaborative approach created problems on the financial and operational side, that a more traditional approach could resolve. Another challenge refers to communication using platforms, instead of face-to-face dialogue, a problem that was exaggerated due to COVID restrictions Regarding the utilization of a digital environment as a facilitator

of circular initiatives, the challenges lie in the underlying processes. Challenges also refer to actors' competencies or involving actors capable of innovating. In a collaborative environment, a challenge is to prevent people from rebounding to their traditional roles, as people keeping their traditional roles, information sharing is also a challenge. Learning as a goal was also a challenge, for project actors. Challenges in the decision making include, depending on external actors for taking the right decisions, as they can be confronted by the innovation and have conflict of goals. External decision making can therefore burden circularity.

The biggest challenge, as noted by participants, lies on expanding those trials projects, scaling up and taking the next step, that is standardization of circular initiatives in infrastructure projects. This relates to information sharing but also on competencies of actors.

5.2.4 Governance Framework

Based on the above analysis, the governance framework for Case A, is presented below.

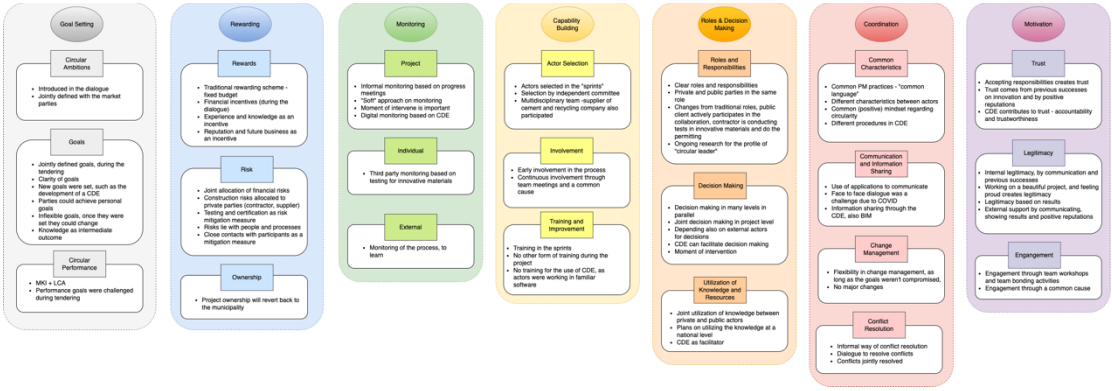

Figure 18: Governance Framework for Case A. Own Work.

5.3 Case B: Construction and renovation of moveable bridges

Case B concerns the replacement and widening of movable Bridge A and the renovation of the adjoined existing movable Bridge B, based on circularity principles. Part of the project concerns also the construction of a bicycle underpass. The project takes place in North Holland and as of 2022, it is in the construction phase.

The project has high sustainability ambitions. The ambitions include a circular design, energy neutral, and low maintenance. Circularity is achieved based on the Industrial, Flexible and Demountable (IFD) guideline, meaning that the design of the bridge is standardize, and therefore elements can be reused in the future. Furthermore, the concept of material passport is utilized to facilitate reuse. Another characteristic that enhances circularity is the use of geopolymer concrete, as well as a painting system that lasts longer. Energy neutrality is achieved using solar panels for energy generation, as well as energy-saving mechanisms. Lastly, low maintenance design, contributes to, among others, circularity as material usage is minimized. Other, ambitions include effective collaboration between the parties involved, and minimum nuisance from traffic retaining.

5.3.1 Interorganizational collaboration in Case B

The initiative started by the need to replace Bridge A, as it was nearing its life expectancy. Furthermore, in Bridge B, a major renovation was also needed. Towards that direction, several public clients, including the province, the municipalities and the waterboard, came together provide a solution. Circularity was introduced as an ambition of the project, in accordance with the Paris Agreement. For the preparation of the project, two private companies were utilized to complete the technical study of the project, with one of them examining it specifically from the circularity perspective. Afterwards, a market consultation

was organized to ensure understanding and achieving support for the ambitions, with more than 120 participants. Through this, the ambitions for the project were defined, and the tender procedure was sketched. As a tendering form, competitive dialogue was selected, to enhance innovative solutions. Four private parties were involved in the dialogue, and through 3 rounds of negotiations, concerning circularity, low energy consumption and collaboration, the winner was selected.

As a contract form, a two-phase contract was selected. Therefore, the client and the contractor collaborated during the design phase, as a bouw team. Actors in the bouw team, included the representatives of the public client, the contractor and the subcontractor, and the engineer, responsible for the design, as an "independent referee" between the former parties. Therefore, interorganizational collaboration is relevant in this case. A conceptual diagram is presented below.

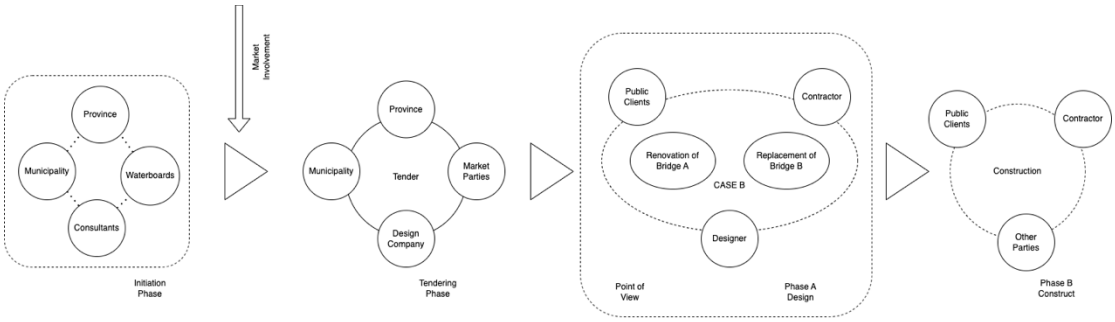

Figure 19: Inter-organizational collaboration in Case B

5.3.2 Governance arrangements in Case B

In this chapter, the governance arrangements for Case B are presented, following the categorization of the governance research framework, as presented in the previous paragraphs. An extensive table with the identified governance mechanisms, the factor that affected their selection, and the corresponding quotes based on the interviews, can be found in Appendix E.

5.3.2.a Goal setting

5.3.2.a.a Circular Ambitions

Circular ambitions were first introduced, through the public client, in confirmation with policies of the government. Although the ambition for circularity was expressed in a higher level, it would require individuals to facilitate the process of implementing it in the project. However, there was not enough knowledge on circular bridges on behalf of the client, and therefore, a consultant company was introduced to advice on circularity. They were given the ambitions, and they organized the tendering procedure to come up with circular solutions together with the market parties. Based on this procedure, the contractor was selected, and as a contract, a bouw-team was selected to cope with the high circularity ambitions.

5.3.2.a.b Goals

The initial goal of the project concerns the construction of bridge A and the renovation of bridge B, additionally, the bridges should be energy neutral, circular, and low maintenance, and also produce less traffic nuisance during construction. Those goals were set by the public parties in collaboration with consultants, and then the tendering procedure was initiated. In consultation with the market innovative exact solutions, were identified. Therefore, both the goals and the solutions for the project were jointly defined in some form, by public and private parties.

The point where this project deviates from traditional projects, is that instead of prescribing the exact solution, a list of requirements was given. However, requirements proved to be an issue for the contractor, as they were numerous, and their interactions were initially difficult to oversee and manage. Numerous goals and requirements were a challenge for all parties. Furthermore, traditional

project goals regarding budget and planning were intervening the sustainability targets. Circularity was implemented, through the IFD guidelines that constituted a goal for the project, and the use of material passports. However, at the same time IFD was standardized based on the outcomes of the project, therefore the project acted as a pilot for the implementation of IFD design principles. Based on the project results, alterations were made on the guideline, and that proved to be problematic. For the renovation in particular, there was an existing structure which was difficult to match with the guidelines. Therefore, it was perceived that for a new structure it would be easier to implement the guidelines, contrasted to implementing them on an existing structure. In the end, the design principles of IFD were only partially followed and that was due to misinterpretations and clashes with other requirements. That was in turn, a result from lack of knowledge and skills in the process, as well as unclear vision communication.

There was a clarity of goals among participants initially. However, combination of the goals was difficult to achieve and some of the goals were even contradicting. Therefore, a "battle of ambitions" was observed, meaning that actors were actively supporting different solutions that compromised an objective. Consequently, that lead to unclarity of goals during the engineering phase, and conflicting viewpoints among participants. On the same note, flexibility of goals was an issue, as during the engineering phase the scope changed, while the requirements remained the same. Therefore, a compromise on circularity was observed. For example, during the design phase the reuse of the steel deck was not implemented, and less circular solution were chosen, due to costs and risks. Lastly, through this project, private parties were able to achieve personal goals, regarding developing innovative solutions, and acquiring knowledge and expertise in circular projects, as well as in public-private collaboration.

5.3.2.a.c Performance Metrics

Regarding circular performance metrics, in the tendering phase, MKI was utilized. However, circularity wasn't the only criterion for decisions, there were other criteria, regarding cost, time and quality. In the design phase, MKI was utilized, although for some design decisions it was apparent which was the best solution without calculation. Material calculation was performed similar to cost calculation, so it was just a minor extra step for designers. Calculations were performed on the basis of percentage better than a reference project. Regarding circularity, other metrics could also be utilized such as Life Cycle Analysis, or Demountability Index, that could compensate for the importance of reusability in the future and consequently, stimulate the bidders to come up with different solutions.

5.3.2.b Rewarding

5.3.2.b.a Rewards

Considering rewards, in the design phase (Bouw-team) there was a budget and actors were financially compensated based on work hours, while in the construction phase, there is a fixed price. This project was not only procured based on the price, but also quality was important, as well as circularity and innovation. There were no financial incentives for the actors, as stimulating the participation through financial incentives was considered wrong. The incentive would be participating in an ambitious project and testing innovations, something that could potentially create positive reputation and lead to future business opportunities. Improved collaboration and a level playing field between client and contractor was also used as an incentive.

5.3.2.b.b Risk Allocation

Concerning risks, initially there was no material innovation in the project, and therefore the risks are known. A risk was the renovation of the existing bridge, as its condition was unknown. Risks also, arose from the reuse of existing materials, such as the steel deck, which was eventually declined as a solution by the contractor. The contractor perceived the risk as burdening, however the risk of reuse is also attributed to the client, while for the contractor it was merely a financial risk. Innovation in the project, raises the risk level, and this can be regarded as negative incentive for participation, on behalf of the private parties. Especially since, financial incentives were not given. Though participants agreed that, small, calculated risks are a necessary clause, when developing innovative projects. Risk wasn't allocated equally, but it was shared between the parties. However, both parties claim that the division could be done better. On behalf of the contractor, they claimed that the risks of innovation burdens

them, and there are no financial incentives for the increased risk, due to innovation. On behalf of the public client, they claim that the financial risks burden them.

Risk management wasn't performed through paying extra to the contractor, but risk was mitigated through standardization. Another risk management tool was the construction of a risk register. Due to shared-risk and responsibilities allocation structure, two participants in the tender chose, not to offer a bid, however this also relates to the two-phase contract, where constructing the project wasn't awarded from the start. Closing, it was observed that different parties had different perspectives on risk and responsibility, as both the client and the contractor claimed that they accumulated the main share of risks.

5.3.2.b.c Ownership Structure

Lastly, considering the ownership structure, the project will be solely owned by the province. Considering other outcomes of the project, such as generated knowledge, they are available for both private and public parties.

5.3.2.c Monitoring

Monitoring started with the evaluation of the proposals, by the contractors on the basis of alignment with the prescribed requirements. Within the collaboration, monitoring was performed through gate reviewing. The process involved representatives of the client and the contractor, asking questions in the project team, regarding price, risk, and requirements. In this process, the representative of the design company, acted as an intermediate, between the client and the contractor. The process started with trust and true ambitions between project participants, but after the design, their relationship became solely contractual. Monitoring the progress in the project, was performed through a progress report. Decisions were taken based on the solutions given by the contractor, with the main goal being focusing on alignment with the prescribed solution. However, this process was rather problematic, as monitoring was basically an informative process, instead of having it's intended collaborative, decision-making function. The outcome of the monitoring process was a report with the deviations from the requirements and the argumentation behind it, that was produced outside the project boundaries.

5.3.2.d Capability Building

5.3.2.d.a Actor Selection

The initiative started with the tendering team, consisting of multiple public actors on behalf of the province, and also representatives of other public clients, such as local municipalities and waterboards. Actors in the tendering phase, weren't able to freely select their partners, however the tendering team was enthusiastic about it, and they were also awarded with a prize for sustainability tendering. For the tendering, two private parties were contracted as consultants, one regarding circularity and one regarding technical details. Their role was to investigate, whether the circular ambitions can be incorporated in the project, advice on the initial requirements, and organize the tendering procedure.

The tendering started with a plethora of actors (120) from different parties participating on a dialogue. Through a competitive dialogue format, four parties were selected to come up with solutions for the project. The parties were competing on the basis of the three goals, circularity, maintainability and low-energy consumption. They were on purpose given limited information on the design, in order to come up with their own unique and innovative solutions. The process, consisted of three rounds, concerning circularity, low-energy, and collaboration, and the winner was selected based on the aforementioned principles. After the contract was awarded, the project team was manned, based on the availability, but also on the basis of a collaborative and circular mindset, as well as, project specific conditions. A collaborative mindset, and being open and having self-confidence, is an important selection characteristic in collaborative projects. Furthermore, empathy and curiosity are also important facilitators.

In the Bouw team, actors could propose other parties to join, however that wasn't utilized in the project, and that was a preference of the contractor, that wanted to freely select his collaborating

parties for the construction phase, but it was also in the interest of the client, as involving more actors in the bouw team was prescribing a certain way of work and specializing the project, and as a result in the construction phase a new contractor couldn't be easily contracted. Contractors select actors to collaborate with, on the basis of reputation, skills and performance, however that is not always possible. Business relations is a factor that influences actor selection, and familiarity facilitates knowledge exchange and capability building between actors. Informal meetings with actors outside of the project were also utilized, to acquire knowledge on sustainability. However, those actors were not involved in the tender as a compact group of parties is needed for the implementation phase. That fact created friction when the bid was awarded, when private parties where not selected to participate. Therefore, a personal approach is important, among the participants.

The project team was multidisciplinary, and had also integrated disciplines, as innovative projects require multiple disciplines to be developed.

5.3.2.d.b Early Involvement

Private parties were involved early in the process, first through the contracting of two technical companies responsible for the technical and the circularity part of the tendering, and then through a market consultation to identify innovative solutions. In the tendering, three private parties were involved and through conversation, one party was selected. The reasoning behind the involvement of private parties early in the process, comes from their expertise and knowledge, especially on innovation. However, the collaboration started on a traditional approach, meaning that the requirements we already set before market parties were involved. And that is perceived as a limit to sustainability solutions, on the behalf of the private party. Therefore, although the private parties were involved in the initial design, the moment of involvement, should have been even earlier, during the requirements definition.

Involvement of parties, throughout the project phases, is also important in order to successfully implement the circular ambitions, and this was also the case for actors in the project. Introducing new actors in the execution phase, who have different goals in mind, regarding planning and minimizing the risks, can lead to not obtaining circular goals. Therefore, when new actors were introduced, the first thing organized, was a manifestation of the circular ambitions of the project, so that every actor understood the assignment. This also aimed to engage actors that came from different projects, that were developed in the traditional way. Participants agreed that bouw-teams are an incubator of selecting a good project team, but involving the right people, and aligning them to the cause is also important. During the design phase, the client, the designer and the contractor, collaborated to come up with an optimal solution, and this was important, as the design is the most influential part of the project, in order to achieve circular ambitions. Integration of the public parties in the design phase, can solve the questions of the private parties, and facilitates the selection of an optimal solution. Furthermore, it helps public parties being more secure about pricing, and additional risks, Lastly, the involvement of private parties in the designing of the IFD guidelines, a secondary outcome of the project, was also a facilitator towards achieving that goal in the project.

5.3.2.d.c Training and Continuous Improvement

A last thing about capability building refers to training and continuous improvement. Actors involved, were experienced and innovative, so no organized training took place. However, actors had collaborative coaching, something that is common is projects that need to start in a short-period time. This training was more about personal behavior and less about skills and capabilities. Also, during the initial phase, consultancy was provided to the private parties, about achieving competencies regarding circularity, but that didn't constitute training. Actors learned together in the project about collaboration and also about the utilization of circular performance metrics, such as MKI. Also, people learned about their responsibilities and learning through their own mistakes.

5.3.2.e.a Definition of Roles and Responsibilities

Regarding the roles of project participants, the role of the public client in the project, is proactive, as it has an active participation in the design phase. Responsibilities regarding the design were shared, between private and public parties, and that is a difference, compared to a traditional project. Regardless, the contractor, had still the lead role in designing solutions.

In Bouw teams, the project organization should include participants that mirror the participants of the other party. However, that was not the case in this project, because there wasn't the capacity within the public client to mirror the private party's organizational structure. The absence of public and private actors with the same role, within the project, was also noted by the private parties, but it was perceived as a financial decision. It was also considered negative, because actors with the same roles from private parties and public parties, tend to see they roles differently, and by collaborating they strengthen the role. The role of the public client is to come up with the requirements, by investigating the ambitions, while the private party aims to fulfil the requirements by providing the solutions, however in order for the solution to be successful, the requirements should be jointly investigated, and that was not the case in the project. Furthermore, to innovate there is a need for connection between the requirements and the solutions, something that can be achieved by having actors from private and public parties, of the same role collaborating.

Bouw-team, as a project delivery method, was selected because the client aimed to accumulate some of the responsibilities of the design, however that was not understood from the contractors, who interpret it as extra responsibility. Also, by accepting responsibilities, the public client was supposed to enhance the process, and implement more effective risk management, however, private actors noted that bouw team didn't fit with the governance structure of the project. In the project, the public client, persist on the traditional roles, and that is affecting sustainability targets and creates misunderstandings regarding new roles and responsibilities in a collaborative form of project development. External public actors and stakeholders that affect the project were also traditional. Therefore, the process was quite traditional, whereas it should be more innovative.

5.3.2.e.b Decision Making and Management Structure

There are different decision-making layers in the project. The first layer concerns design decisions that can be taken within a single discipline. Next, for decisions that affect more than one discipline, and need an integrated solution, an integral decision level is utilized. Following, for solutions have a big impact on goals and ambitions, or refer to contract changes, the decisions are taken on the decision-making team. Lastly, on the higher level, regarding budgeting, there was the political decision level. Apart from that, there was also an advisory board which gave advice regarding the solutions. Decision making is also influenced by external stakeholders. Budgeting decisions were taken outside the boundaries of the project, but positive reputation of the project, influenced decision making.

In decision making, it's important to identify the actors that are responsible for a decision, as engaging the whole team can lead to unnecessary delays. However, that led in problems in the project, as decisions weren't taken in the right place, and decisions were not perceived as important enough to be passed on a higher level.

In the project, decisions were taken jointly by the decision team, that had representatives of the client and the contractor, something that is not common in projects, but it's becoming normal recently. The designer, acted as a mediator between the two parties, having as an objective, to facilitate the decision making. Decisions were jointly taken for solutions in the project. However, that was perceived as challenging by the private party, as it requires consensus, and agreement requires time. Decision making processed, are different in public and private parties. Public parties are pretty much depended on political decisions, something that can create delays in the project. They are also traditionally depended on consensus between public actors and that was perceived as an obstacle in innovation. For private parties, there is no need for consensus, as decisions are taken from a single authority.

Therefore, the problem that was observed is that due to different decision-making models, the two parties couldn't meet on the board level, in order to discuss important decisions. A recommendation given is to set a moment of decision, to resolve the main issues, before starting the engineering part.

5.3.2.e.c Joint Utilization of Knowledge and Resources

Generated knowledge in the project, and how to further utilize it was one of the important questions. Regarding intellectual property generated through the project, it will be available to both parties. The biggest contribution of the project is the establishment of the IFD guidelines. The project acted as a pilot for the redesign of the guideline, by investigating its practical implications on a real project. Therefore, the generated knowledge, will be utilized by a learning community interested in IFD design, to formalize the guidelines, and create capacity, with an ultimate objective of making it the standard for moveable bridges in the Netherlands. Experience on the project is utilized by individuals who give advice for IFD implementation in projects with circular objectives.

Knowledge was internally utilized by the public client, but actors also acknowledged the importance of spreading the knowledge and facilitating joint learning together with private and public parties. Although no concrete plans for knowledge sharing exists yet, the actors believe that it is a possibility over time.

On behalf of the contractor, knowledge was treated as a strategic asset. Although circularity highlights information sharing, this is difficult to be achieved among contractors, due to their business model. More specifically, contractors deal in services and not in products, as other industries. Therefore, their strategic advantage of an innovation can be utilized in a single project, as after implementation it is transferred to the client and can be freely shared. That fact makes innovation not financially viable for a contractor. Therefore, compared to engineering companies that are not actually constructing a project, contractors are less open in terms of information sharing. That often creates misunderstandings between clients, contractors and engineering companies.

5.3.2.f Coordination

5.3.2.f.a Common Characteristics

In the project, there was common ground on some characteristics, but there were also differences. For instance, actors had different experience, with some being more experienced than others. Parties had also differences in their way of working, and the same applied to different disciplines within the same party. However, differences were celebrated within the project, as an important element. Regarding common characteristics, an open mindset was important. Other characteristics are intrinsic motivation towards circularity, also patience and curiosity towards each other. Regarding procedures, project participants adapt to the contractor's line of work, as most of the work for this phase, was on the contractor side. Therefore, the majority of the project participants were not forced to change their way of work. However, other project participants can have difficulties regarding changing their work processes, to get aligned with that of the contractor.

5.3.2.f.b Communication and Information Sharing

Communication in the tendering was organized by a single actor. Distant communication in the initial dialogue with the market was a challenge, due to the lockdown. However, for the individual dialogues with the three selected parties, personal meetings were utilized. During the bouw-team phase, private and public parties communicated in the party level, but also internally in the discipline level. It was also observed, that due to capacity issues on behalf of the public client, communication was fragmented. Project participants communicated using applications, and personal meetings. Meetings in person, was also utilized internally for the private actors. Actors needed to be aware of which method of communication to utilize according to the occasion. The difference between using applications to communicate, and communicating face-to-face, is that through applications you usually talk based on an agenda, on a tight schedule, while in meetings in person, you can see other actors' emotions, and explain to them personally the goals or the ambitions of the project. Face-to-face meetings also contribute to personal expression through body language and enhance creativity. Circumstances were proven an obstacle in the communication as they implied distant communication. And the period where meetings in person were reallowed, was the most productive for the project. Communication also

related to soft skills. Participants noted that lack of communication can lead to problems. Lastly, information sharing was important for the project. It was conducted through the use of applications, provided by the contractor.

5.3.2.f.c Change Management

During the goal setting, there weren't major changes. Some minor changes regard solutions that weren't implemented due to stakeholders' demand, such as the use of rusty iron for the handrails that was denied, in the basis of aesthetics. Other changes regard solutions that were introduced through market consultation, such as the construction of the bicycle lane under the bridge. In the design phase, changes can be bought either by the contractor, or by the public client. To initiate a change, first the impact of the change in the solution was calculated, as well as the timing of the change was taken under consideration. Then acceptance from both parties was required. Changes were consequently managed, with the same process as decision making. However, that showcased the same problems as decision-making, regarding delays and achieving consensus. Furthermore, during the design there were changes and deviations from the requirements, particularly regarding the IFD guideline. Change management wasn't sufficient in this case, as there wasn't enough discussion, and justification on behalf of the contractor, regarding the deviation of the prescribed solution. This could be attributed to the presence room for interpretation in the guidelines on the contractor side, and the unclarity of the vision communication, on behalf of the client.

5.3.2.f.d Conflicts

Conflicts is the project arose mainly due to financial reasons and deviations from the requirements. Another point of conflict was decision-making. Conflicts in the project were resolved through negotiations, and by taking into consideration the different viewpoints of actors and their interests regarding the project. Especially regarding personal interests, it was important to identify whether interests were common, and then conflicts were easily resolvable, or conflicting, then a reduction of ambitions was attempted. Conflicts related to financial issues, arise also, due to knowledge asymmetries between the parties, and differences in perceptions regarding the same subjects. Lack of knowledge, or ignorance, creates lack of confidence, and therefore parties are unable to effectively negotiate and resolve conflicts. Another way of resolving conflicts related to finances, was by proactive conflict management. That is by negotiating for the financial issues that may occur, early in the process. Or by resolving issues in the discipline level, before expanding into conflicts. Lastly, conflict management was performed through gate reviewing.

5.3.2.g Motivation

5.3.2.g.a Trust

Trust was a factor of success for the project, as without trust among partners, there was no collaboration. Therefore, creating trust was an aim in the project environment. Investing early in the process in creating a climate of trust was considered important. Trust could be designed in the project. Relevant actions included, identifying the difference in interests between actors, aligning them to the common cause and being open and transparent. Having a common goal, was important to create trust. Also, being successful and celebrating common successes contributes to trust. Lastly, a positive mindset regarding the goals of the project, facilitates trust. Equally important, was considered to sustain the climate of trust, and to achieve that, openness and communication played a significant role. Creating an environment where mistakes are not punished, but cherished as learning opportunities was also noted. A climate of trust cannot be achieved, by previous positive experience. However, trust issues, arise by previous negative experiences with project parties, or by an enclosed environment where actors' voices cannot be heard. Lastly, the concept of trust related more to trust in the process, than trust in individuals. Trust in the process in turn relates to trusting others making good decisions and also respecting actors' decision-making space.

5.3.2.g.b Legitimacy

Legitimacy was also an important goal in this project. Legitimacy can be expressed, as taking mindful decisions, and transferring decision-making power outside the project boundaries, when necessary. This was noticed as a challenge in this project.

Regarding internal legitimacy, decision-making and clarification of goals are noted as important by the private actors. For public actors, internal legitimacy starts with the role and the responsibility. Decision making is also relevant, since legitimacy as a notion is closely related to respect for the decision-making powers of collaborative parties. During the collaboration, it also relates to communication, more specifically, informing people when it's necessary, and the information regards their role and responsibility. Legitimacy on an individual level regards, respecting the organizational and decision-making structure, and selecting when to involve parties in your decisions. It is also aligned with the notion of trust. Creating a story, and acquiring positive reputation, facilitates internal legitimacy, as well as successes within the project team. Even though a structure was in place, that implied collaborative design, that wasn't the case. Therefore, the legitimacy structure has failed, as actors have compromised their roles.

For the public actors, external support was vital, as stakeholders have also decision-making powers. In the project, external support was achieved by explaining to internal clients about the responsibilities and progress, through weekly appointments. Support is also needed from external stakeholders, or political clients who were notified by memos about the course of the project and the collaboration. Sometimes, also private parties were involved in the political dialogue. The selection of bouw-team as the contract of choice, reduced the risk that external support would not be achieved, as the public client was actively involved in the project team. Publicity is also important for external support. Engagement is another factor that affected external support. When the project was in a later stage and a large financial investment has already taken place, then it was difficult to withdraw external support. On the contractor side, external support was achieved through board meetings, where progress and decision making were discussed.

5.3.2.g.c Engagement

In order to engage actors in the project, a "good story" was important. The story for this project was expressed as building an innovative project aligned for the future. A good story, engage more people to the project, and showcase the project's ambitions. Innovation also played a role, in engagement of the actors, as the project is innovating, and actors were willing to participate. Another fact that facilitated actors' engagement was that during the tender the project won a prize for sustainability. Lastly, positive publicity played also a role in engagement.

5.3.3 Challenges

The main challenges in the project, regarded financial issues. More specifically, the project exceeded its allocated budget. This was partly because of a rise in prices due to circumstances. However, hidden requirements also contributed to the exceedance of budget. In fact, the requirements set were numerous and that created problems for the contractor, regarding the scope of the project. Other challenges in the project level, regarded the combination of diverse goals, that were even contradicting, such as the low-energy and low material consumption goals, and the compromise on solutions, on behalf of the contractor, as solutions that were proposed on behalf of the public client were not selected for cost and risk reasons. Especially, regarding the implementation of IFD, there was a conflict of requirements between IFD and other specifications due to the public client not clearly expressing its vision which led to different interpretations of goals, by the private parties. Challenges in the collaboration, regarded working as a bouw-team, getting accustomed to the way of work of other participants, communication during the lockdown, differences in the decision-making models of involved parties, and understanding the viewpoint of other parties. Another challenge was measuring sustainability, as sustainable solutions are project specific,

Challenges for the adoption circular infrastructure, regard the absence of demand for circular solutions, on behalf of the public client, the traditional character of public clients, the need for a circular supply chain for a circular construction sector, and the inspiration of circular ambitions, to external organizations that are necessary to finalize the project.

5.3.4 Governance Framework

The governance framework of Case B is presented below,

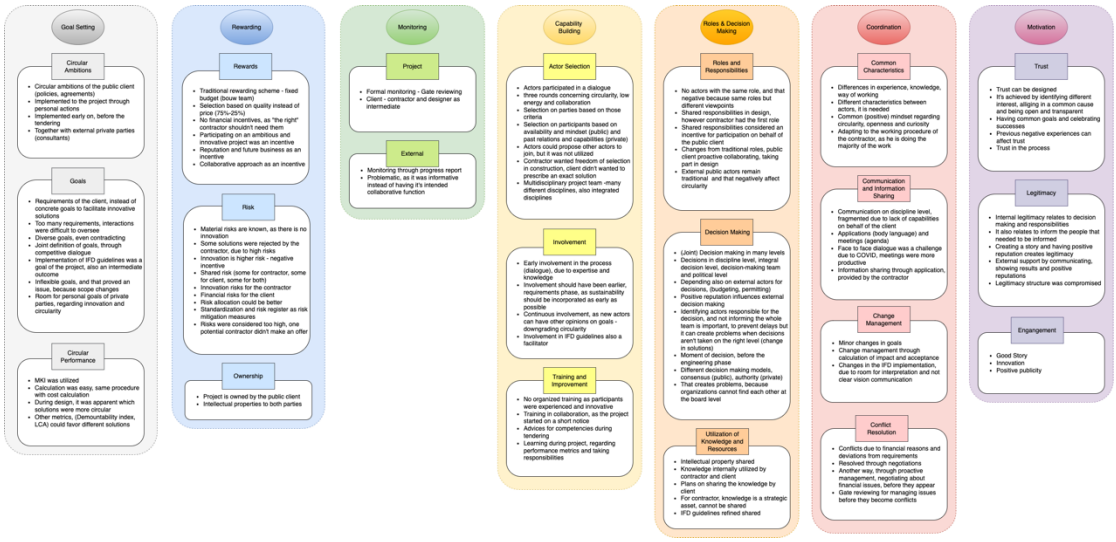

Figure 20: Governance Framework for Case B. Own Work.

5.4 Case C: Circular Viaduct Prototype

Case C concerns the construction of a circular bridge with reusable prefabricated girders, harvested from dismantled bridges, and the development of a business case based on reusing girders. The project is part of a Small Business Innovation Research (SBIR), with an objective to develop circular bridges. As of 2022, the project is currently at phase two, the construction of a prototype.

During phase one, the girders were harvested. Phase two, includes removing the compression layer, inspecting, and validating the girders by external actors, repairing damage in the harvested girders, temporary storage of the girders, integration of the girders into a viaduct, and further testing and validation. After phase two, the project officially ends, but there are plans of market introduction and scaling up of the concept.

Regarding circular economy, the project aims to significantly contribute towards the reduction of primary raw materials and CO2 emissions, through the reuse of existing girders. Furthermore, this project aims at developing a business case based on the harvesting, modification and reuse of prefabricated girders, to coordinate market-wide supply and demand of reusable girders and detect potentially reusable girders from viaducts to be demolished. This contributes to widespread application of circular economy principles in the Dutch infrastructure sector.

5.4.1 Interorganizational collaboration in Case C

This initiative started on behalf of the government. The government's ambition is to achieve a target of 50% less use of primary materials in 2030, and to use 100% renewable and recycled materials by 2050. In order to influence the circular transition, the Ministry has the ambition of becoming a launching customer for sustainability transitions, by giving the opportunity to companies to innovate.

Towards that direction, an open learning environment for circular bridges was organized, in which 60 participants from market parties, governments and knowledge institutions exchanged knowledge and experiences. As a direct outcome of this initiative, an SBIR call was organized. In the SBIR, 32 companies were involved, each with their own ideas regarding circular bridges. 10 of them were selected to

conduct a feasibility study on their concept. During the SBIR, parties collaborated and exchange information. That lead to companies with similar ideas, coming together into consortia, something that was facilitated by the public client. A final selection was made, that resulted in 3 consortia given the green light to build a prototype.

Case C, therefore, concerns a consortium of companies that together with the public client, aim at developing bridges, based on reused and reusable girders. Interorganizational collaboration took place, in all three levels, namely in the open learning environment, the SBIR and the project level. The interorganizational collaboration can be seen in the figure bellow.

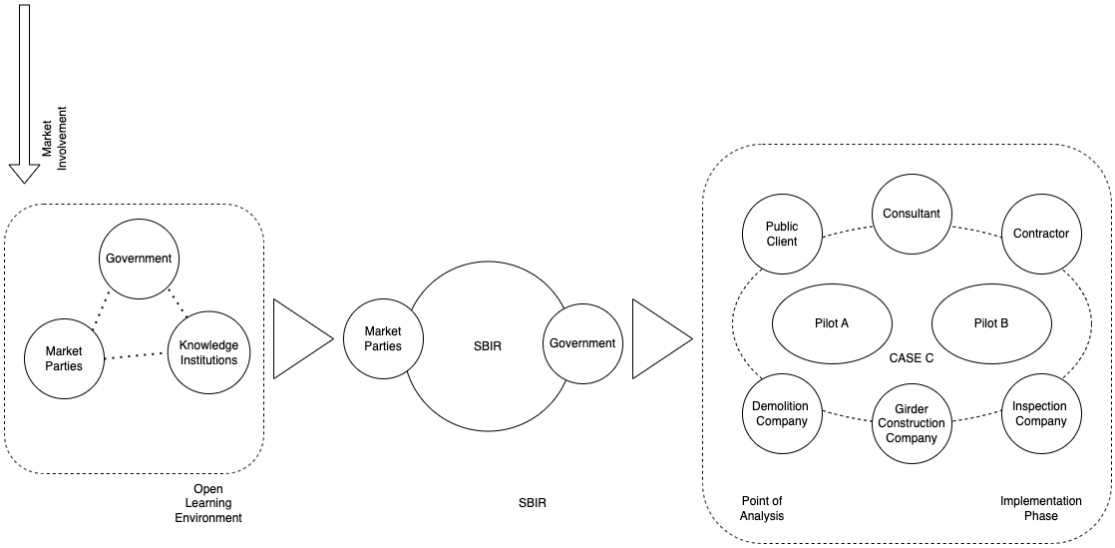

Figure 21: Inter-organizational collaboration in Case C

5.4.2 Governance arrangements in Case B

In this chapter, the governance arrangements for Case C are presented, following the categorization of the governance research framework, as presented in the previous paragraphs. An extensive table with the identified governance mechanisms, the factor that affected their selection, and the corresponding quotes based on the interviews, can be found in Appendix E.

5.4.2.a Goal setting

5.4.2.a.a Circular Ambitions

Circular ambitions were first introduced, through the public client. Although the ambition for circularity was expressed in a higher level, as the government wants innovation, an organized effort through an open learning environment was required to objectify those ambitions into concrete circularity goals. The open learning environment was designed by the public client, by making a scope challenge internally, and an innovation dialogue with external parties. In the open learning environment, 60 people from 16 organizations took part in dialogues around 6 different themes, concerning design, procurement, co-creating, technology, data and business models. Themes were an important component in order to keep people motivated and capitalize on their expertise. Cross-sector collaboration was also important to expand the perspective on circularity. As a result of the open learning environment, an SBIR was organized. In the SBIR, parties were motivated to experiment with their own ideas regarding circular bridges. In this case, the idea was reusing harvested girders in circular bridges, which was tested with a feasibility study.

5.4.2.a.b Goals

In the SBIR initial phase, the main goal was to succeed on being one of the three selected parties, that would build a prototype. This could be achieved with different combinations of solutions, as the SBIR prescribed only the construction of a circular bridge. After the selection, the main goal of the project concerned the construction of a circular bridge, with reused girders. Although reuse of other elements was briefly examined, actors focused on the girders, as it showed more potential for reuse. Another goal was to prove that circular building, is feasible and cost effective, and this was achieved through a business case. A viable business case was required, for the continuation of this circular initiative. Additional goals include the creation of a marketplace for reused girders. However, for financial reasons, this goal was abandoned as the available budget, went to harvesting more girders. The goals were common among all project actors, as the budget was also common for all private parties. To achieve the main goal, other sub-goals were defined, such as the construction of two additional pilots, to test the principles. Those trial projects can be regarded as intermediate outcomes of the project. The sub-goals of the project were flexible and could change after communication with the client. Through this project, parties could also achieve their personal goals, such as proving that less steel can be used in rebar construction, increasing productivity and sustainability by combining new and reused girders, or to enlarge their activities on circularity and building more sustainably. Personal goals were aligned with the goals of the project.

5.4.2.a.c Performance Metrics

Regarding performance metrics, MKI and CO2 emissions were utilized. Raw material usage was an equally important metric for circularity. However, the performance of the project will only be measured after the implementation, as there are still a lot of doubts.

5.4.2.b Rewarding

5.4.2.b.a Rewards

Considering rewards, the actors that were involved in the SBIR were financially compensated, based on a fix budget. The same applies to the parties that were selected for a feasibility study. The financial compensation was an incentive given to companies to pursue innovation. The parties that were selected to build a prototype, were also given a fixed budget, to develop their innovative solutions. The financial compensation wasn't neither the only nor the main incentive for the participating companies, as the project has a non-profit character, and the compensation covered the experimental costs. For the other test projects that were developed, a sponsor was involved, or the harvested girders were sold to create revenue. However, this non-profit character would need to change in the next stage of the project, when, when the concept will be brought to the market. The main incentive was to prove that circularity can work and create positive reputation and future business opportunities for themselves, by being early involved in a future concept for infrastructure.

5.4.2.b.b Risk Allocation

Risk allocation was a subject of debate in the initiative. Regarding the risk of reusing elements, there should be a certification procedure, and the certification should be conducted by the government, otherwise private parties won't accept it. The financial risks of the project were in principle allocated to the client, as the project was financed by the public party, whereas the financial risk of the private party, lies on keeping within the budget. The construction risks were allocated first to the building party. Actors agreed with the risk allocation in the project. Between project participants, the risks were equally shared. Lastly, the real challenge regarding risk lies in the third stage, the standardization of the procedure. And it relates to risk allocation between the different members of the consortium, and the risk of not finding suitable donor and especially, client projects. This is a risk, that can be shared with the public party.

Regarding the reuse of girders, internal resources were utilized to mitigate the risks, but also, an external party was utilized to provide certification that girders could actually be reused. The increased construction risks of reusing girders was the reason private parties have not attempted this construction method. This project showcased that reuse is possible.

5.4.2.b.c Ownership Structure

Lastly, considering the ownership structure, once the project is finished, it will be owned by the public client, the same applies for generated knowledge, as it will be open source. However, other trial projects will be owned by their respective public clients, such as municipalities.

5.4.2.c Monitoring

Monitoring was conducted in the project by the project participants, by the client, through support meetings, and by independent checkers. Therefore, there were three independent layers of monitoring in the project. Monitoring was also conducted by the parent organizations, who individually monitored the progress in the project. For the girders, an external party performed the monitoring. The monitoring was also divided between the two different public actors that were involved in the project, in stage one and stage two. In stage one, there is formal relation based on the contract between the launching customer and the consortium. Therefore, monitoring is formal. Then, in stage two, there is the relation between the consortium and the program client, that is more informal, and the monitoring is performed, through progress reports and meetings,

5.4.2.d Capability Building

5.4.2.d.a Actor Selection

In the initial open learning environment, 60 people from 16 organizations were involved, those people were allocated in the 6 different themes and two team leaders, one from the public and the other from the private domain, were selected. With the start of the SBIR, a project manager was selected, who would organize the initiative. As explained, in the SBIR, 32 companies were involved, and 10 were selected for a feasibility study based on their initial ideas and 3 of them were selected for a pilot. Then the initiating company decided to collaborate, as they didn't have the required capabilities to develop the pilot and the consortium was established. The actors were mainly selected by the project management company, and consisted of a consultant company, a demolition company, and an inspection company.

When, they were selected for the pilot, they also involved a construction company and a girder production company that was not selected. The selection was done in the basis of previous relations. Actors were not jointly selected, but they could offer their opinion about the completion of the consortium. For stage two, that is the construction of a pilot, the consortium consisted of the consultant, the demolisher, the contractor, the contractor of the girders and the external inspector, therefore the consortium is multidisciplinary. Furthermore, it differed from other consortia for traditional projects, as it involved other disciplines. There were also other actors involved, but they were not part of the consortium. The main reasoning behind this collaboration was that parties could not independently develop the project. The selection for the personnel, wasn't on the basis of availability, but on the basis of innovation, expertise and motivation to work on an innovative project.

5.4.2.d.b Early Involvement

The initiative started with the open learning environment, and the reasoning behind that was to involve the market parties earlier in the process and cultivate a circular and collaborative mindset. Most of the actors that participated in the project, were also participating in the open learning environment, and that positively affected their mindset regarding circularity. However, two of the private actors that were later involved, haven't noticed any differences between early and later participation. However, generally, earlier participation was also perceived as a positive thing.

5.4.2.d.c Training and Continuous Improvement

A last thing about capability building refers to training and continuous improvement. Training was provided in the participants of the open learning environment, based on 6 themes. On the project level, there wasn't any organized training, as partners were already motivated and believed in the concept. However, actors they learned a lot about collaboration.

5.4.2.e Roles & Decision Making

5.4.2.e.a Definition of Roles and Responsibilities

Every participant had a clear role, in the project, as well as well-defined responsibilities. Regarding changes in the roles of project participants, for some actors such as the project manager there weren't any changes, while for others, such as the demolition company there was a slight change in the role, from demolition to deconstruction. However, that wasn't a completely new procedure. For the girder construction company, reuse of girders might seem like a threat, but in reality, it was an opportunity. This actor can be utilized in the future as the sales channel for reused girders, as they already have the network and the capabilities. Parties were informed upfront, about the changes in the roles and responsibilities. Challenges regarding roles and responsibilities are expected in the next stage of standardization. In this phase, the responsibility of financing is on the private parties, and that can be uncomfortable for some actors. The changes in roles and responsibilities regarding the next phase, are not yet clear, and the pilot is aimed to shed light on it.

5.4.2.e.b Decision Making and Management Structure

Decisions on the project were taken in two main levels, namely the workgroup and the steering committee, and this is the usual procedure for the sector. The workgroup was designated with problem solving, while the steering committee with significant decisions. In the workgroup level, there was a meeting every two weeks, or on special occasions. Decisions related to technicalities and were taken through negotiations. In the steering committee, important (and usually) financial decisions were taken. The steering committee was also responsible for conflict resolution. There was also external support in decision making from the client. External decision making, was also utilized for decision that regard change of the sub-goals. Parties had different decision models and interests, for instance, regarding to risk.

5.4.2.e.c Utilization of Knowledge and Resources

The open learning environment was a facilitator of knowledge exchange between public and private parties. However, in the SBIR the traditional character of construction project development prevailed and therefore, knowledge exchange remained on the company level. Therefore, other initiatives were also implemented to facilitate learning and information sharing within governmental agencies. However, knowledge sharing was a significant aspect of the SBIR, and solutions that were open source were awarded extra points in the tendering phase. Therefore, the preferred solution was agreed to be open source. Generated knowledge was jointly utilized within the consortium, and that is also important for the next phase. Knowledge was also shared, with the other consortia that are developing a prototype. This was considered also an important step, towards standardizing circular projects. As there is not a mature market yet on circular bridges, competition is actually needed, in order to influence the establishment of a grown market. Regarding resources sharing, initially the public client was negative on utilizing harvested girders for other public guest projects. That created problems for the consortium, that couldn't find an available guest project, to test their solution. However, that was changed, as the public client decided to allow resource sharing, among other public clients, a decision that fitted the private actors' perspective.

5.4.2.f Coordination

5.4.2.f.a Common Characteristics

In the open learning environment, people were selected to participate based on their profile. A collaborative culture was built up, based on openness and diversity. Circularity as a notion, motivated and connected people. Therefore, in terms of a shared culture, the characteristics of the participants were common. Emphasis was given on the process, and this was facilitated by the early involvement in the open learning environment. This was also manifested in the project team, as actors have a common belief towards the solution. Project participants were also open with each other, as such a collaborative approach would fail, without openness. That is a subject of mindset but also regards the combination of parties that were involved. Soft skills played also an important role in the project, as it can facilitate communication and resolve conflicts. Motivation towards circularity, was also a common characteristic in the project and this was due to an organizational (positive) circular vision. There were also common characteristics within the project team, as it was a flat organization. Another point noted is that all

group characteristics should be on the team and represented through the actors. Lastly, although the project was completely different in comparison with other infrastructure projects, the way of working was the same.

5.4.2.f.b Communication and Information Sharing

Communication and information sharing were internally organized by a single party. That was challenging, because there were multiple pilots concurrently developed, and channeling information across the projects was difficult. Communication in the project was conducted either on person, or through applications. BIM was not relevant to this project, as the project was still in the harvesting phase. Information was shared through the use of an application.

5.4.2.f.c Change Management

During the project, there were a lot of changes, and they were managed in the biweekly meetings. There were also changes in the sub-goals of the project, and they were managed through communication with the client. A significant change in the project, concerns the original guest project for the reused girders. It was managed by developing an extra trial project, with the available girders.

5.4.2.f.d Conflicts

Conflicts in the project were resolved internally, by utilizing the same procedure as decision making. Conflicts were resolved by participants who had soft skills, were communicative, and had influence on other team members. Participants noted that there weren't any conflicts in the team, and this was partly because issues, were reported and managed by the steering committee before escalating into conflicts. Therefore, conflicts were managed by jointly identifying and addressing potential issues. Another issue regarded the outsourcing of an activity, and it was managed by openly talking in the project team and jointly deciding to allocate the activity at a project member. Lastly, conflicts might arise in the next stage, that regards a privately financed project.

5.4.2.g Motivation

5.4.2.g.a Trust

The initiative started with high trust. The positive climate of trust among participants was created in the open learning environment. In the project, openness among participants facilitated trust building, It was also observed that when the party that organized the initiative showcased openness and transparency, then other participants mimicked this kind of behavior. Trust was also achieved through frequent communication. Another factor that affected trust is transparency regarding the financial situation. Therefore, to enhance trust, meetings where expenditure was thoroughly discussed were organized. This openness regarding cost, positively influenced trust among partners.

5.4.2.g.b Legitimacy

Internal legitimacy was achieved by a combination of positive climate and clarity of roles and responsibilities. Internal legitimacy was also achieved, by communication the vision of the initiative, by showcasing the results, and by making a business case and a solid earning model,

External support from the public actors was important for this initiative, because reused girders are still financial more expensive that new beams, and therefore, in order for the business case to be successful, the public client should stimulate reuse of the girders. This can be achieved by incorporating the reuse principle in the tendering. Another way that the public client can support the initiative, was by convincing other actors to accept reused girders, and by being flexible and accepting changes on behalf of the private parties. External support from the private organizations was achieved, as a consequence of personnel high in the hierarchy with circular ambitions, and by explaining to superiors, the potential added value for the parent company. For parties that can be potentially harmed by the adoption of reused girders, such as the girder construction company, external support referred to support within their company. This can be achieved through dialogue, by scaling advantages and disadvantages, and explaining that project and organizational goals are not conflicting.

5.4.2.g.c Engagement

Engagement started from the initial phases of the project, and it was partly because of a common mindset and a motivation towards circularity. However, it was noted that motivation refers to individuals, and not organizations. In the project, participants were engaged through their common interests and common goals. Experience and motivation played also a role. Another factor that engaged participants relates to the subsequent third stage of the project, the development of a business case and the possibility of future business and profitability.

5.4.3 Challenges

The main challenges in the initiative regarded standardization and how can circular viaducts be developed, so that the market adopts them as a viable alternative for bridge infrastructure. Another challenge in this initiative regarded the establishment of a feasible and financially viable solution to build a circular viaduct. Currently, the costs of reusing are high, and therefore, circular viaducts are actually more expensive than building new ones.

Another challenge regards, who burdens the additional costs of innovating. This can be resolved if the public client starts incentivizing reuse in the tendering, and that can be achieved by motivating the public client to adopt innovations. Moving to the next stage, standardization, is a challenge. Standardization and scaling up are considered the main challenge for the future. They entail, establishing a girder's marketplace and making a business case out of harvesting and reusing girders. This is challenging, as until now the public party is a financier, while in the business case it is more entrepreneurship, and parties might not feel comfortable with it. Furthermore, there is the question of whether the business case can stand alone, without the participation of the public client.

In the project, the main challenge regarded finding compatible donor and guest projects. Particularly finding a guest project proved difficult. Actors had already invested in harvesting, and the lack of an available guest project was frustrating. Moreover, when a guest project was found, it was abandoned as it fell into the jurisdiction of a different public client. Another challenge in the project, was that parties had different cost structures, and therefore the paying scheme has to be organized differently for each party. A last challenge regards, on being open and sharing, in a competitive open market.

5.4.4 Governance Framework

The governance framework of Case C is presented below,

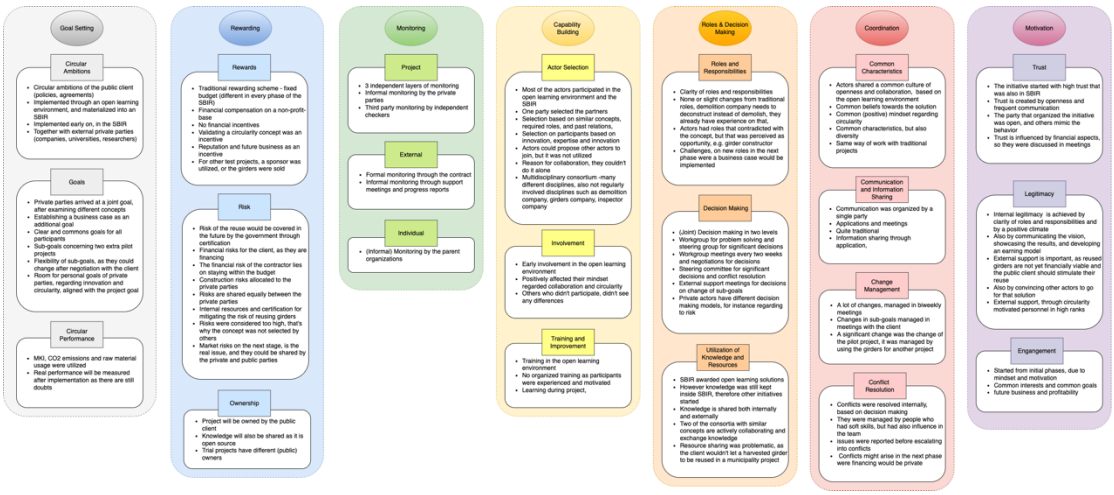

Figure 22 Governance Framework for Case C. Own Work:

6 Analysis

In this chapter, the analysis of the initial findings of the multiple case study is presented. First, through a cross-case analysis the similarities and differences across the cases are acknowledged. They are then presented in the form of a table, in the respecting sub-chapters. Then, the case specific challenges that were identified are presented, and governance mechanisms that could potentially resolve them are presented.

6.1 Cross-case analysis

In this chapter, a cross-case analysis is performed. The analysis is conducted on the basis of the seven governance dimensions, as presented in the previous chapters.

6.1.1 Goal Setting

Through this research, it is observed that circular initiatives are taken before the project commences. The initiative agent is the public client, due to the need to comfort with European and national directives and legislation regarding circularity. Although the directives are in place, it often lies on personal interests of participants to introduce circularity, as it is still not a mandatory guideline. Furthermore, it is suggested that market parties are also capable of introducing circularity ambitions, due to their knowledge and expertise. Due to these knowledge asymmetries between public and private parties regarding circularity, private parties are utilized for the tendering procedure and to materialize circular ambitions into concrete circularity goals. Therefore, the lack of knowledge on behalf of the public client that regards the procedure, is overcome by the introduction of market parties as consultants, and the lack of expertise on how circular principles are introduced in the project is overcome through market consultation and involvement of private parties in the goal setting. Regarding circularity ambitions, the differences across the cases lie in the moment of introduction and the party that initiated them. In Case A the introduction was made during the tendering phase, and initiated by the private parties, in Case B circularity was introduced by the public client, through actions by specific people, and in Case C, circularity was introduced by the public client and was materialized through joint effort between the public and client actors.

Regarding goals, across the three cases, goals were jointly defined by project participants, during the earlier stages of the project. However, a difference is that in Case B, numerous requirements were already set by the public client, before the actual goal setting procedure, and the involvement of the private party. Goals were also divided between project goals and organizational or personal goals of the participants, which were considered equally important to be represented in the project. Intermediate outcomes, or secondary outcomes were also apparent in the cases, and they refer to the generation and sharing of knowledge. A difference is, that in Case A the utilization of the knowledge, through a Common Data Environment, was considered a goal later in the project. Clarity of goals is noted as important across the cases. Contradicting goals in Case B were considered a problem. Regarding flexibility, the initial goals are inflexible, and this is noted as a problem in Case B, as parties cannot cope with change of scope during the project implementation. However, sub-goals can be flexible, and parties can request changes, as seen in Case C. Another point mentioned in the literature, is the creation of a vision, instead of detailed requirements (Leising et al., 2017), and the joint definition of requirements by the project team (Versteeg, 2019). The absence of participation of private parties in the requirements phase, was noted as a problem for Case B, and therefore public-private collaboration in the requirements' phase is perceived as important.

Regarding performance metrics, this research implies that a combination of different metrics should be utilized to achieve higher circular solutions. Across the cases, MKI and LCA are noted. Measuring circularity is an open field of research and therefore it is governed by uncertainty. Furthermore, different performance metrics suggest or highlight different solutions, and therefore there should be consensus and an informed decision on which metrics to include.

6.1.2 Rewarding

The first part of rewarding refers to incentives for participation, or rewards. It is observed that small financial incentives are given for participation in circular initiatives, however financial incentives are not a part of the rewarding scheme of circular infrastructure projects. As main incentives for participation, experience and knowledge on circular projects are highlighted. This is turn leads to future business opportunities. (Positive) reputation is also noted as an incentive for participation. A difference regards, that in Case B, the collaborative approach in the project was also perceived as an incentive from the public client's side, because it contributed to less responsibilities on the contractor side. However, private parties didn't share the same perception. Another difference regards the fact that in Case C, the project was developed on a non-profit basis. As an incentive, the private parties considered the development of a financially viable business case.

Across the cases, risks are allocated in both parties, public and private. However, this is not done on an equal basis. Financial risks are allocated more to the public client, who finances the projects, and construction risks are allocated more to the contractor, as his traditional role implies. As a risk mitigation measure, third parties are involved for testing and certification of material innovation. Therefore, risks are also transferred outside the boundaries of the project. In Case A, it is noticed that the majority of risks lie with the change of process, the roles and the mindsets of actors, and not on material or construction risks, as the concepts that are developed are tested and approved. While in Case B, innovation is perceived as the main risk, and it was not financially compensated for. Lastly, in Case B, the main risk lies with the standardization of the process and the economic viability of the concept. Another difference concerns the risk mitigation measures. In Case A, the close collaboration and personal connection between participants was considered a risk mitigation measure. In Case B, standardization of the process and the joint creation of a risk register were noted. While in Case C, the capitalization of internal resources referring to the capabilities and expertise of the project's participants, was utilized.

As this research concerns infrastructure projects, ownership of the project is solely on the public sector. Other secondary outcomes, such as intellectual properties of project outcomes that are traditionally owned by the private parties, are also jointly owned with the public parties. This is prescribed in the contracts. A difference here concerns Case C, where two trial projects were developed for a different public client. Naturally, the ownership of said projects is on the respective public clients' side.

6.1.3 Monitoring

This research identifies that all three ways of monitoring are apparent in circular infrastructure projects. Emphasis is given on informal monitoring, due to the collaborative approach on the projects. Third-party auditing is also utilized for certification of innovating solutions. There are also different monitoring layers, namely monitoring in the project, external monitoring by the public client, and internal monitoring on the basis of individual organizations. In regard to differences, in Case A monitoring was also conducted through the Common Data Environment. The public actor monitored also the project to achieve competencies for circular and collaborative projects. In Case B gate reviewing was utilized. In Case C, monitoring was also conducted on the basis of the individual participating organizations.

6.1.4 Capability Building

The initial selection of participating actors is performed in the tendering, through a competitive dialogue. It is observed across the three cases, that selection criteria for sustainability and innovation were also in place. In Case A and Case C, the involved parties were also present during previous initiatives, namely the circularity sprints and the open learning environment respectively. During the project phase, parties select their partners jointly based on expertise, their mindset and previous relations. Private actors could also provide recommendations for essential actors that need to be involved. A difference is that in Case C, the main responsibility for actors' selection lies in a single private

party, while in Case B, the private party could suggest other participants to enter the design phase, but they preferred not to, in order to have greater flexibility for actor selection during the construction phase. Based on this research, the multidisciplinary aspect of the project team is apparent. Actors that are not usually involved, such as suppliers of cement and recycling companies in Case A and demolition companies and girders constructors in Case C, are also members of the project team.

This research indicates that collaborating parties are involved early in the project, and this is achieved through inclusion in circularity initiatives. Continuous involvement is also important, as actors that come later in the process, can negatively influence sustainability targets. A difference across the cases, is that in Case B, the private parties were not involved in the requirements' definition, something that was considered problematic.

Regarding training and improvement, it is observed that in Cases A and C, traineeship was provided for project participants in the preliminary phase, outside the strict boundaries of the project. However, no organized training took place during the project implementation. Lastly, circular infrastructure projects are considered by participants as a great opportunity for learning, regarding circularity but also regarding public-private and company-level collaboration, as they are developed in a collaborative environment. In Case B, a traineeship regarding collaboration was given to project participants, something that is common for projects that have to commence in a short time period.

6.1.5 Roles and Decision Making

Actors have acknowledged the importance of clarity in roles and responsibilities. Furthermore, as circular infrastructure projects are developed in a collaborative environment, jointly by public and private parties, having participants of both parties in the same role is considered as beneficial for the project. Specifically, having two participants in the same role can inherently strengthen the role, as different parties have different perceptions regarding circularity, as well as different responsibilities and decision-making power. This was apparent in Case A and Case C, but not in Case B, due to budget and capabilities constraints. Changes in the roles of participant parties are also noted. For example, in Case A the public client is proactively collaborating, by participating in the design phase, and the contractor has also the responsibility of testing the innovations. The same applies in Case B. In Case C, private parties, such as the demolition company, or the girders producer, are slightly changing their roles and responsibilities.

The research indicates three different decision-making levels. In the project level, decisions that regard problem solving are taken jointly by project participants through negotiations, while in the steering group level, decisions that regard financial issues or significant decisions are taken. Knowledge and information on the project level acts as a facilitator of decision-making in the steering group level. Since in circular infrastructure projects, the commissioner is the public client, external decision-making is also a relevant level, and it regards politically motivated decisions by external stakeholders. It is perceived that, there is no central decision-making authority, and decisions are taken in multiple levels at once, both internally and externally. However, in Case B, different decision-making models between public and private parties is noted as a challenge. Specifically, inside the public parties, decisions are taken based on consensus, while for private parties, decisions are taken based on authority. Private parties cannot find their equivalent of a board level, in the decision-making model of the public parties, and that creates problems, such as delays or indecisiveness. In Case C, it is also noted that private parties can have also different decision-making processes, or take decision based on different factors, such as risk tolerance.

Concerning utilization of knowledge and resources, it is observed that knowledge is utilized jointly by public and private parties, as this is prescribed by the contract in all cases. In Case A, knowledge exchanges were facilitated through the common data environment. Moreover, each party can also individually utilize the generated knowledge. A point worth noting here is, that knowledge is treated differently between the different actors. For instance, as noted in Case B, knowledge is perceived as a strategic asset for the contractors, and therefore they tend to disclose information, and be averse towards information sharing. Regarding resources sharing, it is noted in Case C that there were

problems between reusing girders harvested from one public clients' project to another public clients' project.

6.1.6 Coordination

Common project management practices are noted as important across the cases. However, diversity in project management practices and different characteristics of actors, is a consequence of the collaborative and multidisciplinary character of the project. Moreover, actors pinpointed the cultivation of diversity as an important factor in the collaboration. Based on this research, a common collaborative and circular culture can be designed by early participation of actors in circularity initiatives.

Communication and information sharing is conducted through the use of applications and personal meetings. The importance of face-to-face dialogue is also noted by participants, although it is hindered by circumstances such as the recent COVID lockdown. Information is also shared through applications. As noted in Case A, a common data environment is important for information sharing. In case B, where interfaces are managed from a single party, getting accustomed to the way of work can be challenging for other participants.

Regarding change management, it is observed that changes are managed with the same way that decisions are taken. Changes may regard the scope of the project, specific goals, or the selected solutions. In Case A, no major changes were implemented, whereas in Case B, the was a compromise regarding the following of the IFD principle, and in Case C, there was a change in the actual guest project, where harvested girders would be reused.

The process of conflict resolution is also relevant to the decision-making structure. Therefore, it is indicated that conflicts are resolved internally, through dialogue and negotiations within the project team. For important decisions, relating to budgeting, the steering group is utilized. Across the three cases, it is observed that most conflicts arise due to financial and budgeting issues. A difference is that in Case B, conflicts that arose due to requirements were not resolved, and the solution was compromised. It is noted that proactive conflict management should take place, in order to cope with financial problems that might occur. In Case C, conflicts were resolved by actors that had the necessary soft skills, decision-making powers and legitimacy.

6.1.7 Motivation

Participants note that trust can be designed in the project in various ways. Accepting responsibilities generate trust among participants. Previous success and positive reputation also influence trust. Trust is lastly influenced by common goals, alignment of interests and being open and transparent. Another observation in Case C, is that when the party that organizes the initiative is open, other parties mimic that behavior. Also, being open in the financial aspects in noted as important regarding trust, and this is mainly because the project was implemented on a non-profit base.

Legitimacy is expressed as internal legitimacy, within the project team and external support by parent organizations. Internal legitimacy is closely related to trust. Based on governance arrangements, communicating, and accepting responsibilities affect internal legitimacy. Internal legitimacy is also achieved by the expertise of the actors involved, intrinsic motivation on circularity and belief in the project, and by showing results. External support is important for the circular infrastructure projects, as public clients are involved. It is achieved by communicating results, and by the positive reputation of the project. Another factor that affects external support is the intrinsic motivation of external actors regarding circularity. A difference is that in Case B, respect for joint decision-making is noted as a factor of influence towards internal legitimacy. Another difference is that in Case C, external support is achieved by creating a financially viable and profitable business case.

Engagement of actors on a common cause can be achieved by having common interests and goals. Publicity and the possibility of future rewards can also engage actors. In Case A, engagement is achieved

with team building techniques, such as workshops or activities. In Case B, the importance of creating a "good story" is noted as important.

6.2 Similarities and differences

The three cases showcase many similarities regarding governance arrangements. The similarities could be attributed to the nature of the project (bridge project), the institutional environment of the project (projects that are developed in the Netherlands, jointly by public clients and contractors) and the similarities in the collaborative way that the project is implemented (collaboration between public and private actors in the design phase).

A first difference concerns the circularity principles that are utilized in each case. In Case A, the circularity principles are the use of recycled materials, reuse of secondary construction elements such as wooden handrails, and reduce of carbon dioxide emissions. In Case B, circularity principles are the reusability of the structure, reduce of emissions based on the low energy and maintenance ambition, as well as refurbishment of the second bridge. In Case C the reusability of intact girders is the guiding circularity principle. A second difference regards the project delivery method that is 57utilized in each case. In Case A there is a Design and Construct (D&C) contract, whereas Case B regards a two-phase contract and Case C a Small Business Innovation Research (SBIR). However, in all three cases there is inter-organizational collaboration between public and private parties, for the design and development of the project. The three cases differ based on the disciplines that are involved in each case. As noted, the multidisciplinary character of circular infrastructure projects is apparent, however the combination of disciplines is different across the cases. Except the public client and the contractor, other parties that are involved are a common data operator and a recycling company in case A, a designing company as an independent referee in case B, and a demolition company, a quality and safety inspector, a girder construction company and a consultant in case C. Lastly, the cases differ on the point of view in the analysis. The project for Case A has already been completed. Case B is in the design phase, while Case C is in the construction phase.

6.2.1 Similarities and differences in governance arrangements

Based on the cross-case analysis, the similarities and differences across the cases can be seen in the table below.

Table 1: Similarities and Differences across the cases

Governance Dimension	***Similarities***	***Differences***		
		Case A	***Case B***	***Case C***
Goal Setting	Circular Ambitions			
	Introduction of circular ambitions before the project commences	-	-	Introduced in the open learning environment (pre-SBIR)
	Introduction of circular ambitions through the public client	-	Introduced in initial talks with public stakeholders (pre-tendering)	-
	Materialization of ambition through collaboration between	Materialized through market consultation,	Materialized through personal actions, of	Materialized through the open

	public and private parties	as the initial ambition was innovation	motivated actors	learning environment
	Goals			
	Joint definition of goals	-	Detailed requirements instead of goals	-
	Room for personal and organizational goals	-	-	-
	Intermediate outcomes regarding knowledge generation	Knowledge as a secondary outcome, transformed into a goal	IFD guidelines as a secondary outcome	Business case and girders marketplace as a secondary outcome
	Clarity of goals	-	Diverse and contradicting goals	-
	Inflexibility of initial goals	-	-	-
	Flexibility of sub-goals	-	-	-
	Circular performance metrics			
	Combination of different metrics	-	-	-
	Consensus on metrics selection	Ambiguity in circularity performance metrics in the tendering	Other metrics could lead to other solutions	-
Rewarding	Rewards			
	(Small) financial incentives for participation in circular initiatives	-	-	Non-profit basis
	Experience and knowledge on circular projects as incentive	-	Collaborative structure of the project as an incentive	-
	Future business opportunities and (positive) reputation as incentive	-	-	Development of a financially viable business case, as an incentive
	Risks			
	Joint risk allocation	-	Parties claimed that they had	Shared financial risks

			the main share of the risks	
	Allocation of different types of risks in the party that can handle them better	Risks regarding the process and people	Innovation as risk	Economic viability as risk
	Testing and certification as a risk mitigation measure	Close contacts with project participants as risk mitigation measure	Standardization and risk register as risk mitigation measure	Use of Internal resources (knowledge and expertise) as a risk mitigation measure
	Ownership			
	Public ownership of the project	-	-	Other (external) public parties are owners of the trial projects
	Shared ownership of additional outcomes	-	-	-
Monitoring	Informal monitoring as a consequence of collaborative approach	Monitoring of the process	Gate Reviewing	-
	Third-party auditing for certification of innovative solutions	Monitoring through the CDE	-	-
	Different layers of monitoring, internal, external, and intra-organizational	-	-	-
Capability Building	Actor selection			
	Actor selection	Joint actor selection	Selection based on tendering	Actor selection mainly from a single private party
	Selection of parties based on non-traditional selection criteria	-	-	-
	Selection of actors based on expertise and past relations	-	Other parties were not selected in the design phase, to have more flexibility in the construction phase	-

	Multidisciplinary teams	-	-	-
	Involvement of actors that are not traditionally involved in collaborations	-	-	-
	Involvement			
	Early involvement of actors, through circularity initiatives	Previous involvement in the sprints	Actor involvement in the tendering phase	Involvement in the open environment
	Continuous involvement of actors, across project phases	-	-	-
	Training and Improvement			
	Training of actors during their participation in circularity initiatives	-	Collaboration traineeship	-
	Improvement of capabilities regarding circularity and interorganizational collaboration	-	-	-
Roles and Decision Making	Roles and responsibilities			
	Clarity of roles and responsibilities	-	Clash of responsibilities	-
	Public and private actors with the same role	-	No actors with the same role, from public and private parties	-
	Change of roles and responsibilities	-	-	-
	Decision making			
	Different layers of decision making	-	-	-
	Joint decision-making on the project level	-	Friction with decision making	-
	Decision-making in the higher level for important decisions	-	-	-
	External (political) decision making	-	-	Minimal external decision-making
	Different decision-making models	-	Different decision-	Different decision-

			making models between public and private parties	making process, relating to profitability and risk tolerance
	Utilization of knowledge and resources			
	Joint utilization of knowledge and resources on the project level, by public and private parties	Common Data Environment as a facilitator	-	-
	Individual utilization of knowledge and resources, by organizations	-	-	Resource sharing between different public clients
	Differences in the attitude towards knowledge sharing, based on the role	-	-	Knowledge share between different consortia to enhance circularity
Coordination	Common characteristics			
	Diversity in characteristics and practices	-	-	-
	Cultivation of a shared culture, based on early involvement in circularity initiatives	-	Shared culture based on circularity mindset	-
	Communication and information sharing			
	Communication through personal meetings and applications	-	Communication and information sharing protocol provided by the leading party	-
	Common environment for information sharing	Common data environment for information sharing	-	-
	Change management			
		No major changes	Changes in the solution	Change of guest project

	Changes regard scope, goals or specific solutions			Change of sub-goals
	Change management based on the decision-making structure	-	Changes Individually implemented, compromise on circularity	-
	Conflict resolution			
	Conflict resolution based on the decision-making structure	-	Conflicts due to requirements	-
			Conflicts due to decisions	
	Internal resolution of conflicts, based on dialogue and negotiations	-	Proactive conflict management by deciding on financial issues, in beforehand	Conflict resolution through actors with soft skills, and decision-making powers
	External resolution of conflicts, regarding budget and important decisions	-	-	-
Motivation	Trust			
	Cultivation of a climate of trust	-	-	-
	Accepting responsibilities cultivates trust	-	-	-
	Shared goals and interests cultivate trust	-	-	-
	Openness and transparency	-	-	Actors mimic the behavior of lead party, regarding openness and willingness to share
				Openness in financial aspects, contributes to trust
	Legitimacy			
	Internal legitimacy based on trust	-	Respect for decision-	-

	Communication cultivates internal legitimacy	-	making powers creates legitimacy	-
	Motivation for circularity enhances legitimacy	-		-
	Showcasing results and a clear division of roles and responsibilities cultivate legitimacy	-		-
	External support by communication results and positive reputation	-	-	External support through providing a viable business case
	External support based on positive stance of parent organizations towards circularity	-	-	
	Engagement			
	Engagement based on intrinsic motivation	Team Building techniques	Good Story	
	Engagement based on common goals and rewards			

6.2.2 Proposed governance framework

Based on the similarities that were identified in the previous chapter, a first governance framework is proposed. The framework is based on the research framework that was developed through the literature review in Chapter 4, validate through the multiple case study, as performed in Chapter 5. The framework can be seen in the figure bellow.

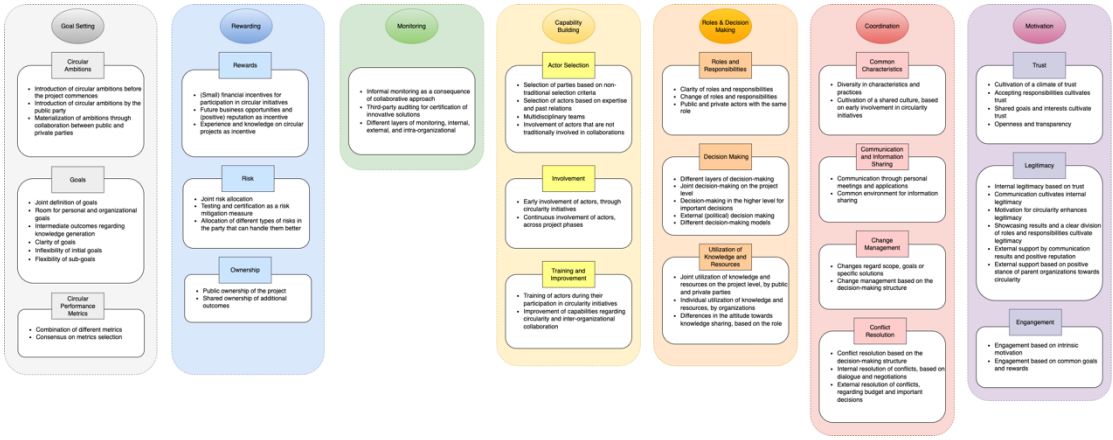

Figure 23: Proposed Governance Framework, based on the similarities acknowledged through the Multiple Case Study. Own work.

6.3 Case-specific challenges

In this chapter, the case-specific challenges are analyzed for each case, and possible connections between challenges and the existence (or absence) of governance mechanism are given. The analysis is conducted for each case separately in the following sub-chapters.

6.3.1 Challenges in Case A

The first challenge that arose in the project, regards measuring circularity. As explained, MKI and LCA was utilized as circular performance metrics, however, parties that were involved in the tendering procedure claimed that other performance metrics could suggest other circular solutions. This is perceived as a problem for the project, as it can create ambiguity during the tendering phase. A combination of different circular performance metrics could be utilized to resolve this problem, as well as a dialogue between the participants during the pre-tendering phase, in order to achieve consensus on the metrics and resolve any misunderstandings. This challenge arises from the fact that circularity in the construction sector is still largely a new concept, while circular performance metrics is an open field of research.

Another challenge relates to collaboration between the different parties. Particularly achieving consensus and a mutual understanding. This can be accounted to the multiple disciplinaries involved, as well as the collaborative structure of the project. This collaborative approach, led to financial and operational problems, that could be potentially resolved through a more traditional approach in the project. This relates to traditional relations between project participants, namely the client and the contractor.

Challenges also relate to the competencies of the involved actors, that work on an innovative and collaborative project. It is noted that, not only inside the context of the project, but also on the external environment, actors lack the skills and motivation to be innovative, to accept risks that relate with innovation, and to overcome their traditional roles and responsibilities. A similar challenge regards the prevention of actors from rebounding to their traditional roles. Particularly for information sharing, the challenge lies on making private parties, such as contractors that are traditionally secretive, more open towards sharing information and actively collaborating. In this project, these challenges are well acknowledged. In order to cope with them, and to provide opportunities for future iterations of similar circular projects, a common competencies environment is developed. Through this initiative, the required competencies and skills for actors that are involved in circular projects are investigated. Furthermore, to enhance knowledge and information sharing among all actors, the common data environment is utilized.

A fourth challenge relates to the dependency in the decision-making by external actors. It is observed that external actors with decision-making powers, such as permitting personnel, are confronted by the innovative solutions as there is a conflict of interests between organizational goals and the circular goals of the project. The challenge lies on satisfying the demands of external actors with decision-making power, that could potentially compromise the circularity objectives of the project. This challenge closely relates to achieving external support as a governance arrangement. Therefore, it is suggested that governance mechanisms such as communicating the results and showcasing positive reputation and cultivating a positive stance towards circularity in the parent organizations, are relevant.

Table 2: Challenges and proposed arrangements in Case A

Challenge	*Conditions*	*Proposed Governance Arrangement*
Consensus regarding circular performance metrics	• MKI and LCA as circular performance metrics • Performance goals were challenged during tendering	• Combination of different performance metrics • Consensus on metrics selection • Joint definition of circular performance metrics

Achieving consensus and mutual understanding	• Collaborative structure • Multidisciplinary project	• Traditional approach in the collaboration • Traditional role of client and contractor in project implementation
Competencies of involved actors to innovate and collaborate	• Actors with traditional roles and mindset • Actors that are traditionally secretive and negative towards information sharing	• Common competencies environment in order to acknowledge the required changes in terms of competencies and skills • Common data environment to enhance information sharing
External support of actors with decision-making powers	• External actors that consider circularity as conflicting with their organizational goals • Dependency on external actors for decisions, regarding licensing and permitting	• Achieve external support through frequent communication and sharing of the results • Showcasing positive reputation of the project • Cultivate a positive climate towards circularity in the parent organizations

6.3.2 Challenges in Case B

The main challenges in the project relate to financial issues and the collaboration between the participants. The project has exceeded its allocated budget. This was partly because of prices' rise, but also due to hidden requirements, that were only uncovered during the design phase. For instance, a temporary bridge needed to be built, for transportation to be continued while the project was developed. This requirement was not accounted for during the initial budgeting, and it contributed to budget overruns. Therefore, a thorough investigation of requirements in the front-end phase, by experienced and capable actors could potentially resolve this issue.

The process through which requirements were set is also noted as challenging, as requirements were numerous, and they were solely set by the public parties. Numerous requirements led to diverse, and even contradicting goals. For instance, low energy consumption that was materialized through the construction of a solar panel field, was contradicting low raw material usage. Private parties, who were not involved in the requirements phase had encountered challenges with those requirements. They couldn't identify interactions between the requirements as they were not apparent at first, while also, if they proposed a change, it would need to be accepted from the client, a process that required a lot of time. Therefore, the first part relates to involvement of the private parties later in the process. The second part relates to the differences in the decision-making models of the private and public parties. Clarity of requirements, as well as involvement of the private parties earlier on, could potentially resolve this issue.

Furthermore, during the project, the scope changed from the design to the implementation phase. This was considered as a challenge, as the private parties noted that there wasn't flexibility to account for

these changes, while public parties perceived the scope change as a compromise on the circular solutions. The way that those changes were proposed and managed from the private party, was negatively perceived from the public agents, who felt that their decision-making powers were compromised, as solutions from the private parties were selected. Especially, regarding the implementation of IFD, there was a conflict of requirements between IFD and other specifications. And this can be attributed to the fact that the public client has not clearly expressed its vision, which led to different interpretations of goals, by the private parties. To resolve this challenge, clarity of visions and goals is important. Furthermore, formal monitoring and control as well as, active involvement of the public actors in the decision making is important. However, to achieve that, an enhance on the capabilities of private parties is needed.

Challenges in the collaboration, regard working as a bouw-team. Specifically, the governance structure of the public client, wasn't fitting to the selected collaborative method. That was attributed to lack of capabilities and personnel within the public client, and a different governance structure. Due to that, the project functioned in reality as a normal construction project, with a clear division between client and contractor. However, since all processes were designed for a bouw-team structure, that led to challenges for the participants. And this relates to differences in decision-making models among participants, as well as an inability to understand the different viewpoints of parties. The capabilities of public parties are also relevant to resolve this challenge, as well as establishing a similar working structure in the public organization, in order to meet the private actors in the same levels.

Table 3: Challenges and proposed arrangements in Case B

Challenge	*Condition*	*Proposed Governance Arrangement*
Budget overruns due to hidden requirements	• Requirements set by the public client. • Inadequate planning during the front-end phase	• Involve capable and experienced actors • Enhance the capabilities of public actors • Involve private parties during the requirements phase
Numerous requirements that led to contradicting goals	• Diverse, even contradicting goals • Too many requirements, interactions were difficult to oversee	• Clarity of goals • Focus on a single goal, instead of all • Engage private parties during the requirement phase
Scope change that led to compromise on circularity	• Inflexibility of goals • External monitoring was informative • Solutions were provided by the private party, without consulting • Breach of decision-making process • Lack of capabilities and personnel on behalf of the public client	• Clarity of goals and clear vision communication • Formal monitoring and control • Involvement of the public actors in decision-making • Enhance the capabilities of public parties
Collaborative way of working	• Non-compatible working structure between the public and	• Enhance the capabilities of public parties • Adjusting the working structure between the

	the project organizations • Traditional project structure • Differences in decision-making models among participants • Different viewpoints of parties.	project and public organization • Aling decision-making models of external and project organizations • Clear vision communication

6.3.3 Challenges in Case C

In the project, finding compatible donor and guest projects was considered a challenge. Regarding girders reuse, that constitutes harvesting girders from an existing infrastructure that needs to be demolished, in order to reuse them in an available infrastructure project that is currently developed. The main challenge lies in finding an available guest project. The situation is even more problematic, as a financial investment was already in place, considering the harvesting of girders. Therefore, the absence of a suitable guest project, was also a financial risk for the project team. Furthermore, when a guest project was found, it was abandoned for ownership or authority reasons, as the project was developed by another public client. In order to cope with this challenge, joint utilization of resources by public clients is proposed as a governance arrangement.

Another challenge in the project, was that parties had different cost structures, and therefore the paying scheme has to be organized differently for each party. Furthermore, as the project was developed on a non-profit base, safeguarding that each party covered only their respective expenses was also difficult. The challenge was resolved, by implementing internal monitoring in the project, for the financial issues. Internal legitimacy is also a relevant governance mechanism here.

Being open and transparent in a competitive market was also a challenge, especially for private actors that are not accustomed to disclosing information. Therefore, a change in the role of the participants is implied., by jointly utilizing knowledge and available resources.

A last challenge, regards the development of a business case, as the main objective of this project was to prove that the reuse of girders, is feasible and financially viable. At this point, the reuse of girders is actually more expensive that constructing one. However, this can be resolved if the public client starts incentivizing reuse in the tendering. Furthermore, through achieving external support through motivating the public client to adopt innovations is relevant.

Table 4: Challenges and proposed arrangements in Case C

Challenge	*Existing Condition*	*Proposed Governance Arrangement*
Matchmaking for guest and donor projects	• Non availability of guest project	• Joint utilization of resources by public clients
Differences in rewarding schemes across participants	• Different cost structures	• Internal monitoring for financial aspects • Internal legitimacy
Openness and transparency between private actors	• Tradition roles of project participants	• Change of roles and responsibilities • Joint utilization of knowledge

Feasibility of girders reuse	• Cost of reuse • Cost of innovation	• Incentives for reuse • External support through providing a viable business case

6.3.4 Revision of the governance framework based on the challenges

Based on the above analysis, the similarities, differences, and case-specific challenges are acknowledged. Case-specific challenges, indicate governance mechanisms that can be included into the governance framework. Furthermore, those challenges could potentially be manifested in other circular infrastructure projects. Therefore, those governance arrangements are included in the final governance framework. New governance mechanisms mainly regard *the requirements and the circular vision, that should be jointly defined from the start, the more active participation of public actors in the monitoring and the decision-making process, by involving capable actors, and the incorporation of traditional elements in the collaboration between public and private parties during project implementation.* The revised governance framework that includes all additional mechanisms can be seen in the figure bellow.

Figure 24: Proposed Governance Framework for Circular Infrastructure Projects. Own work.

7 Discussion

In this chapter, a discussion of the findings is presented. First a redesigned governance framework is presented, based on the information gathered through the interviews. Then the governance mechanisms that differ from the literature are presented, based on a comparison between the theoretic governance framework and the one developed through the multiple case study. Then, possible connections are suggested between the different governance mechanisms. Lastly, the challenges that relate with the standardization of circular infrastructure projects are discussed. The discussion ends with the limitations for this research.

7.1 Redesigning the framework

During the interview procedure, conclusions are drawn regarding the cohesion and the completeness of the research framework. Those conclusions are utilized to expand the framework and adapt it for circular infrastructure projects. Consequently, a new research framework can be developed. This framework can be utilized by researchers on the field of circularity and governance to study circular infrastructure projects. In this sub-chapter, the adaptions per governance dimension, are thoroughly discussed. In the end, a new research framework is illustrated. The differentiations across each dimension can be seen on Appendix F.

Regarding circular ambitions, except the timing of implementation, the party that implements the circular initiatives is also relevant. Regarding goals, relevant mechanisms are the party that sets the goals, the clarity of goals, the flexibility of goals, the possibility of parties achieving individual goals, and intermediate goals. Regarding circular performance, except the metric that is utilized, the ambiguity of performance in circularity is also relevant.

Regarding rewards, the relevant mechanisms are financial incentives, experience and knowledge, and reputation and future business. Rewards tied to performance are part of the financial incentives, while rewards tied to lifecycle are irrelevant with construction projects, based on this research. Concerning risk, not only allocation is relevant, but also risk mitigation measures. Lastly, regarding ownership, project ownership as well as ownership of secondary outcomes, such as patents or innovations, are also relevant.

Regarding monitoring, all three modes are relevant, (formal, informal, and third-party monitoring), however the function and the level of monitoring are relevant. That relates to whether monitoring is performed, internally, in the project level, externally, from the client, or authorities, or organizational in a single party level.

For the next dimension, capability building, the first difference is that the mechanism regarding engagement is transferred to the more relevant dimension of motivation. For actor selection, the relevant mechanisms regard the party that selects the participants, the disciplines that are involved in the project, and the selection criteria. Involvement regards the timing of involvement, as well as the continuous involvement throughout the project. The last mechanisms, training and improvement, regard whether actors subjected to a specific training, or acquired capabilities or knowledge, during the project.

For the next dimension, roles and decision making, the first difference regards the removal of the leadership category. Leadership in circular networks is currently an open field of research, and therefore not enough information could be collected. Furthermore, management structure and decision making are combined into a single category, concerning decision making. In roles and responsibilities, relevant mechanisms refer to clarity, allocation among the parties, and changes from traditional roles and responsibilities. In the next category regarding decision making, decision levels, authority and model(s) are relevant. In the final category regarding utilization of knowledge and resources, relevant mechanisms regard to internal, within the project boundaries, and external outside the project boundaries.

In coordination, the first mechanism regards common characteristics. They regard group characteristics, common culture and mindsets and common work procedure. Communication and information sharing regards authority and modes of communication. In change management, the change type and the measures for change management are relevant. The same applies to conflict resolution.

Regarding motivation, first trust is relevant. Therefore, the measures that are utilized to create trust are noted. The next mechanism refers to legitimacy, and therefore internal legitimacy and external support is relevant. The last mechanism refers is engagement, as in practice it is perceived similar to shared commitment. Therefore, the two mechanisms are combined to a single mechanism, engagement, that regards the measures that are taken in the project to engage participants.

Based on those corrections, a new research framework is created. This framework can be utilized by researchers, in order to study the governance of circular infrastructure projects. The redesigned framework of governance is presented below.

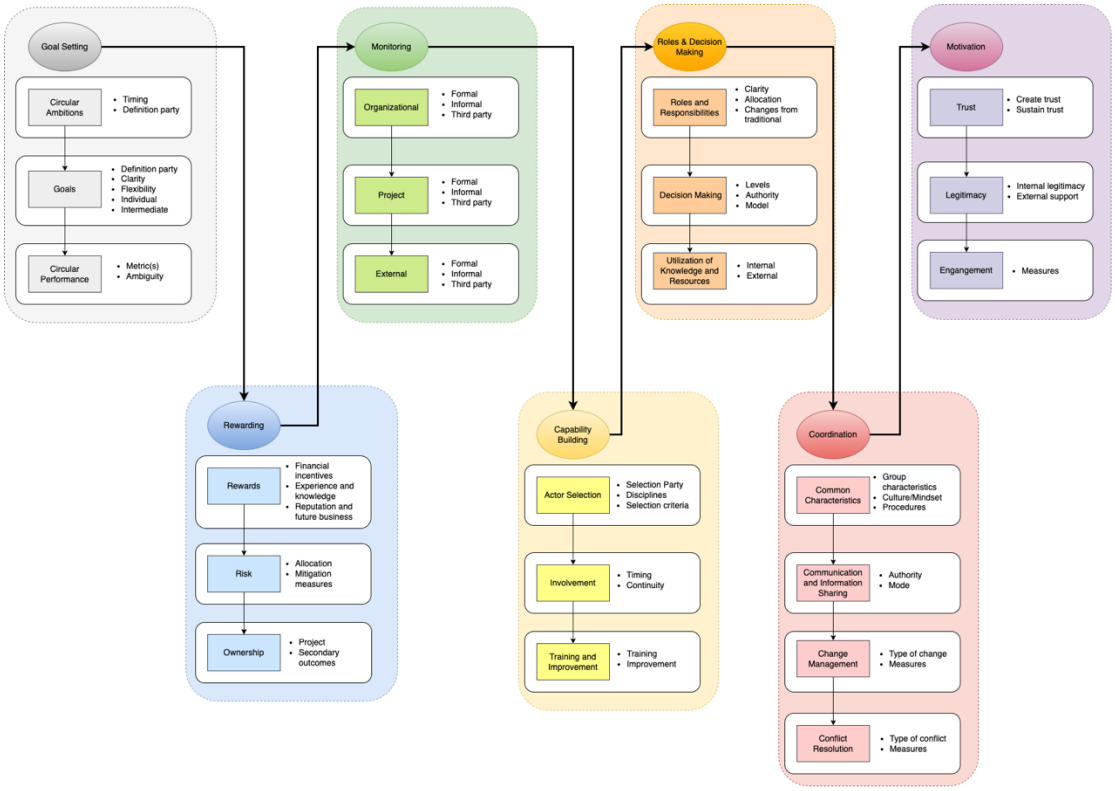

Figure 25: New Research Framework, based on the findings of the interview procedure

7.2 Governance mechanisms in theory and in practice

A second point of discussion, regard the acknowledged governance mechanisms based on the case study, in comparison with the mechanisms that are acknowledged through the literature review. The categorization based on the seven dimensions is followed.

Regarding goal setting, literature suggests that circular initiatives should be taken from the start of the project, (Versteeg, 2019) and to realize them collaboration between stakeholders is important, (Leising et al., 2017) as different organizations have different perceptions of circularity, and they translate differently circular ambitions to circular goals (Kooter et al., 2021). The research indicates that indeed circular ambitions are taken before the project commences. However, other arrangements are also

observed, that regard the introduction party, how ambitions are materialized into goals, and the clarity of the circularity ambitions. Regarding goals, joint definition, clarity, and flexibility are noted as important (Kujala et al., 2020, Kooter et al., 2021). However, other mechanisms such as room for personal and organizational goals, intermediate outcomes, and focusing on a few specific goals instead, instead of aiming for diverse goals are also noted. Another point mentioned in the literature, is the creation of a vision, instead of detailed requirements (Leising et al., 2017), and the joint definition of requirements by the project team (Versteeg, 2019). These mechanisms are also apparent in the cases. Lastly, regarding performance metrics, literature suggests new performance metrics (Police & Batocchio, 2018). Through the analysis, it is observed that relevant mechanisms are combination of different metrics, consensus on metrics selection, and joint definition of circular performance metrics.

Based on the literature, possible rewards for parties include financial incentives, or reputation and future business (Kujala et al., 2020). However, the analysis indicates new rewarding mechanisms such as, (small) financial incentives for participation in circular initiatives, financial incentives, in the tendering, future business opportunities and (positive) reputation as incentive, and experience and knowledge on circular projects as incentive. Literature suggests, shared risk allocation on the project level, (Kujala et al., 2020; Versteeg, 2019; Leising et al., 2017), this mechanism is validated through the multiple case study, as joint risk allocation is observed. Furthermore, other governance arrangements are acknowledged, such as testing and certification as a risk mitigation measure, and allocation of different types of risks in the party that can handle them better. Regarding the ownership structure, it is noted that a shared ownership structure is a facilitator of governance (Kujala et al., 2020). However, as this research regards infrastructure projects, the project is publicly owned. Another acknowledged mechanism regards shared ownership of additional outcomes.

Monitoring in the project level is conducted through a combination of formal, informal and third-party auditing (Kujala et al., 2020). All three forms are apparent through the cases. Furthermore, different layers are acknowledged regarding internal, external, and intra-organizational monitoring.

For capability building, actor selection is considered an important governance mechanism (Kujala et al., 2020), while another mechanism refers to multidisciplinary project teams, as a prerequisite of circular projects (Leising et al., 2017), something that is validated through the research. It is also observed that parties are selected based on non-traditional criteria, actors are selected based on expertise, past relations and capabilities. Actors that are not traditionally involved in construction projects are also involved. A characteristic of circular project, that is often discussed in the literature, concerns the early involvement of the supply chain (Versteeg, A., 2019), and the outcome of it can be knowledge exchange between parties and mutual dependency (Kooter et. al., 2021). That is also apparent through the cases, as actors are involved early, through circularity initiatives. Furthermore, involvement of the actors in the requirement phase is also noted, while continuous involvement of actors across project phases is also noted. Training and improvement of actors, to meet circular demands is another governance mechanism noted in the literature (Kujala et al., 2020). This mechanism is validated through the research, as training of actors took place during their participation in circularity initiatives. Furthermore, an improvement of capabilities is suggested, regarding circularity and inter-organizational collaboration, particularly regarding public actors.

Regarding roles and decision making, clarity of roles and responsibilities is noted as a governance mechanism (Kujala et al., 2020). This is validated through the multiple case study. Furthermore, a change of roles and responsibilities is noted. Other acknowledged governance mechanisms include establishment of a common competencies' environment, public and private actors with the same role and traditional role of client-contractor in project implementation. For decisions, decision-making is noted as important on creating a climate of trust (Kujala et al., 2020; Brown et al., 2020) as well as circular oriented decision making (Brown et al., 2020). Across the cases, different layers of decision-making are acknowledged, namely the project level, where joint decision making takes place, a higher level were important decisions are taken, and an external level where political decisions are taken. Active involvement of public actors in decision-making, is also proposed. Also, different decision-making models are observed, and an alignment of the different models between external and project organizations is proposed. Joint utilization of knowledge and resources is noted as a facilitator of joint action in collaborations (Emerson et al., 2011). This is also observed through the cases. However,

utilization of knowledge can also be performed among the private parties, or by individual organizations. Differences in the attitude towards knowledge sharing, based on the role of the actor, is also observed. Lastly, joint utilization of resources across public clients is also proposed.

For coordination, the first arrangements regard common characteristics of actors, common project management practices and shared culture (Kujala et al., 2020). A common (positive) mindset regarding circularity is also noted as important (Leising et al., 2017). However, in practice diversity in characteristics and practices is observed. Furthermore, a cultivation of shared culture is based on early involvement on circularity initiatives. Regarding communication, a clear vision communication is proposed, in order to align actors on a common vision. Communication is achieved through personal meetings and applications, while a common environment is utilized for information sharing. Changes regard not only, change management but also the nature of change, while conflict resolution is performed both internally through negotiations and externally through authority.

In the motivation dimension, trust is an important factor of success based on the literature (Kujala et al., 2020; Emerson et al., 2011; Bryson et al. 2015; Versteeg, 2019; Leising et al., 2017), and this is a direct consequence of the collaborative character of circular infrastructure projects. This is also noted in practice. Through the multiple case study, it is indicated that accepting responsibilities, shared goals and interests, as well as openness and transparency cultivate trust. Internal Legitimacy (Emerson et al., 2011) and external support (Leising et al., 2017; Cramer, J., 2020), are noted as important. Through this research it is noted that internal legitimacy is based on trust, while communication, transparency in financial issues, motivation for circularity, showcasing results and a clear division of roles and responsibilities cultivate legitimacy. External support is achieved through communication results and positive reputation, showcasing profitability and by a positive stance of parent organizations towards circularity. Engagement is also noted as important (Emerson et al., 2011) and is based on intrinsic motivation of participants and by shared goals and rewards.

7.3 Interactions between the difference governance mechanisms

Based on the analysis, it was observed that there are governance mechanisms that affect the selection of other mechanisms. That was also acknowledged due to the fact that, several identified quotes in the analysis through the ATLAS.ti software, were associated with more than one governance mechanism, something that implied a correlation between them. The correlations can be schematically seen in Appendix G. In this chapter, the main interactions that are acknowledged are noted, and a possible connection is suggested.

First, there is a possible connection between *Room for personal and organizational goals* in the goal setting dimension, with *Experience and knowledge on circular projects as incentive,* in the rewarding dimension. The two mechanisms are basically referring to the same thing, that is acquiring the necessary capacities to develop circular projects. Furthermore, another possible connection regards *Experience and knowledge on circular projects as incentive* and *Future business opportunities and (positive) reputation as incentive,* as for private parties the acquisition of experience and knowledge is directly affecting the future business opportunities. Another possible connection regards the *Involvement of private actors in the requirement phase* and the *Materialization of ambitions through collaboration between public and private parties,* as the latter is a direct prerequisite of the former. The same applies for the *Joint definition of goals.* The two governance mechanisms that regard the circular performance metrics, namely *consensus on metrics selection* and *joint definition of circular performance metrics,* are also related, since the latter can be regarded as a sub-set of the former.

Regarding risk, the mechanism *Testing and certification as a risk mitigation measure* is closely related to the monitoring arrangement of *Third-party auditing for certification of innovative solutions,* as they are basically referring to the same issue. Furthermore, the *Allocation of different types of risks in the party that can handle them better* is also closely related to the *traditional role of client-contractor in project implementation* mechanism. *Shared ownership of additional outcomes* is also related with *Joint utilization of knowledge and resources on the project level, by public and private parties,* as the latter can be regarded as a subset of the former.

Moreover, in the monitoring dimension, *Formal monitoring and control by the public parties* is closely related to the *traditional role of client-contractor in project implementation* mechanism.

Moving to the capability building dimension, specifically in actor selection, the two mechanisms *Multidisciplinary teams* and *Involvement of actors that are not traditionally involved in collaborations,* are closely related, as the latter is a subset of the former. *Continuous involvement of actors, across project phases,* is also relevant to the *engagement* mechanism on the motivation category.
Cultivation of a shared culture, based on early involvement in circularity initiatives, is an outcome of *Early involvement of actors, through circularity initiatives*. *Clear vision communication, alignment on a common vision* closely relates to *Clarity of circularity ambitions. Change management* and *conflict resolution*, both relate to the *decision-making* mechanisms.

Lastly in the motivation dimension, it is observed that *Clarity of roles and responsibilities* and *Joint definition of goals,* are prerequisites of *trust building*. *Internal legitimacy* is affected by *Communication and information sharing, and Clarity of roles and responsibilities* while *External support* is relative with *Future business opportunities and (positive) reputation as incentive* and *External (political) decision making.*

7.4 Challenges regarding the standardization of circular infrastructure projects

Project participants have acknowledged the standardization of circular infrastructure projects, as the main challenge across the three cases. Currently, circular infrastructure projects are regarded as "*isolated islands of innovation*", in a traditionally rigid infrastructure sector. Therefore, the biggest challenge lies on expanding those trials projects, scaling up and taking the next step, that is standardization of circular initiatives in infrastructure projects. To achieve this, certain steps are identified. They relate to *willingness on behalf of the participants to pursue circular projects, establishing a circular supply chain*, and *systematic gathering and sharing of knowledge regarding circularity.*

The first step regards to motivate actors to select circular solutions. For public actors, circularity is an ambition. However, the traditional character of public clients needs to be changed in order to satisfy those ambitions. Since infrastructure projects include a plethora of stakeholders, an organization-wide change in perceptions and roles is implied, in order to motivate actors to achieve circular solutions. Towards that direction, the common competencies environment that is developed in the context of Case A, is relevant. Through this, the changes in roles and responsibilities for project participants are noted, and the required capabilities are identified.

The second step concerns the establishment of a circular supply chain. Private actors across the supply chain need to be motivated to change their roles and work procedure to cater for circularity. In practice, private parties are needed to invest on circular solutions. This can be achieved by showcasing that circular infrastructure can be financially viable. Up until now, circular solutions are considered more expensive than traditional ones. For example, the cost of reusing a girder is actually higher than building a new one. However, this can be resolved if the public client starts incentivizing reuse in the tendering, through establishing selection criteria that regard circularity. Until now, the public parties are the sole financiers of circular infrastructure, and support by the public client is vital towards circular solutions. However, a circular supply chain, entails entrepreneurship and private initiatives. A subsequent challenge relates to circularity business cases standing alone, without the participation of a public client. Case C, indicates that this could be the case for girders reuse, however there are no concrete results yet about the financial viability of such an initiative.

The last step regards information and knowledge gathering and sharing. It is observed that across the cases, mechanisms were in place to gather generated knowledge, share it both internally and externally with interested parties, and utilize it in future iterations of circular infrastructure projects. Therefore, that indicates that participants are aware of the value of knowledge regarding circularity.

7.5 Limitations

The limitations of this research regard the case selection, the methodology, the data gathering method, the literature sources, as well as the generated outcomes of the research. The limitations can be seen bellow.

- A multiple case study was selected as the method of choice. It consisted of three cases of infrastructure projects. A different combination of cases could provide different results, regarding the identified governance arrangements.
- All cases concerned the development of circular bridges, therefore other type of infrastructure projects, such as roads or water and sewage treatment plants can showcase different governance arrangements.
- Two of the selected cases were atypical of standard infrastructure projects in the Netherlands. Case A was developed in an "innovative environment" and Case C considered more the development of a business case for reusing girders that the construction of an actual viaduct. Moreover, Case C, was developed on a non-profit basis. Therefore, those cases didn't indicate typical challenges regarding financial and permitting issues.
- The initial research framework is based on *inter-organizational governance, project network governance and collaborative governance*. However, circular infrastructure projects in practice are developed as innovative projects. Therefore, the concept of innovation is relevant, and through a literature review on *innovative collaboration* other governance arrangements could be identified. For instance, the concept of *intellectual property management* is absent from the current framework.
- As a data gathering method, a combination of semi-structured interviews and project documentation was selected. However, sensitive documents such as contracts were not available. Furthermore, the available documentation was not showcasing any relevant information on governance arrangements, and therefore it was utilized only to support the claims on the interviews and describe the process in the projects.
- Semi-structured interviews were conducted with project participants. However, some critical actors, such as circularity advisors and contract managers were not available for an interview. Moreover, the interviews were conducted remotely, with a specified timeslot. Therefore, some critical information regarding the selection of governance arrangements could be omitted.
- The extensiveness of the research framework poses a limit to the depth of the analysis and the level of detail that was permitted during the interviews. Therefore, governance arrangements could have been omitted, or not given the proper attention.
- Information regarding relevant governance arrangements, such as *circular leadership*, or *new competencies* was limited. Therefore, although those elements are considered important for a governance framework for circular infrastructure projects, they were omitted on the basis of availability of information.
- As an outcome, a framework of governance for circular infrastructure projects is presented. Although the framework illustrates the governance arrangements on each case, generalization across circular infrastructure projects cannot be claimed.
- The governance framework, as presented in the previous chapters, can be utilized to systematically examine circular infrastructure cases, and not as a guideline regarding the appropriate governance arrangements that should be utilized in circular infrastructure projects.

8 Conclusions and Recommendations

In this chapter, the conclusions of the research are presented. This is achieved by answering the research sub-questions, and the research question as stated in Chapter 2. Furthermore, recommendations towards practitioners on the field of circular infrastructure projects, as well as future researchers are given.

8.1 Conclusions – Answering the research question

This research aimed to shed light on the governance of inter-organizational collaborations in the context of circular infrastructure projects. This was achieved by identifying the governance arrangements that define the collaboration, as well as challenges that occurred in the collaboration. Furthermore, the research aimed to identify how governance arrangements lead to challenges, and how can challenges be resolved through the utilization of governance. Therefore, the initial research question is the following.

Research Question: How are inter-organizational collaborations for circular infrastructure projects governed, which challenges relate to governance and how could the associated governance challenges be tackled?

To answer this question, several sub-questions were defined, as they emerged from the reasoning behind answering the main research question. In this chapter, the sub-questions are answered in order to provide a concrete ground to answer the main research question.

The first question regards what constitutes governance, which governance arrangements are acknowledged, and which factors influence their selection.

Sub-question 1: What is governance, and which are its dimensions, antecedents and mechanisms?

This question is answered through a literature review. Although many definitions of governance exist, on the context of this research, governance is defined as *the set of rules and procedures, that are utilized to coordinate, adapt, and safeguard economic exchanges among actors on the project environment.* Furthermore, seven factors that influence governance, or antecedents, are acknowledged. Those refer to the *size* of the project, *past relations and perceptions* of project participants, *the policy and legal framework,* the *power-dependency structure, the uncertainty* in the project environment, *the type of the project,* and lastly, *unity or diversity* between the actors.

Regarding governance mechanisms, notable is the work of Kujala et al., (2020) on project network governance. Therefore, their framework acts as the starting point of this research. However, it is enriched based on other works regarding inter-organizational governance and collaborative governance. The categorization of governance dimension in six different categories is followed, however a new category that regards *Motivation* is also added. The first category *Goal Setting* regards how goals are set, and include governance mechanisms such as *joint performance goals,* and *clarity* and *flexibility of goals.* Another mechanism that refers to *intermediate outcomes* is also added based on the work of Ansell & Gash (2007) on collaborative governance. *Rewarding* regards the incentives given to project participants to align with project goals and the acknowledged governance mechanisms relate to *performance rewards, risk allocation, ownership structure* and *reputation and future business.* Considering *Monitoring,* the three governance mechanisms regard *formal control and monitoring, third party monitoring and auditing* and *informal monitoring.* The next dimension refers to *Coordination.* The mechanisms regarding coordination are *common project management practices, shared culture, values and norms, communication and information sharing change management* and *conflict resolution.* Based on the literature, an additional mechanism is added concerning *face-to-face dialogue.* The next governance dimension refers to *Motivation,* and it is entirely based on the work of Emerson et. al., (2011). The governance mechanisms refer to *mutual trust, mutual understanding, internal legitimacy*

and *shared commitment.* For *Roles & Decision Making,* the three main mechanisms that Kujala et. al., (2020) acknowledge are *definition of roles and responsibilities*, *management structure* and *authority for decision-making.* Furthermore, two other mechanisms regarding *leadership* and *joint utilization of knowledge and resources* are added, based on the work of Emerson et al., (2011). Lastly, regarding *Capability Building,* the acknowledged mechanisms refer to *actor selection* and *training and continuous improvement,* while another mechanism *principled engagement* is also added, based on the work of Emerson et al., (2011). The categorization of governance arrangements is presented on *Chapter 4.3.2 Dimensions and Mechanisms of Governance.* The governance mechanisms that are acknowledge based on the literature, can be seen bellow.

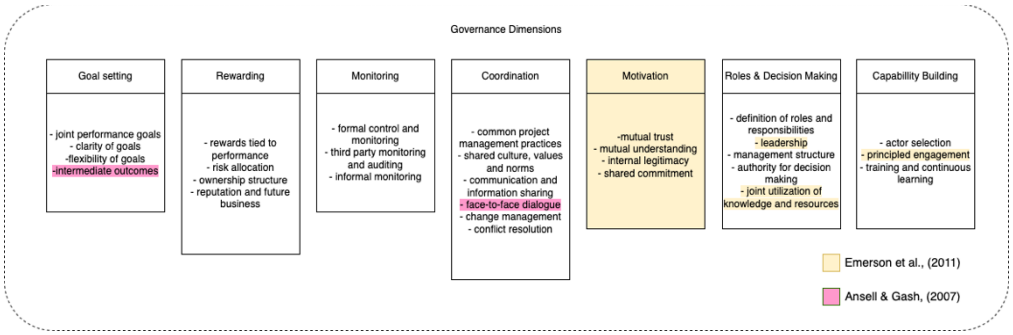

Figure 26: New Governance Dimensions and Mechanisms. Adapted by Kujala et al. (2020), Emerson et al. (2011) and Ansell & Gash (2007).

The next step concerns the adaption of the framework to circular infrastructure projects. Therefore, the next sub-question is the following.

Sub-question 2: What additional requirements does circularity impose in the governance of circular infrastructure projects?

Through a literature review, specific characteristics of the collaboration in circular projects are acknowledged. By incorporating the unique characteristics that circularity imposes on infrastructure projects in the conceptual framework of governance, a circular governance framework can be developed.

The first point concerns the creation of a shared circular vision (Leising et al., 2017; Brown et al., 2020), expressing the *circular ambitions* (Versteeg, A., 2019; Leising et al., 2017) for the project. Another challenge that occurs when setting circular goals, concerns how to measure those goals. For this reason, new *circular performance metrics* (Police & Batocchio, 2018) need to be introduced. Therefore, *circular ambitions* and *circular performance metrics* are added as governance mechanisms. Furthermore, authors claim that non-traditional contracting (Leising et al., 2017) should be implemented on circular projects. This has an impact on *rewarding*, as *risk allocation* and the *ownership structure* are inherently different. Therefore, the governance mechanisms remain the same although they are expressed differently. New mechanisms that can be added in this dimension, refers to the establishment of *shared* (financial) *incentive*s and *rewards tied to lifecycle* (Leising et al., 2017). For *monitoring*, a new governance mechanism is introduced. It refers to utilizing circularity experts, or "*Transition Brokers"* (Cramer, J., 2020)*,* as a control and monitoring structure. Regarding *coordination* of activities, the use of information technology and more specific Building Information Modelling (BIM) (Leising et al., 2017), is noted as an enabler of circular economy. Therefore, a new governance mechanism can be *Use of new technologies*. In the *Motivation* dimension, *Top-down support* (Kooter et al., 2021) and *external support* (Leising et al., 2017; Cramer, J., 2020) are noted as important mechanisms, therefore *external support* can be added as a mechanism. Regarding *leadership*, it is perceived as an important factor by many scholars (Leising et al., 2017; Kooter et al., 2021; Hart et al., 2019). A leader with a strong circular mindset can enhance the motivation of project participants and facilitate the creation of a circular vision (Leising et al., 2017). *Pioneering leadership* (Kooter et al., 2021) inspires project participants and create awareness towards circular initiatives while *facilitative leadership* (Arfaoui et al., 2022) ensure

integrity and trust. Therefore, those leadership characteristics can be added in the same dimension. Further, on *roles and decision making*, it is noted that in circular projects all parties should have a clear understanding of their roles and responsibilities (Cramer, J., 2020). Therefore, *definition of roles and responsibilities* is added. Another challenge regards decision making. Traditional approaches of single-party decision making should be altered to a *collaborative circular-oriented decision making* (Brown et al., 2020). Therefore, a new governance mechanism regards the *circular-oriented decision making* in the project. *Early involvement of the supply chain* (Versteeg, A., 2019) in the project, is also added as a mechanism, in the *Capability Building* dimension. Actors involved should have a "*circular mindset*" (Police & Batocchio, 2018; Witjes & Lozano, 2016; Kooter et al., 2021; Brown et al., 2020) and should be intrinsically motivated towards the common cause. Another aspect is the multidisciplinary character of the project team (Leising et al., 2017). Therefore, a *multidisciplinary project team* is a prerequisite. The process of adapting the framework for circular projects, can be seen on *Chapter 4.4 Adapting the Framework for Circular Infrastructure Projects.* The circular elements included in the governance framework are illustrated bellow.

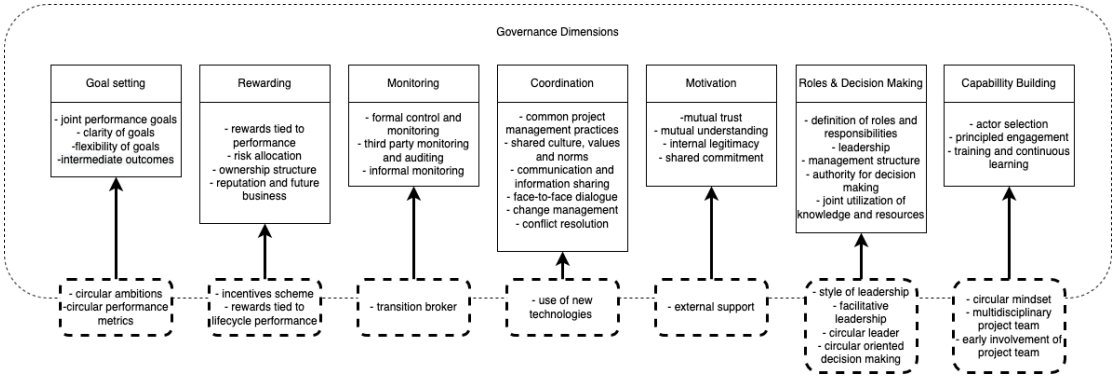

Figure 27: Governance Mechanisms included in the Governance Framework, based on the literature. Own work.

By combining those arrangements into the research framework and rearranging the dimensions to mirror the process of a construction project a new framework is developed. This framework acts as the research guideline to investigate how inter-organizational collaboration is governed in circular infrastructure projects. The process of arriving at a research framework, is described in *Chapter 4.4 Adapting the Framework for Circular Infrastructure Projects.* The research framework can be seen bellow.

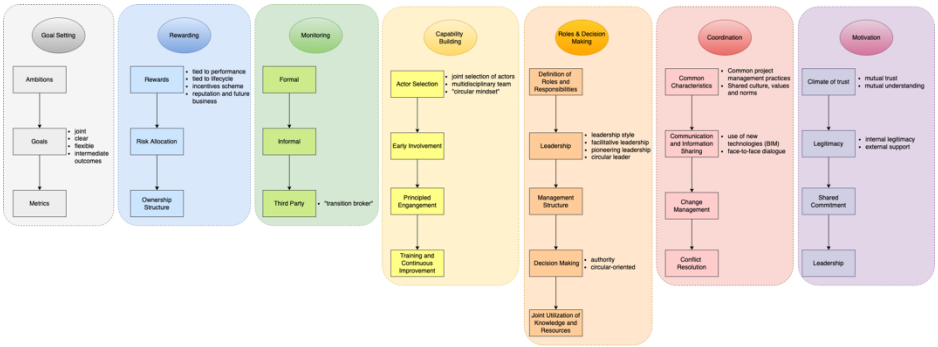

Figure 28: Research Framework of Governance for Circular Infrastructure Projects. Own work.

Based on this framework, a multiple case study is conducted to acknowledge the different governance mechanisms and antecedents that are present in circular infrastructure projects. Therefore, the next sub-question is answered.

Sub-question 3: What are the dimensions and mechanisms of governance of different circular infrastructure projects, which external factors influence the selection of mechanisms, and what are the main challenges that occur in the collaboration?

The multiple case study is conducted across three cases of circular infrastructure projects, that are developed in the Netherlands, jointly be public and private actors. As a data gathering method, semi-open interviews with project participants are selected, while project documentation is utilized to describe the project and identify characteristics of the collaboration. The outcome of this process is three case-specific governance frameworks and the associated challenges. The initial results are presented in *Chapter 5 Multiple Case Study.*

Based on the initial results and through a cross-case analysis, the similarities and differences are acknowledged across the cases. Subsequently the next question is the following.

Sub-question 4: What are the similarities and differences that can be identified in the governance of different circular infrastructure projects?

The cases are showcasing many similarities regarding the governance arrangements, and this could be attributed to the nature of the project (bridge project), the institutional environment of the project (projects that are developed in the Netherlands, jointly by public clients and contractors) and the similarities in the collaborative way that the project is implemented (collaboration between public and private actors in the design phase). Similarities are noted on the basis of the categorization of the seven dimensions of governance.

Specifically, for *Goal setting* it is observed circular ambitions are introduced before the project commences, and the introduction party is on principal the public client. However, in order to materialize these ambitions into concrete circularity goals, a collaboration between public and private parties is needed. Furthermore, goals are jointly defined, while an observation is that those projects leave room for private parties to achieve their personal and organizational goals. Intermediate outcomes that regard knowledge generation and share, are apparent across the cases. Goals are also clear among project participants. Lastly, regarding flexibility, initial goals are inflexible but there is flexibility in achieving sub-goals. For performance metrics, a combination of different metrics is utilized, while consensus on metrics selection is also noted as important.

For *Rewarding*, it is observed that there are (small) financial incentives for participation in circular initiatives, before the project commences. An additional incentive concerns experience and knowledge on circular projects. Across the cases, it is noted that future business opportunities and (positive) reputation is the main incentive for participation in a circular project. Risks are jointly allocated; however, each participating party is accumulating different types of risks based on their role and capabilities, in order to counter it better. Concerning innovation, testing and certification is utilized as a risk mitigation measure, both internally and from external parties. Lastly, regarding ownership, it is observed that projects are owned by the public client, however other secondary outcomes are jointly owned by all parties.

For *Monitoring*, as stated above, there are three different layers of monitoring, internal, external, and intra-organizational, observed. Furthermore, monitoring is in principled performed informally, as a consequence of collaborative approach and through third-party auditing for certification of innovative solutions.

In the *Capability Building* dimension, it is observed that parties are selected to participate based on non-traditional selection criteria, that could include quality, circularity and sustainability. Furthermore, actors are selected based on expertise and past relations. Multidisciplinary teams is also noted as a governance mechanisms, particularly the involvement of actors that are not traditionally participate in collaborations, such as demolition experts and recycling companies. Regarding involvement, actors are early involved through the circularity initiatives, while the continuous involvement of actors, across project phases, is noted as important. Lastly, regarding training and improvement, it is observed that training of actors took place during their participation in circularity initiatives, while improvement of capabilities during the project, regards both circularity and interorganizational collaboration.

In the *Roles and Decision-Making* dimension, clarity of roles and responsibilities is a common mechanism. An additional mechanism, regard the participation of public and private actors in the same role, as based on their differences in power and responsibilities, the role is strengthened. Furthermore, it is observed that traditional roles and responsibilities change in circular infrastructure projects. In decision making, three different layers are acknowledged, namely the project level, where decisions are taken jointly, the higher level (or the steering group), were important decisions are taken, and the external level, where usually political decisions that affect the project are taken. The differences in the decision-making models of project parties are also noted, and it can potentially lead to problems, such as miscommunications or delays. Lastly, regarding utilization of knowledge and resources, it is noted that there is joint utilization by public and private parties in the project level, however parties can also utilize knowledge and resources themselves, intra-organizationally. Another common observation regards the differences in the attitude towards knowledge sharing by the project actors. This can be explained based on their role within the project.

In the next dimension, *Coordination*, first it is observed a diversity in the characteristics and the practices of involved parties, something that stem from the multidisciplinary character of the projects, and the collaborative approach in the development. However, actors not necessarily see that as a difficulty, as they acknowledge the power of diversity, in achieving circular objectives. The next observation regards, the cultivation of a shared culture, based on early involvement in circularity initiatives, as participation in similar initiatives is indicating a (positive) change on mindset towards circularity. Regarding communication, personal meetings and applications are utilized, while for information sharing, a common environment is noted as important. Changes, regard the scope, the goals and the specific solutions, and they are managed in accordance with the decision-making structure. The same applies for conflicts. They are resolved both internally in the project, based on dialogue and negotiations, and externally, in the higher level, when they regard budgeting and important aspects.

For the last dimension, *Motivation*, actors acknowledge the need to cultivate a climate of trust. They proposed a plethora of ways to achieve that, with the similar ways being, accepting responsibilities, create common goals and interests and being open and transparent. Concerning legitimacy, it is observed that internal legitimacy is closely connected to trust. Furthermore, frequent communication, intrinsic motivation for circularity, showcasing results, and having a clear division of roles and responsibilities, are all mechanisms that cultivate internal legitimacy. For external support, communicating results and achieving a positive reputation is considered important. Furthermore, a positive stance of the parent organizations towards circularity, is considered equally important to achieve support. Lastly, engagement of project participants is achieved based on intrinsic motivation on circularity, and by having common goals and rewards. The similarities of the cases are presented in *Chapter 6.1 Cross-case analysis*. They are schematically presented, based on the research framework, in the figure bellow.

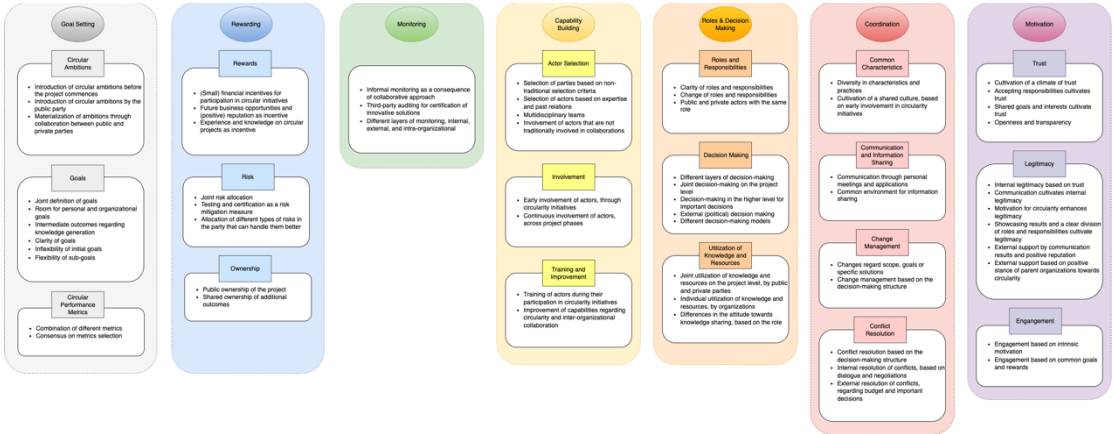

Figure 29: Proposed Governance Framework, based on the similarities acknowledged through the Multiple Case Study. Own work.

Concerning the differences across the cases, those can be attributed to the different circularity principles that are introduced in each case, the project delivery method that is followed, the disciplines that are involved, and the phase of each project during the analysis. In terms of governance mechanisms, the main differences are observed in the *Goal Setting, Rewarding* and *Motivation* dimensions.

More specifically, in *Goal Setting*, it is observed that circularity ambitions are materialized through market consultation in Case A, as the initial ambition was innovation, and in Case B, they are introduced through personal actions of motivated people. In Case C, they are materialized through an open learning environment. For goals, in Case A, a secondary outcome knowledge generation was during the project transformed to a goal, while in Case B the project started with detailed requirements already set, something that led to diverse and contradicting goals.

For *Rewarding*, in Case B, the collaborative structure of the project was considered as an incentive, while in Case C, the project was developed on a non-profit base, and the development of a feasible and financially viable business case for reusing girders, that could later prove profitable, was considered as an incentive. Regarding *risks*, in Case A, it is noted that the main risks regard the process, and motivating actors to support the project. And this risk was managed by keeping close contacts with project participants. In Case B, innovation was considered the risk, and it was mitigated by standardizing the procedure, and completing an elaborated risk register early on in the project. Accordingly, for Case C, the main risks concerns the economic viability of the business case. For innovation risks, internal and external resources were utilized, by the mean of testing and providing certification. Regarding ownership, a difference is that in Case C, other public parties, such as a Municipality are owners of the trial projects that are developed through the business case.

In *Monitoring*, a difference is that in Case A, monitoring was performed through the Common Data Environment (CDE), while also public parties monitored the process of collaboration, in order to gather knowledge to utilize it in future collaborations. In Case B, gate reviewing was utilized for monitoring, something that was proposed by the private parties.

Regarding *Capability Building,* it is observed that in Case B, the involved parties (public client and contractor) decided not to involve other parties in the design phase. That was decided, to have flexibility during the construction phase. For Case C, actor selection was performed through a single leading party. Considering involvement, it is noted that actors have been involved earlier in the process, however the point in time differs across the cases. Considering training, in Case B, a collaboration traineeship was given before the project commences, something that is usual in projects that have to start on a short notice.

In the *Roles & Decision-Making* dimension, it is observed that the absence of same roles for private and public parties was considered a challenge. Furthermore, while in decision-making, differences are acknowledged in Case B, regarding the decision-making model for private and public parties, but also between the models of private parties, in Case C. Concerning utilization of knowledge and resources, in Case A, the CDE was proven to be a facilitator of exchanges, while in Case C, resource sharing between public actors was noted as problematic.

Regarding *Coordination*, it is noted in Case A, that CDE was a facilitator of information exchanges, while in Case B, the leading actor was responsible for the communication and information sharing protocol and process. In change management, there were differences across the cases, in the type of changes, as well as, how they dealt with them. For instance, in Case B, a change of solution on behalf of the private party was seen as a compromise on the circularity of the project. For conflict resolution, in Case B, conflicts were sourcing from the requirements, and therefore it was suggested that a proactive conflict management by actively engaging in conversations regarding them before project commences could be beneficial. In Case C, it is noted that conflict resolution, is performed by actors that have the soft skills to manage them, but also the legitimacy and decision-making powers to talk on behalf of the team.

Lastly, regarding *Motivation*, there are differences in the factors that actors across the three cases consider as important for achieving trust, legitimacy, and engagement. In Case C, it is noted that trust can be consequence of actors mimicking the behavior of the leading party, in terms of openness and willingness to share, while also openness in the financial aspects is considered as important, since the project is developed on a non-profit basis. In Case B, it is noted that respecting the decision-making powers of other parties, is an antecedent of internal legitimacy, while in Case C, external support is achieved by showcasing a successful business case, proving that the concept is financially viable. Lastly, engagement is achieved through team building techniques in Case A, while the importance of a "good story" is noted in Case B. The differences can be seen, in *Chapter 6.1 Cross-case analysis.*

The next step in the analysis, concerns the identification of the main challenges in the project, across the three cases, and their relation to governance arrangements. Therefore, the next question is.

Sub-question 5: What are the main challenges that occur in circular infrastructure projects, and how they relate to the implementation or absence of governance mechanisms?

To answer this question, the project specific challenges are identified for each case. Next, the antecedent factors that lead to those challenges are noted, based on the interviews. Lastly, a combination of different governance arrangements that could potentially resolve those challenges is proposed. This procedure is followed, for each case and it can be seen on *Chapter 6.2 Case specific challenges.*

In Case A, there are four identified challenges. The first relates to measuring circularity during the tendering phase. That proved problematic, as some participants had different perceptions on circularity, particularly how circular their solution was. It is observed that MKI and LCA were selected as circular performance metrics. Therefore, that challenge could be resolved by selecting other performance metrics as well, and by providing traineeship up-front, on how circular performance metrics are utilized. Another challenge relates to the collaboration between participants, particularly regarding achieving consensus on decisions and a mutual understanding. That can be attributed to the collaborative structure of the project and the multiple disciplines that were involved. The actors suggested that a more traditional relationship between client and contractor could resolve this issue. The lack of competencies of the involved actors was also noted as a challenge, as the actors had their traditional roles and a traditional mindset. Furthermore, being open and transparent was also a challenge. The actors aim to resolve those issues, by developing a common competencies environment were the required changes in terms of roles and responsibilities are investigated. The common data environment is also utilized to enhance information sharing between participants. The last challenge relates to achieving external support. External actors are often traditional, and they considering circularity and innovation as conflicting with their organizational goals. Furthermore, there is a dependency on external actors for decision making. Therefore, the governance arrangements that relate to external support are relevant here, namely frequent communication and sharing of results, positive reputation, and the cultivation of a climate of trust in the parent organization.

In Case B, four challenges are also acknowledged. The first refers to hidden requirements, that led to budget overruns. Those requirements were a consequence of inadequate planning during the front-end phase of the project. They could potentially be resolved, by involving capable and experienced actors, also from private parties, and by enhancing the capabilities of public actors, that were responsible to set those requirements. A second challenges relates to the diverse requirements that led to contradicting goals, within the project. As requirements were numerous, the interactions were difficult to oversee, therefore it is proposed that clarity of goals, and the reduction of requirements could lead to a more optimal result. Furthermore, the engagement of private parties during the requirements stage, could potentially lead to less requirements and a better understanding, within the project team. Next, the scope change that led to a compromise in the circularity of the selected solution was considered a challenge. The inflexibility of goals, and the informative monitoring on behalf of the public client, lead to solutions being selected solely by the private parties. Consequently, the decision-making process was breached. That can also be accounted by the lack of available and capable personnel on behalf of the public client, in order to contribute more on the project. To cope with it,

clarity of goals and vision is proposed as a governance mechanism. Furthermore, a more formal control and monitoring, as well as actively involvement of capable public actors in the decision-making could potentially resolve this issue. The last challenge, regards collaboration in the project. It is observed that the public client had an organizational structure and decision-making model that differ with those of the project organization. That led to a traditional relation between the public and the private actors in the project. This challenge could potentially be resolved by altering the organizational structure in the public client's side of the project, so that both parties can meet on the all levels, and by enhancing the capabilities of actors.

For Case C, challenges regard the matchmaking, or finding a compatible guest project for girders' reuse. The relevant governance arrangement here is joint utilization of resources by public clients, as it was observed that girders harvested from one public clients' project could not be reused in another public client's project. Another challenge relates to the differences between the rewarding scheme for each participant, as parties had different cost structures. That was resolved through internal monitoring for safeguarding that each party works on a non-profit basis. Furthermore, achieving internal legitimacy and trust is important here, and therefore the mechanisms of internal legitimacy are relevant. Being open and transparent was also a challenge, since private parties are traditionally secretive in construction projects. This challenge was resolved by motivating a change in the role of the private parties, in order to be more open. Joint utilization of knowledge and resources is also a relevant governance mechanism here. Lastly, the feasibility of girders reuse was also a challenge, since the cost of reuse is actually more than constructing at the moment. This can be resolved by incorporating incentives for reuse in future tendering, and by achieving external support from the public clients for similar initiatives. By combining the information gathered through the sub-questions, the main research question can now be answered.

Research Question: How can governance arrangements be designed to address challenges in the inter-organizational collaboration for circular infrastructure projects?

The analysis has provided a framework of similarities across the cases, furthermore differences were acknowledged, and challenges were linked with the presence of absence of specific governance mechanisms. Case-specific challenges can be potentially resolved through the implementation of governance mechanisms. Those mechanisms are identified, either directly through the project participants, or by a comparison between how different mechanisms indicated different results across the cases. Therefore, the research framework is enriched with the identified governance dynamics to counter the case-specific challenges. Consequently, the answer to the research question is an elaborated governance framework, that showcases the procedure through which a circular infrastructure project can be developed, so that the known challenges can be overcome. The governance framework can be seen in the figure bellow.

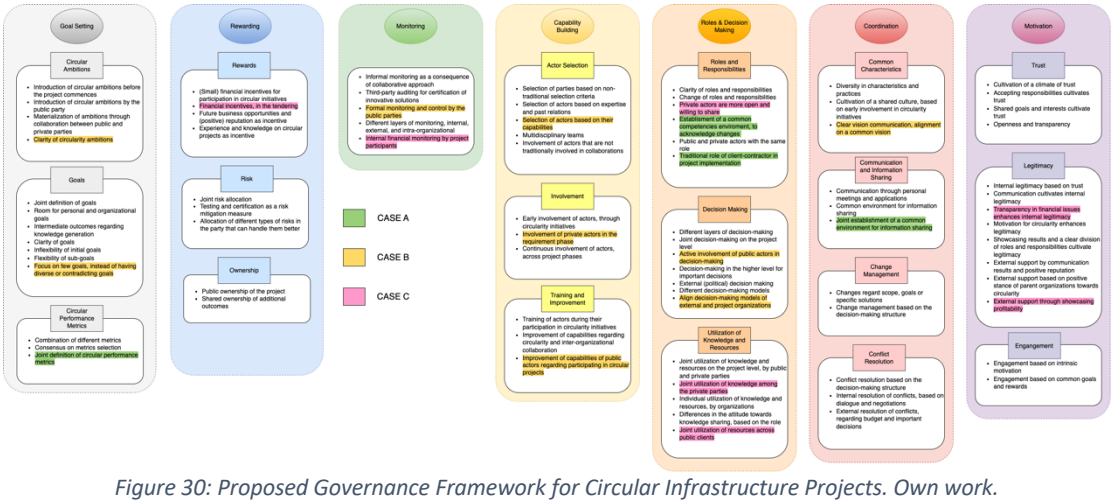

Figure 30: Proposed Governance Framework for Circular Infrastructure Projects. Own work.

8.2 Recommendations

Through this research, several recommendations can be provided to the reader. Recommendations can first and foremost, refer to the practitioners in the field of circular infrastructure projects. Particularly, public actors that are interested to develop a similar project, but also private actors that would like to have a proper understanding of their responsibilities and the potential challenges that circular infrastructure entails. Secondly, recommendations are given towards future researchers in the field of governance of inter-organizational projects. Those regard, future research topics, as well as expansions and re-evaluations of the research framework.

8.2.1 Recommendations for practitioners

Based on this research, it is important to acknowledge the differences between a circular infrastructure project, and a circular infrastructure sector. At this stage, circular projects are considered as isolated "islands" of innovation, in the traditional, rigid infrastructure sector. Circular projects are developed independently by many public actors in the Netherlands. On the contrary, developing a circular infrastructure sector, is noted as the outmost goal across the cases. Such a sector prerequires, a circular supply chain, legislation that imposes circularity, instead of circular guidelines, as well as opportunities to develop those kinds of projects. Therefore, it is inherently differently what exactly those two notions entail.

The institutional environment of infrastructure development currently opposes the development of circular infrastructure projects. However, those projects are an important way of challenging the regular way of working and providing innovative solutions. In fact, developing circular infrastructure projects is important towards changing the infrastructure sector, as it provides valuable lessons to project participants, as well as circumstantial evidence that circular projects can be successfully developed.

Therefore, the generation and sharing of knowledge should be an embedded goal for circular infrastructure projects. This can be achieved through a common data environment, or other relevant measures that can safeguard that knowledge is not lost or remaining in certain parties. Through this, not only project participants, but also external actors that may be interested and actively pursuing circularity, could potentially access the generated knowledge. Therefore, actors would not be necessarily "reinventing the wheel", with every subsequent iteration of a circular project.

Another observation, that is apparent through the cases, regards the fact that circular infrastructure projects are developed in a collaborative way, jointly by public and private parties. Collaboration is needed, as actors cannot achieve their goals individually. It is therefore important to collaborate, in order to utilize knowledge and experience of other parties, in order to achieve circularity. Collaboration should be also implemented from the first stage of the projects, before requirements are set.

A collaborative approach, however, requires continuous involvement and actors with specific collaborative characteristics. It is observed that, not every actor has the necessary capabilities, skills, or motivation to collaborate. Therefore, it is important to select the right actors, on the basis of their skillset but also their openness to collaborate and their intrinsic motivation. In the event, that an organization lacks the specific competencies to work in a collaborative way, either by lacking personnel on specific roles, or lacking the capabilities to withstand an intensive procedure that lasts for an extensive time period, it would be potentially safer to revert to the common role and relation dynamics, of a traditional construction project.

Positive reputation, and future business opportunities, are noted as an important incentive for participation in circular infrastructure project. As circular infrastructure is not yet a standard procedure, it is perceived that actors that accumulate knowledge and experience on circular projects, they will acquire a competitive advantage in the future. Therefore, showcasing the importance of circularity, and presenting positive results, is an important strategy to engage parties in circular projects.

A last observation regards the importance of external support. As mentioned above, the current institutional environment of infrastructure, can be perceived as opposed to circular infrastructure projects. Therefore, before a project commences, external support by public and private parties should be actively sought. This can be easily achieved if the parent organizations are already heavily invested in circularity. Engagement of external actors can also be achieved by showcasing results and positive reputation.

- Make a clear distinction between what is a circular infrastructure project and what entails a circular infrastructure sector.
- Circular projects as a way of changing the construction sector.
- Knowledge generation and information sharing are important to standardize circular infrastructure projects.
- Early collaboration between public and private parties is important, to capitalize on knowledge and experience of private actors and authority of public actors.
- Investigate the capabilities of actors for collaboration, select actors based on their skills and intrinsic motivation.
- If an organization lacks the capabilities to collaborate, a traditional approach should be preferred.
- Positive reputation and future business opportunities, as the main incentive for participation in circular infrastructure projects.
- Engage and achieve the support of external actors, through cultivating an intra-organizational circular mindset, showcasing results and achieving positive reputation.

8.2.2 Recommendations for future research

As discussed, circular infrastructure projects are inherently innovative projects, though the concept of innovation is absent in this research. In fact, this is one of the limitations of the study, since the framework is developed based on the work of Kujala et al., (2020) on project network governance, with subsequent additions based on the literature on collaborative governance and interorganizational governance. Therefore, a future study that includes governance mechanisms that are aimed towards innovative projects could be potentially valuable.

The proposed framework of governance is constructed based on a multiple case study that includes three cases. The cases are also similar, since they regard bridge projects, that are jointly developed by public and private parties, in a collaborative way. Therefore, it perceived that different governance mechanisms can be apparent in different cases. Subsequently, a validation of the proposed framework through a new case study is also relevant, as a future research subject.

A Qualitative Comparative Analysis (QCA) can be implemented, based on the framework, in order to identify which combination of governance mechanisms can lead to potentially successful circular infrastructure projects. An analysis based on this method, was the initial aim for this study, however due to lack of available data, a multiple case study was selected. Therefore, once a larger data set is available, QCA can be utilized to identify an ideal configuration of governance mechanisms. Moreover, QCA can be implemented to investigate how governance mechanisms relate to governance outcomes, such as overall satisfaction, or opportunistic behavior, based on the work of Roerich et al., (2020).

Another initial goal of this research was to investigate how the different governance antecedents affect the selection of governance mechanisms, for circular infrastructure projects. For that reason, an elaborated list of antecedents was compiled through a literature review. However, this research couldn't shed light on how specific antecedents connect to specific governance mechanisms. Therefore, a future research subject could be the identification of antecedent factors that affect the selection of a single mechanism, or a combination of mechanisms in a circular infrastructure project.

As explained in the discussion part, there are indications that specific governance mechanisms are affecting or depended on the selection of other governance mechanisms. For instance, the governance mechanism *regarding room for and organizational goals* in the *Goal Setting* dimension, is suspected to be connected with the *experience and knowledge on circular projects as incentive* mechanism, that belongs in the *Rewarding* dimension. Such dependencies are also noted in the limitations part of the study by Kujala et al., (2020) on project network governance. Therefore, systematic research on the interactions between governance mechanisms, is a potential research theme.

The recommendations for future research can be seen bellow.

- Enrich the framework with governance arrangements and antecedents that are stemming from literature on collaboration for innovative projects and perform a multiple case study with the new framework.
- Validate the framework through a multiple-case study concerning a combination of different circular infrastructure projects.
- Perform a Qualitative Comparative Analysis (QCA) in order to identify which configuration of governance mechanisms lead to successful circular infrastructure projects.
- Investigate the connection between governance antecedents, or pre-existing, external factors, and specific governance mechanisms in the context of circular infrastructure projects.
- Identify possible interactions between the different governance arrangements, for circular infrastructure projects.

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Appendix A – Case Selection

Table 5: Case selection

Projects	*Circular Infrastructure*	*Circular Principles*	Public Private Parties	Completion	Availability
First circular viaduct	Viaduct	• Design for reassembly • Modular construction • Re-usable • Traceability	Yes	Completed	Yes
Pilot A	Viaduct	• Reuse of concrete prefab beams • Building materials' marketplace	Yes	Ongoing	Yes
Pilot B	Viaduct	• Re-usability scan • Circular design • High quality reuse of building materials	Yes	No data	No
Pilot C	Viaduct	• Design for reassembly • Modular construction • Re-usable • Requires less material and maintenance	Yes	Started	Yes
Circular area development	Area development	• Circular initiatives	Yes	Ongoing	No
Construction airport pier	Building project	• Reusing energy • Reusable sustainable materials	No	Ongoing	No
New flooring on airport pier	Building project	• Recycled plastic	No	Ongoing	No
Light as a service/ display as a service project	Network project	• Take-back-systems • Service as a Product	No	Ongoing	No
Construction of airport car park	Building project	• Demountable	No	Ongoing	No
Construction of airport mortuary	Building project	• Demountable	No	Ongoing	No
Replacement of 2 bicycle bridge decks	Bicycle bridge	• As a service approach • Sustainable and circular design • Durable design • Extension of lifespan	Yes	Ongoing	No

Reconstruction of municipal road	Road	• As a service approach • High quality reuse of materials after the life cycle	Yes	Ongoing	No
Temporary road	Road	• As a service approach • Material Passports • High quality reuse of materials after the life cycle	Yes	No data	No
Sustainable road management	Road	• As a service approach • Extension of lifespan • High quality reuse of materials after the life cycle	Yes	Ongoing	No
Renovation of bridge	Bridge	• Re-use of materials • Modular construction • Low maintenance • Energy neutral	Yes	Ongoing	Yes
Construction of 4 sustainable bridges	Bridge	• Re-usable • Materials of residual flows • Cement-free • Maintenance-free • Absorbs CO2 and particles	Yes	Ongoing	Yes
Renovation of traffic control post	Building project	• Use of secondary raw materials • Circular building • Demountable • Energy neutral • Build one building instead of three new traffic posts	Yes	Ongoing	No
Renovation of Railway station	Building project	• Reusable and recycled materials • Energy neutral	Yes	Completed	No
Construction of pumping station	Water works	• Modular building • Cementless concrete • Energy neutral • Long lifespan • Reuse of old piles	Yes	Ongoing	No
Renovation of pumping station	Water works	• Modular building • Cementless concrete • Long lifespan • Prefab façade parts	Yes	Ongoing	No

The selected cases are highlighted in green. The reasoning behind the rejected cases, comes on the basis of confirmation with the five criteria. The criterion that is not confirmed in each case is highlighted in red.

Appendix B – Literature Review Diagrams

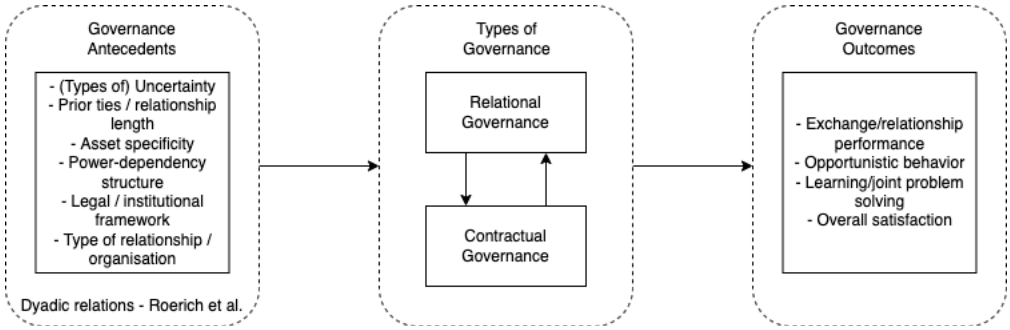


Figure 31: Multidimensional framework of inter-organizational governance (Roehrich et al., 2019).

Table 6: Predictors of Effectiveness across Network Governance forms (Provan & Kenis, 2008)

Governance Forms	***Trust***	***Number of Participants***	***Goal Consensus***	***Need for Network Level Competencies***
Shared Governance	High density	Few	High	Low
Lead Organization	Low density	Moderate	Moderately low	Moderate
Network Administrative Organization	Moderate density	Moderate to many	Moderately high	High

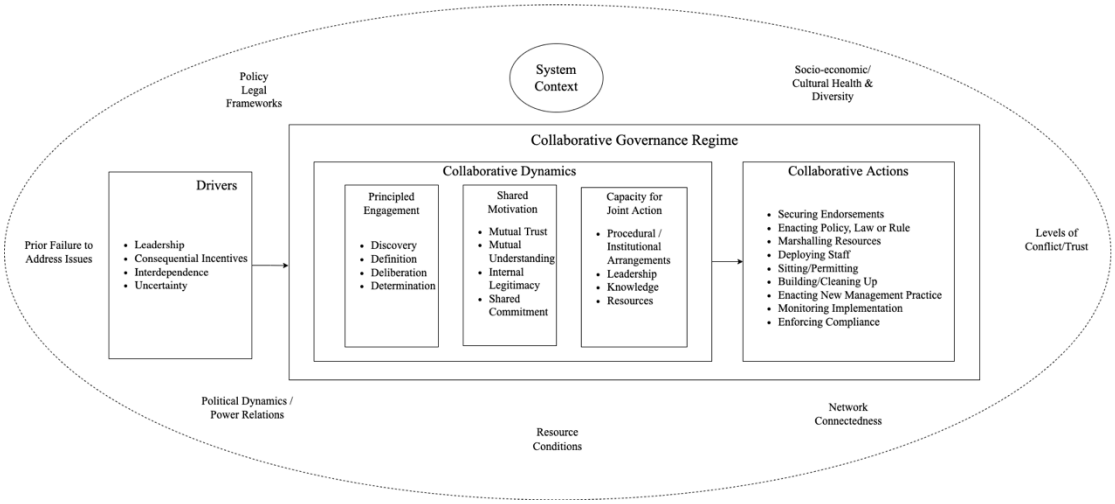


Figure 32: Collaborative Governance Regime (GCR) (Emerson et al., 2011).

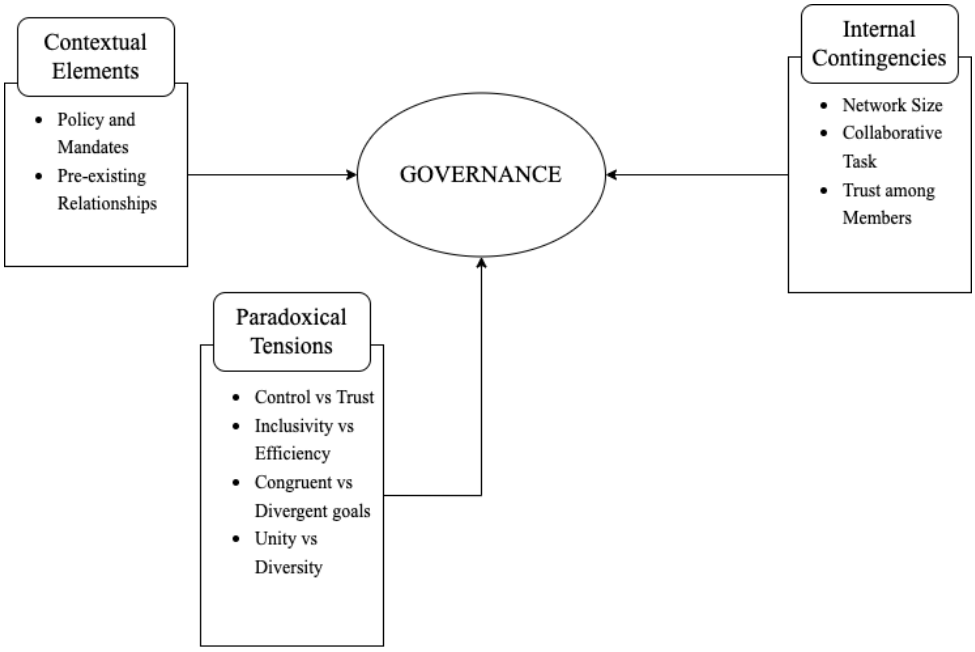


Figure 33: Factors that affect Governance in Cross-sector Collaborations (Bryson et al., 2015)

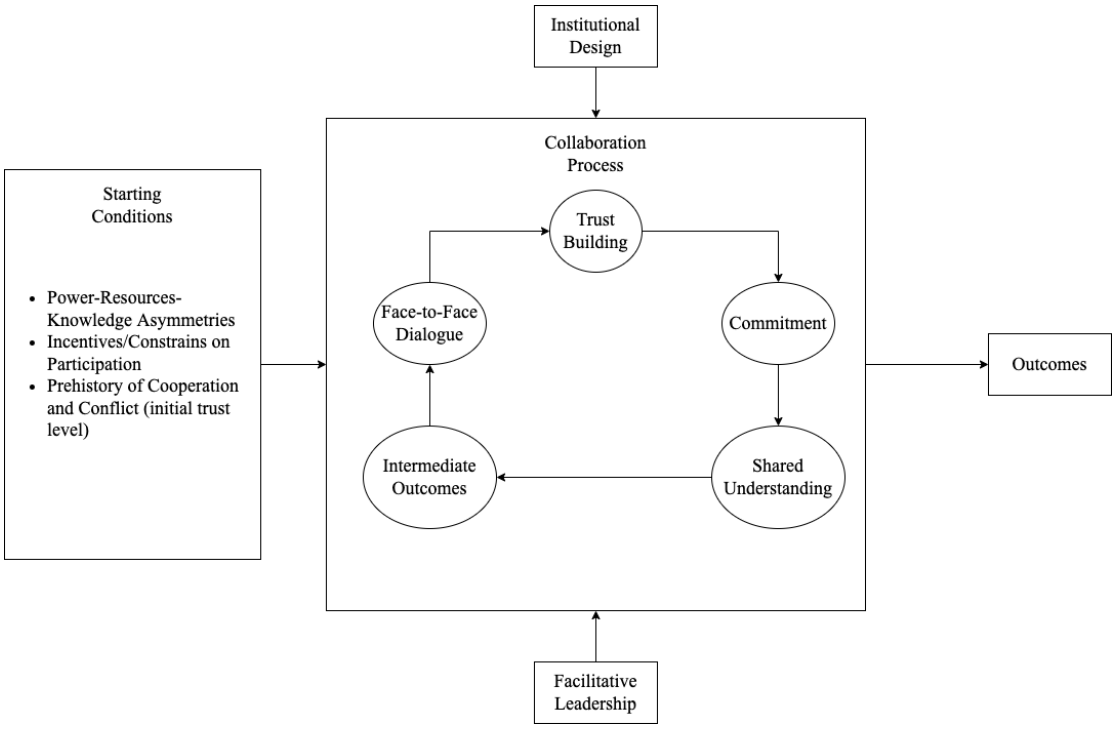


Figure 34: Model of Collaborative Governance (Ansell & Gash, 2007).

Table 7: Circular Construction Projects Characteristics (Versteeg, 2019).

Circular Construction Projects Characteristics
Circular initiatives from the start
Define ambitions instead of requirements
Jointly defined requirements
Trust and transparency
Resources and knowledge freely accessible
Shared commitment, vision, and philosophy
Early involvement of the supply chain
Attention to end-life management
Jointly selection of partners
Non-hierarchical and cooperative organizational structure
Equal distribution of risks and profits
Main challenges on collaboration and management

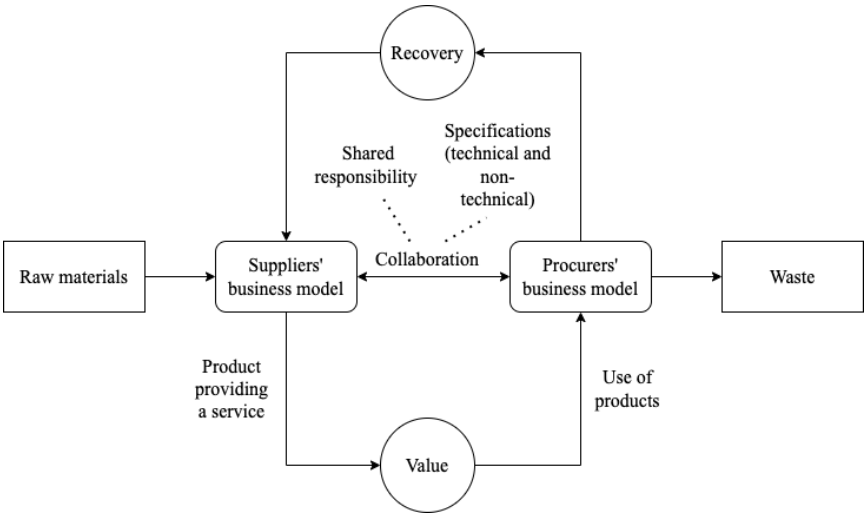


Figure 35: Collaboration between Procurement and Business Models (Witjes & Lozano, 2016).

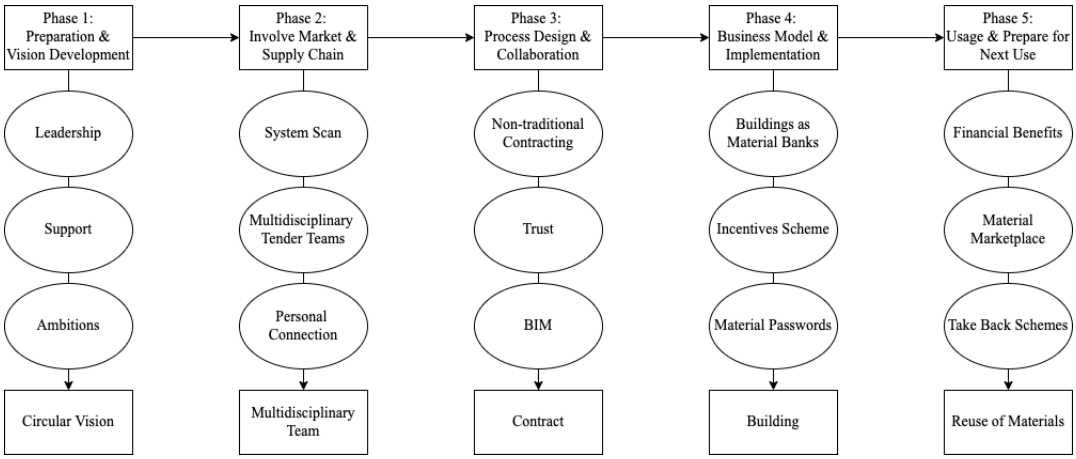


Figure 36: Collaboration tool for CE in the building sector (Leising et al., 2017).

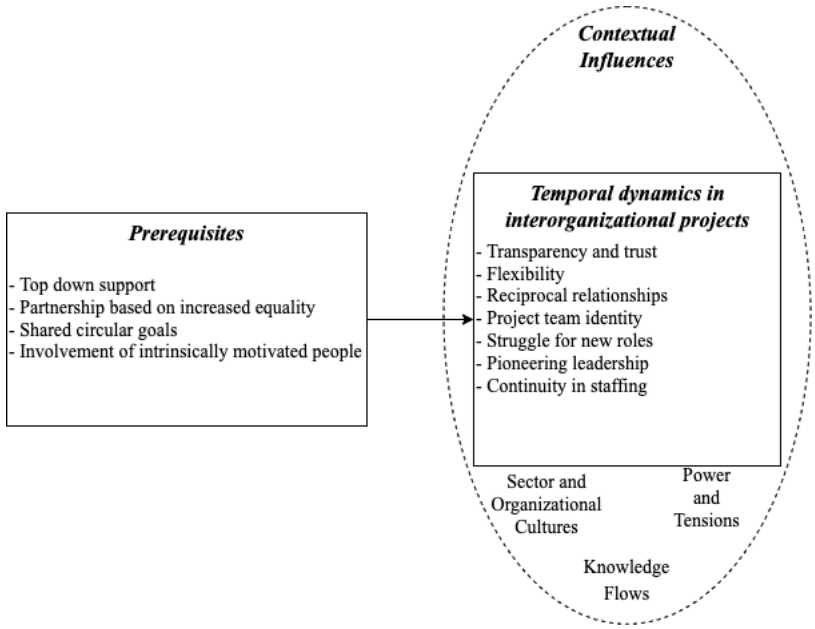


Figure 37: Dynamics of interorganizational projects that are relevant in the realization of circular construction projects (Kooter et al., 2021).

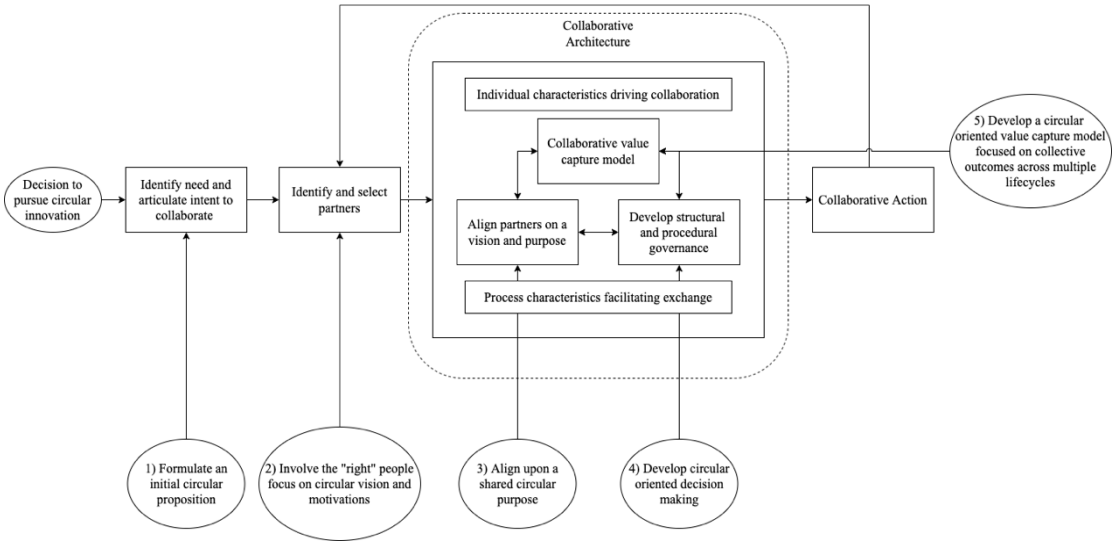


Figure 38: Collaborative Circular Oriented Innovation Process Model (Brown et al., 2020).

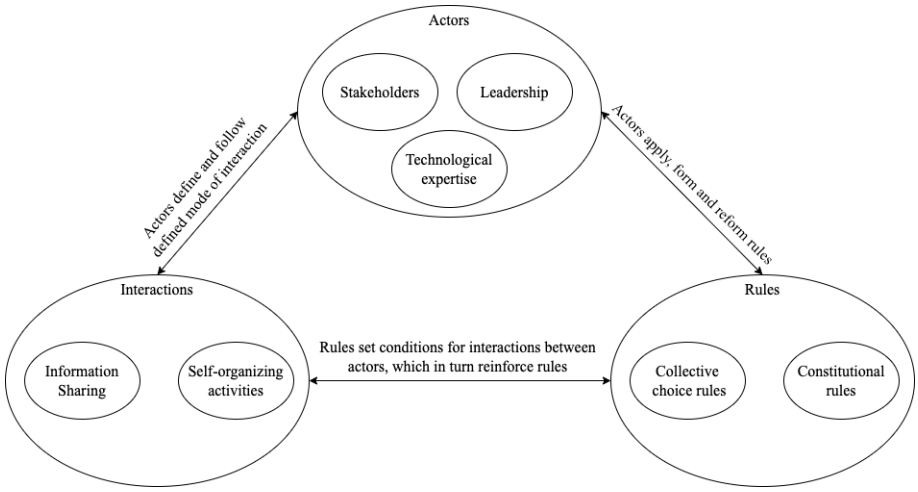


Figure 39: Model of Governance Arrangements (Arfaoui et al., 2022).

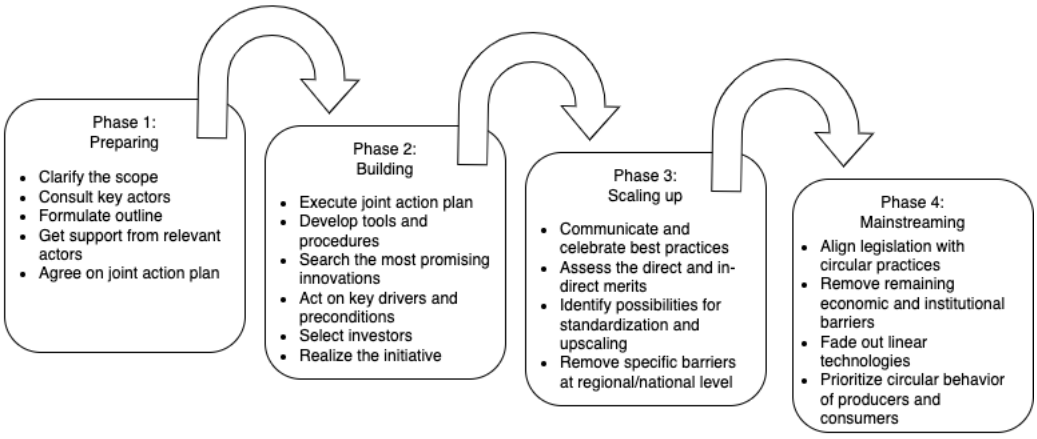


Figure 40: Phases and Activities of Circular Initiatives (Cramer, 2020).

Appendix C – Governance Antecedents

Table 8: Acknowledged Governance Antecedents based on the literature. Own work.

Governance Antecedents			
Governance Type	*Literature Source*	*Categorization*	*Name*
Collaborative Governance	Bryson et al. (2015)	Contextual elements	Policy and Mandates
			Pre-existing Relationships
		Internal Contingencies	Network Size
			Collaborative Task
			Trust Among Members
		Paradoxical Tensions	Control vs Trust
			Inclusivity vs Efficiency
			Congruent vs Divergent goals
			Unity vs Diversity
	Emerson et al. (2011)	System Context	Resource Conditions
			Policy and Legal Frameworks
			Prior Failure to Address Issues
			Political Dynamics / Power Relations
			Network Connectedness
			Levels of Conflict/Trust
			Socio-economic/Cultural Health & Diversity
	Ansell & Gash (2007)	Starting Conditions	Power-Resource-Knowledge Asymmetries
			Incentives / Constrains on Participation
			Prehistory of Cooperation and Conflict
		Institutional Design	
		Facilitative Leadership	
Network Governance	Provan & Kenis (2008)	Key Structural and Relational Contingencies	Trust
			Number of Participants
			Goal Consensus
			Need for Network Level Competencies
Interorganizational Governance	Roehrich et al. (2020)	Governance Antecedents	Uncertainty
			Prior Ties / Relationship Length
			Asset Specificity
			Power-Dependency Structure
			Legal / Institutional Framework
			Type of Relationship / Organization

Appendix D – Interview Protocol

0. Introduction

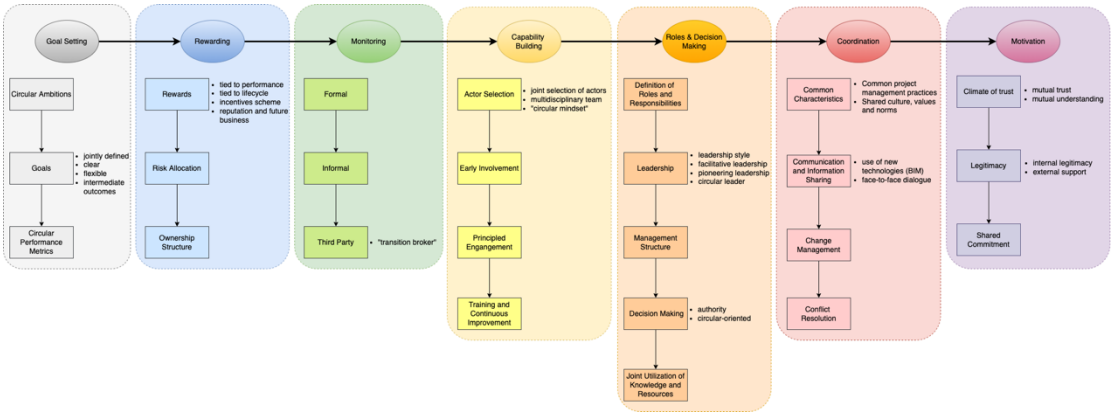
Question 1: What is your background? How were you involved in the project? What was your role?

Question 2: How do you conceptualize circularity? What does circularity mean to you, for your position/area of expertise?

Question 3: How do you conceptualize governance? What it means for your role and your profession? Do you see a link between governance practices and achieving circular ambitions?

On the context of this research, governance is conceptualized as *the set of rules and procedures, that are utilized to coordinate, adapt, and safeguard economic exchanges among actors on the project environment.*

Presentation of the Research Framework



1. Goal setting

Staring with goal setting, I am interested to know about the circular ambitions of the project, how those were translated into goals, and which metrics were utilized to measure circular goals.

Question 1.1: Did the project started with circular ambitions or where they later added? Who set them? (*Circular Ambitions*)

Question 1.2: How were those ambitions translated into goals? How were the goals set? Have actors had an adequate opportunity to influence/participate in project goal setting? (*Joint goals*)

Question 1.3: As goals for circular projects often span across the project lifecycle (e.g., dismantling and reuse of materials) I would like to ask you

whether in the project were also intermediate outcomes or goals considered. (*Intermediate outcomes*)

Question 1.4: Regarding the goals, were they clear to you? Was there ambiguity or unclarities? Are there well-defined performance goals aligned with project goals for each project actor? How was it ensured that goals were clear for all project participants? (*Clarity*)

Question 1.5: Were there any changes in the goals during the project? Why did goals change? How did you deal with it? (*Flexibility*)

Question 1.6: Regarding performance metrics, I understand that circularity is often difficult to measure. Did you utilize certain metrics? How could you measure if your (circular) goals were achieved? (*Performance metrics*)

Question 1.7: The last question concerns potential challenges that you faced in the goal setting of the project. Where there any, and how did you overcome them? (*Challenges*)

Comment: Differences in comparison to projects without circular ambitions?

2. Rewarding

Secondly, I would like you to briefly explain me the rewarding scheme.

Question 2.1: What was the rewarding scheme for the project? Did you utilized rewards based on the performance, lifecycle or combination? Why? How did they affect the collaboration and the implementation of circular objectives? (*Rewards*)

Question 2.2: What incentives (financial or others) where utilized to attract interested parties? (*Incentives*)

Question 2.3: What about future business opportunities and (positive) reputation? Did it attracted or affected the interest of parties to collaborate/participate in the project? (*Future business/reputation*)

Question 2.4: About risk sharing. Innovative projects are noted as particularly risk bearing projects. How did you cope with that? Were risks collectively shared, or allocated to different actors? Do project actors have a stake/ownership in the project? (*Risk sharing/ownership structure*)

Question 2.5: Were there changes in the rewarding over time? Why? How did you deal with it? (*Changes*)

Question 2.6: The last question concerns potential challenges that you faced in the rewarding of the project. Where there any, and how did you overcome them? (*Challenges*)

Comment: Differences in comparison to projects without circular ambitions?

3. Monitoring

Next, I would like to ask you to briefly explain to me, how was performance monitored in the project. (Formal, informal, third party).

Question 3.1: Why was this monitoring system selected? How did this influence the achievement of circular objectives? (*Monitoring*)

Question 3.2: Where there any changes in monitoring during the project? (*Changes*)

Question: 3.3: The last question concerns potential challenges that you faced in the monitoring of the project. Where there any, and how did you overcome them? (*Challenges*)

Comment: Differences in comparison to projects without circular ambitions?

4. Capability building

The next dimension refers to the capability building. That is, how the necessary actors were selected for the project, how they were engaged in the project and their training/improvement during the project.

Question 4.1: Could you please explain to me the actor network of the project? Which actors were selected, from which fields and how were they selected, based on which criteria? Did actors share a circular mindset? *(Actor selection, joint selection, multidisciplinary team, circular mindset)*

Question 4.2: In which project phase were the actors involved? Early involvement of actors is often noted as an enhancing factor in circular projects. Was that the case in your project? (*Early involvement*)

Question 4.3: Next I would like to briefly explain to me the engagement process for the actors, starting from the preparatory phase. Were there actions taken to engage the actors into a common cause? (*Engagement*)

Question 4.4: As circular projects are innovative, participants are often required to be trained in order to acquire certain capabilities. Did you have the possibility to obtain training for necessary capabilities within the project? How did this training look like? (*Training/Improvement*)

Question 4.5: The last question concerns potential challenges that you faced in capability building of the project. Where there any, and how did you overcome them? (*Challenges*)

Comment: Differences in comparison to projects without circular ambitions?

5. Roles and Decision Making

The next set of questions regard the roles and decision-making process in the project. Here, I would like to know about the roles and responsibilities of the actors, the management structure and the decision making, how resources were jointly utilized and the leadership in the project.

Question 5.1: I would like first to tell me about the roles and responsibilities within the project. To what extend were they clear to project participants? Were they forced to change during project implementation? (*Roles, clarity, changes*)

Question 5.2: Regarding leadership, what can you tell me about the leader of this circular network? What was the leadership of the network? What was the style of the leadership? (*Facilitative, pioneering, circular*)

Question 5.3: What was the management structure of the project? In other words, by which path were decisions communicated through the project? (Why) (Regarding contributing to circular objectives?) (*Management structure*)

Question 5.4: Regarding the decision making, what was your domain of decision-making and how were decisions taken in this respect? Why? Was decision taken based on the circular objectives? Did the procedure change during the project? *(Authority, joint decision-making*)

Question 5.5: Next, I would like to ask you about knowledge and resources. Were they freely available to all project participants? Were they jointly utilized? How was it safeguarded? (*Utilization of knowledge and resources*)

Question 5.6: The last question concerns potential challenges that you faced regarding roles and responsibilities and decision making. Where there any, and how did you overcome them? (*Challenges*)

Comment: Differences in comparison to projects without circular ambitions?

6. Coordination

Coordination refers to aligning actors' actions so that they can effectively work together. A first step to that direction is common characteristics between project participants.

Question 6.1: Did the parties utilize common project management practices in the project (e.g. common tools, common processes)? Was it significant? (*Common PM practices*)

Question 6.2: What about shared culture, values and norms? Did parties shared common circular ambitions? (*Culture*)

Question 6.3: Regarding communication and information sharing. How actors communicated during the project implementation? Were new technologies utilized? (*Information sharing*)

Question 6.4: Did you utilize face-to-face dialogue between actors? Why? What value did it brought? (*Face to face dialogue)*

Question 6.5: What were the major external and internal changes during the project and how did they affect the achievement of circular objectives? How were these managed? (*Change management*)

Question 6.6: On projects, inevitably conflicts arise. How were they resolved in your case? (*Conflict resolution*)

Question 6.7: The last question concerns potential challenges that you faced in coordination. Where there any, and how did you overcome them? (Challenges)

Comment: Differences in comparison to projects without circular ambitions?

7. Motivation

The last dimension refers to motivating the partners to achieve the common goals within the project environment. Hence, I would like to know about the trust building techniques that were utilized and how legitimacy and commitment was achieved.

Question 7.1: I would like to start by asking you, how was trust cultivated between the different actors? Was there any specific trust building techniques utilized? Was a positive climate of trust created in the project? (*Trust building*)

Question 7.2: In the literature it is noted that actors should share a common understanding of each other's role, goals and values. Was it the case in this project? Did you see it as a significant aspect? (*Common understanding*)

Question 7.3: How was internal legitimacy created in the project? In other words, how was each project participant confident that his values are

safeguarded and believed in the trustworthiness and credibility of other parties? (*Internal legitimacy*)

Question 7.4: Projects are in general separate entities from parent organizations, with different goals, ambitions and structure, while they are directly depended on them. Therefore, external support is noted as important in the literature. Did you face any challenges in this domain? How was external support for the project by the parent organizations was achieved? (*External support*)

Question 7.5: Shared commitment How were parties committed to a common cause? How was that achieved? *(Shared commitment*)

Question 7.6: The last question concerns potential challenges that you faced in motivation. Where there any, and how did you overcome them? (*Challenges*)

Comment: Differences in comparison to projects without circular ambitions?

Appendix E – Governance Arrangements and Quotes

Table 9: Governance Arrangements and Quotes for Case A

Goal Setting	***Circular ambitions***		
	Lack of knowledge	Later introduced	• **"The project wasn't meant to be circular when we started." PL#1, "It was more from a perspective of the innovation. Then from a circularity perspective." PL#1** • **"We were going through a process of thinking about innovation and circularity. But it was mainly about innovation then." PL#1**
	External expertise	Jointly defined	• **"They were going to go through a process that was constructed, through a series of different sessions. […] The issues were "what is circular", "how do you think outside the box in design", "how do you think about engaging with the environment" and they kind of went through a whole series of sessions. Where I think they knew that side as well." PL#1** • **"And by this time a lot of elements of the bridge could be made circular and when you have in advance, knowledge of materials coming in them being circular and an idea of the end of the life cycle of the bridge." PL#2.** • **"[So, you made that sort of dialogues between many parties in order to came up with objectives to better understand what circular economy is and how you can resolve the problem right?] Yes. For the knowledge of the safety of circular materials application, because it was innovative. Second, to see if this kind of collaboration is a problem. And three, how can we save the extra costs because of the building failures? That's where we started to with it." PL#2.** • **"For example, one contractor that came up with cementless concrete bridge, the other one came up with wooden bridges and the third one with something else. This process led to the designs they come up with." PL#1** • **"In our minds, to create and to maintain a circular economy, you need to have information about what you're reusing, what is the state of it, what is the remaining life span and the remaining value of your products." CDEO** • **So, we got polymer concrete in combination with secondary building materials. Our goal was […] an alternative form of cement." C** • **"I'm not sure if we could say what circular is. What circularity was at that time." PL#1**
	Legitimacy	By public client (introduced)	• **And the first thing I've done is I went to the people of municipalities, but also the provinces and also the national government. And I asked: "What are for you the most challenging, the greatest challenges to develop this innovative message for sustainable and circular construction?" PL#2**
	Goals		
	External expertise	Jointly defined	• **"[You said that they were jointly set by the whole team during the tendering.] Yeah." PL#1,** • **"So that was entirely up to us, and that question was eventually asked through the program." C** • **"We have chosen to go for this product. Like I said, that suits our company." C**
		Clear	• **"[We didn't know] Maybe not even what we requested them to be." PL#1"** • **"So, we had the tender document with all the requirements and the people, the parties of the contract would submit questions now and then we would answer them and spread them evenly amongst all the participants." PL#1** • **"They had questions about the life-cycle analysis, about the financing availability. They had questions about facts.**

Goal Setting			**There were two bridges. We have one budget for two bridges. Yeah, there were questions. How can we use the budget for the different bridges?" PL#1**
		Personal and organizational goals	• **"And (through this project) we were given a chance to show also in the municipality and province that we can do it. The projects in the world expo, was a way to show to the municipalities, the more the governmental side, that we can do something useful for them." CDEO** • **"My goal was to show that this is possible and to "take them with us" but even if their minds are differentiated from this whole process." CDEO**
		Inflexible	• **"So, that is very important to have the people around that know the goal and to make it happen." PL#2** • **"I mean for example we had moments when things were specified. And then, when you proceed that turns out to be a nice thing to say but it looks very difficult for them to achieve this" PL#1** • **"No, we stuck to the original plan. They had to do better." PL#1"**
		Learning as a goal	• **"Let's see what we can learn out of it for the future. Because, what we have to do in Holland is to replace and renovate 85,000 to bridges." PL#2** • **"Our goal was to achieve a bridge. And that was that. But next to that, we have to learn. Most projects don't have that combination and that's the challenge." PL#2** • **"How can we make those kinds of projects a lot of much better. And how can we look for the problems that caused the failure costs etc. And the digital platform and the sources behind." PL#2,** • **"How can we collaborate together, the government and the builder. Because they're in that interaction, there are some things awfully wrong, so that cost a lot of money. It's 60 billion. So, we feel the costs is an issue." PL#2** • **"And that's a very important thing because. There's a lot of chat around the environment, and everyone is talk, talk, talk. But the only thing where you can do things and learn things is by doing it and so, it's very important that our mission was to develop bridges." PL#2**
		Knowledge as Intermediate outcome	• **"Knowledge is an outcome of the project. This output is also interesting." PL#2** • **"During the period it become much more important to develop and deliver the (generated) knowledge." PL#2"** • **"It went from being an indirect goal to a direct goal." PL#2** • **"It also relates to sharing the knowledge and information as well as making sure that knowledge and information comes to it, and we can utilize it and embedded it in our economic model." PL#1**
	Circular performance metrics		
		Diverse	• **"The ecological footprint and LCA analysis was selected" PL#1** • **"If you only look at the lifecycle, you don't take into consideration what can be used in other places and plan in that order so, that's a macro view on how we need to tackle these kinds of problems. You can get complementary benefits from replacing these bridges, and that's also what we did in the initiative." CDEO**
		Ambiguous	• **"Ultimately, it was quite difficult when the projects were scored, and the results were announced" PL#1** • **"And our life cycle analysis experts were able to motivate this, but they (other party) claimed that other considerations could have been used that led to a different outcome and that it was not uniform in its judging or in the approach. So, it was open to interpretation. They thought that and I'm sure they're right." PL#1** • **"It's nice to be able to have a flexible and new kind of ad hoc process, but you do need to provide some certainties and guarantees." PL#1**

			• **"Like, is it fully circular? Nobody knows. On some aspects we did well, other aspects you know, there's other ways to go." PL#1**
Rewarding	***Rewards***		
		Financial incentives (dialogue)	• **"Also, for the people that participated to the groups that we built around the contractors, for example students or biologists or architects, they also got a very small financial compensation." PL#1**
		No financial incentives (tendering)	• **"That's how we scored them, not so much how we paid them for the performance. […] I doubt whether that was integrated in payment." PL#1**
	Personal goals	Experience and knowledge	• **"That is one of the rewards for everyone, I think. And not only knowledge, but also the experience. Experience on what kind of processes and what kind of questions are we faced with. And all the organizations know that these are the questions of the future, and this is also, you could call it, the standard procedure for the future. But how does it look like? And what does it ask from me or my organization? That was also important." PL#2**
	Experience and knowledge	Reputation and future business	• **"Their reward was to be able to build bridges at the World Expo. I mean they had some monetary rewards for the hours, but this was very low." PL#1** • **"How do we get something that's very interesting for the visitors of the Expo?" PL#2** • **"For the builder, it was also important to settle his name on the list of the builders that are innovative, and they are open for these kinds of projects." PL#2**
	Risk allocation		
		Joint (financial)	• **"I think both contractor and project owner, municipality and province, paid some of the higher costs that incurred." PL#1**
	Role and responsibilities	Private (construction)	• **"Yes, [the team divided the risks between the participants or did the contractor has all the risks for the Bridge] that's right and we have an obligation of 10 years for the risk of building. And, indeed, we have acquired a certain risk for us, not just us, but also the construction group. So, it's us (the contractor) but also the supplier etc." C** • **"But yes, it is always the case in these kinds of things that yes, someone has to take on that responsibility and want to run that risk. And yes, that is part of the profession, so to speak." C**
		Mitigation measures	• **"For the concrete, an institution was utilized to certificate it." C** • **"We also had to do a lot of tests in between. And yes, in the end it took a bit longer than we thought." C** • **"But do you also have so much confidence in your own product? Then that is not immediately a very big risk." C** • **"For me it was very important to have access and very good contact with all organizations and the directors of the organizations, the director of the park. And the people from the Municipality and the Director of the Province. And then there is the relationship with the builder. And that is important because you have to have a back-up plan. You must do that." PL#2** • **"And about the risks, people are the risks. And systems are the risks, not the materials and not the techniques. You can solve that kind of problems." PL#2** • **"[every participant has a conflict of goals in in their mind on the one side you have to be innovative and do something new, but on the other hand you have to stick with the system, the goals] and that's the key thing, some people are open for innovation but still there are a lot of people who don't have the competencies. I mean to be able to do that. They won't work with risks and innovations and are hanging to their systems very tight." PL#2** • **"And they are risk averse because they don't want to have any problems on the project. But they need to see that this is like a risk management tool." CDEO**

	Ownership structure		
	Nature of the project	Public	• **"The expo is managed by an event management organization. And the event, the show is now finished. This organization is the sole shareholder." PL#1** • **"They are there now. They are there. They are owned by the people there." PL#1** • **"The ownership will revert back to the Municipality." PL#1** • **"The owner of the bridges was the Municipality." PL#1** •
Monitoring	Collaborative approach	Informal (progress meetings)	• **"[…] A project team, like a project progress team. With participants from the contractor, their licensing people, the contract manager for the Municipality and the contract manager for the contractor. I was also involved. The architect, the suppliers of the cement. We had meetings on a weekly basis, where we managed the construction." PL#1** • **"There was a committee with the parties involved." C** • **"So that 3-party committee has been created to carry out those inspections and that testing and that monitoring." C** • **"We decided quite early on that we were going to have a kind of "soft" approach. […] We do have a soft approach to this. This was agreed quite early on in the process." PL#1** • **"I would imagine there's much more stipulated approach on the projects that have every little detail signed up. That was not the case for us. It was a kind of an ad-hoc process." PL#1** • **"I think we agreed and understood like if we want to do this, if we want to show that we can do something different we have to take a friendly approach." PL#1**
	Certification	Third party (testing)	• **"For the concrete, an institution was utilized to certificate it." C** • **"And the bridges are still monitored to this day, so a section of the second bridge, for example." C**
	Common data environment	Digital (CDE)	• **"And so with data filtration and clash detection and meetings, we can monitor the design process and planning process, in order to get everybody aligned." CDEO** • **"I think the one big benefit of sharing things in a database is that you don't need to worry anymore about what is the truth." CDEO**
	Goals	Process	• **"And I think the point now, where we are, and this is what I was saying in the beginning, is we need to understand the whole process." PL#1**
Capability Building	***Actor Selection***		
	Ambiguity in performance metrics	Joint selection	• **"It was a collaboration between the province and the municipality to build this innovative bridge." PL#2** • **"And I built a team with J., and S. and other people and we went to all work on that." PL#2** • **"And the people from the province were given to me. If I may say that correctly in this way. And so, I had to deal also with people I didn't choose directly myself." PL#2** • **"The tender process we have not done it ourselves. So, that's an external agency that has done that." PL#1** • **"With them we kind of constructed a process where we invited 3 Contractors" PL#1** • **"So, we selected them and asked them, they wanted this bit and that, and we kind of constructed teams around them that were going through a process of thinking about innovation and circularity. But it was mainly about innovation then." PL#1** • **"So, we got three parties, and we invited those partiers to join in the process with all the learning etcetera." PL#2** • **"And we started with first inviting the people who joined in the hackathon to be on those teams." PL#1** • **"We made obviously a selection criteria document." PL#1** • **"Criteria were written down and they (contractors) have their proposals based on that. And what was true or wrong was clarified." PL#2** • **"So finally, there was a jury that selected the builders for the two bridges." PL#2**

Capability Building			• **"Obviously on some of the tender aspects I think it needs to be fully clear because you can't have ambiguity in the process. And that happened." PL#1**
	Lack of knowledge and resources	Multidisciplinary	• **"Yes [expertise is important, also experience in the know-how] exactly." C** • **"And that consisted of other people, so in addition to our own team and that other people were also students, but also other technicians from the construction world, who have all sorts of interfaces with sustainability. And so that also means innovations of other products. But also, two architects were on our team, for example, next to our own architect. Also, the students, as I said. Someone who came from engineering with a certain angle." C** • **"Yes, so that's something special, isn't it? This has been a very special tender from the program. And the special character of that is that, in addition to our own team, we have also received a selection from the municipality, or rather from the program, right? That is from the municipality and the province. So, our team consisted of about 10 to 12 people. And together we have come up with a design and concept to win the competition. So, it was a completely different tender form." C** • **"And you can't do it alone. Look, we are of course the company, and we make the product and offer it in its entirety. But there are also companies, like one from Utrecht, who ultimately supplied the concrete types for us, so to speak. And, that really is a special product, which was supplied by another party, to be able to put down the total product for us. So, various companies are also involved in that chain to eventually build the bridges." C** • **"And what is also interesting for you is that we take into consideration also permits and enforcement from the start during those tenders, so that there is competent authority." C**
	Involvement		
	Collaborative approach	Early	• **"So yes, it was quite an experimental environment and I think it was clear from the outset that we needed to accept it in advance that friendly litigation." PL#1** • **"It wasn't written down. You kind of knew in advance, that if you sign up for this, it would be a walking through process." PL#1** • **"Yeah. So, we joined the initiative. Later, but yes, still in the early phases." CDEO**
	Urgency		• **"The train is going anyway, but we need everybody on board, and I think […] we can already start the train going. But we need others to move with us." CDEO**
		Continuous	• **"And so that's how it all started from there, we were a little bit involved, but it was on the build-up and then once there was a global understanding of what the project could be, we were involved in the tendering process and so forth, so until today we're working on it." CDEO**
	Training and Continuous Improvement		
	Lack of knowledge regarding circularity	Training (in the dialogue)	• **"And so, people really got a lot of training. They're called sprints." PL#1** • **"The issues were "what is circular", "how you think outside the box in design", "how do you think about engaging with the environment" and they kind of went through a whole series of sessions." PL#1** • **"Until the final jury there was also a training for them with the goal to get to the most innovative solution. Regarding the process, the materials etc. How can we make the most innovative solution." PL#2** • **"So yeah, there was a lot of training, a lot of new information, a lot of new ways of working together." PL#1**
		No training (in the project)	-
	Familiarity	No training (in the CDE)	• **"A little bit." CDEO** • **They were able to use the 3D model and the document management system, so they were using it." CDEO**

			• **"But for making a planning towards a 4D planning, that's something that we typically did." CDEO**
Roles & Decision Making	***Roles and Responsibilities***		
		Clear	• **"To be aware of your role." PL#2** • **"We 've got to show them of course, that we are a well-considered choice on their part, and that we can also take on all kinds of responsibilities. And on the basis of those responsibilities that you accept, you create a certain trust towards your customer." C**
		Roles with both parties	• **"They also provided the legal contract manager. This role was also on the other side (contractor side)." PL#1**
	Nature of the project	Changed	• **"It's a totally interactive process. In traditional projects the public actor commissions the bridge to the builder. In circular projects is completely different." PL#2** • **"Take for example, the use of this cementless concrete. We were able to scale it up […] and this kind of came as a surprise, for example for the licensing people. They really felt that they were being confronted with something and pressured into moving along with things." PL#1** • **"And the people of the permits, the people who are doing the contracting or the asset management. They are all busy with their own goals. They are one-sided. Or maybe some of them understand you must be innovative for the future, but then their management says "no, that's not your goal. That's your result. Stop it." PL#2** • **"Because there are always people or systems you have to fight with. People are people, and systems are systems. And the system says on the one side you have to be innovative but on the other side, you have to meet goals and there are a lot of different functions and different goals that relate to each function." PL#2** • **"Yes, of course. It is such a specific thing. It has cost us a lot of time and energy to even being able to realize the work. Because it was something else. And everything you do or try new, takes of course a lot of attention and energy." C** • **"We also had to do a lot of tests in between. And yes, in the end it took a bit longer than we thought." C** • **"We also had to make many test pieces. Because the concrete is very different from normal concrete, so we also invested time and energy to get used to that product and to process it properly in the bridge itself." C** • **"We also had to deal with permits to be allowed to build from the Municipality. Because it is of course also a completely new product for them. So yeah, that's a two-way interaction." C** • **"You have to take people along in what you are going to change and what if they can't do that? Then you're not going to get an optimal result." PL#1** • **"You need to go different about the whole process and mainly by the data that you have, what you do with it, the sharing, what you already know when you start with the project and people need different skills." PL#1**
		New Competencies	• **"And the second thing we developed was the competence thing. I think you also heard it from other people. These competencies. We have made an analysis of the problems we solved. So that we are confronted with the possibilities on that kind of projects. We look on how can we solve these problems. What is needed from people in each role etc." PL#2** • **"How can the roles and processes in an organization be changed, but also the knowledge and skills of the people who are involved." PL#2** • **"And we as team, we have created a common competence environment where we say "ok, this is the ideal process". We need to have these functions so these are the job descriptions and these job descriptions to require these characteristics, or competences." CDEO** • **"The focus is on developing competences and skills for people who are having the overview of a municipality or a**

Roles & Decision Making			**company. Information management and application management and this way of thinking that's a critical area." CDEO** • **"Digitalization in the construction industry because it's really a tool which can help in our mindset. Make the construction industry more effective and reduce failure costs and prevent a lot of miscommunications." CDEO**
	Leadership		
	Lack of knowledge	Investigation	• **"And now we are developing also a circular leadership program. How do you do a circular initiative with circular ambitions? Circular building? What kind of competencies are needed to make it successful? And that's the leadership question." PL#2**
	Decision Making		
		Multiple levels	• **"[By explaining to the higher strategic level, the details about the project. It's like a feedback loop, right? Because the people that actually has the problem has to communicate with you and then you have to communicate with someone above you in order for the right decisions to be taken] Yes." PL#2** • **"The decisions had to be taken on other places. The licensing people had to give their permit. For all of our functions where the Municipality was involved, they had to make their decisions. We helped them and persuaded them to make good decisions." PL#2**
	Flat organization structure	Joint (in project level)	• **"Everything was straight forward." C** • **"Our organization is quite flat, so we have been directly involved from the start from the higher level to project level. So, we are immediately involved in the lead of the initiative." C** • **"Ok so in the process in the design and the development, we have a transparent procedure." PL#2**
	Authority	External	• **"So, you are depending on other people on the functions for all the decisions that have to be made, and that's one of the most challenging things, especially in circular and innovative development." PL#2** • **"How are you able to manage this kind of decisions made by those people? Because if they say no, it's no." PL#2**
		Moment of intervention	• **"What I have learned is, you have to be aware, to choose the good moment to go. The moment of intervention. […] But don't hesitate." PL#2** • **"If you organize it well and you plan something well you can show the impact of decisions." CDEO**
		CDE as facilitator	• **"OK, so we have consensus, we know what's in the document and we say, "ok we have three documents which are good and two that are bad". So, the three documents win, let's say the consensus, and have the political decision." CDEO** • **"If you're really looking into what we are doing as we are working, we have the input we are making a decision and we have an output. […] And for decisions, you need input. And this input, that's something we defined. We try to define with the stakeholders the information as an overview. And we said, take all this information in account at the moment to make a decision. But also, within the project we make a lot of decisions. And they are also on a small scale. […] we're gathering it and we are putting it on one big pile, you get more analysis**

Roles & Decision Making			**about it and you can make more grounded decisions." CDEO**
	Utilization of Knowledge and Resources		
	Goals	Joint utilization of knowledge	• **"But that was also at the end, the goal. How can we make those kinds of projects a lot of much better. And how can we look for the problems that caused the failure costs etc." PL#2** • **"Let's see what we can learn out of it for the future." PL#2** • **"And I think that's where ultimately, the value of this project and its legacy also sits." PL#1** • **"Sharing the knowledge and information as well as making sure that knowledge and information comes to it, and we can utilize it and embedded it in our economic model." PL#1** • **"For example, there are endless amounts of different kinds of concrete, isn't it? And there are also lots of trials going on and I think you need to get come to the point where, [..] to be able to combine and share the results." PL#1** • **"Ultimately, you have to work together in a different way and share more information, digitalized information, so that you can improve the process." Otherwise, you'll keep on being in this in this kind of trial and experimental phase." PL#1** • **"But licensing person, for example, in Maastricht, or in another country, may have less worries or be more confident if they know what the people in in our city have learned." PL#1** • **"So, it's all of the things, the sharing and having confidence from all the participants, to make it work." PL#1**
		Joint utilization of resources	• **"And also, this Municipal data environment (GD). We've got it to share specific data with the client." C** • **"Yes, of course we had already offered something at the front, and we have a concrete technologist from the concrete company. And on our own project management, we went through the steps every time." C**
		CDE as facilitator	• **"And the digital platform and the sources behind it are very important." PL#2** • **"[…] this digital environment. That was the first thing I've organized in this case. I 've invited an organization on the national scale to share the knowledge we have developed and the system we've developed. To help others use our cases, in Holland." PL#2** • **"We can redevelop it to be broader, applicable in a broader way, and link it to other digitalization projects like the digital twin" PL#1** • **"We want to enable the architect, the constructor, the contractor and everybody else to make a model and we did the organization." CDEO** • **"That's how we want to make it. Because we track and change, we track, and we check all the changes. We know who has done what, and what comments are made on it. So, you can really track down all the changes which have been made, and you can visualize them. But also check for inconsistencies, such as, the beams are bigger, why and who did it, and who I need to call." CDEO**
Coordination	***Common Characteristics***		
	Multidisciplinary team	Different characteristics	• **"[To have a team with the same mindset and using same resources even computer software], is absolutely crucial." PL#2** • **"No. We have plenty of clashes and misunderstandings and this was quite difficult." PL#1** • **"Yes, I think we had our discussions absolutely because we are not all the same, but I think there was a way of common thinking." PL#2**
	Early involvement	Common mindset	• **"When the team is talking with one mouth. That's a very difficult and you have to develop this common language." PL#2** • **"[Enthusiasm towards circularity, it's important when you work with likely minded people on that subject] And that**

Coordination			**also fits in with our company philosophy. We think that is an extremely important part of our future agenda." C**
		Different procedures (in CDE)	• **"So, we tend to do this exercise with the stakeholders and come up with a structure for the project and we can add other companies that can map towards the structure. So, the system can be adapted to their way of working, with this mapping mechanism." CDEO** • **"Everything will be mapped if you do it properly towards the proper place." CDEO** • **"And so, I want to show that they can work how they are used to work and almost identically with the same process." CDEO**
	Communication and Information Sharing		
	Circumstances	Applications	• **"[Communication with project participants was also flat and straightforward.] Yes" C** • **"In dialogue we are dealing with the client, but also with the contractor and the supplier, so with various disciplines and clients and people." C** • **"Communication differs between parties. They are not the same." C** • **"But now you have to think together with the builder from where can we get it? How can we do it better? What do we learn from it? What your problem in in this case? What extra time or extra knowledge do you need? What is the builders' perspective? So, you have to communicate it. It's an interaction between the contractor and the public actor. How do you call it? That interaction is very important." PL#2** • **"So, communication was done through teams and construction meetings." C** • **"But we also learned that it is very possible to have operational questions, regular operational questions, with meetings through Teams." PL#2**
		Personal meetings	• **"Unfortunately, there was this COVID situation as you may recall, so face to face dialogue for our project, was like this now (Videocall)." PL#1** • **"For example, if the licensing people have been able to meet on site more often with the contractor and meet him at their yard and see all the different contracts and all the different samples. I think, they would have been less stressed." PL#1** • **"That was absolutely a challenge because it was new for everyone, and you were used to see each other face to face." PL#2**
		Information sharing through CDE	• **"The data platform was very important indeed in this case, so that is how we held a lot of the details about the project and how we talked with other participants." PL#2** • **"Yeah, so it will solve a lot of communication, miscommunication and discussion problems." CDEO** • **"We have 4 stages of information, 4 statuses. Work in progress, while we conceptually thinking about our work. Then we have the share status where we share within the company or with the stakeholders, but it's not final at all, it's a sharing one just to get approval or to get to share this information and if we share it so if we place it in a "container" and if I sent to you a message "can you check this for me". I should say also why I send it to you. For approval, for information? Do I send it for review or whatever? And so, and then you have a phase called "published" where we say, OK, we approve this. With the information we had at that moment, this is the final. It can be revised for various reasons, e.g. budget or change of design or personnel." CDEO** • **"And the project is still evolving, but we have all approved the information to this point. This is the way of working at this stage, so that's published. And then if we revise it, a version goes to the archive, another version goes back to "work in progress" where we start building again, share, publish it and so it's a cycle, a flow of improving." CDEO**

			• **"[You use utilize new technologies like BIM.] Yeah, exactly." PL#1** • **"BIM is the base of our commercial data hub." PL#2**
Coordination		***Change Management***	
		Flexible	• **"Change management, I think we were quite flexible as long as we stuck to the original tender requirements." PL#1**
		Conflict Resolution	
		Operational and financial conflicts	• **"We have plenty of clashes and misunderstandings and this was quite difficult." PL#1** • **"So, there are elements that cause friction. Also, on the financial side. The choices that have been made on the contract management side, relating to operational aspects." PL#1** • **"[Every participant has a conflict of goals in in their mind on the one side you have to be innovative and do something new, but on the other hand you have to stick with the system, the goals, etcetera.] Yes, that's the key thing." PL#2** • **"I don't think everybody understood each other always. And I think that was a learning process." PL#1**
	Collaborative approach	Negotiation	• **"Well, we haven't got any conflicts in the team […] If there was anything, it will be immediately pronounced and resolved. So, we have not known any conflict among ourselves. No, we know each other well enough to remain justified there'. C** • **"We were going to have a kind of "soft" approach. We agreed that the contract manager, by negotiations would try to resolve the issues." PL#1** • **"And conflict resolution has been also informal and I'm glad to say we managed to keep away from formal ways of litigation, or traditional "steps". Which is good." PL#1** • **"Yes. Dialogue is key." PL#2** • **"[There was no need for conflict resolution mechanisms because there were no conflicts between us] Yes." C**
		Jointly	• **"The contract managers would resolve the issues together with other participants, such the contractor, the director and the program manager, if necessary. We managed to resolve our conflicts in a friendly tone, not very formal." PL#1**
Motivation		***Trust***	
	Collaborative approach	Trust creation	• **"So, the trust factor I think was quite high." PL#1** • **"[Informality benefited the trust between the partners, right?]. Yeah definitely" PL#1**
	Previous positive experiences		• **"And that worked. It worked quite well, regarding the process. Those design sprints and the knowledge sprints. That help people to put in a mindset that we we're doing something different, from what they would normally do." PL#1**
	Roles and Responsibilities		• **"Yes, the trust, look. We 've got to show them of course, that we are a well-considered choice on their part, and that we can also take on all kinds of responsibilities. And on the basis of those responsibilities that you accept, you create a certain trust towards your customer." C**
	Information Sharing (CDE)		• **"I think the one big benefit of sharing things in a database is that you don't need to worry anymore about what is the truth." CDEO** • **"So, if you update something you update it in the central place, and everybody can see that it's updated, and it has been you which is updating it and so there's no discussion anymore about which is the latest drawing." CDEO**
		Legitimacy	
	Communication	Internal Legitimacy	• **"Talk talk talk." PL#2**
	Previous success		• **"We had a track record on innovation and being able to get things done. We did this with a lot of people. So, it's important that you refer to someone that was mentioned before. You can show something to the people, and they can believe you. You can do what you are doing, and you have the results to help you." PL#2**

Motivation	Common characteristics		• "**So yes, there is a lot of enthusiasm for this kind of initiative. Everything in the field of sustainability and circular building materials. There is interest in that. And yes, that is also, I think, the success model." C**
	Results		• **"And this is the nice thing, people, if there's a beautiful project like a world expo that works quite well." PL#1** • **"We had the advantage that we could work on something that was a real bridge or more bridges. Also, we developed things that we were proud of. And proud. That's very important thing. We are together and we are proud of what we are achieving." PL#2** • **"Again, the advantage is that you are doing things and that they are real." PL#2**
	Communication	External Support	• **"The support I got from the people that are my bosses, people in the Municipality, the director of the park etc. To get support, we had every three weeks meeting, but if there was a problem (and we've had a lot of problems) I could always count on them to support me." PL#2** • **"[By explaining to the higher strategic levels, the details about the project. […]]. Yes." PL#2** • "**But sometimes you have to fight your own fights and battles. But it helps if you have that support." PL#2** • "**I found it very difficult in my "own house" […]He thought "you guys are going to do some small bridges and you think that you can make a contribution to this big need for change and replacement and repairing of bridges' […] Then, he said, "well you guys actually build 2 beautiful bridges and in a very short time you had a very interesting process. As he quite rightly said, that's not how would you usually work. But you know, you said on, on the data front, on the material front, I think you, you guys discovered some interesting things." PL#1**
	Results		• **"In addition to it, the world expo is also a stage where they want to see these kinds of initiatives. It is also a very nice "calling card" for the expo that these bridges are being built. So, from that side, they are given their support to this initiative." C** • **"If you have an alternative to the material that is regularly used. Then you have the sympathy and support of your environment." C**
	Engagement		
	Team workshops	Measures	• **"If I may say, it you have to invest in "how do we act like a team?" "What can we do" Maybe some workshops with the team? The point is how can we do that? That's very important." PL#2**
	Team building activities		• **"On the other hand, it is sometimes very, very necessary to meet, to see each other, and to drink a coffee or beer or eat something together because that's the basis for the team building." PL#2.**
		Importance	• "**You have to take people along in what you are going to change and what if they can't do that? Then you're not going to get an optimal result." PL#1**

Table 10: Governance Arrangements and Quotes for Case B

Goal Setting	***Circular ambitions***		
	Policy	Earlier introduced	• **"So, when we started this project just for the maintaining part, we said "OK, we have a technical scope for the project, but we also signed the Paris climate agreement", and we have to do some more circularity […], so instead of just talking about it, we have to do something about it." PM**
	Policy	By public client (acknowledged)	• **"The government has some wishes, some ambitions for the project, but also has a set of standard requirements for the project." IDM** • **"But for this project. We also said "OK we have the climate agreement in Paris in 2016. And also, other national agreements. We made all kinds of agreements such as the concrete agreement. Or circular economy agreements." PM** • **"[[…] due to political reasons and the policies, you added the goal of making it circular right?] Yes, yes. That's right." PM**
	Personal interest	By specific person (introduced)	• **"I said "Well if we try it again then we need to add some, well, some sustainability targets." AM** • **"[…] They didn't come from an upper level; it was mainly because of your own interest? Yes" AM** • **"Well, everybody knows it's there, but nobody read what's in it." PM**
	Lack of knowledge on circularity	By private parties (incorporated)	• **"So, we have to make a journey as an organization to understand what's meant by a circular bridge." PM** • **"[…] but it is more on an abstracted level." PM** • **"It was the province, with the advice company and Municipality colleagues." PM** • **"We asked a bureau to guide us "can we ask this kind of bridge from the market?" AM** • **"[And you started from a broad idea and then we you get into requirements with the help of private parties?] Yes, exactly." AM** • **"And so, we made, with all the project partners, we as a province, we contracted an advice company, who has done these things more often, to help us understand the meaning of the climate agreement." PM** • **"The translation from wishes to partial requirements and partial ambitions that were utilized to select the right contractor, there were a given for me." IDM** • **"So, there is the vision, the circular objective or aim to have a circular solution, but then how to further implement that solution? […] but so, when you translate your vision to go to solution for instance" IM** • **"So, we could exactly, say this is what we want. [so, this was done through market consultation, right?] Yes." AM** • **"So, we did all the conversations with stakeholders and converted the dialogue to requirements or to ambitions and wishes. Mainly ambitions and wishes are used to select the best contractor." IDM** • **"You need some specific goals to be suitable. In the project we had ambitions of circularity, maintainability, energy neutral. We know what we want but we don't know how to do it. And so, you have to make a good decision what kind of collaboration you need to complete the project." PM**
	Goals		
	Ambitions	Diverse goals	• **"So, we asked these three things. The energy neutral, low maintenance and well, not a lot of material." AM** • **"So, for the goals of the project. They were for it to be energy neutral bridge, a circular bridge and also to minimize the CO2 footprint of the bridge in the realization phase." IM** • **"[..] we also have to make sure that is a long-time solution." PM**

Goal Setting			• **"OK we want to make a circular project. We want to reduce the needed energy and we want to make a better maintenance, better maintainability. So that were the three goals." PM** • **"Yes, the goals were circularity. A circular bridge. An energy sufficient, energy neutral bridge, low maintenance cost and a fourth one was less traffic jams during construction." IDM** • **"And so, for instance, a circular bridge goal was filled in by selecting the IFD." IM** • **"And for the circularity, we also want to make the material passport, we have a book let's say, that can tell us, what kind of materials did we use in building the bridge, and how much and which size does it have, and how it's connected, So, it is easy to demount the bridge again, and use it in another project. So, this is also part of the circularity." PM** • **"And the goal of the project start-up period should be to get to that thing. To get to that way of working together." IM**
		Requirements instead of goals	• **"So, normally we make a design, and we give that to the contractor and say "OK, build this bridge". But we thought if we give them a design, they will just make the design we gave them, So, we choose to give limited information about the design. We said which elements are needed to be on the bridge, so the car lanes, one cycle path." PM** • **"So, we got an abstract contract with functional requirements." PM** • **"And the main characteristic was that there was actually a very complete, very complete D&C and a tender underneath the question of the province. So, they showed us, that they had something completely worked out. They could have also put it on the market as a D&C tender. And what that means is basically that there were an awful lot of requirements. […] Thousands." C**
		Jointly defined (based on requirements)	• **"[And if I if I may ask, did you do it with the help of an external company, an advisor company, as you said?] Yes, we used a company. And also, a normal technical company that will do the engineering." PM** • **"[So, this was done through market consultation, right?]. Yes" AM** • **"And then we asked the market, well, the bridge builders. We asked them to give us a solution and present us the solution." AM** • **"So, at first, we also made a market consultation, we have these three goals, circularity, maintainability and reducing electricity usage." PM** • **"We asked the several contractors, to give some kind of solutions for making a more sustainable project, so we didn't prescribe the exact solution. But the contractor was challenged to give the best plan for making a circular bridge." IDM** • **"At the bridge there is a certain space available to come up with the solutions, yeah." C** • **"One of the measures to achieve this goal from our side was IFD, the IFD design principles and then other goals were complemented by, for instance, the bid. By, the proposal of the of the contractor." IM** • **"The first problem was how do they interact with other measures that had headed for us. That's very hard to oversee because we don't know the origin of these measures." C**
	Requirements	Contradicting	• **"We should have had said "OK, well in this bridge we're going to tackle this vision, and in the next bridge we are going to tackle that vision". And then in the next version we're going to combine these visions and maybe do a smaller project with all of them. So, to really pace ourselves and also allow the transition into some new**

Goal Setting			**way of thinking. To take a bit longer and for the risks and the all the design complications to be examined." IM** • **"Time shouldn't be the main focus on that, it is the quality that should be the main focus but the way that the province governs this kind of contract is time and money, and not on sustainable goals. It's very traditional time and money." C** • **"The goals were very clear" AM** • **"Because there are some new technologies or there are some challenging targets who are not doing well together, like maintenance free and low energy consumption. Well, it could be very hard to make a technical machine like that." AM** • **"[Yes of course they are. Some of them could be also contradicting, yes?] Yes, it could be." AM** • **"So, we try to obtain one of the goals, that was being energy neutral, we ended up making a solar field for the energy. […] we have to put more infrastructure to produce the energy, while from a circularity perspective and reducing building materials, I said, well, that's very strange because we want to use less material, but to get the other goal, the energy neutral, we have to put more material to produce electricity. Yes, It's a contradicting. But, we finally were able to well, getting into all the goals." PM** • **"This was an option making all guardrails steel, so that we don't have to paint them […] but that was only possible if we would replace all. Also, a lot of the younger bridge. So, also the parts of the bridge that were good enough. But we don't have to replace those parts. So, that was one of the options that we couldn't integrate in the design because we didn't want to replace all the parts of the younger bridge. […] That not very sustainable, because we are going to put new materials on it. Well, the materials we have, we can still use for another 50 years." PM** • **"So, that was also the, well, the battle of ambitions. Can we do aesthetic one, or can we do the sustainable one or the easily maintainable? [and this also comes to what we talked before about the goals that could be contradicting at times?] Yes." PM** • **"Because when you start the engineering, that's a whole different process, where an enormous amount of people is getting involved, and that process you must start it with a very clean view, very clear goal." C** • **"And when you have such a conflict in hierarchies of requirements, […] you can see that there is uncertainty on where in the hierarchy a certain requirement or ambition or goal is. Then it becomes ambiguous to what degree this goal should be filled in and in what way it should be filled in." IM** • **"So, the degree to which the contractor and also the engineering company interpreted those goals was always different and conflicting sometimes with our goal as a province, and also the vision or the visions of each individual organization." IM**
	Requirements	Inflexible	• **"[so, flexibility of goals and scope is a challenge for you] Yeah." C** • **"And that means that, when you have a contract on the scope, and after the contract is awarded. There's only limited room in changing the scope within that same contract." C** • **"But it's always, well up until now, it's been a huge problem that the scope that a client has to award. It must be very strictly described. […] But it's an obstacle in the early stages, in the involvement of the contractor." C** • **"So, when you've awarded the contract and after the elaborated engineering progress it looks like your scope is getting very different from what has been awarded on. It becomes a burden and that's a problem for public**

Goal Setting			**clients which they see as well, and they have difficulty of overcoming that." C** • **"We thought it was a really good idea, high-quality reuse of the steel deck instead of using it as a low-quality steel in the ballast. But for the contractor, it was way too risky to reuse that material." IDM** • **"So, it was, yeah, too expensive to reuse this steel. And we said you could also reuse it within the traditional recycling chain, because it's clean steel. So, in that case, it wasn't optimal for circularity because between reuse and recycling, reuse is better. But, yeah it costs so much, and we didn't have infinite budget. So, needed to make some decisions. And the discussion proved it was too expensive for the effect that it had." IDM**
		Personal	• **"So, I think there is a lot of knowledge about bridges for engineers but there are never asked to utilize it. So, if a company isn't asked about "give me a bridge which is low maintenance" then we will only get whatever we always get. So, if you have another question, they say well ask me because I have the solution ready for you." AM** • **"We ourselves have set a goal to be the most sustainable civil contractor by 2025." C** • **"We, also have set goals in the area of sustainability and circularity." C** • **"[And do you think that inside the project, there was room for you to obtain your own goals or to achieve your own goals or your organization or your company goals […], Yes, and that's why we work on this kind of projects. And mainly it relates to the translation on our company behalf, of the client goals, to give the right advice and then sometimes to take the extra step to make more sustainable solutions. And we take all the lessons learned from different circular projects, also outside the government, the province, as we also work for other provinces. So, we can learn from several projects than the one we have with the client." IDM** • **"So, if we want to achieve our goal, we have to be able to do that on projects. We're a project leaded organization C** • **"So, apart from the sustainable ambition. There was also this ambition to get experience with bouw team collaboration. That meant something extra for me." C**
		IFD guideline as intermediate outcome	• **So, we took this initiative to standardize the parts, and we used these standardized parts in this bridge." AM** • **"But that is it. It's a special project and we hope to learn in this project more things that we can utilize also in other projects and branches." AM** • **"Our company we're actively involved in the development of the IFD, the guidelines. So, we are one of the early adapters of the guideline, we are in the group. We try to make sure that each version is getting better." IDM** • **"And in the study phase of the of the project, IFD was set as a requirement, design requirement for the project but that was still in the time that the first iteration of the normative document happened and then as a consequence of the design phase of the project, some alterations in IFD were made and we have a revision of the document." IM** • **"Well, one part that was difficult in the design was using the IFD. Because well we came up with this principle and this was the first project where we were going to use it in real life. So, we had to do some work for the IFD principle. But that was that. Finally, we agreed in which way we could do it, as possible as we could." PM** • **"But just like we discussed very early in the beginning, you should start with standardizing and not when you nearly finished then say okay and now, we're going to standardize everything." C**

Goal Setting			• **So, the goal was for it to be the first IFD bridge in the Dutch infrastructure sector, and for that bridge to be possible. And this was before we made IFD standards so there was at that point conflict and hierarchy of IFD and our standard specifications as a bridge." IM** • **"When you build a new bridge, the guideline is better utilized than when you renovate a bridge." IDM** • **"And we also found out that when you make a completely new bridge, it won't be so difficult to implement in. So, the difficulty is using IFD is in maintaining projects in bridged that were already built." PM**
	Lack of knowledge and skills	Partial fulfilment of goals	• **"Those decks are sort of fixed, and the principle of IFD is met on the level of the technical agreement, but the girders are, well they are not demountable." IM** • **"There is a scope creep of the vision that you have set in the beginning. The IFD solution. [..] because of the hierarchy in which the requirement was set. That looseness of the requirement. Because there was a lot of room for interpretation on the contractor and the engineering firm side. The way that IFD is interpreted by the various actors and organizations within the project, there was a huge deviation on that. So, there were many discrepancies that were in the latest stage uncovered, and that was difficult to roll back to an earlier design stage. And to correct those mistakes or to redesign the vision." IM** • **"But because we didn't have the skills, the experience, the shared vision on how the IFD bridge should come to be or be designed or be constructed, nor internally across team members within the province but also across team members within the engineering company. It resulted in a tendering procedure where weren't able to incentivize or coordinate this vision of IFD bridges into the perspective of the contractor." IM** • **"You always need to realize what are the skills necessary and what are the interfaces with other design solutions or problems or other engineering disciplines […]" IM** • **"Where we also didn't communicate our visions and our interpretations clearly." IM**
	Unclear vision communication		
	Circular performance metrics		
		MKI for circularity	• **"So, the bid is awarded on some very specifically described measurements, for us, the lowest MKI value was the goal. […] From a circularity and sustainability point of view our goal was as low MKI as possible." C** • **"Sustainability and circularity at the project was measured by MKI." C** • **"Yeah, we do MKI calculations. But it's not for every design decision. It's not that you always calculate MKI, so in some designs it's obvious what the best solution is so you don't need to make a calculation to point out that this solution is the best one." IDM** • **"At the end of every design phase, we make a calculation based on how many materials are in the designs there. It also had the same amount of material as we are using for making a cost estimation of the project. So that's an extra minor step, that we do to make sure we are on track, regarding the total circular economy score on the project." IDM** • **"So, if you're in a preparation phase, you already make your own MKI calculation and you point out that's your reference, the starting point and all the all the solutions that the contractors provide should be measured up to the same reference to make sure that it's so much in percentage better. So, I think that the main goals within the clients and in between them are in a percentage less in MKI." IDM**
		Other metrics for other goals	• **"[…] the project was evaluated, not only based on price, but also based on other metrics, which I can't recall, but I**

Goal Setting			know that, for instance, the MKI was one of the metrics, but also innovation, circularity." IM • "So, circularity is not the only one criterion to make a decision, of course there are more. But yeah, when everything results in that one best solution. Then it's OK and you can start designing the rest of the project." IDM • "Phase one was very much time and money driven. […] And that creates frustration at the start of the engineering process. So, you should be clear to all stakeholders up to this moment "You can participate in goals and in key performance indicators" C • "Well, we combined a lot of the targets, and we measured them in advance." AM
		Different metrics – Different solutions	• "No, so the only metric that was used was MKI, which indicated the CO2 footprint, of a specific solution or element, the impact of a certain solution with regards to its CO2 footprint or its environmental footprint translated into financial value. But we should have used another metric. IM • "And so we did a good job by introducing the MKI, but you could have introduced more metrics for it to be more circular." IM • "Regarding circularity, sometimes it costs more material to be IFD. But it's better, if you want to better reuse it after years." IDM • "Life cycle analysis, total cost of ownership […] Also, some other indexes, such the demountability index, which would assess and quantify the design solution on the basis of how demountable a certain solution. So, if you would introduce such metrics or such incentive structures, you would also get different results." IM • "So, for instance, if you would design an in-situ solution for a bridge deck, for instance, you would use less materials in cubic meters, which would be so using less concrete now is a more efficient way to reduce your environmental footprint now. But by introducing other metrics you will be able to equalize, for instance, the importance of it to be demountable, and reusable in the future, so that you don't have to remake this footprint in the future." IM • "Because, it would have simulated the bidders in the tender phase. You also think of other solutions rather than solutions that would reduce MKI drastically. Yes, so I think using also other mechanisms would have been efficient." IM
Rewarding	***Rewards***		
	Participation	No financial incentives	• "There were no financial incentives. It was just getting the project. So, we thought that the market was big enough to get those projects." IDM • "[So, if I may ask you about it, do you give the contractor some financial incentives, let's say. I'm thinking about bonuses for completing it early, or bonuses for being more innovative. […], No, we didn't." 8:30 ¶ 351 – 353 in 2.4 Thesis Meeting PM • "We thought it was enough, […], I think, the most important is that you contract the right contractor. Based on his goals, it's ambitions. And if you need to stimulate that with finances, maybe you don't have the right contractor." IDM • "You have price and quality, and we had a bigger share of quality. I think it's 25 to 75 or something so the quality was very important for us and yes, the price is not so important." AM • "And then on the other hand, the way that the project was evaluated, not only based on price, but also based on other metrics, […] for instance, the MKI was one of the metrics, but also innovation, circularity." IM
	Personal goals	Experience and knowledge	• "But they loved the challenge to build another kind of bridge. Not a standard bridge, but something different." AM

Rewarding			• **"Because the contractors also have these innovations for being more circular, so they want to make sure that they work on ambitious projects and sure we gave them the space for implementing their innovations." IDM** • **"A very innovative project, giving opportunity to a lot of market parties to investigate their own innovations and to provide their own, or to further develop their own innovations and so forth to be in a platform of development. That was one of the baits that we used to attract partners." IM** • **"So, people who are making bridges and that's their core business, they have to make bridges and admittable as cheap as possible or with well proven technology. [...] And here they had a challenge that they could well try new things and they also love it, so everybody is enthusiastic about it." AM** • **"So, it gave us an opportunity to develop our own goals and techniques in engineering, but also in executing work." C**
	Experience and knowledge	Reputation and future business	• **"[So, do you think this was incentive, right? To see your innovation in practice and it can also open the door for future business? And also, reputation?] Yeah." IDM** • **"Our incentive might have been that we made our step ourselves in implementing circularity and seeing our ability in our engineering process and to have some extra knowledge on that. But apart from that, that's reputation and future business." C** • **"So, our only reward is in the reputation and future business." C** • **"So yeah, as a contractor you want to have innovations but the most important thing for our contractor is getting these innovations in projects so they can bring, they can earn back their investment. But also, the publicity, it's a snowball effect. Innovations that are applied in real life, isn't that sufficient?" IDM**
		Collaborative approach	• **"And normally we are only looking at "What's the price of a bridge" and "Can it go lower and lower?". So normally you put the price as a central point. But, if you put other things centrally, then you get, I think, in the life span of the bridge, you get a lot of value." AM** • **"A novel governance structure, a project governance structure for us to be on a more equal, a level playing field between both the public client and the contractor. So, to improve the way that we're collaborating. That was also what's in for them." IM**
	Risk allocation		
		Innovation risks	• **"Well, it's not new because, solar panels are not new; we use it everywhere and it's going well. Um to be sustainable? materials are not something new, and to have a maintenance free bridge, it's not new. It's a combination of a lot of things that are not new." AM** • **"We had discussion about the renovation of the bridge. That was the main risk, I think, for the contractor and yes, it's always difficult when you have an existing structure. So, in the design phase, you're not really sure about the condition of the construction. So yes, that's something difficult." IDM** • **"We thought it was a really good idea, high-quality reuse of the steel deck instead of using it as a low-quality steel in the ballast." IDM** • **"But for the contractor, it was way too risky to reuse that material. IDM** • **"It was more because of the risks of reusing existing steel. But if it's more than that, we can say it's the risk of the client and not the risk of the contractor. […] And then you make sure when it's a cost and when it's some risk. Some cost for risk." IDM**

Rewarding			• **"[So, the risks in these kinds of projects, I think in innovative projects are generally more than building traditionally right?] Yes." PM** • **"But apart from that the incentive is actually a negative incentive because you raise your risk level. Alright, so when we do everything, like we always done the last couple of 100 years, we have a low risk level. When you try to develop something new you raise your risk level." C** • **"And that, I see that as a problem, because that is not awarded in the contract that we have." C** • **"Take some risks. Some small, calculated risks. If you don't take any risk and do everything well, then it is more of the same. So, you have to take some risk and say, well, this is probably a better solution, but we don't know it yet. But we should see it. Then, well, you will see sometimes that it's not a better solution, but sometimes you can learn a whole lot of new things." AM**
	Collaborative approach	Joint (in project)	• **"It's never equally but, what we did was the following. We started the process; we selected the contractor with an execution contract. And that execution contract had an annex, where we make sure that some risks are located to the contractor, some to the client and some for both." IDM** • **"Well, someone who builds it, and we take some risks. Because there are some new technologies or there are some challenging targets who are not doing well together, like maintenance free and low energy consumption. Well, it could be very hard to make a technical machine like that." AM** • **"And I said, well, when it's for both you need to make sure that in the Bouw team phase, we are smart about what risk is and how it's allocated." IDM** • **"We exceeded our budget […], so the risk wasn't only for the market, for the contractor but also for the client. It was a shared risk." IM** • **"And because we said, OK, we do the building phase, we work in the design together. We will also be equally responsible for the mistakes that we made." PM**
	Rewards	Public (financial)	• **"No, risk wasn't allocated. So, if we wanted it to be changed then it would have been our risk. So, the way that risk was distributed didn't incentivize, for instance, the contractor to be as precise as possible in fulfilling the ambition of the client. I see now that they were carefree or risk free to make certain decisions and also for any cost overruns to be fully compensated. So, I don't know if that's specifically attributed to the risk structure or to the power distribution between the contractor and the client." IM** • **"But there have been a few setbacks in design which were fully compensated by the government, so there was not much risk on the private sector side." IM** • **"But in the end the truth is that we took, as a government, as a public client, we took most of the risks towards us." IM**
		Private (innovation)	• **"[So, you think that risk allocation could be a little fairer, let's say because it's an innovative project, right?] Yes, and it's not like it's debatable. But the way that the discussion is being led, is not mutual. There's not together. That's very traditional." C** • **"And that, I see that as a problem, because that is not awarded in the contract that we have." C**
		Mitigation measures	• **"[Did you pay the contractor more for the risks that he was taking, right?] No." AM** • **"What we tried to do is to use standard materials and there are parts of the bridge, and we try to make it a standard in Holland. So, if we, well, if we have to use it again, we can get our new materials very easy." AM** • **"We also did some risk sessions. And also, we gathered as many risks as possible there to make sure that we can**

Rewarding			manage them. And we did an update at the end of the bouw team phase." IDM • "We could make a risk register. Well, there's some risk. They depend on, well, there are different things that initiate the risk. So, we say if this risk, occurs, but it's about reason A it's the responsibility of the client, but when it's reason B it will be the responsibility of the contractor. So, we wrote down that in the actual contracts. Okay, these are the risks". PM
		Misconception regarding risk division	• "Well, this rule about responsibility for mistakes, there were two parties that didn't give an offer. In the competition we had three parties and two said, well, the risk of the reliability is too high for a company, so I am not allowed, I am not bothered to give an offer for this tender." PM • "So here you get, you can do the first part, but […] They are not sure. They, well the companies that can build it, they want it because the money making is well in the building. So, this contract is mainly designing and making hours and getting paid for the hours so […] there's no profit in the designing part, […] so the risk of we do things and the chance that we cannot build the thing and then somebody else, another contractor will build the bridge, but I will be responsible for the design I've made, but I'm not going to build. So, that's what they thought. […] That's why they said about the risk that it is too high. […] The risk is high that we are not able to build the bridge, only design it, but we will be responsible for it." PM • "We said, well, you are responsible for the whole thing. Normally, the contractor is responsible for the whole thing and now we say OK, we are doing this thing is together, so we shall take of some of the responsibility that you have. But some of them read it, and they said no, normally, as clients you are responsible for the whole thing. And now you are going to make us responsible for the 50% of your responsibility, so that was another way of thinking. […] that part, that wasn't understood by some companies." PM
	Ownership structure		
	Nature of the project	Public	• "It's public (project)." AM • "[It will be in the ownership of the province.] Yes." IDM
		Joint (intellectual property)	• "Well mainly in bouw-team phase. There were some requirements about the ownership of intellectual property. And I think it's also regulated in the next phase. […] all the intellectual properties should be available for the client also. So not only for the contractor." IDM
Monitoring		Formal (gate reviewing)	• "It's gate reviewing." PM • "At our contractor side, we have this method of gate reviewing." C • "Now we use the gate reviews, and we made them together. So, it was one person of the contractor and one person of the province. So, we are asking the building team, the project team. "How about the price? How about the risk? How about the requirements of the stakeholders?" We ask a lot of things." PM • "So, you have to set a gate review just to make sure that, that it's, and we are together." C
		Internal independent monitoring	• "The independent referee", IDM
		Change of monitoring procedure across the phases	• "We evaluated the proposal on the basis of IFD. So, that was also part of the monitoring where we made some suggestions for the contractor to focus on, given their proposal." IM • "It started with trust and true ambition on personal level to make these developments. But once you've designed it, it's become solely contractual." C

Monitoring	Capability Building	Informative instead of decision-making process	• **"We did the progress report every month and in it was all the solutions from the contractor that they've given us, in the selection. It all was linked to decision-making process […] we have to give them a green flag. And it was like are we going for it?" […] That was the way that we monitor. It was some kind of stick to the plan monitor. And in every design step we did the MKI calculation." IDM** • **"Decisions were taken based on the report, And the same for extra assets in the design phase. So, the reuse of the steel deck, yeah it didn't become a green flag due to what we said before." IDM** • **"Just every month we did a progress report, and we did an update of the progress. […] The main goal is to stick to the solution, so you not only focus on what has been your main priority for the last four weeks. if you don't stick to the plan, it's always stop." IDM.** • **"Then we entered the complex phase with all the organizations I just mentioned and at that point in time monitoring becomes very difficult. " IM** • **"So, it was increasingly difficult to monitor progress when you ask for any updates. So, even when a decision was made, we weren't informed, even though that was part of the governance structure. In the end, an engineering report of the design was made with all the deviations on the basis of the technical agreement, which were inevitably incorporated into the design. So, they deviated on many points from the standards that we prescribed, wherein they evaluated whether they gave some kind of argumentation why they deviated, but it was never run by us as the ones responsible for coordinating and monitoring innovation within the project." IM** • **"So, in the end we were burdened with a report with all the deviations and the argumentation and that is the monitoring, the degree to which we were able to monitor progress on terms of IFD." IM** • **"So, monitoring should also happen within the project organization and that wasn't the case." IM**
Capability Building	***Actor Selection***		
		Pre-tendering selection by public parties	• **"A manager who asked all the stakeholders what they want. There was a technical manager, there was a tender manager. There was also a specialist from an engineering Bureau and there was a project leader and a communication manager. So, there were a lot of special people, and it was really a nice combination team." AM** • **"And we didn't do that alone as a province. But we also used the local governments the waterboards, where well the bridge is situated in the water and there are two municipalities." PM** • **"And if you have a team like that, I didn't select this team, but if you have a team like that then you can do more extraordinary projects." AM** • **"People were very enthusiastic, and they won also a prize for the most sustainable group during the tender." AM** • **"We used a company (for circularity). And also, a normal technical company that will do the engineering." PM** • **"So, we had two companies, one for the circularity part and one for the more normal technical part, or the normal scope of the project. So yes, we used 2 companies to complete the study for this project." PM** • **"We asked a bureau to guide us "can we ask this kind of bridge from the market?" because if we ask them for something and they have to invent it, then it's too much for them. But well in our case, it's all possible." AM** • **"And so we made, with all the project partners, we as a province, we contracted an advice company, who has done these things more often, to help us understand the meaning of the climate agreement." PM**

Capability Building		Tendering selection by public and private parties	• **"So, we started it, and we did it with a lot of partners […]. We also have a university involved. It's the contractors, the client. So first, well the government, the client and also the University and the knowledge group." PM** • **"So, it was a competitive dialogue format," 7:3 ¶ 19 in 2.3 Thesis Meeting IM, "So, for the contracting we used a dialogue. A competitive dialogue." PM** • **"So, in in the competitive dialogue we [..] invite everyone who wants to compete, that they want to participate, and we'll have a selection to get into a maximum of four parties." PM** • **"We didn't want to involve a lot of people, of course, because only one can build the project. So, we got the competitors, but one didn't compete. So, we got three parties and we said, OK we 'll have one big presentation where we can meet everyone." PM** • **"So OK, we have these three goals, circularity, maintainability and reducing electricity usage." PM** • **"So, normally we make a design, and we give that to the contractor and say "OK, build this bridge". But we thought if we give them a design, they will just make the design we gave them. So, we choose to give limited information about the design. We said which elements are needed to be on the bridge, so the car lanes, one cycle path." PM** • **"Next, we made the rounds, on the three courses. The first round was about circularity, the other one was reducing energy and also the way of working together, because we wanted to do the design in a two-phase contracting base. So, we want to do the design that will fit the best to the cause of the project." PM**
	Availability	Joint selection	• **"But after that we needed to make the team. And currently in the Netherlands, there's too much work, so we really need to do it with the people that we could get in a short amount of time. To get the organization full. But we try to make sure that we have the right person, and I think we had a great team." IDM**
	Past relations		• **"I select parties and people on proven (reputation) […] We work with partners we select. Parties and people, on basis of safety, performance, those indicators. We look for people and parties that fit within our own way of thinking within our communication we work process wise, and safety wise. And preferably also sustainable wise." C** • **"Shall we always pick from that? Well, it's a little bold, it's our wish." C** • **"I think that we as a contractor are at the most experienced with that. We have collaboration with a group of partners where we make movable bridges with. It's always the same group. We know each other very well. We know how to use our management systems and we know everyone on a personal basis." C** • **"But when we are together, we can easily share what knowledge do we have, we can identify what knowledge we miss, and what do we need extra. And then we decide together, well maybe to get an extra party. To get extra knowledge within the team." C**
	Mindset		• **"It's also about making sure that the mindset is correct. So, someone could be really good in making a circular design. But there are also always project specific boundaries that you need to get within. Also project specific conditions. What is circular for one person might be something different for someone else so, you can select the right people, but you also need to make sure that the conditions are correct to get the best out of it." IDM** • **"And, like I said, it's not a question of goodwill or bad will or something. Not everyone has the seniority, or self-confidence, to make himself vulnerable in this collaboration. Because that's what I think you need to do**

Capability Building			**when you really want to work together. You have to be able to make yourself vulnerable. And the only way is to have a certain amount of, seniority about yourself, or awareness of your place in the organization, safety in your organization." C** • **"Empathy is important. But not only empathy, also, curiosity. Let's be fair, not everyone has that on the degree that it's needed." C**
		Limited parties	• **"It is a possibility. They didn't use it, but we had some consulting meetings about coatings on steel, […] I think they did a meeting with a demolition company also. So, there were some meetings about stuff with suppliers but not really. The supplier will not be really part of the bouw team. So, they're not really contracted within the bouw team." IDM** • **"And I think that was. It was a preference of the contractor to make sure that he has his own space. That he can choose in the execution phase what kind of suppliers he would like to use.", "It was also the preference of the client, because if we make a design that is only fixed for one type of supplier, it still could collapse. At the end of the bouw phase, we could still say there is no further agreement between the contractor and client. We stop this project, and we try to select another contractor". IDM** • **"So, we had some companies that have advised us. They did not take part in the real, in the actual contract, but they advised us on sustainability issues and we also had some meetings with outside companies." C** • **"But that didn't work out very well at the end they were not involved in a tender phase, they all also want a piece of the pie. When the bid is awarded. And that is not always possible, so you also need to have a compact group of parties that are, well they are the project. The core of the project. You need this. You can't make it very big." C** • **"There's always this thing. When people are involved in a tender phase, they all also want a piece of the pie." C** • **"That's why the personal approach is also important." C**
	Nature of the project	Multidisciplinary	• **"Yes, we were all, so we're always working in a multidisciplinary context, always. And we hardly ever make anything in a single disciplinary, anymore." C** • **"There are some other kind of disciplines. We have a civil discipline, for the concrete and structural foundations and stuff, we have one for steel structures, we have a mechanical, we have installations, or it's called the industrial automatization nowadays but it's basically installations, we have a road infrastructure discipline for the asphalt and those things." IDM** • **"Yes, we have many disciplines and maybe also integrated disciplines like the architect is not only responsible for civil or steel works, but it's integrated within the integrated processes." PM** • **"So we tried, we said that somehow, well, building a movable bridge is a difficult project. It's not only concrete or asphalt, it's a lot of disciplines integrated." PM**
	Involvement		
	Legislation	Noninvolvement in requirements phase	• **"And that's where we step in. And that means that we when we step in. We start with very basic traditional approach." C** • **"And the main characteristic was that there, it was actually a very complete, D&C and a tender underneath the question of the province, so they showed us, that they had something completely worked out. They could have also put it on the market as a D&C tender. And what that means is basically that there were an awful lot of requirements." C** • **"But most of the sustainability chances are much more basic. They go back to the very core of what do we do? What kind of solution do we do? We do we need there,**

Capability Building			**when renewing this bridge for example? And that very much limit us in the things that we can do to achieve a more sustainable construction, or first a design and then a construction." C** • **"It's been a huge problem that the scope that a client has to award. It must be very strictly described. And they tell me that it's a European thing. But it's an obstacle in the early stages, in the involvement of the contractor." C** • **"Well, whenever we were involved in a much earlier stage there were far less requirements. Most of them, have yet to be decided. And that gave the team wings, well it made the team fly. [..] your motivation is much higher." C**
	Experience and knowledge	Early	• **We were actually involved earlier (than the contractor) because we made the contract for the project. IDM** • **"And then we asked the market, well, the bridge builders. We asked them to give us a solution and present us the solution." AM** • **"Yes, and proceeding that, also the tender phase." C** • **"There were three parties who wanted to give us a solution and we choose one of these parties and then we had a long conversation about, well, what do you want and what can you give us and what are the costs. And then they came with detailed planning so now we have a total plan. So, the three parties, they all got their plans, and we choose the best one and then we made the plans in more detail." AM** • **"So, I think there is a lot of knowledge about bridges for engineers in but there are never asked to utilize it. So, if a company isn't asked about "give me a bridge which is low maintenance" then we will only get whatever we always get. So, if you have another question, they say well ask me because I have the solution ready for you." AM**
	Nature of the project	Continuous	• **"[Do you think that this is important in your project? Team members that they understand the project that they have worked together? Maybe they have also collaborated successfully in the past and now they have some trust between each other, or they feel like a team?] Yeah, yeah, it's always good to have that. I think it's maybe more important when you do sustainable solutions. Because it's still, it's not really fixed how sustainability is achieved." IDM** • **"Yeah, the team contractually is stopped. So, it's now the second phase. But in the collaboration, you see that, well, we still meet a couple of the same people, because, in the management there has been some changes, but I think on the work floor there's still the same people." IDM** • **"But if you have a new design team, they take the contract, they look at the requirements and they see a design, they say "so that's what we need to do". And if you are in the bouw-team phase, you have this kind of incentive to make the best out of those ambitions. But when you're in the construction phase or in the execution phase, the focus is mainly on making sure that you'll start your building steps on time, with as low risks as possible." IDM** • **"And so we did the redesigned step. We did a kick-off and we made sure that the ambitions were in the top of mind again. Because you have started project, you read those ambitions one time and when some time has passed, not every designer has still the ambitions on the top of his mind." IDM** • **"Sometimes, someone from another project comes to your project and they are used to work in the traditional way, where you have requirements and when you meet up those requirements you get a score and that's sufficient. But there are several degrees in how you meet up those requirements. To do that correctly, you need to understand the project ambitions and you need to**

Capability Building			**understand the client and sometimes you need to make a discussion about a certain requirement." IDM** • **"Yeah, the bouw team is a good step in selecting the right team and making the right conditions for these kinds of developments. But still, you need to select the right team and to make sure that it's aligned." IDM** • **"So, in this case we were pretty close together and we made it. Yes, it was not that "fixed" kind of everyone giving their solution. But, when we were designing the solutions, it came off its own like in a normal discussion, comparing several solutions." IDM** • **"Also, the most influential, the most effective start over the project is in the beginning of the design phase. So, the people who are designing in this phase they completely embrace the ambitions. They'll learn how to develop those ambitions to design, and they will stick to the design to make sure that, these ambitions are still coming true." IDM** • **"So, to counter issues like, should there be a better offer? What is the change? Does it allow us to get extra paid or not? So, we said OK we have to do this together. We're both designing. So, the contractor is not just designing, but we help them think about what's the best solution. And that will end with an integrated design." PM** • **"One other thing is that normally we get the price at the end of the tendering. They make a price, but they, well we make a price and we're going to design later. And what you normally see a lot, when a contractor does the designing a risk will appear during the design and they say "well, let's deal with that risk". But now it doesn't fit the price, so we know, we have a lot of cases like that. And then, what's the right price? So, we said, OK, first we do the design together, we make sure that we agree about the design of the things that we are going to build. Then we're going to make the price. And when the price is right you are going to do the building." PM**
		Common involvement in similar initiatives	• **"But also, in our company we're actively involved in the development of the IFD, the guidelines. So, we are one of the early adapters of the guideline, we are in the group. We try to make sure that each version is getting better." IDM**
	Training and Continuous Improvement		
	Collaborative approach	Training (in collaborating)	• **"We had a coach for collaborating. But yeah, it's more common in projects where you need to start in a short time period. So, it's not really project specific or bouw team specific. But we had a coach who was conducting the starting project meetings. And we have some projector evaluation, some project follow-ups." IDM** • **"So that was some kind of training we had. But it was more about management and personal behavior and how to collaborate and how to evolve as a team." IDM** • **"But in the end, what we came is not training. It was advice on the possibility for them to adopt certain capacities, or to retrain or to rescale. Training was something that we didn't really do." IM**
	Experience and knowledge	No training (in the project)	• **"I don't think so. There were experienced people, and they knew that this is special project with special requirements, and I don't think they needed any training." AM** • **"Technical people like to be innovative. I don't think they need any training or motivation." AM**
		Learning	• **"And I think we can learn together with the construction company as they are also learning. I think it's fascinating to do it together with the market." AM** • **"So, you invest on MKI at first, and you hope to break even after years. So, is that good? So, there was a main issue within the contract, over all the disciplines on how should we implement it, regarding the ambition for a circular bridge? And also, we have some training in that as well." IDM**

			• **"There are two things that should be education. Just like I should be educated. But also people should be given safety, in the sense that they are responsible for what they do but there should be a positive responsibility. It's a rewarding responsibility. And we live in a society where more and more responsibility is seen as a risk. But within my team I, well, I wouldn't say I support mistakes, but learning through mistakes, makes a very steep learning curve." C**
Roles & Decision Making	***Roles and Responsibilities***		
	Risk Management	Shared responsibilities	• **"And for this project it was 50-50, for the Bouw team. So, when the responsibilities were 50-50 also, the decision making should be 50-50, so that's the difference in this project, regarding this project." IDM** • **"OK, the first phase, the designing phase is what we do together. And instead of the contractor does everything and we only check if they designed based on the requirements, we said "Well we want to do a bouw team."" PM** • **"Now we have the same responsibility. We are both responsible for finding the right solution for this project." PM** • **"We as a province we said, well, you are responsible for the whole thing. Normally, the contractor is responsible for the whole thing and now we say OK, we are doing this thing is together, so we shall take of some of the responsibility that you have. Some of them read it, and they said no, normally, as clients you are responsible for the whole thing. And now you are going to make us responsible for the 50% of your responsibility, so that was another way of thinking. Yes, but normally you are responsible for everything. And now we say, OK, we take the half of your designing responsibility, so we take it so you can have less risk. But that part, that wasn't understood by some companies." PM** • **"To make an effective process and we were more able to do some risk management. So OK, if this risk occurs, we will take the responsibility for it." PM**
		Changed	• **"[…] and we've converted them to more proactively collaborating. Contributing to the processes of the design, instead of making remarks that always go back to the start of the designs step." IDM** • **"[It's Co-creating instead of keeping the traditional client-contractor or subcontractor role and dynamics.]" Yeah. IDM** • **"Normally in, well, normal contracting, it's the contractor who is responsible for the designing phase for the building. But we said, "Okay, now we want to do the design." PM** • **"[So, do you think that your role actually as a client has changed in this project by going into this bouw team model?], Yes, because normally we say okay. Well, it's up to you and you are responsible, so good luck with that. And we will buy a red pencil and write after what you do and didn't do from the requirements that we gave you. So, now this made us more responsible. But it also gave us the chance to change the requirements so we can make the best solution for our goals." PM.**
	Capacity	Roles from single party	• **"It was about him (the contractor). So, in this case we were pretty close together and we made it. Yes, it was not that "fixed" kind of everyone giving their solution. But, when we were designing the solutions, it came off its own like in a normal discussion, comparing several solutions." IDM** • **"Also, in the bouw team the principle about it is that you have one project organization within which the whole project organization is mirrored between the parties, and they collaborate on a basis." IM** • **"But that didn't happen, we didn't have the capacity to mirror this bouw team on our side. And as a**

Roles & Decision Making			consequence, things got lost in the engineering process because there wasn't enough communication." IM • "It's about understaffing and the inability for the project team to function as a bouw team and respect its principles in a way for it to be efficient." IM • "It was chosen that the team, the joint team we put together should not have two people on the same chair. […] And that decision was financially led. That two people on the same chair you had that there, it was considered to be double as expensive." C • "And, my point of view on that edge is that you should always put two people on the same chair. Because from the client side, you have the standard, the project manager, the contract manager, technical manager, environment management, whatever. And on our side, we have also those people, but they do completely different things. [If you put two people in the same role] You strengthen that role enormously." C • "The people from the client are responsible for the "what" and the people from the contractor are responsible for the "how". And you need to put them together because you cannot decide the "how", when you don't know why. […] So, you have to bring that together, and that's on every role. That's on project management role. That's on technical role. That's on contractual role. You need to put them together because you have to connect the "what" and all the "why" questions behind it, with the "how". And in the project, we didn't have that connection." C • "That's not the real understanding that you look to make progress to make innovations, real innovation, you need to know "why", and the step to "why". Well, that's so you need to strengthen every role so that you can cover the whole area from "why" to "what" to "how"." C
		Traditional	• "I think the main problem is that the method they choose of collaborating with the contractor in this case did not fit at all with the governance within the province. And that was that's difficult for people in the project team." C • "We feel that the public clients have difficulties in implementing sustainability, practices in their normal building activities. They're very traditional. They depend very much on proof and technology." C • "So, the people that have to maintain the system, for example, we feel that first, on the top of their mind, is the traditional approach." C • "And that means that we when we step in. We start with very basic traditional approach." C • "People have to, well, be the very masters of their skills, but they also have to be open as well for new solutions and other combinations." AM
	Decision Making		
		Multiple levels	• "So, if it's a design decision that you need to make within your own discipline, like "what quality of concrete I'm going to use", you can keep it within your own discipline. You make a decision and note it in the logbook. And it's OK to make that decision at that kind of level. At the end of a design phase, we could still check, so if there's an issue, we can see it." IDM • "And then are decisions made within several disciplines. Like in the layout of a movable bridge. You have the mechanical parts that need to be lined up. The electrical parts that need to be lined up, you have to shift all the concrete and the steel elements and so they all need to be lined up correctly. Then we say OK, it's a design issue, but it's not really a management issue. It should be an integral, integrated solution. Then we can take it up to my level as an integral design manager. We see some pros and cons and make sure that it's within the project ambitions." IDM

Roles & Decision Making			• **"But if it's really a solution with a big impact on time and money and the ambitions or a contract change. Then we made this decision at the decision-making team." IDM** • **"And at the much higher level, is still the political aspect, […] we finally have to go to the politics if we had to, because the costs were higher than the budget." PM** • **"So, the principle was that there was a steering board or a project board that all decisions had to be taken to. Towards which decisions had to be communicated, and also there was an Advisory Board which had to give advice to the project board on whether these decisions are right, or true, or favorable or unfavorable." IM**
	Collaborative approach	Joint (in project level)	• **"It's not really normal that the client and contractor both involved in the decision making. Normally yeah, it's not common. But it's becoming normal now these days to work in a non-traditional way." IDM.** • **"And most of the time you first try to do it within the design team to have the best solutions and you try to prepare a solution for the contractor and the clients, so that they have the right information to make a decision." IDM** • **"So it was, yeah, too expensive to reuse this steel. And we said you could also reuse it within the traditional recycling chain, because it's clean steel. So, in that case, it wasn't optimal for circularity because between reuse and recycling, reuse is better. But, yeah it costs so much, and we didn't have infinite budget. So, needed to make some decisions. And the discussion proved it was too expensive for the effect that it had." IDM**
		Joint (in committee level)	• **"We have the decision team, and the decision team was 50 % of the client, 50 % of the contractor and myself bringing up the specific decisions, and the design issues. Um, and this was the way it worked within the project." IDM**
	Authority	External	• **"Well, we always ask all the stakeholders what they find of the bridge, of the design, of the form, and everything. And for our case, it's a very normal bridge because one of the stakeholders, the Museum, so, the big pumping system, they said; "well, we don't want a very nice, unique design for the bridge because then it won't suit with our old building". So, they said keep it like it is. Yeah, so this is one of the stakeholders who asked for something in the project." AM** • **"[So, whose decision was to not take that into consideration?] Yeah […] We have a committee that looks to what are the shape and the color and these characteristics? […] And this is from the local government." AM** • **"So, there was a lot of money and so we have to go three times back to our colleagues, so our boss and to say, well "the prices are going up and the project is more expensive than we first thought" AM** • **"So, because the calculation was much higher than the budget, there was a decision on how we could, well, how could we complete the project." PM** • **"We had so many good stories in the newspapers about the bridge and the project was so far, so they could only say yes to the price. Yes, OK, but it's not a cheap bridge." AM**
	Roles and Responsibilities	Infraction of levels	• **"But in the decision-making part. I always focus on who is necessary to make the decision. Because if the decision-making process stops somewhere along the way. I also need to inform those people. So, if I inform the entire team about the decision making, I also need to inform the entire team about taking another route, […] and sometimes if people know that the decision-making process is taking too long someone else takes advantage of this issue and say well there's some problems over there. I'll deliver not this week, but I do it next week because there are others late as well." IDM**

Roles & Decision Making			• **"So, my perception of what happened is that decisions weren't made where they should have been made." IM** • **"And also when required some kind of formal decision making that wasn't always perceived for it to be as important or fundamental for it to even be passed towards the decision-making body." IM**
		Different decision-making models	• **"Yes, I think it's completely different between how the processes are and how the decision making is with the client and how the processes and decision making is with the contractor. And now you need to collaborate." IDM** • **"So that the politics said, OK, we can give you more money to complete the project. So, we had to wait, a waiting phase in between, but we didn't expect." PM** • **"That their main objective and the start of this kind of a project is to get consensus with all stakeholders, including maintenance stakeholders. So, consensus on the project, on financing the project, on the requirements of the finished product. And that is all based on traditional methods and traditional knowledge." C** • **"Yeah, and I can understand how that happens because, a consensus with all the parties is very important in Dutch public work. But it is also, a how do you call it? A break or an obstacle, a huge obstacle in innovation." C** • **"So, we do not have a consensus environment. We have someone we can ask to make a decision and then make a decision and you can agree or disagree. You can talk about it, that's no problem. But you have a decision. And then you can move on, because that's the objective. You can move on." C** • **"The problem that we have is that on most public client sides, it doesn't work like that. So, when we have an issue. We think we have to step up to our board level. They don't have a real partner to talk with. Because they expect someone who is just like them. With us we need a decision and then we move on." C** • **"I see that as a problem because, when you as an organization, when you decided to make that development together, on the way you work together and there is a new kind of collaboration, you need to do that also as an organization. You have to be able to find each other also on a board level or on director level or whatever level it is. And that is what we find very difficult because you don't have this connection. The connection is there on the project level, but on the escalation level, the connection is gone." C** •
		Moment of intervention	• **"That was also a problem that we had in the Engineering's phase. So, when you engineer something that is a little different from what you're used to, you need agreement on that. And that takes much more time to achieve than normally. So, they don't have the time that you need to really understand and to challenge each other to optimize it. It's not there. Because in the end it's all time and money driven and very tight." C** • **"That is also a recommendation that I will make for this circularity and sustainable things that you mark that moment that you say, "okay, this is all." These are all the sustainable and circular things that we are entering in this project and then start the engineering. Because when you start the engineering, that's a whole different process, where an enormous amount of people is getting involved." C** • **"But at a certain point you should "freeze" at an agreement. We all agree on freezing, and we start focusing on making that in detailed engineering to something we can build. Because that engineering, that engineering process is something that should be no different than any other construction project." C**
	Utilization of Knowledge and Resources		

Roles & Decision Making	Collaborative approach	Joint (intellectual property)	• **"But that's an interesting question. I think it's one of the most important questions." AM** • **"All the intellectual properties should be available for the client also. So not only for the contractor" IDM**
		Public (internally and externally)	• **"Yes of course, we are on it. We are an organization who likes to try and to learn together. So yes, we are very open about it." AM** • **"So, we're learning, but how do we spread the learning? So that is I think a very important question." AM** • **"And I think we can learn together with the construction company as they are also learning. I think it's fascinating to do it together with the market." AM** • **"There are no concrete plants, but yes it will happen, I think. There will mainly be webinars and, I call them business gatherings about sustainability or infrastructure and there will be a statement probably from the contractor. Those kinds of things, so it will develop over time." IDM**
	Strategic asset	Private (internally)	• **"Well, it's a good thing to make a good bid when the project is awarded but it's a strict strategic knowledge." C** • **"So, the idea of circularity is the right to share, but for us it's a strategic asset." C** • **"Well, we're always in competition. There are no bids that we do not want. So, we are always in competition." C** • **"When you deliver a product and you are the real product owner, it's much more rewarding for a contractor to invest in sustainability and to be more open about it. That's how, apart from construction industry, all the other industries work. Well, you know that we deliver a service." C** • **"And therefore, all our knowledge is strategical. Especially when we know, and it also nearly always contractual, that all innovation that we have on a project, goes to our client for free. And it's available for everyone. So our innovation gives us an advance for only one project. And after that, it's everyone's innovation. C** • **"So, so there is no incentive for us to invest. And we have a lot of examples where we did invest in products, and we lost an awful lot of money." C** • **"And an engineering bureau never have to construct the real thing, so they never experience in real time, the consequences of this engineering project. They feel much more free to share their sustainability measures or something with the client. Because there is no consequence on that. […], so when clients are saying, we feel that contractors are a little traditional still on this day, they make the comparison between the contractor and engineering companies, but that's a different story. We have to make it happen. We are responsible for the actual result." C** • **"I think that, when you do not feel fully recognize that It will block us from cooperating with those companies we should cooperate with. So, client, engineering company and construction company. At this moment I feel that, because of this misunderstanding they're not seen as supporting towards each other, but as contradicting each other." C**
	Intermediate outcome	Joint (guideline)	• **"And it was the first time in everything, right? So, in that sense, we learned a lot and also in that sense we realized the changes that needed to be in place for it to be successful in future projects." IM** • **"As it was new and we, no one really knew what the implications were and what to expect and how to interpret it. So, the IFD was an ongoing learning process." IM** • **'And we have a great little learning community which allows different project teams to collaborate together on, for instance, problems that they encounter." IM**

Roles & Decision Making			• **"So, we double down on our knowledge infrastructure, at least for the problems of the province. So, we spent last year focusing on that and in the coming period, we are going to formalize a bit more. And by formalizing, I mean to create a routine, and out of the routine to create more organizational capacity to tackle the solutions that come out of it." IM** • **"Every time I hear about a project, I contact them, and I say "Hey, nice, good that you're going to do this. I would like to engage with you guys to help you out and give a presentation". To give a little heads up on what you can expect, what things you should look out for, and how you can implement certain things already, or be mindful of certain things. And how to know where you can get help, what kind of help, and who are the people in the organization that have different types of knowledge." IM**
Coordination	***Common Characteristics***		
	Experience and knowledge	Different characteristics	• **"One was more experienced than the other, so that's something different." IDM**
	Mindset		• **"Well, there has to be certain basic requirements. But that does not mean that everyone should be the same. You need different personalities within a team." C** • **"You need not to be scared of parties or people that look in a completely different way to the same subject. And that's what I look for. And what I expect is a curiosity in each other." C**
	Multidisciplinary		• **"Some were used to the way of working within the contractor, some was the supplier, or a hired service from the contractor, so they weren't really used to it." IDM** • **"I needed to implement also the different ways of working within disciplines like civil works are different from installations." IDM**
		Common mindset	• **"There is always a common ground on certain characteristic but there are also the differences." IDM** • **"[So, this mindset, to be open for new solutions and not being stuck to the past. I think this is pretty important in what you are doing right now. Isn't it?] Yes." AM** • **"[So an intrinsic motivation towards sustainability and circularity, is this a prerequisite of working in such projects, right?] Yeah, yeah." C,** • **"The amount of personal involvement is high. Not everyone can do it because you have also to be curious towards each other and you have to wait. You need some specific characteristics to make it work." C**
		Common procedures	• **"And there we also used not only that place but also the normal working way with the SharePoint, the OneNote etcetera. And it was really open. The contractor had its tools. We didn't need to develop a tool. We said what team is doing most of the work. And the contractor was making the most of the work. So, let's make sure that we use all the facilities from the contractor, so the biggest part of the team is used to working with these facilities. So yeah, we didn't have any starting issues and we were getting used to it" IDM** • **"But for me it was more difficult because I wasn't really used to how things work. So, I was used to applications, I was used to SharePoint but it's always a little bit different with a new contractor. And it might be the same program, but it's differently organized, it's different how the team uses the facilities. Sometimes you have a team, that is really keen to use it, and know the processes. But there are also team members that say "Processes are not for me; I only do the technical issues" IDM**
	Communication and Information Sharing		
	Roles and responsibilities	Fragmented	• **"But that didn't happen, we didn't have the capacity to mirror this bouw team on our side. And as a consequence, things got lost in the engineering process because there wasn't enough communication." IM**

Coordination			• **"And as you said, it relates to soft skills. So, communication is a soft skill. You said, it's a "soft question" but the soft questions are very hard to answer. So, if you do your communication not right then it could be a lot of trouble in the rest of the project. So, it's sometimes harder than the technical things." AM**
	Circumstances	Applications	• **"But the time of the first presentation was on the first lockdown, so everyone was sitting at home. So, we were trying to understand how to work in these new conditions. So that made the first part a bit, well experimental." PM**
		Personal meetings	• **"And for the individual dialogue with each competitor, we were able to come to the office, and have the meeting on person." PM** • **"But yeah, as soon as it was a possibility, we had a contact day, in the office of the contractor." IDM** • **"And maybe, maybe truthfully, Corona Crisis was a very big obstacle to achieve that type of collaboration. I don't know that, but I assume." IM** • **"That made the starting of the project really hard." IDM** • **"[…] and sometimes we had this period of two or three months where we could work together within on one meter. Those periods were by far the most productive periods. […] But, I find it very difficult to really interact with someone through a screen." C**
		Different levels of communication	• **"I only started in the beginning, but we had a communication person." AM** • **"Communications go both ways." IM** • **"So, if you want an engineering team with all the disciplines and the engineers of the client side are also working together with the engineers of the contractor and the engineering firm, right?" IM**
		Different modes of communication for different occasions	• **"We have in these kinds of projects, in the company we said we must have two days in a week where we're all sitting together." C** • **"Things like this teams, but also BIM models, they are extremely helpful in the process of working together. But, I think we need to be aware, to my occasion especially, what can be done in teams and what you really need to do face-to-face." C** • **"There's an awful lot of what you can do on distance, it depends on what your job is." C** • **"Yeah, because in a Teams meeting, if you want to have an effective team meeting, you have an agenda and you follow the agenda. So, most of the time you only talk about what's on the agenda, or it will be a little bit of small talk stuff when waiting for others. […] So this also, when you're in the team meeting, that's this one hour that you see each other." IDM** • **"But on the other hand, just like you said BIM models and talking through teams, or having a checklist "have you done this, or that, and have you found any problems", that can easily be done by teams, or it can be done even better." 9:115 ¶ 674 – 694 in 2.5 Thesis Meeting C,** • **"But, it really helps when after a meeting you see someone again. And we had this discussion about something and sometimes you see somebody's emotional about it. So, you need to talk about it. Or when you see that someone is not really getting the main goal. And when you are in meeting with ten other people, I am not going to tell someone "You can do better". It helps more when you see each other face to face. […] So, you need to read, to really have a feeling about what we are discussing in the meeting and how it is working within the team." IDM** • **"But for me, especially when there's something where you need more interaction than just speech, so you need body language, or a whiteboard to have a creative development of thought, well, for me it's very important to have a personal interaction." C**

Coordination	Role and Responsibilities	Information sharing through applications	• **"We need to get back more information to the team." IDM** • **"And there we also used not only that place but also the normal working way with the SharePoint, the OneNote etcetera." IDM**
	Change Management		
		Calculation of impact and joint decision	• **"One of the changes was, I asked for a bridge with rusty iron, this type of iron that is covered with rust. And well, they want to make a white bridge again. Because rusty is now, people like it a lot, but not over 20 years probably. It's ugly, probably. Well, they wanted a classical bridge." AM** • **"Yes. So, what we also added is that we put the bicycle road under the bridge. So, they go up and then they go over the bridge. So that's the bicycle road and it goes under the bridge. That is a nice solution. That was a new solution. [And this came during a consultation with the market, yes?] Yes." AM** • **"First of all, a change can be brought up in the bouw team by the contractor or the client." IDM** • **"We try to make it smart. We try to make sure that we investigate what the impact is and that it is the right time to make such a change. Certain changes you don't make in the execution phase or it's too early or too late." IDM** • **"For each issue, for each change, you have to make sure that client and contractor are approving the change." IDM** • **"[And the in order to make some changes the same decision-making procedure that you told me before is followed?] Yeah, I think it's always the same steps. But the way you work it out, in the project in detail or in the higher level, that depends on the issue or the change." IDM**
	Requirements and unclarity of vision	Infraction of change management process	• **"And the other one is that when we propose to make a change. That also has to be accepted by the client. And acceptance within the client takes a lot more time than we have in the tender." C** • **"So, what happened is that a lot of changes were made, and a lot of design interpretations were made." IM** • **"For instance, the deck of the bridge, not the movable part but the other two parts, the fixed part. Those decks are sort of fixed, and the principle of IFD is met on the level of the technical agreement, but the girders are, well they are not demountable." IM** • **"Because there was a lot of room for interpretation on the contractor and the engineering firm side." IM** • **"Where we also didn't communicate our visions and our interpretations clearly." IM** • **"Ideally there should have been a bit more discussion in between, in which we could have countered some of the argumentation and discuss whether deviation was rightful, if it was indeed a good deviation or justified to prioritize the update of the technical agreement." IM**
	Conflict Resolution		
	Knowledge asymmetries	Operational and financial conflicts	• **"And what we saw in this collaboration is, in the end we showed the price was much higher than the budget. And we asked about it a couple of times. We asked for the price to be in the budget every time. And finally, the price isn't in budget." PM** • **"We had some major conflicts within the project, and they were all about money." C** • **"[…] it was for example the steel bridge deck that we needed to reuse. Well first the client said we were going to reuse it, and the contractor said we're going to reuse it as a ballast, for the new bridge. Well then, he said, it's not possible. Well, as a client, you're not really happy when a contractor gives you a solution and later on, he says it's not possible." IDM**

Coordination			• **"And we also had one of the engineers on the province's side to come up with a solution and a study on how this could be solved, but the solution wasn't implemented because they already chosen for another one." IM** • **"And we don't speak the same language. We don't know what we are talking about, and that goes both ways actually." C** • **"And the way that I see it, it's mainly caused by a lack of knowledge." C** • **"I find that the language of technique is universal. […] The technique is never a problem when you can talk about it. […] Money is always a problem, because then there's no mutual language for money other than it's that many euros." C.** • **"We don't have a good conversation about the way that a project is funded, mainly because we don't know, or we're not really curious about it. […] And that is, yeah, there's a lack of confidence, between parties to talk about it, and the lack of confidence is mainly driven by ignorance. And not knowing, and when you do not know, when you doubt." C**
	Collaborative approach	Negotiation	• **"Now, we mainly manage them by making the conflict negotiable." PM** • **"Then we have to think about what the views of the other parties are." PM** • **"So, sometimes the interests of both parties are different." PM** • **"So, you see this conflict internally always going on "what is right and what is wrong" and what is the project ambition and the project's interest and the organizational interest." IM,** • **"[And if I may add, it's also about a conflict of interests, right? Because I think for technique, for quality, for things like that all parties, aim for the best result. But in terms of money one party aims to compensate for their work and their losses and the other aims to not providing any more money.] Yeah." C** • **"But when you start talking about the interest that each party has, you see sometimes that it is the same interest. So, when you see the same interest, it will be easy. Then you can we can agree because we have the same interest. And sometimes when the interests conflict you have to find a way to how to make it possible to get the interests of both. So, reducing the ambitions of the interest." PM**
		Proactive	• **"Well, the thing is what you see when you start a project like this everyone is talking about technique […] And everyone agrees. […], Let's first start, the same kind of input on the contract side. Not saying that's the contract, take it or leave it, or something like that. Or that's the money take it or leave it. Let's put the same kind of effort in "How do we talk about money? How do we talk about contractual issues?" And that is very much underrated in all two-phase contracts that I know." C** • **"Why don't you solve this issue within your own design team?" That's the way you finish issues." IDM**
		Gate reviewing	• **"Which we use that to make sure that our process is done not only correctly but also yeah, how do you call that? Well, that we feel comfortable, that we do the right thing and that we don't proceed when some issues are not resolved." C**
Motivation			***Trust***
	Collaborative approach	Early	• **"And when you start collaborating without trust, that they will do the right thing, then that will be the death of the collaboration." PM** • **"Yes, it's not just a step. It is essential. When you don't make that's a dead end." C** • **"Yeah, most of the time it's within a pre-startup meeting." IDM** • **"[Trust is] on an individual basis and on the project basis every time. Again, you need to build this sense of trust**

Motivation			**and you can do this. I think trust can be designed and you need to design it. And if you design it appropriately it can be very productive for the outcome of your project." IM**
	Collaborative approach	Create mutual trust	• **"Yes, I think. Trust is the premise of running a good project. Trust is really important. You should invest a lot in starting to trust one another." IM** • **"Trust is very important." PM** • **"And also, in a way trust is needed. If you don't have it. It's a killer of our projects, right? The lack of it, right?" IM** • **"So, in that sense trust is the outcome that you seek." IM** • **"Getting everybody level, and everybody's differences about the project and making sure that you have the same vision the same ambitions and also be transparent on the things that you were not on the same page regarding your ambitions. But most of the time, my personal way of working is just being open." IDM** • **"And what is needed to get the trust, is to be open. And start talking about your interests. Both parts in the team should have. And I think that just being able to start talking about the problem and your interests and justice, that is making the differences in interest visible." PM** • **"Yes, you need an open mind for trusting people without knowing them." PM** • **"Trust means that you need to have common assumptions on what is on, how the project should be designed, right? So, you need to have a good foundation of understanding one another and be transparent towards one another. And what are each other's incentives? How is everybody in the race?" IM** • **"So, you need to have a certain degree of transparency when argumentations can be found for certain design decisions." IM**
	Goal		• **"[Do you think that this is important in your project? Team members that [...] have some trust between each other, or they feel like a team?] Yeah, yeah, it's always good to have that. I think it's maybe more important when you do sustainable solutions. Because it's still, it's not really fixed how sustainability is achieved." IDM** • **"Yes, so I think it's very important to have a common goal." AM**
	Results		• **"And you have to be successful. So, success creates success. So, if you're one a team and you have success, well, celebrate your successes. Even, if they are small. And have fun. It's very important to have fun together and to have open discussions." AM**
	Mindset		• **"And don't say it's not possible. Don't use this kind of words. Because if you don't think out-of-the-box then you're doing the same bridge or the same solution that everybody does." AM**
	Openness	Sustain mutual trust	• **"And then, you will need to hold the trust in the parties." PM** • **"Trust is something that you have to build and build and build. It's a very tedious process for it to happen. And even though, trust can be gone again, right?" IM** • **"But finally I think, maintain the trust is just by keeping in the go, you have to go in talking about the problem. It doesn't help if you are closed. When you pull back and stop talking. Be in contact. You have to keep talking about it. And finding a way to come to a solution." PM** • **"And so, making the mistake is not a problem, So the important is learning from it, the problem and the process. We need to help our colleagues." C**
	Past relations (negative)		• **"It's not like you want trust, there you go, right? And it's not like; "Oh, well I've worked with that guy before". Yeah, they can influence it. They can. But trust is not like "Oh, well we work with you two years ago with this organization, therefore we trust one another." IM** • **"So, one of my team members. He is also in another project with the same contractor, where he lost his trust**

Motivation			**in this company. So, it's difficult for me to keep his trust, to keep him open to the contract." PM** • **"But on the other hand. When you don't make this atmosphere where people can speak out and talk about it, you can expect at the end that you will be surprised." C**
	Decision-making	Trust in the process	• **"So there are various things about trust that you need to take into account. One is to trust the process. There's trust in the process. So, we're doing this together. We're making a design and we're going to go through all the phases together. And we need to trust each other and each other's expertise. But in order to get to that point of trust, you must go through other stages first, right?" IM** • **"So you want , have the best circular solutions, […]. Then you need to trust each other that you will be in it together. So, at one point you could say, "well, trust is something like that; I trust you that you make a good decision". But is this the trust that we're talking about? That you trust each other to make a good decision? Or, is trust relates to "when you make a decision that influences my degree of decision making, then I trust you that you are going to inform me about it"? So those are different modes of trust that you need to think about. Like, what is the trust that you're trying to stimulate." IM**
	Legitimacy		
	Decision-making	Internal Legitimacy	• **"[…] And you need to make sure that the organization supports and complies with what we are doing." IDM** • **"The thing that was wrong or could have been better at the project is legitimacy." IM** • **"What they expect of me, is that when there is a decision, I make the decision." C** • **"So, my view on legitimacy in infrastructure projects with circular ambitions is be mindful of your organization and involve them whenever a decision exceeds your decision-making power and your expertise." IM** • **"So, in a way I would say it goes both ways. So, you have legitimacy when you talk about "my decision is legitimate" due to my role, as I have legitimacy, there is respect for the role that I have within the project team, and that legitimacy is acquired as a consequence of your past experience, but also the way that you act within your current role, and you legitimize your decision making." IM** • **"So, to have your own mental models running, to identify when you need to involve other parties to make a decision or to evaluate a certain phase within the project, right?" 7 IM**
	Reputation		• **"It's only a small prize, not a lot of money or something, but for the team, people were enthusiastic about it, and you could read it in the newspapers." AM**
	Motivation ("Good-story")		• **"The story behind it is special." AM** • **"Okay, well everybody found the story to be a good story, a logical story. And yes, they said we have to do it. So then, it's like a snowball rolling out of a mountain. It's getting bigger and bigger. That's really, I think, the way it works. So yes, it was a good story, but at the end it the project came up to be more expensive. This is the only bad thing." AM**
	Clear goals		• **"Or, when there is some difficulty about interpretation of a goal, I well, I helped him or her to decide on that." C**
	Roles and responsibilities		• **"Yes so, most of the time you start a project with a plan of execution. And you point out your task, your responsibilities and that creates legitimacy, I think. It's a good starting point." IDM** • **"I think legitimacy. You, as an individual or as a project you need to be legitimate, so I think that's all about respect for the bigger picture, your organization structure, the degree to which you are able to mismatch certain decisions and also to evaluate at what point this exceeds your own decision-making authority or your**

Motivation			**expertise and for you to be integer. I don't know if this is the correct word." IM**
	Communication		• **"And then you just start doing it and you when your collaboration evolves during the project you also know when to contact and what kind of people." IDM** • **"And when people have the feeling that you inform them when it's really necessary. That's also a kind of trust. You don't need to know everything, but if I am going to inform you, then it's within your role or your responsibility. That evolves during the project." IDM**
	Trust		• **"And then you have internal legitimacy, and this is completely aligned with this notion of trust. How do you legitimize your actions or words?" IM**
	Results		• **"And you have to be successful. So, success creates success. So, if you're one a team and you have success, well, celebrate your successes. Even, if they are small. And have fun. It's very important to have fun together and to have open discussions." AM**
	Communication	External Support	• **"So, I have every two weeks, an appointment where I talk with my client about the progress we made in the project and if we see upcoming difficulties, we can talk about how to deal with them." PM** • **"These are the external stakeholders and sometimes, this was the main part, we have to contact also the external stakeholders. But first of all, I managed that with my internal client. And then we go to the external client" PM** • **"So, we make a report of our progress on the total program and that will go to the political clients. And on some incidental ways, I make a memo to the political client to inform him about, well, the results of the bouw team and well also the difficulties, what went right and wrong. And the state of the project." PM** • **"And there was a collaboration. We were the three of us and also another contact person of the external client. And sometimes we also go to the political external clients, as collaboration parties." PM** • **Well, we have, for these kinds of projects, every four week a board meeting as we say. And there we discuss all kinds of matters that concern the project. Personal based, financially, technically, contract issues. And I feel that when I have an issue, I can discuss that there, just like my people can do with me." C**
	Engagement		• **"Exactly, that's what it was. So, they could only say yes, because we couldn't go back again." AM** • **"When you are in a point that you are so engaged in something that you can't actually go back. But in our case, well, newspapers wrote about it, also local newspapers, and it always was in a positive way. And if you have positive articles, then a lot of people want to be involved with it. So, in a positive project, it's easier to get things done. But well, it has some issues." AM**
	Results		• **"And I have to be able to explain what I do when and when they say that they have a feeling an explanation is sufficient, or when they agree I don't, normally, I don't have any problem with that." C**
	Roles and responsibilities		• **"And mainly I explained about my responsibilities and the progress to the internal client." PM** • **"So, we have to go to the local government to get a permit, but they said, well they didn't like the way it looked, so they didn't want to give the permit to build it. So, we say, OK, that happens with the same stakeholders. So, we said in this project we want to reduce this risk, but by making the permit by the contractor, we will start the negotiations about permit and aesthetic stability in the voting process. So, we are able to change the aesthetics, the requirements of the aesthetics, without being in a process where the contractor is already building parts or buying parts. Because then, the process of changing will be a lot more expensive than when you do this more in front in the process. These ambitions bits." PM**

Motivation			• **"So, legitimacy through structure does not mean that legitimacy has been acquired by the project team and their individuals, so legitimacy is something that you can design for, but there should also be a process in place that gets the project up to running up to speed, wherein the structure is lived by." IM** • **"If without even knowing about the process you can deduce the characteristics of the process, by observing the organizational principles of the group of individuals interacting, collaborating together. So, in a project context, that would mean that the governance structure is implemented. When you see behavior that correlates with the structure that you've defined as an organizational as a governance structure of the project." IM**
	Reputation		• **"We had so many good stories in the newspapers about the bridge and the project was so far, so they could only say yes to the price. Yes, OK, but it's not a cheap bridge." AM**
	Engagement		
	Motivation ("Good-story")	Measures	• **"Everybody was very enthusiastic about it and, um, I make a story because storytelling is very important." AM** • **"So, an important lesson here is getting the story." AM** • **"So, next to the bridge there is a big, old, pumping station. It's a steam pumping station and there were three steam pumping stations built in 1850 and this one is a museum now. And my story was well this pumping station is 50 meters from the bridge. That's a solution for that time, for 1815, because then we tried to get more lands and we dried up a polder. And now we have to build bridge that is for the future of our time. So, we have to make it sustainable, and everybody found it a logical story and said "let's do it"" AM.** • **"It's a good idea and then the whole idea gets bigger and bigger and while this is a good thing… " AM** • **"So, everybody liked the story. It was a story that I have invented with someone I talked about it, and they said "Well it's a good one." AM** • **"So, we have to replace it, but we could also replace it with normal bridge, a standard bridge and we didn't do that because of this story, and because everybody loves the story. So, well, it was a good idea and then, well, someone else took it over and wrote it down all the specifications." AM**
	Nature of the project		• **"So well, if you have a successful story people are interested and then you have a bandwagon effect, and someone wants to be the project leader of this project. So, it was really a special status because it's not a normal project, well, it's an innovative product and a lot of people came with the suggestion to make it even more innovative. So, it started to get its own dynamics. And that's a good thing." AM** • **"Technical people like to be innovative. I don't think they need any training or motivation." AM**
	Reputation		• **"People were very enthusiastic, and they won also a prize for the most sustainable group during the tender." AM** • **"It's only a small prize, not a lot of money or something, but for the team, people were enthusiastic about it, and you could read it in the newspapers." AM** • **"But in our case, well, newspapers wrote about it, also local newspapers, and it always was in a positive way. And if you have positive articles, then a lot of people want to be involved with it. So, in a positive project, it's easier to get things done. But well, it has some issues." AM**

Table 11: Governance Arrangements and Quotes for Case C

Goal Setting	***Circular ambitions***		
	Policies	Earlier introduced	• **"There have been many different ideas, for automated production, reuse, design, everything, you name it. But from the start we started with the reuse of girders." PMC** • **"[…] And then they all came up, one day at the end of that period of six months, I think, with all how they think it should be. Those conclusions were all used in the actual SBIR which went to the market." PMSBIR** • **"[So we can say that Rijkswaterstaat gave you some line of thinking and then, what you will do what you wanted to do with it, it was your decision, right?] Yes, because the question of circularity from the start it was very big." PMC**
	External expertise	Jointly defined	• **"So back to that, the teams came up in a maybe, six-month period. We also did "expeditions" to other companies who do something with a circular ideas or sustainability or with materials. But we also went cross sectoral. We believe that not only the sector itself can solve things, but also other sectors can contribute. So, some teams went to the Innovation Centre of P. for instance, and that's what's went through for six months period." PMSBIR** • **"We got the view of the internal stakeholders by doing a scope challenge and scope challenge is something which is used from the start." PMSBIR** • **"So, the scope challenge is actually, you ask the internal stakeholders what they expect of it, what criteria they think are important, what they want to change and which problems they see in their domains." PMSBIR** • **"And what we did with external stakeholders, is we also had an innovation-oriented dialogue, which consists of the same questions, actually. So how do they want to see in it, to qualify what they see as possible criteria for it, and what they see for opportunities?" PMSBIR** • **" So, it's not a question of yeah, are we within this project in all the right parts? It's more the question of can we get this done? Because then, we can get one of the main elements in infrastructure much more sustainable. So, yeah, much more reduction of CO2 and use of materials." CM**
		By public client (introduced)	• **"Yeah, we have to do it (circularity) by 2050 and 2030." PMSBIR** • **"So, and by circular economy, that means that it has to be circular already. And it has to be better than before, and it has to be easier and clear and that it had to be for a better environment." PMSBIR** • **"I think the government is also the booster for innovation, right? So, we had all the things. All the signs were on green." PMSBIR** • **"So, I said, well, if we have to do that in 2030, we must be having the markets ready at 2027. So, our perspective was always to do an earlier supplier involvement. Early involvement of the market. So that's why we're an open and learning environment […]." PMSBIR**
		Defined through dialogue	• **"So from those 16 organizations, we came up with 6 themes, the dialogues were consisted of 6 themes." PMSBIR** • **"So, we made six themes, one was on design, the other one was procurement. There was co-creating. I can't build up in English, I have to think very hard. So, another one was technology. And there was also data and business models. And every team had one particular person from a government agency and one from the market or from knowledge institutes. Universities were also joining." PMSBIR** • **"So, the six teams that I told you about, they were consist of about 10 people, each with of course the two people who made it work." PMSBIR** • **"So, and then I came home, came back to the office and I said to my partners. We need to have themes because**

Goal Setting			**people who like to talk about concrete that's perfectly fine and they make it roll. But if someone is sitting there who isn't interested then we don't have real progress." PMSBIR**
			Goals
	Collaborative approach	Jointly defined (private)	• **[OK. But, during the earlier phase, in the SBIR was there a way of actually influencing the goals? Perhaps, getting your goals also in there?] Yeah, because the question of the SBIR was just, design something that's reusable. That was it. Yeah, that was the goal." TA** • **"I think it actually had to start. We are doing a good job by saying that these are the goals that you will have to meet, So, there is no question about it anymore. We have to do it and I think that's the only way to get it done." TA** • **"[Hmm, that's also a pretty good point that when the budget is common, the goals are the same, common also.] Yeah." CM**
		Clear	• **"Well, the goal is to build a circular bridge." BDM** • **"Uh, yes, and that was from the beginning. Reuse the girders." PMC** • **"So, our concept is to build a circular bridge with reused girders." BDM** • **"There have been many different ideas, for automated production, reuse, design, everything, you name it. But from the start we started with the reuse of girders." PMC** • **"Yes, and we think about reusing other elements, but we think the girders have the most potential. So, we set our focus on the girders." PMC**
	Collaborative approach	Flexible (sub-goals)	• **"So we had [a budget] for our pilot project and we can reach the goals of our pilot project, but the sub goals are […] Flexible yes, that's the correct term." BDM** • **"So, we talked to Rijkswaterstaat, is it allowed to do that? To do so? They said yes, because it's growing the market. So please do so." BDM** • **"And we use this to talk to our clients and see where we can put the money in. But it's always on a nonprofit basis." BDM**
		Personal	• **" So, in stage one, our goal was to succeed. We want to be one of the three parties who can do the job. Yes, because the idea was nice. But for our company, it was too expensive. So. The money out of the SBIR project, we could use it very well." PMC** • **"But on the other hand, we still want to be involved in this project is because we used to apply some amount of rebar into the girders. And in the past that was less rebar. Now we have to put a lot of rebar, to new girders. And rebar also is made of steel. Steel is also pollution. A lot more pollution is caused by steel, but nobody talks about that. Everybody's talking about concrete. But my point is, if you can say that an older girder is still good with less rebar, then the new girders can also be made with less rebar. So that's also a side goal of our company, in this project. So, to get things evolved." TA** • **"For example, if you have a big project where we'll have to make twenty new bridges, or 25 girders, to meet our goals and also the government's ambition, we could say a part of it we will make it with old girders and a part of it with new girders. So, then we will have I think the best of both sides." TA** • **"So, yes. That's our goal. If we combine it all in the projects, so old and new girders, that's where we see a lot of advantage." TA** • **"And as I told you just right away, sustainability is one of the goals, but a goal also is to enlarge our activities on circularity. So, those are the two main goals, I think, where we meet the project goals." CM** • **"So yeah, I think those are the most important for us. To enlarge our activities in circularity, and to build more sustainable." CM** • **"No, I think the goals for the company are pretty much in line with the project." CM**

Goal Setting			• **"The goals we had were pretty much the same as I told you just right away, but then it was more focused on building more sustainable projects, and not enlarge our activities on circularity." CM** •
		Intermediate outcomes	• **"And, yes. Our companies wanted to show there that circularity can work through a business case. We didn't see a business case, where we get a profit to make investments." PMC** • **"And from the project-side, the goal is to get a few of our own business units out there. Then we also believe, this is the future of how we build infrastructure in the Netherlands. So, these are the steps that we have to take, and this is a position we would like to get to support our project, and our business." CM** • **"No, you won't, sure. So, we have the goals for the environment, but the one way to do it, is to make a profitable case and then it's going to work. Otherwise, it won't." TA** • **"So, we had some goals in the pilot project. We wanted to establish a marketplace." BDM** • **"When we collect beams and we deliver them as a circular solution to our project companies, or even other third-party companies, then we have business with some other parties." CM** • **"It's not going to happen, and because the money that we reserved for that part we are investing it now in harvesting the girders from the project." BDM** • **"And, we're going to do it. We did it twice and we're going to do it for a third time. The third is the real pilot project, and then we will make a report of it. And that's the end. That's the end of our contract." BDM**
	Circular performance metrics		
		Diverse	• **"Oh yes, MKI and CO2 emissions." PMC** • **"Oh, right. No, it's not only that. It's about the raw materials." TA** • **"Uh, so if we mine them out of the ground, it's not that pollution, but there comes a time that there are no ground materials available anymore. And circularity is a one way to keep them in the economy." TA**
		Difference between design - implementation	• **"[When you say that you don't exactly know if the project would be successful, you mean in terms of budget and scheduling issues, things like that, right?] Oh yes, but also in terms of what is the real CO2 emission reduction that we can achieve here, or what are the costs of building circular instead of buying a new bridge." CM** • **"Yeah, we have goals to build more circular and to reduce emissions. So, the main goal is to reduce material and emissions until 2030. We have some measurements to do. To measure if we are on the right path, or if we have to, well increase the circularity threshold. So, I think that's one of the main goals, but eventually in such projects we can make large steps to build more sustainable, but there are a lot of, how do you call it? There are a lot of doubts." CM**
Rewarding	***Rewards***		
	Innovation	Financial incentives (SBIR)	• **"They got a budget. Each got a budget; I think about 10,000 euro's which they can use in the way they feel fit." PMSBIR** • **"And the 10 of them got 90,000 for a feasibility study." PMSBIR** • **"Which really helped them. That's what we got back from them. It really helped them because then you can, for instance, an engineering company can make a team which is paid for. Normally they have the know-how to book the hours because they, well they don't get paid." PMSBIR** • **"And yeah, what's really important to know it that this early payment of our government makes it possible for companies to innovate, because then they have money then and they don't have to do it themselves." PMSBIR**

Rewarding			• **"[…]. But for our company, it was too expensive. So. The money out of the SBIR project, we could use it very well." PMC**
		No financial incentives (in project)	• **"And after that, the 10 that did the feasibility studies they got judged again by an independent commission. They were judged by an independent commission, and they got 3 who got an order for an SBIR for 1.5 million. And that's actually the status now." PMSBIR** • **"Well, the budget of the public party was fixed. We had some room to go left or to go right. But yes, the budget was fixed." CM** • **"For the three companies that were selected it's OK. They have 1.5 million that they can they spend it on a new innovation perspective." PMSBIR** • **"Well, in the other projects, we also tried to get a sponsor, or we could deliver the beams for the price we need to get to the next stage." CM**
		Development on a nonprofit basis	• **"But actually for others that is not a lot of money. But for a small engineering company this is of course a lot." PMSBIR** • **"Yes, yes. Good contacts. And we were paid only the cost. So, companies usually don't incorporate circularity, without a profit. And that's very nice that all the parties we need, they accept this non-profit characteristic. And they did because we have a motivation." PMC** • **"And we use this to talk to our clients and see where we can put the money in. But it's always on a nonprofit basis." BDM** • **"But there are experimental costs. And we need money to experiment. So, with through these projects we can get money, and we take it to test it." PMC** • **"So, we don't make any profit, and it's good that our costs are compensated." BDM** • **"We don't have to make a profit at this stage, but if we look further, in five years then of course you have to make a profit because otherwise you don't exist anymore if you are a small party." BDM** • **"So, that's a part of our reputation. And we want to act according to this reputation and this motto. But of course, we have to make a profit as well. And we can't eat bread from the reputation. Reputation opens doors to projects but it's always the projects that we need to make a profit and to earn money of course." BDM** • **"We're talking about certain phases. We're now in the second phase to get things done and end this SBIR project. And once that's ended, we will go to the next phase. I think we'll end our consortium and then we'll just do projects" TA**
	Early involvement	Reputation and future business	• **"And, yes. Our companies wanted to show there that circularity can work through a business case. We didn't see a business case, where we get a profit to make investments." PMC** • **"Because it's a big opportunity to get things going." TA** • **"And we make little business cases for ourselves as a consortium, but not with the aim to make a profit. It's the aim to make the wheel turning." BDM** • **"So, we always had that in mind I think, and looking at the markets, they always look at opportunities to get the "next one." PMSBIR** • **"The reputation is one of them, one of the factors, but it is smaller than we initially believed. So, when we get this done, then we can enlarge the success of achieving new circular projects. So, when we can do this more often, then we can offer our clients more circular solutions. Like, more CO2 reduction." CM** • **"So, we believe that by dealing with these assets, this will bring us better or more projects." CM** • **"[Hmm, so future business is important], Yes, so that's our main goal." CM** • **"Yes, so more publicity than profit." PMC**

Rewarding			• **"They have high standards because it has to be like a new girder. But for them, when it shows that isn't lacking a reused girder, it is very nice for publicity." PMC** • **"[Yes, so future business opportunities is one of the significant things for you in this project, right?] Yeah, sure. But you have to be honest about it. You will have to make money otherwise the company will not exist anymore, that's all." TA** • **"What is in for us? Well, as a matter of fact, the market in the pre-cast girders is, how do you say it? We have a lot to do." TA** • **"Yes, sure, Let's be honest on that. I think, if you don't change, some other company will change and if you can be ahead of them, it's beneficial." TA**
	Risk allocation		
		Public (testing)	• **"Of course, that's one of the things we are still looking at actually." PMSBIR** • **"You can look at it, as well it's not cracking in 100 years, it's looking well, maybe we can reuse things. So how do you go with the risk on that? And how does one company, who is in the company that get this used one? Yeah, you need a certification on that." PMSBIR** • **"I think the government is obliged to do that because otherwise people won't accept it." PMSBIR** • **"So, you need to have some kind of certification, I think, through a government agency, because otherwise it won't work. They won't accept having risks, but risk will always be there. Everybody's trying to marginalize the risks. And of course, the market will always like it when the risk will go to the buyer, to the client." PMSBIR**
	Financing	Public (financial)	• **"So, the public party started and sponsored this innovation research. So, for this project, financially the risks were low." CM**
	Budget exceedance	Private (financial)	• **"We had a certain amount of money to realize our pilot. So that's the risk we took. Could we make this pilot and keep it within budget? So that's one of the risks we took. Yeah, I think that's the main risk. So that's why I have to start from sponsoring. But the main risk for us is that we did a proposal, and if we can fix it within the budget. I think that's the main risk for us." CM** • **"Well, the budget of the public party was fixed. We had some room to go left or to go right. But yes, the budget was fixed. So, if it doesn't fit financially, then it was our risk." CM**
	Roles and responsibilities	Private (construction)	• **"So, first of all, the risk is for the contractor, who built it." PM** • **"[But you say the consortium side have a complete account of all the risks in terms of the reuse of the girders?] Well, we accounted the risks of the regulation." BDM** • **"So, I think that these risks, the risk allocation was on us. Well, it's up to us to prove that there are no risks, no other risks for our clients. And we do that. So, it's possible." BDM** • **"[So would you suggest that maybe the client could accumulate a little bit of the risks from your hands? Maybe that would be a good strategy?] No, we don't. We don't want them to take over any risks from us. And we want them to accept, that it's not a new one because it looks different, of course, because it's second handed." BDM**
		Joint private parties (in project)	• **"[...] But all the risks should be borne by all the competitors, of all the companies." TA** • **"Last week I made just a brief setup for the responsibilities and what we have to deliver at what part. But now we're not responsible for that. Yeah, of course our name is sticking to it, so that's more a commercial risk, but on the back end it's an equal risk." TA** • **"The other risks were general. We could speak about them, and we start and we talked on how we could manage them." CM**
		Joint (future risks)	• **"However, the real challenges are with stage three, when we will deal with real projects. This standardization is the**

			important part. In this phase, our combination cannot be regarded as a business case. We don't have a contract with each other. We have something like an informal alliance that aims to innovation. Everybody is willing sharing the knowledge and participate in the initiative. The problem is, that everybody wants a share of the potential profits, but what about the risks? And even losses? That's something that we should think for the next phase." PMC • "Because that's what happened. We didn't have projects. We can harvest girders and they didn't have projects where we can use and place our girders. And that was a big problem. That was a risk." PMC • "Yes, but it would be nice when Rijkswaterstaat takes a part of that risk." PMC • "Because it's in an innovation, and a party has a bigger risk." PMC
Rewarding	Innovation	Mitigation measures	• "So, within this project we had a lot of specialists who could inspect, or they could make engineering calculations on whether those beams were right to give them a second life. So that's one of our measures to reduce the risks. But you're right, that's one of the risks that we as a private party had." CM • "So, we stand for the safety. We recalculate, we inspect, we repair, and we do everything to make it as a new girder as possible, to fit the new project. And we guarantee this. So this is not about the safety of this girder. This is not a risk that other elements are not the same. That's the same thing." BD • "[…] we have an external party. We work together to first write in a protocol on how to reuse girders. So, every step is written." PMC • "And we worked, along and a plan. And I checked it, with the external party. I have been in at least partly checked it also. So, they will come with a certificate and an explanation on it." PMC • "Well, we delivered these reused girders with a certificate." BDM • "And we can prove, that they don't have to be afraid of any damage. Because we recalculate, and we inspect. And we have an independent firm that comes and controls what we have done. And they give us certificate." BDM • "But this was one of the reasons that nobody did it. Because they were afraid of this risk allocation, and they were afraid of the regulations. But because we do this project right now, we can prove that it can be done." BDM
	Ownership structure		
	Nature of the project	Public (project)	• "[And about the ownership structure of the project that you are constructing right now. I assume, that it will be all transferred into the public client right into Rijkswaterstaat. But what we can say also about ownership is that you selected the open-source approach and so you are willing to give to the public what you're going to learn, in order to expand the space?] Yes. Exactly." PMC
	SBIR	Public (knowledge)	
Monitoring		Multiple layers	• "And so this is what we did here. So firstly, we do the checking ourselves within the consortium. Then, we asked the client to come and join in it, because they have experts as well. So, come on with your experts to show you that it's alright. And thirdly, the lock at the door. That's the certifying independent checker." BDM
	Collaborative approach	Informal (progress meetings)	• "No, we do it on our own. So, within our combination of partners, we did the project management ourselves." CM • "Well firstly we monitor ourselves." BDM • "Then we have guys, from Rijkswaterstaat GPO. And, we have a partnership to work on stage 2. That is more like a partnership. So, in the line of a PPP. And we have to convince them that the girders are safe to use for a long time and therefore we are open and transparent." PMC • "So, when they want to see the progress, or the results, I will go to them with our work on the girders, and they can

Monitoring			**look at it. And we can show in this stage the modification of the girders." PMC**
	SBIR	Formal (based on contract)	• **"And we had team meetings, internal team meetings. We also had a support team meeting with Rijkswaterstaat." CM** • **"So, being there to watch, asking the client to watch. So, this is all our own consortium thing." BDM** • **"First, is the Rijkswaterstaat PPO. They are the clients, and they hopefully help us with our bridge. And then we have our contractor to do the building for me. And there is a very formal relationship between those parties." PMC** • **"So, there is the old contract that we signed, and we have to deliver. We have to confirm that the contract is closed." PMC**
	Certification	Third party (testing)	• **"And finally, we asked an independent checker to come and look at the result and inspect and ask questions, and maybe do suggestions to do things better." BDM** • **"And we worked, along and a plan. And I checked it, with the external party. I have been in at least partly checked it also. So, they will come with a certificate and an explanation on it." PMC** • **"Yes. They don't check the calculation for the construction, they check if the reinforcement in the girder is alright, if it is damaged. And whether there is damage by the modification of the girder. And whether it needs some repairing, so it can be reused." PMC**
		Informal (parent organizations)	• **"We had internal meetings within our company to, well, be informed at the right way for the progress in this project." CM**
Capability Building	***Actor Selection***		
	Involvement	Single party selection	• **"And based on that, well, we got 32 people who offered the quotation. Of that 32, we got 10 companies who are co-creating companies, sometimes where more in one companies in the collaboration." PMSBIR** • **"This project, this pilot project has two stages. The first stage was to prove and write a report about your concept. And there were over 30 parties that that made the concept. But, there were only three parties that were selected to make a pilot. So, in this first stage we were alone." BDM**
	Past relations		• **"Later on, when they were selected for the pilot, they made the conclusion they were not complete within this partnership. So, they asked us. We had good contacts with R, because we were more often together with them. So, they asked us if we were interested to join the combination and that was also asked to H. as the new beam producing company. So, they're mainly producing new beams in the market." CM** • **"So, they weren't involved in one of ten parties. And they told us that there were maybe a good party to cooperate with, as a combination. And that was very nice. And basically, we are in a collaboration with H, who built new girders." PMC** • **"So, we looked around and that's where my experience came in. I'm the account manager of the contractor, I knew from the regular talks that I have with them, that they were interested in this project and that they were doing over the years circular projects. And they have succeeded themselves, to handle a girder, an old girder and take it to new place. And they did it in several projects, so when it came to the question which party is best to create a consortium, which one is it trusted partner, I advised to deal with them. So, that's something that I did." BDM**
	Motivation		• **"So, we didn't get to choose it. We were chosen." TA** • **"Oh, we did it ourselves." BDM** • **"So, we think it over we talk to our partners, we asked, "Is there something missing?" And we feel that we have now a complete consortium with all the aspects covered." BDM** • **"But they're motivated and that's very important. They are motivated to join us. Because we knew we had to**

Capability Building			**experience new things. Then you have to deal with motivated people and motivated parties." BDM**
	Experience and knowledge		• **"At the start of stage 2, there were ten parties. We and H where involved, along with other parties that were selected." PMC** • **"But when we started when we were selected to do it and make a pilot project. Then, we realized we are not the ones that have crane drivers for instance, we are not the ones that have the personnel to handle the sow of girders, etc. That's the contractor, so we need a contractor firm." BDM** • **"Yes, we started with the contractor V, because they demolish bridges. So, they could give as hand on girders. And we involved S, because we also think it was very important, an external quality party." PMC** • **"And so we had the best experts from our partners, and they want to join and they want to work for each other." BDM**
	Innovation		• **"Much of the project groups that I see around are established with the persons that are available. So, we were selective and that's a luxury." BDM** • **"So we looked in the organization of our partners and said which one is the most innovative, is the most driven by it? OK, then he or she should join." BDM**
	Nature of the project	Multidisciplinary	• **"So, the consortium consists of many parties. In this case, the contractor is our customer, and we collaborate. So, the engineering company, a supplier, and a demolisher. I think is a very good combination." TA** • **"Yes, so there were 4 parties involved. D that had the business model for stage II and they were also responsible for the matchmaking. We also had H as a girder fabrication company. And V our demolition experts." PMC,** • **"And, what's really important in this case is that you have to work between the chain, at the whole chain. And that was necessary because we were asked to do a lot of specialties within the steps we have to take, to get the reuse of a beam. So, we need it every party for their specialism to be involved, and I think that is one of the difficulties." CM** • **"And in my view, they are a trusted partner. So, It is not a regular contractor that I work with, […] And they were interested because they see as well that the demolition business is changing as well. It's becoming a deconstruction business instead of demolition." BDM** • **"Mainly, S. was not within the consortium, but was the one we hired for some specific activities, like the certifying part." CM**
	Experience and knowledge		• **"So the main thing is that you can't do it on your own, and through this collaboration, it's working." TA** • **"In my experience I noticed that if you want to make a change, it's very hard to do it on yourself. And it's hard to do it with one company, and I think that initiative was a very good opportunity to cut through the section of the market in total." TA**
	Involvement		
	Experience and knowledge	Early (majority)	• **"So, I said, well, if we have to do that in 2030, we must be having the markets ready at 2027. So, our perspective was always to do an earlier supplier involvement. Early involvement of the market. So that's why we're an open and learning environment because it seems that it costs more time in the beginning." PMSBIR** • **"So, we always were like we have to get the market early involved because it's necessary to give them a good mindset." PMSBIR** • **"[Do you think that early involvement is important in such project? So that if an actor is involved earlier on, and has a better understanding ,that can facilitate the process?]Yeah, I think it's good that we have a broad line up of all the different companies […], and the sooner you can bring it in, the better it is, the better the plan will work out, and that's what we have proven already." TA**

Capability Building	Nature of the project	Late (minority)	• **"But in the end you see, there are two parties of the prototypes who were there already in the open learning environment. Their mindset is radically different than the one who wasn't." PMSBIR** • **"(The other party) They just stepped in at the moment we did the SBIR, which is OK I mean, but it's a different rhythm, right? It's a different mindset." PMSBIR** • **"So, we were one of the two companies that were involved later on. So, that's how the matchmaking was made." CM** • **"[And do you see a difference between people that were involved earlier on and people that involved in the later stages?] No, no, not at all." CM**
	Training and Continuous Improvement		
	Collaborative approach	Training (in open learning environment)	• **"So, we made six themes, one was on design, the other one was procurement. There was co-creating. I can't build up in English, I have to think very hard. So, another one was technology. And there was also data and business models. And every team had one particular person from a government agency and one from the market or from knowledge institutes. Universities were also joining." PMSBIR** • **"They were, well, they were interrogating, interviewing. They were getting perspectives. […] Those conclusions were all used in the actual SBIR which went to the market." PMSBIR**
	Experience and knowledge	No training (in the project)	• **"[Yeah, was there basically a training on the subject?] Oh, no. But all the parties were convinced that we can reuse girders. And so they'd like this solution." PMC** • **"I think no one has got a training to work or to be involved in this project. So, it was more of a fluid procedure, to understand how to work together and that went well, so the steering committee also doesn't have to get some measures to work better together. So, it was all really good from the beginning." CM** • **"[And did you during the project, had any training, or did you acquire new capabilities or was there someone trying to teach you new things in the project level?] Not like an organized teaching, but I do learn a lot from the collaboration." TA**
		Learning	• **"Not like an organized teaching, but I do learn a lot from the collaboration." TA**
Roles & Decision Making	***Roles and Responsibilities***		
		Clear	• **"Another important thing is that everybody has a specific role, that fits in the project. So, the clarity of roles is important." PMC** • **"[…], but every partner took their right role in this project. So, that was good to see." CM** • **"Oh, yeah because I think that's a good thing to understand, all the engineering until now has been done by the engineers, because they're engineers, right? So, we rely on their experience on that. Because, yeah, there are new calculations, sure we saw it but there is no involvement going on from us. So "You'll do this and we do that"." TA**
	Nature of the project	Slight changes	• **"[…] Does this project require something extra from you in terms of traditional projects, let's say? No, it was, well in the sector we are working all the projects have some uniqueness." CM** • **"For me it's not very different because I consider myself as a person who ties together the wishes from the market with the capabilities that we have as a as a firm, and in this case the capabilities that we have as a consortium so, I am a connector." BDM** • **"So, your question was why is this different from your natural job? It's not quite different, it's my natural role as a connector and a motivator." BDM** • **"And they were interested because they see as well that the demolition business is changing as well. It's becoming a deconstruction business instead of demolition." BDM**

Roles & Decision Making			• **"Oh, I think the way they we were working, V. is a demolition company. Reuse is not new in our sector, so that's the new part. But the way they are working like moving out the girders, as beams that was pretty much the same as they do, incidentally in some cases. So in 95% percent of the cases, they will demolish the beams, but in 5% they have to take it out like we did for the reuse project." CM** • **"So it wasn't totally new, but, the new aspect here is you would like to reuse them, so there were some restrictions or some extra measures to get the beam right out of the bridge." CM** • **"So, our partner, a construction company are saying why do you do that? Because it's a threat to you. And I answer, no, it's not a threat. It's a big chance and we have to take it." TA** • **"It's their business. In the future, maybe it's logical to ask the firm that makes the new girders, to be also the selling channel for the reused girders, that's a possibility." BDM** • **"And we showed them, that they can be the sales channel for reused girders as well. So that's the reason that we asked them to join us as well." BDM** • **"And we realized that maybe we can use their sales channel and their connections, that these kinds of firms have in the market, because they get questions, and give you answers by making new girders." BDM** • **"[And do the parties knew in beforehand, so before entering a collaboration with the consortium, that their roles might change, and how this was supposed to be?] Well yes, because we talked with them about this. Otherwise, they're not a good partner." BDM**
		Expected changes in next phase	• **"In these activities, that are the newest. Because in our sector we always work in projects where the public party is financing. So, when we have to realize something, we make an offer for a specific budget and then the public party pays. And here it is more some questions about entrepreneurship. I think those are the two different modes. So, the way we work together over the chain in the second one is where we do it more often with entrepreneurship. And the question is, are we all comfortable about it?" CM** • **"But the how. That's what we are discovering right now. That's why there is a pilot project. So, the how question is, the one we are answering right now." BDM**
	Decision Making		
		Multiple levels	• **"We have a working group. […] I'm taking part in this project group and all partners have a person in the project, and we have a steering committee above. The working group will report to the steering committee and the steering committee watches over the financials and the planning, etcetera. So, this is our usual project model that we use. No, big deal. We are used to that." BDM** • **"Generally, we tried to solve problems in the workgroup and significant decision making was done in the above group, in the steering group." PMC**
	Collaborative approach	Joint (in project level)	• **"Yes, every two weeks we meet each other and talk about all the subjects. Sometimes you have extra meetings. And there are meetings, about special subjects. Once in a month we talk for example, for big decisions in the partnership." PMC** • **"And in the work group we look for the cost, the technical part, for the calculation and we built it." PMC** • **"So in the workgroup there is a lot of talking, about a lot of subjects to make a decision. And yes, which is best for the project?" PMC**
		Joint (in committee level)	• **"And we also had a steering committee, yes. [But the steering committee was more about strategical decisions, right?] Yeah, that's right." CM**

Roles & Decision Making			• **"There is a, how do you call it? A Steering Committee of the directors of our companies. And they would discuss for decisions with a lot of money involved, or important decisions. So, then we ask for the steering committee." PMC** • **"[Are there all decisions taken by this steering committee or only for the big financial, let's say decisions?] Only for the big decisions yes." PMC** • **"And if is seeming to become a conflict, then we go to the steering committee. Yes, yes." BDM** • **"And we say: "Oh hey, there's a potential conflict, please, take a decision." BDM** • **"[So, in order to resolve the conflict, you can always go to the upper level to the steering group and let them decide?] Yes." BDM**
	Goals	External	• **"We had a contact person for all contractors, he was the same for other consortia, and he also participated in the meetings." PMC** • **"And there was a meeting with Rijkswaterstaat because they are still our client in this case. Well, they don't say client in this case, but they say partners. That's very good. And there's a meeting every month. So, there are three different meetings." TA** • **"So, we talked to Rijkswaterstaat, is it allowed to do that? To do so? They said yes, because it's growing the market. So please do so." BDM**
		Different decision-making models	• **"About decision making, it's important to understand that every party has a different business model. For instance, a party doesn't want to invest without a profit, while others are more open to it. It also relates to how risk averse or risk seeking is each party." PMC**
	Utilization of Knowledge and Resources		
	Collaborative approach	Joint (internally)	• **"And now we are doing a lot of a lot of meetings, a lot of research, a lot of knowledge exchange." TA** • **"So, in our consortium, we actually want to share all the information with each other. And we actually have to start, if we want to go to the market." TA** • **"And we work together with another consortium. And they have also this reuse of materials as a study there for their pilot project." BDM** • **"We suggest collecting all the knowledge. Not only within our company, but also with other parties and consortia. And to utilize it in a next project. And we understand that it is necessary to do it more often, to increase stimulation. And we suggest that." CM** • **"[And also capitalize on all the generated knowledge by 3 pilots, right? And not just from 1, right] Yes. Two of the three." CM** • **"This is one of the measures you can take, but there are also other measurements to increase the simulation through the reuse of materials. So, we suggested that after an excellent start, it's important to get the next project together." CM**
	SBIR	Joint (externally)	• **"So, we were just trying to establish on the forehand, an open learning environment where we could get a multi perspective from stakeholders both internal and external." PMSBIR** • **"Then we kind of noticed OK, we are an open learning environment, and we got a lot of perspective, right? But as it tends to go to an SBIR, the company starts using it as a real project which of course is but, on the same time, you don't have to steer it like a real project because as it is an SBIR. So, what happened was that the knowledge that we build up was really actually only in the team and some people who know it." PMSBIR** • **"So we were kind of looking at how can we still get this shared knowledge to show other companies could take a turn, or other government agencies that can learn from us and can do something with the learning, and experience." PMSBIR**

Roles & Decision Making			• **"So, we started a buyer group for bridges which I am the project leader now. And we are currently working on a procurement strategy to advise how we can do that and take it even further. I think if we look at it and say at this moment it's really after running a year, this is actually needed. Because yeah, well, I always say the frustration is in incubation." PMSBIR** • **"[Is this joint utilization of knowledge and resources a significant thing in the SBIR?] For me it was. I don't know if other people see it like that." PMSBIR** • **"So, from the first round, we saw that our innovation, wasn't a new innovation that we can do alone. So, everybody could copy the innovation. And, in the SBIR project you can score points, when your (solution) was open source." PMC** • **"Yes, it's in the contract. But we feel that it's good to do it because it's not a mature market and we have to share knowledge to grow." BDM** • **"But the main reason that we have this natural partner is that we know that there should be more competition. So, we're not trying to be the only one to do it. [And this is actually why you share the knowledge right?] Yes." BDM** • **"Yes, but it's also in the competition and when competition is established in the grown-up market, and this is not yet a grown-up practice. This is not grown up, so we can't have too much competition because we have to grow it first to put it on the market." BDM** • **"The wheel got start turning and well, we tried to do it by talking, by establishing connection." BDM**
		Joint utilization of resources (public)	• **"And we have a party, a province, with the project. And they could use our girders, that we harvest for that project. But Rijkswaterstaat didn't accept that their girders would be used for a province project." PMC** • **"Yeah, so this is the first obstacle and maybe it is passed when they try to be inclusive, but we had a big problem." PMC** • **"And I think that after a year, Rijkswaterstaat has changed its mind and now they accept to give their girders for province projects. And for the new 8-9 girders they will probably use it for a province project, so there is change in the mindset." PMC** • **"And we also made one project by adopting our solution with another, third public party. But it is all separate from the fixed budget of Rijkswaterstaat." CM** • **"So it's nice when you can reuse the existing girders in smaller projects, and that is projects from the provinces." PMC** • **"Yeah, absolutely yeah. But I'm glad that Rijkswaterstaat also sees that that's necessary. That's why they will continue with the scalability of it. And to collect all the experiences." CM**
Coordination	***Common Characteristics***		
	Early involvement	Common culture	• **"Well, the culture was built up, I mean it was of course it was like bad stuff, but it wasn't a typical rat race that culture. So, what we actually did we built actually in a different environment next to the already existing organization environment." PMSBIR** • **So, I think the culture we built in the team is that it was open as a lot of people like to work harder than they usually did I think because they were in it with not only their mind but also with their heart. So, I think. But there were a lot of different kind of people in in the teams." PMSBIR** • **"In such a project, you have to have partners who are willing to be open about what we do, how we work, what the real costs are. When the openness isn't there, then I think the project will fail. And here we have a partnership with partners, who are quite open about those costs." CM** • **"[A common culture] It's really important. And when there were difficulties in the project. There was mostly contact**

Coordination			**between some of the team members who understand more the soft skills and take good measures to have happy faces within the team." CM**
	Early involvement	Common process	• **"But yeah. It's just more like an organic way that evolved on its own procedure." TA** • **"[I think what you said about the process and sticking to the process is pretty important towards that direction, right?] Yeah, yeah, absolutely yeah." CM**
	Actor selection	Common mindset	• **"So, we really had big conversations about it and just look at the profile and the feeling we had. And they really wanted to do it because they feel the good vibe and the energy." PMSBIR** • **"I think mindset is maybe one thing, but it all depends on the parties who are working on it. So, one of them is more open than the other one. So, you have to have a right fit between parties." CM** • **"Oh, yes. Because we're the had the head ones in the firms that want to be innovative and want to be circular." BDM**
	Motivation		• **"But the mindset was that we are all doing something which is really nice and needed. I think that's what banded us all. What connected us." PMSBIR** • **"But we really believed in it so, you need to have a very intrinsic motivation to keep on going. It's not that easy." PMSBIR** • **"But all the parties were convinced that we can reuse girders. And so, they'd like this solution. It was a common practice, for every party to go to work like this, in this combination." PMC** • **"So, we all want to do the same. So, I think the collaboration is very, very good, yeah? Everybody wants to do it." TA** • **"But, in our group we support each other. I realized, it's because we are all experienced people, and we know what to do and we're motivated. We're all motivated to do this. So, we are motivated to work for each other and that's not common sense. That's not common." BDM**
	Flat organization	Common characteristics	• **"[And do you find it important to have some common characteristics? Some common project management structures or practices and also some common culture between the parties? And I mean the way that you view circularity or the way you view working with your partners, is this important?] Yes. Basically, it's a flat organization." PMC.**
	Actor selection	Different group characteristics	• **"Yes, group characteristics. You have to watch that all characteristics are there. Because we have the commercial aspects of the girder […]" BDM** • **"So these aspects should be represented in the persons, right?" BDM**
		Common procedure	• **"[So in your team, was there a procedure that you have to follow in terms of what software do you use? What time do you work? What practices do you use?] No, not at all because when it started it was pretty covered by the client. And after that we all gathered up behind the themes." TA** • **"This is the starting point. And that was also the case in this project. It was totally different than a normal realization of infrastructure in the Netherlands, because now we were at first only working on the feasibility study and later on, we did the pilot so it was totally different than the reality of engineering and realizing infrastructure in the Netherlands. So, yeah totally different. But the way we were working well it was pretty much the same as we do, in such kinds of projects." CM**
	Communication and Information Sharing		
	Roles and responsibilities	Organized through a single party	• **"And R. is doing the pen work, forwarding the show quickly on this. They are doing a lot to combine all the information. And that's also a thing I learned, maybe it's not a answer to your previous question." TA** • **"There's a lot of information going on. And that is because we have the projects that we're doing, just not one project but we are working on 2,3 projects." TA**

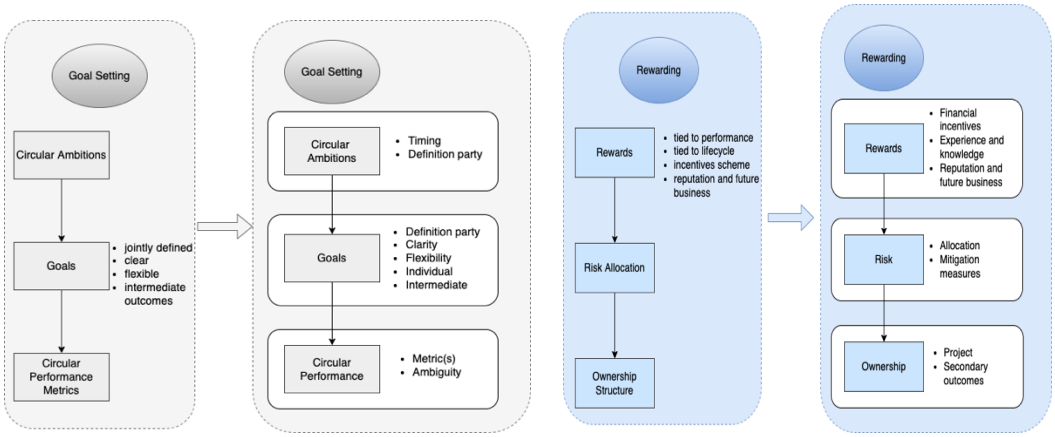
Coordination			• **"So, this contains a lot of information and it's I think it's hard to channel all the information. But they are doing a good job. I couldn't do it." TA**
	Circumstances	Applications	• **"I always start face-to-face, with a new relation. Um, and then we use teams, of course. And I myself, I don't use BIM? BIM is not needed for this project, of course. The project where the girders, the reused girders are put in, of course it needs to fit in the BIM of that project. But this project of ours, the sowing, doesn't have BIM. Which communication do we use? Well, we use the phone. We use teams. We use the personal contact, well not anymore though." BDM** • **"[BIM like building information modelling, Revit files, etcetera?] Oh, like that no." TA**
		Personal meetings	• **"And there is a new business line that actually starts, and it includes a lot of meetings." TA** • **"Yes, every two weeks we meet each other and talk about all the subjects. Sometimes you have extra meetings. And there are meetings, about special subjects. Once in a month we talk for example, for big decisions in the partnership." PMC** • **"So in the workgroup there is a lot of talking, about a lot of subjects […]" PMC** • **"No, it was really quite traditional communication within the team." CM**
		Information sharing through applications	• **"[…] we also work on a SharePoint site together, but those were the two main ways we worked together." CM**
	Change Management		
	Collaborative approach	Negotiation (internally)	• **"If there were any changes. Um, yeah, there were a lot of changes. I think. Yes, a lot of changes. But like I said, because there was a lot of information and there's still a lot of information, it is still going on, which we funnel it very well. […] so giving an answer to your question. There were a lot of changes and we just addressed them in our biweekly meetings and just follow them up." TA**
	Authority	Negotiation (externally)	• **"So, we can start again sometimes and do some other activities, with the acceptance of Rijkswaterstaat. So, in this part we were free to explore options." CM** • **"So, this is how we deal with changes. […] we are capable to shift a little bit, while keeping the goal in mind. And we talk to the client, what is you opinion? We have to take that into consideration, and the we can change our goal a bit. So, we ask "Do you agree that we do this?" and the say "Yes, because we ask for it". and then we go on. And in this way so, we try to think too much and to talk with them." BDM**
		Change of goals	• **"A major change was made by Rijkswaterstaat, who said OK, these girders should fit in a regional project. But we thought a project of the province in the south. Our aim was to make a real project. Then they asked, can you look for another project to use these girders? But that was a difficult task, we couldn't find one. Further, they said OK, it's complicated that you have one contractor in your team, while we have other contractors who are making a new viaduct. How, do you deal with that? This is complicating. Why don't you take a project from our partner? OK, we said, well do you have a project that fits in the regulations? In the end, we found a project, an expansion project that was contracted by our contractor, near the center of the Netherlands. OK, what are the specifications? OK, the length doesn't suit to the girders that we have already. OK, what then? Is there a possibility to get a reused girder from another project? OK, finally we found them, and they are 200 kilometers far away." BDM** • **"So how do you deal with changes? Well, within our consortium, we try to make a new combination and to do it in the way I described. So, this is why we do this. In the end we had too many girders." BDM**

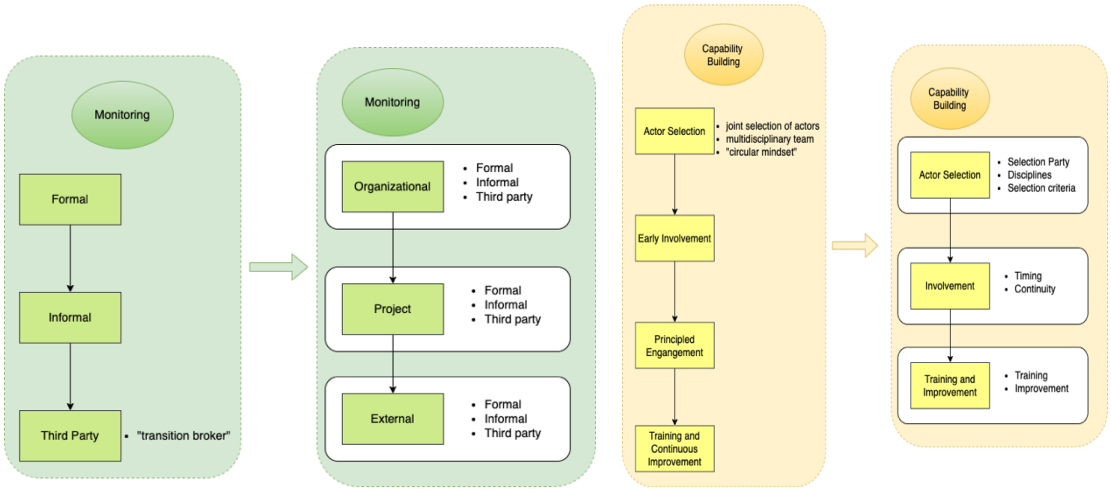
Coordination			• **"Well, we said OK we have extra girders. What do we do with extra girders? OK, there's a temporary project in the north as well, we can use them. So, let's make another pilot project. So, we use that to be more experienced. Because it's a temporary project, it's lighter work and regulations. So, we used it to better our process for the real pilot project. Then we have the six girders in the first location and there's a client, a province that wants to have them as a third project. So, we are doing this. We're going to use them in a province project." BDM**
	Conflict Resolution		
	Collaborative approach	Negotiation (in project)	• **"And when there were difficulties in the project. There was mostly contact between some of the team members who understand more the soft skills and take good measures to have happy faces within the team." CM** • **"[Was it the case that the right people, the more open and more communicative people were selected to resolve those kinds of issues?] Yeah, absolutely." CM** • **"Difficulties were discussed between team members who also have influence in the team. Who are the open ones, more strategic oriented and have influence in the team." CM** • **"And if there are some, they are for example when we mounted the first bridge we have to move the old girders and somehow we didn't do the lifting of the girders but it was a outsourced." TA** • **"And I addressed it. I said that we put so much effort into it and that's so good. And then we just do the last part of it and we made a mess of it in the he end. So, I think we should take a look at ourselves, including me and just don't do it again. And everybody agrees, so now we just said if there should be done lifting. We also do the lifting." TA** •
	Roles and responsibilities	Reporting of issues	• **"No, we did not have any conflict. I think the mood is always positive." TA** • **"Yes, of course. Because there were, well not so many conflicts, but there were issues to discuss." BDM,** • **"So I'm trying to avoid conflicts. And I am doing this by addressing potential conflicts or issues. And it's not only my task." BDM**
	Authority	Decision-making (steering committee)	• **"It's every partner's task to bring up the potential issues. And we are all responsible that it doesn't grow into a conflict. And if is seems to become a conflict, then we go to the steering committee." BDM**
Motivation		***Trust***	
	Collaborative approach	Early	• **"We had trust, high trust, and I think looking back at it now, I don't know how it will be in two years. But looking back at it now, I think it's a quite extraordinary process we did together." PMSBIR** • **"So, what we actually did we built actually in a different environment next to the already existing organization environment." PMSBIR**
	Openness	Facilitators of trust	• **"In general, I create trust in the team by being open myself, and just tell them how I am, what's the situation at our side, and what is important for us." CM** • **"So, I think openness with an open mind and open attitude you create trust. That's the way I have it in this team." CM** • **"I think, in generally we have a team with people with an open attitude." CM**
	Roles and responsibilities (initiator)		• **"Oh yeah. I think that R. did very well, because they initiated everything in it. And they said I'm open about everything. And they were open about everything. And I think all the partners are copying that kind of behavior." TA**
	Communication		• **"Apart from that, for trust building, we have seen each other every 2 weeks. We had a meeting. So, I wouldn't say that we saw each other a lot." PMC**
	Rewarding		• **"So, in this line of work, money is important. So, trust relates to what is paid, and to how we spend the money. Every 4 weeks, we had a meeting where every party gives**

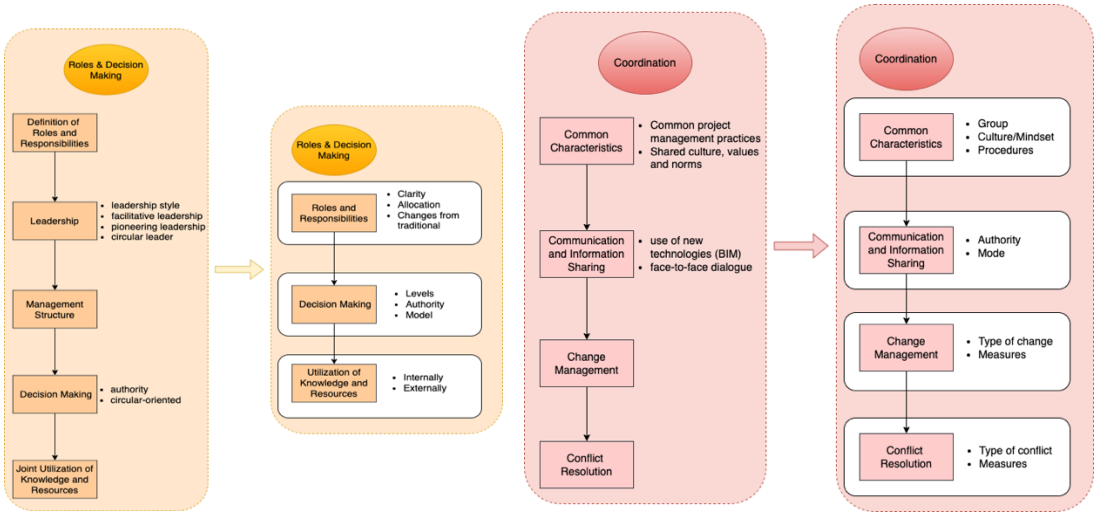
Motivation			**their expenses. In this way, we see that everyone is repaying their costs actually, and not making a profit. And so we create trust." PMC** • **"In such a project, you have to have partners who are willing to be open about what we do, how we work, what the real costs are. When the openness isn't there, then I think the project will fail. And here we have a partnership with partners, who are quite open about those costs." CM**
	Legitimacy		
	Motivation	Internal Legitimacy	• **"Well, an important thing is that everyone is paid based on the cost. Another thing is that everybody is willingly participating. They want to do it by their heart, and everybody is happy when they work on the project, and by the exposure that comes with it." PMC**
	Roles and responsibilities (clarity)		• **"Another important thing is that everybody has a specific role, that fits in the project. So, the clarity of roles is important. I would say legitimacy comes as a combination of everyone feeling nice and having a role that fits in it." PMC**
	Communication		• **"By talking. And by sharing our results. So that they see it works, it can work. Or that it's not working right now, but there is potential there." BDM**
	Results		• **"So showcases, and making business cases." BDM**
	Rewards		• **"Because people are driven by results in many cases in the market. So, you have to show them that there is a possible earning model." BDM**
	Matchmaking	External Support	• **"External support from the government and setting the base for circularity is pretty important for those projects." PMC** • **"But at some point, we made a business case and we concluded that we needed principle from Rijkswaterstaat." PMC** • **"Because it was always financially much more expensive to get a beam, a second-hand circular beam out of the roads instead of buying a new one. So, we have a phase where a circular beam is more expensive than a new one. But we also believe that will change in the future." CM** • **"So one of the issues is if we can reuse those beams. But the other thing is that they have to stimulate it. They have to start private-public collaborations, to stimulate it. And the simulations are not quite there, or they are too low at this moment, in this case for beams." CM** • **"Yeah and it depends on our collaboration, but mainly it depends on the government. And they should reward it or compensate for it in a way that it is viable and competitive." TA** • **"Because in this phase we just need the public party to encourage it to do it more often, or to stimulate it." […] But I'm glad that Rijkswaterstaat also sees that that's necessary. That's why they will continue with the scalability of it. And to collect all the experiences." CM** • **"So, you will have to dictate that instead of demolishing and make a lot of waste out of it, you will have to reuse the girder in a complete way." TA** • **"And then, the stage after this we have to prescribe in new contracts that girders that exist, should not be demolished, but should be taken out as a whole and delivered back to the client for taking care of it. So if you did, if you do that, you prescribe it and then it's not demolished. Then you create a storage" BDM** • **"We already advised that they have to start increasing the stimulation factor in every tendering. To reduce the costs when you increase the bonus factor for the MKI. For instance, with an increase of the bonus factor within 2%, the case of beams will succeed. So, the public party or the private parties can then initiate all this business by themselves. So they can start the next "flight" themselves." CM**

Motivation	Flexibility of goals		• **"We asked the client to accept it." BDM** • **"We are capable to shift a little bit, while keeping the goal in mind. And we talk to the client, what is you opinion? We have to take that into consideration, and the we can change our goal a bit. So, we ask "Do you agree that we do this?" and the say "Yes, because we ask for it". and then we go on. And in this way so, we try to think too much and to talk with them." BDM**
	Motivation		• **And if you have an architect and you ask an architect, look at this this new bridge that it's built from partially reused girders, maybe he says, "I think it's ugly" because… And we asked the client to talk to the architect and explain that ugly is not an issue. Alright. So, not a constant color. It differs because it reused." BDM** • **"Oh, yes. Because we're the had the head ones in the firms that want to be innovative and want to be circular." BDM**
	Communication		• **"So, I had several meetings internally to explain why this is important for us and how it can help us to build more sustainable so, when you're involved in this project, you do a lot, you're getting a lot of experience and I used it to inform my management about how important it is for us and what are the benefits or the changes that can be derived from this project." CM.**
	Organizational goals		• **"And yeah, we've talked about it a lot of times. We let it rest nights and nights. And all the cons and pros because like I told you, it's also a threat to us because, there will be less market for new girders. But yeah, in the end we judged. If we see all the advantages and the disadvantages, the advantages are more. So we did it very thoroughly with the two of us, my manager and myself." TA**
	Engagement		
	Common mindset	Facilitators of engagement	• **"But the mindset was that we are all doing something which is really nice and needed. I think that's what banded us all. What connected us." PMSBIR**
	Motivation		• **"Because sometimes someone is very internally motivated but within an organization, he isn't really connected in the organization. So that's I think in your research is really good to pinpoint." PMSBIR**
	Common goals		• **"So, we all want to do the same. So, I think the collaboration is very, very good, yeah. Everybody wants to do it." TA**
	Experience		• **"But, in our group we support each other. I realized, it's because we are all experienced people and we know what to do and we're motivated. We're all motivated to do this. So, we are motivated to work for each other and that's not common sense. That's not common." BDM**
	Rewards		• **"In phase three, for us is going on further like a collaboration, like a consortium to make a project. [to make a business case and be able to utilize it right?] Yeah, yeah." TA**

Appendix F – Redesign of the Governance Framework







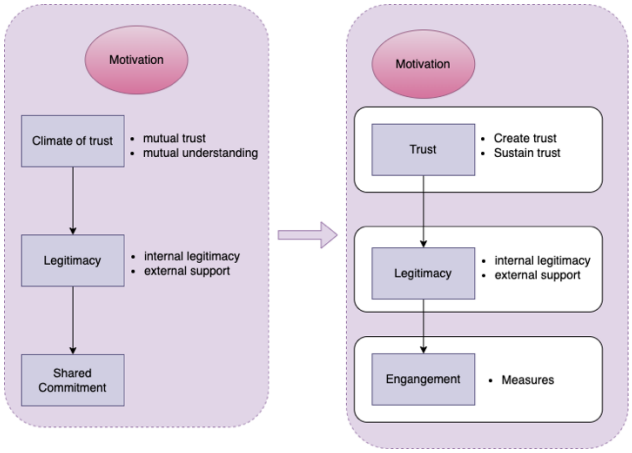


Figure 41: Redesigned Governance Dimensions and Mechanisms based on the feedback of the interview procedure

Appendix G – Correlations between governance arrangements

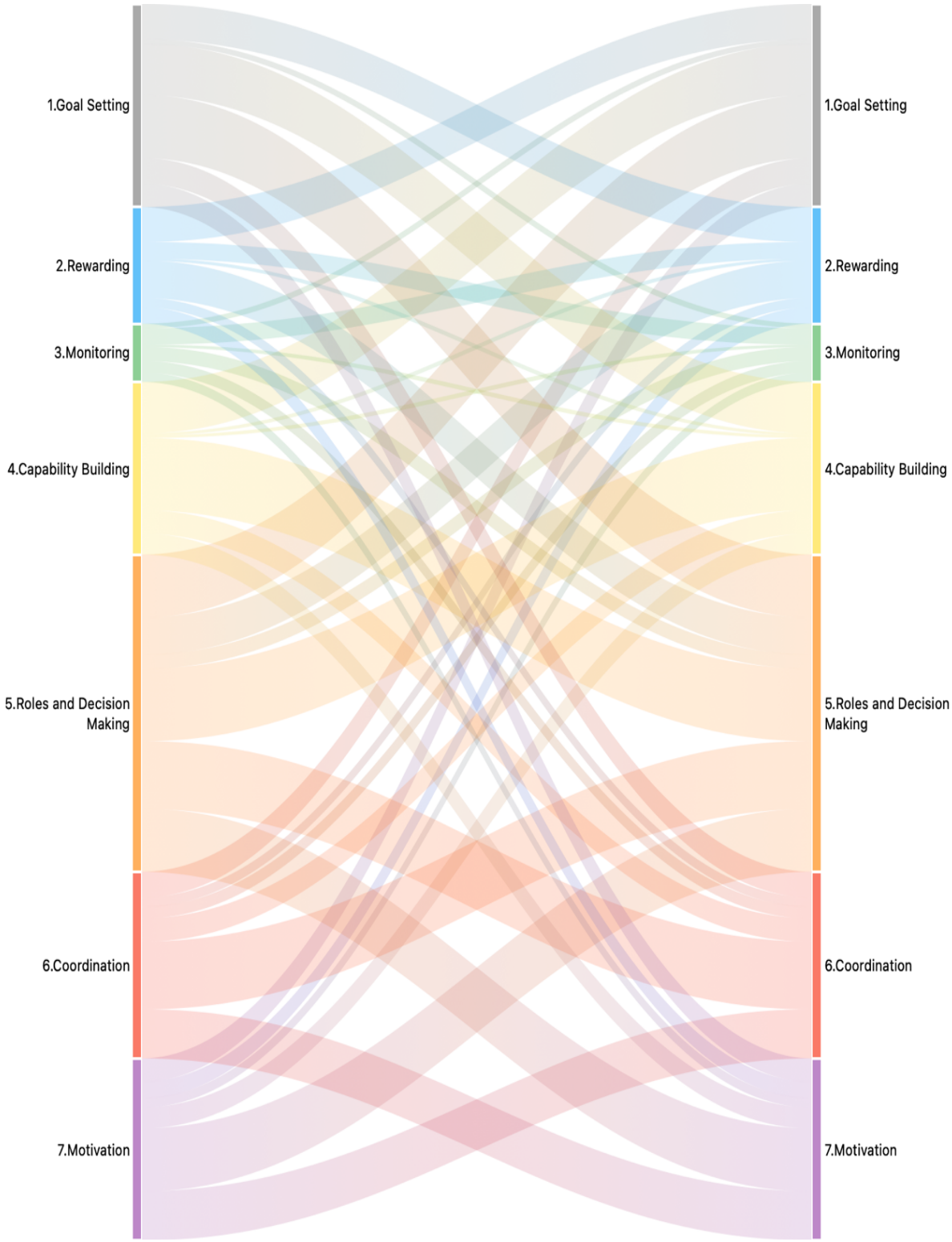


Figure 42: Correlations between Governance Dimensions. Image generated through ATLAS.ti

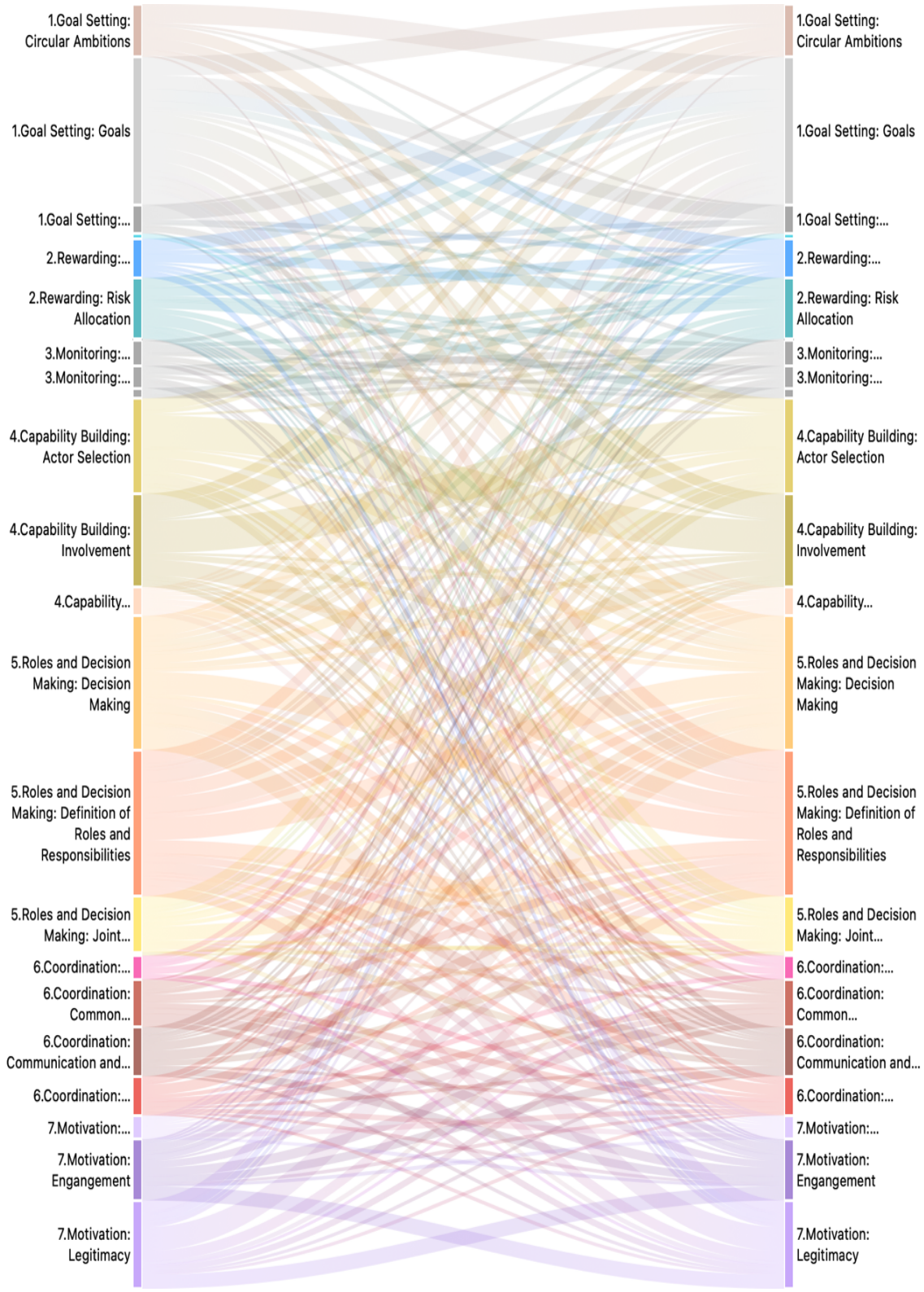


Figure 43: Correlations between Governance Mechanisms. Image generated through ATLAS.ti

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