Master's Thesis

Investigating governance mechanisms in the inter-organizational collaboration between public clients and contractors during the front-end phase to facilitate the transition towards a circular economy in the built environment

M.Sc. Construction Management and Engineering

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Delft University of Technology

TU Delft

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Preface

This thesis is the outcome of support and contributions from several people who deserve a special mention. In the first place, I would like to thank my graduation committee, Ph.D.(c) Pedram Soltani, Dr. D.F.J. (Daan) Schraven, and Dr.ir. A. (Ad) Straub, for the help, guidance, and support they offered me during my master research. It was a great honor to work together. It went very smoothly; gaining so much knowledge and enjoying the journey.

Working on my master's thesis was a tremendous experience. I had to delve into the professional field to find suitable projects and people to interview, which was challenging. Therefore I would like to express my gratitude to all the people I interviewed for this research who kindly gave me some of their busy time to provide me with valuable information and enjoyable experiences.

Last but certainly not least, I would like to thank my husband Santiago for being the greatest pillar in my life; all this is yours, as well as mine. To my family, parents, and brother, all the efforts are for you.

Hopefully, I succeeded in conducting research that will contribute to the existing knowledge while being applicable to the building sector practice. Enjoy reading the result!

Anyely Mazo Goez
Delft, 2022

Abstract

The circular economy in the construction sector aims to lessen the environmental impact of construction projects by incorporating the end-of-life phase into the design and the conscious use of reusable resources. To achieve a circular economy in the built environment, it has been evidenced in the literature and practice that governance mechanisms in inter-organizational collaboration are required between the multiple parties involved to quickly rethink the purpose of the project, the desired outcome, and the aligned efforts towards the solutions of circular challenges. This research gains insight into the governance mechanisms that have proven to be desirable or beneficial in the collaboration between public clients and main contractors during the front-end phase in building projects with circular values. It is accomplished through two stages: (1) a comprehensive literature review was conducted where 25 articles were selected based on keywords related to inter-organizational collaboration. It brought the most representative knowledge of the existing forms and types of collaboration on construction projects, as well as an existing framework created to analyze the approaches for coordination, adaptation, and safeguarding of exchanges between the focal parties of inter-organizational projects. The literature included a second search of current circular practices in construction projects; (2) a multiple-case study strategy was conducted to explore how the inter-organizational collaboration between public clients and contractors was governed toward the delivery of circular building projects. Data was collected from publicly available documents and semi-structured interviews on the three cases that shared the most similar approach based on applied circular practices. This study's result contributes to the current literature and practice by asserting that governance mechanisms in inter-organizational collaboration between public clients and main contractors facilitate the adoption and implementation of circular practices in building projects. The results expressed that relational and contractual governance mechanisms complement one another in goal-setting, capability building, roles and decision-making, rewarding, coordination, and monitoring. Various governance mechanisms within each of these dimensions can be employed to pursue circular practices under specific contexts, thereby supporting the transition to a circular economy in building projects.

Executive summary

Introduction
The circular economy (CE) concept is advocated to alter the existing dynamics of production and consumption centered on "take, make, use, and dispose," which endangers the planet and future generations' ability to meet their needs. Therefore, the circular economy adopts models for "closing, narrowing, and slowing loops" of resources. Although the CE idea is gaining global acceptance in various industries, the construction industry remains one of the most conventional and least innovative in this regard.

The literature relating the circular economy and the built environment focuses on economic and environmental perspectives. However, there is limited literature that emphasizes the social aspects, such as the required arrangements, structures, and processes for the coordination, adaptation, and protection of inter-organizational collaboration exchanges, to manage the circular process effectively. Similarly, in practice, many construction companies still lack expertise in the field of circular economy, as well as the skills and knowledge to independently implement all the processes that circularity necessitates in construction projects. Thus, it makes collaboration with other actors a prerequisite for circular economy. Nonetheless, collaboration, despite its importance, is portrayed as opaque and a black box where the governance mechanisms employed by numerous companies to define inter-organizational collaboration remain unexplored. Consequently, a lack of understanding regarding particular governance mechanisms beneficial for inter-organizational collaboration is one of the primary challenges to developing CE in projects.

Research objective
This research aims to gain insight into the governance mechanisms that have proven desirable or beneficial in the collaboration between public clients and main contractors during the front-end phase of building projects with circular values. Then, comprehensive research was conducted through this study to respond to the research question:

How is the inter-organization collaboration between public clients and main contractors governed towards the delivery of circular building projects during the front-end phase?

Research approach
The research was comprehensive, qualitative, and exploratory. For this purpose, a *multiple case study* approach was selected, which involves the investigation of various associated cases. The cases were selected according to four distinct eligibility criteria. The multiple case study strategy was suitable for answering the main research question because it permitted the exploration of multiple contemporary projects in the real world that meet the criteria for circular building projects. Conclusions are expected to be analytically generalized using multiple data sources to identify patterns and variations across case studies on governance mechanisms that have proven beneficial for the collaboration between clients and contractors in this type of circular project.

Research methods
This investigation included both an inductive and a deductive approach. The systematic literature review on governance mechanisms in inter-organizational collaboration and circular practices in building projects was inductive since it included an examination of general concepts and principles. In contrast, the multiple case study was deductive in nature because it explored the governance mechanisms and their influence in particular circular practices within projects.

In the exploratory analysis, the literature review was essential; 25 peer-reviewed papers contributed significantly to the development of the data collection protocol, for the in-depth interviews, and to the interpretation of the findings. Also helped in the definition of circular building projects, the identification of a proper framework that captures the various possible governance dimensions for the

structure of the research, and the commonly used and mentioned collaboration aspects that may lead to improved performance in construction projects in general.

Two qualitative methods, in-depth interviews and publicly available information, were used to acquire the data. The in-depth interviews consisted of semi-structured interviews with expert professional on the circular building project cases. They were selected through purposive sampling as the aim was to conduct interviews with professionals from both governmental organizations (public clients) and private companies or consortiums (contractors). On the other hand, the collection of public information was conducted as directly as possible with the actors involved in the project, utilizing various websites or digital reports from the parties involved.

Hierarchical analysis was utilized in the multiple case study data analysis strategy. Hence, the data analysis was conducted in two phases: an individual analysis of each study case and a comparison analysis, commonly known as cross-case analysis. Using Atlas.ti, the interviewee's responses were qualitatively examined for the individual analysis. Later, the cross-case analysis was constructed using the results of the individual analysis and a pattern-matching approach. It consisted of comparing and contrasting the data from all of the cases and identifying similarities and differences in the adoption of governance mechanisms and the resulting implementation of circular practices in building projects.

Results and analysis

The structure developed by the Kujala et al. (2021)'s framework served as a guide for analyzing individual results and cross-case analysis. Consequently, governance mechanisms that influenced the implementation of circular practices were found for each dimension of goal-setting, capability building, roles and decision-making, reward, coordination, and monitoring.

In the *goal-setting* dimension, mechanisms such as early contractor involvement for the definition of goals, building workshops, debates, joint definition of circular goals, and dialogue sessions were identified. These mechanisms guaranteed that the client, developer, and contractor collaborated from the outset to determine the most appropriate means to design and develop the building. Consequently, circular practices such as modularity, design for adaptability and flexibility, design for disassembly, optimization of material use, prefabrication, and deconstruction, among others, were implemented. Circular practices could not have been proposed in the absence of these mechanisms that provided diverse perspectives and circular expertise from the onset.

In the *capability-building* dimension, mechanisms were identified that ensured that appropriated partners were tied to the projects at an early stages. Partner selection mechanisms that supported the implementation of circular practices were discovered. Similarly, mechanisms for learning and continuous improvement served to disseminate inside organizations the best practices that achieved positive results for the transition to a circular economy. Such competitive dialogue strategies that provided discounts for circular interventions and quality were the most effective at promoting building design, construction, and operation to reduce costs through implementing circular practices such as reusing and recycling materials and components. Similarly, the implementation of interventions such as water collection and re-circulation, the use and production of renewable energy, the design for adaptability and flexibility, and the specification of higher-performance materials were intended to reduce the building's long-term operating costs.

In the *roles and decision-making* dimension, the flexible governance structure, expert teams to give advice and influence decisions, and leadership roles were some of the various mechanisms identified in the three cases that facilitated the implementation of circular practices. Likewise, internal discussion sessions, core teams, and joint definitions of roles and responsibilities were mechanisms that inculcated inter-organizational collaboration to enable actors to make appropriate decisions based on knowledge and share understanding.

Similarly, in the *rewarding* dimension, there were mechanisms such as reputation and flexibility in the allocation of risks that encouraged the formation of new circular ideas and the application of circular interventions, even if they were initially uncertain. On the other side, it was discovered that mechanisms such as pain and punishment mechanisms prevented contractors from implementing circular ideas that were not in line with the established objectives.

Furthermore, in the *coordination* dimension, a vast number of mechanisms were analyzed to align the behavior of each actor so that they could collaborate effectively. There were identified mechanisms, including cross-functional coordination teams, formal communication channels, project culture, collaborative sessions, and formal conflict management systems. In addition, the analysis found mechanisms that aided the adoption of circular practices, such as shared culture and informal integral discussions. Those mechanisms implanted circular thinking centered on reusing, recycling, and optimizing the use of resources within the project.

Finally, the analysis on the *monitoring* found client-implemented and contractor-enhanced contractual governance mechanisms, such as the verification and validation environment, contract module system, and information technology systems. Similarly, monitoring was strengthened by relational mechanisms such as steering sessions, informal dialogues, and personal relationships that aided in comprehending the individual and collective abilities and challenges to monitor actors implicitly.

Discussion

This study contributes to both the current literature and practice by examining the governance mechanisms that have proven to be beneficial in the collaboration between public clients and main contractors, as well as the impact of these governance mechanisms on adopting circular building practices. The results and analysis of this study also gave rise to discussing five specific points that substantiate and confront the literature.

First, this study sought to find the influence of governance mechanisms on the adoption of circular practices in building projects. Using the framework that structures the governance dimensions of inter-organizational collaborations, it was possible to find numerous mechanisms, arrangements, procedures, and approaches that facilitate or inhibit the application of circular practices.

Second, this discussion aimed to conclude on the joint effect of governance mechanisms on inter-organizational collaboration. The study, therefore, revealed how various governance mechanisms might interact differently and produce different outcomes. Here, it is discussed how specific mechanisms strive to enhance collaboration over project goals. Whereas, how other joint processes and arrangements attempt to maintain control, regardless the presence or lack of inter-organizational collaboration.

Third, the study also discussed the perceptual differences between public clients and contractors for the implementation of governance mechanisms. Here, two contributions were perceived. Firstly, the role of the public client as a legal agent providing contractual governance mechanisms. Secondly, the role of the main contractor who pursues relational governance mechanisms to deal with the day-to-day challenges in the project. The discussion provides practical examples from the three case studies to substantiate the assertions.

Fourth, the study evidenced the role of the type of project delivery model on the selection of governance mechanisms. The discussion rounds about the three types of integrated PDMs present in the cases and the governance approaches that they have in common.

Finally, the empirical findings of this study substantiate the literature by exhibiting the influence of antecedents on the implementation of governance mechanisms. This research discusses the encountered preconditions of institutional and organizational environment, task characteristics, sector and organizational cultures, preexisting relationships, and tensions and power structures.

Limitations and recommendations

Study limitations

- The investigation's research strategy involved analyzing three case studies. A simple project's outcome is the third part of the outcomes, which affects the study analysis.
- Purposive sampling ensures that influential individuals are interviewed, yet this study had 13 interviewees for the three case studies. However, there is always room for debating the size of the interviews that constitute an important marker of the quality of qualitative research.
- The research follows a self-reported nature of the data. This self-reported data presents some limitations as respondents may exaggerate their situation to stand out over other situations. Also, respondents may under-report the severity of some issues to minimize the attention on those issues.
- It is known that qualitative research is context-sensitive, so the results and conclusions obtained from the research depend on the context.
- The study included a single public client, in particular, that may have pre-established governance processes; this reveals tendencies in the various case studies that may not be reflected in other public client projects.
- In addition to the documentation used in this investigation, the investigation sought to gather additional information on the projects. Nonetheless, the parties concerned were unable to disclose this information, limiting the investigation's coverage in these aspects.
- Even though the interviews were prepared using semi-structured questions and were meant to address each of the six dimensions of governance, the interviewees may have omitted certain crucial research-related issues.
- Some questions may elicit sensitivity or recall negative memories that respondents do not wish to discuss, so diminishing the quality of the data and the possibility of obtaining crucial research findings.

Recommendations

- Involve diverse public organizations in research to discover the distinctions and similarities between the governance mechanisms established for circular building projects.
- The research could employ quantitative methods to obtain data that can be used for generalization.
- Future research can aim to demonstrate correlations between the governance mechanisms identified in this study and the circular values of the projects in order to provide governance mechanisms that clearly support the circular transition in building projects.
- Future study can investigate performing and action-based research consisting of including a pilot case to accompany a circular building project during the front-end phase for the selection and application of governance mechanisms.
- Each governance dimension tackled in this research can be approached separated with in-depth research aimed at investigating the governance mechanisms, prerequisites, antecedents, and efficacy in the transition to a circular economy in building projects.

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Nomenclature

Abbreviations

Abbreviation	Definition
CE	Circular Economy
CO2	Carbon dioxide
C2C	Cradle to Cradle
D&B	Design and Build
DBFMR	Design, Build, Finance, Maintain, Remove
DBFMO	Design, Build, Finance, Maintain, Operate
EU	European Union
GHG	Greenhouse Gas Emissions
IOC	Inter-organizational Collaboration
PDM	Project Delivery Model
RQ	Research Question
SQ	Sub-research Question
TU Delft	Delft University of Technology

1

Introduction

This chapter introduces the motivations and defines the problem, objectives and research questions of the thesis. Section 1.1 defines the problem addressed, sections 1.2 and 1.3 present the research objective and research questions, respectively. Then, Section 1.4 establishes the practical and theoretical importance of the research in the build environment. Later, the research design is presented in Section 1.5. Finally, the chapter ends with an overview of the report in Section 1.6.

MVSA Architects (2022)

The circular economy (CE) concept is proposed to change the current dynamics of production and consumption focused on 'take, make, use and dispose' that puts our planet and the ability of future generations to meet their own needs at risk (Brown et al., 2021). Thus, the circular economy contemplates adopting models for 'closing, narrowing, and slowing down loops' of resources. Although the CE concept is gaining global momentum in different different industry sectors, the construction sector remains one of the most traditionalist and least innovative in this subject (Leising et al., 2018).

Some of the main reasons why the construction sector must accelerate the transition to a circular economy is that due to its traditional practices and business models based on linear economies, this sector generates a high negative impact on the environment, such as resource depletion, pollution, and greenhouse gas emissions (GHG) (Çimen, 2021). For instance, de Wit et al. (2018) emphasizes that the global construction sector involves more than 40% of the annual consumption and use of raw materials worldwide. Similarly, only the building sector is one of the biggest consumers of natural resources and generates around 30% of all waste in the EU, whereas around the 25% in the world (Hjaltadóttir & Hild, 2021; Pham et al., 2021). Nonetheless, only an estimated 20-30% of the total used materials are recycled or reused at the end of the building's life cycle (Leising et al., 2018). Then, in terms of energy use, buildings are responsible for 25-40% of the world's total, which contributes enormously to the release of CO2 (WEF, 2016). Similarly, greenhouse gas emissions from the extraction of materials, the manufacture of construction products, as well as the construction and renovation of buildings are estimated at 5-12% of total national GHG emissions (European Commission, 2020)

During the last three decades, these figures have been matter of concern since those reflect the notorious built environment's impact on the natural environment. For this reason, ambitions, movements, and regulations have emerged to achieve a circular economy in the construction sector. For instance, the need for the transition to a CE in the construction sector was established as a vision in the Circular Construction Economy Transition Agenda, which outlines the strategy of the Netherlands for achieving a circular construction economy by 2050 and contains the Agenda for the 2018-2021 period (Holland Circular Hotspot, 2018). Therefore, there is currently a challenge to increase awareness, knowledge, and mechanisms to implement CE in the construction sector.

In this way, the circular built environment refers to a way to achieve a resource-effective society through new business models supporting the minimization of waste by reducing, reusing, recycling, and recovering materials during the whole life-cycle of built environment components (van Stijn & Gruis, 2020). Consequently, the circular economy in the construction sector seeks to reduce the environmental impact of construction projects through the integration of the end-of-life phase in the design, and the conscious use of materials that can be reused in future developments (Leising et al., 2018). However, it has been evidenced in the literature and practice that to achieve a circular economy in the built environment, *inter-organizational collaboration* is required between the actors involved throughout the project cycle (Coenen, 2022; Hjaltadóttir & Hild, 2021; Kanters, 2020; Leising et al., 2018; Mies & Gold, 2021; Mishra et al., 2019; Vazquez-Brust et al., 2020), as typically no a single party can fully solve the circular challenges. Here, inter-organizational collaboration is defined as the way wherein the relationship between organizations results in the exchange of resources, facilitating the creation and exchange of new knowledge and forces that benefits all parties involved. Consequently, *governance mechanisms* are seen as the contractual and relational arrangements in collaboration that allow the multiple parties involved to promptly think together about the purpose of the project, the desired outcome, and the aligned efforts toward shared goals (Bryson et al., 2015; Vazquez-Brust et al., 2020).

1.1. Problem definition

The literature that relates the circular economy and the built environment focuses on economic and environmental perspectives. However, there is scarce literature that emphasizes the social aspects such as the required arrangements, structures, and processes for the coordination, adaption, and safeguarding of inter-organizational collaboration exchanges in circular projects (Berardi & Brito, 2021; Kujala et al., 2021). In the same way, many construction companies still do not have experience in the field of the circular economy nor have the skills or knowledge to individually operate all the procedures that circular construction projects entails, so collaboration with other actors emerges as a necessary condition (Brown et al., 2021).

Moreover, whereas isolated construction procedures were sufficient for linear economy applications, the circular economy does not reflect this reality. CE needs a fundamental reconsideration of roles and responsibilities, collaborative capacities, and multidisciplinary approaches (Kooter et al., 2021). It also necessitates the participation of the project's key actors from the outset in order to strive synergies that assure the implementation of CE practices throughout the project's stages (Berardi & Brito, 2021; Karhu & Linkola, 2019; Leising et al., 2018).

Furthermore, collaboration, although essential, is also described as "opaque" and a "black box" highly diverse where governance mechanisms used by multiple organizations to define inter-organizational collaboration, remain unexplored (Moratis et al., 2019; Vazquez-Brust et al., 2020). There is still limited understanding of how to govern inter-organizational collaboration in complex projects (circular buildings fall into this category) that exhibit uncertainties, time-finite spans, and coordination of multiple inter-dependent organizations (Chakkol et al., 2018). That is why the lack of knowledge related to specific governance mechanisms beneficial for inter-organizational collaboration is one of the main obstacles to developing circular projects (Bryson et al., 2015; Hjaltadóttir & Hild, 2021; Vazquez-Brust et al., 2020).

Consequently, the above is summarized in the problem statement:

"Although it is recognized that collaboration is a critical condition for the circular economy, there is a lack of knowledge about what governance mechanisms enable inter-organizational collaboration during the front-end phase to cope with delivering circular building projects"

1.2. Research objective

The aim of this research is to gain insight into the governance mechanisms that have proven to be desirable/beneficial in the collaboration between public clients and main contractors, during the front-end phase in building projects with circular values. To do this, it is necessary to start exhaustive research that responds to the research question.

1.3. Research question

To achieve the research objective, the main research question is formulated as follows:

"How is the inter-organization collaboration between public clients and main contractors governed towards the delivery of circular building projects during the front-end phase?"

In order to answer the main question, the following sub-questions are formulated and will be solved through the development of the thesis:

- **SQ1:** What are the characteristics of building projects with circular values?
- **SQ2:** What existing framework best represents the governance dimensions for inter-organizational collaboration in construction projects?

- **SQ3:** What inter-organizational collaboration aspects can lead to better performance in construction projects?
- **SQ4:** Which governance mechanisms are used between public clients and contractors in circular building projects?
- **SQ5:** What distinctions and similarities are observed between various circular building projects in relation to the governance mechanisms in inter-organizational collaboration?

1.4. Importance of the research

The objective of the research has been motivated by a latent problem that is observed in practice, as well as, the literature scarcity on a clear description of the governance mechanisms that can be applied in inter-organizational collaboration between public clients and contractors to facilitate the transition to a circular economy in building projects.

Scientific relevance

Research on the intersection of circular economy and collaboration are growing in the construction sector. However, today the literature is limited to mentioning that collaboration is a key aspect of the circular economy, but does not investigate the underlying governance mechanisms to guarantee the collaboration between organizations that pursue the transition towards a circular economy. That is why this research strives to contribute with scientific knowledge in specific aspects such as:

1. This research bridges these two research streams, circular building projects and governance mechanisms in inter-organizational collaboration between public clients and main contractors by providing insight on what types of governance mechanisms would be effective in achieving certain circular tactics, under specific circumstances or context.

2. This research is significant because it provides empirical evidence of the initiatives currently employed in the collaboration between public clients and contractors to facilitate the transition to a circular economy within building projects. These initiatives include processes, structures, arrangements, and tools in governance. Therefore, this research is influential in light of the literature on project management, construction management, and circular economy;

3. The study employed the existing framework of Kujala et al. (2021) to identify and synthesize collaborative aspects and governance approaches for the inter-organizational collaboration from the current literature. Consequently, enhancing the existing framework with the findings of the comprehensive literature review on what kind of approaches stimulate collaboration in the dimensions of goal-setting, capability building, roles and decision-making, rewarding, coordination, and monitoring.

4. Although the research is based on a qualitative method, limiting its statistical generalization, the results are conclusive and logically focused on real case studies. Therefore, it provides reliable information and an analytical generalization of the governance mechanisms beneficial in inter-organizational collaboration for future studies in building projects.

Consequently, in order to close the gap between literature and practice, this study will deliver what governance mechanisms are being implemented in the circular building sector for inter-organizational collaboration and how these mechanisms relate to the endorsement of circular practices in building projects.

Practical relevance

Recently, there has been a need to achieve a circular economy in the construction sector (Holland Circular Hotspot, 2018). Therefore, in practice, it is possible to see CE implementations in building projects, where these projects implement circular practices based on diverse CE schools of thought (Crowther, 2005; Leising et al., 2018). However, these practices cannot be conceived in a disjointed and traditional way where the client is the dominant and dictatorial party in decision-making, whereas the contractor is the sorely needed executor and reliable for the risks.

The transition to CE in the construction sector implies more complex changes, such as the inclusion of new business models that promote the retention of high residual values in materials, thus creating a disruption in the ownership concept for buildings, their materials, and components (Adams et al., 2017). However, it requires a change in the clients and contractors' participation (Kirchherr et al., 2017). So far, this transition and required changes have not been an easy task, and the close collaboration with the actors involved is an aspect that although it is understood important, few know how to tackle and how to deal with it effectively. Therein, the need for clear and empirically-obtained governance mechanisms to master the inter-organizational collaboration that can cope with these social challenges during the transition. Therefore, this research can provide a greater understanding and insight to public clients and contractors in how to govern from different dimensions the collaboration and relationship, to make possible the implementation of CE in their building projects.

1.5. Research design

The research design is the logical sequence that connects the empirical data to a study's initial research questions and, ultimately, to its conclusions. The research had an in-depth, qualitative, and exploratory approach. For this, the approach of multiple case study was chosen, which consists of an examination of several cases linked together (Stake, 2006). As the multiple case study strategy helps avoid the risk of deductive theory confirmation and generalizing observations (Stake, 2006), it is adequate to answer the main research question. Moreover, it allows exploring contemporary multiple bounded systems in real life through comprehensive, in-depth data collection involving multiple sources of information. Therefore, it makes possible to gain a deeper understanding of the research question and its theoretical evolution, as well as the differences and similarities of governance mechanisms between public clients and the main contractor in the three circular building projects under study. So at the end, it is expected from multiple source of evidence, to find patterns, and differences between case studies on the governance mechanisms that have proven to be beneficial for the collaboration between clients and contractors under this type of circular projects, to analytically generalize conclusions on several units (Creswell & Creswell, 2018; Eisenhardt, 1989; Yin, 2003).

Therefore, the research design approach follows the structure of the multiple case study of Yin (2003), and it is summarized in Figure 1.1. The initial step *Define & Design* consists of literature review, selection of case, and the definition of specific protocol for the data collection process. Then, in the second step *Prepare, Collect & Analyze*, each individual case study contains a 'whole' study based on in-depth interviews, and review of publicly available information, in which convergent evidence is required regarding conclusions that other cases can replicate. After, the third step *Analyze & Conclude* includes a cross-case analysis, which provides the extent of the logic replication and why certain cases demonstrated similar governance mechanisms while others contrasting results. Also, it includes the discussion that consists of the analysis of the empirical findings in combination with the existing literature to create specific points for discussion. Finally, conclusions and recommendations exhibit the answer to the sub-questions and main research question, also emphasizing the suggestions for further research.

An important aspect of the research design corresponds to the feedback loop (see the dotted arrow line in Figure 1.1). The feedback loop represents the situation wherein information missing is discovered during the conduct of one of the individual case studies. For example, these findings could lead to the re-formulation of the data collection protocol. Without this feedback, the research is at risk

of being distorted or ignoring relevant information indispensable for the quality and validity of the results (Yin, 2003).

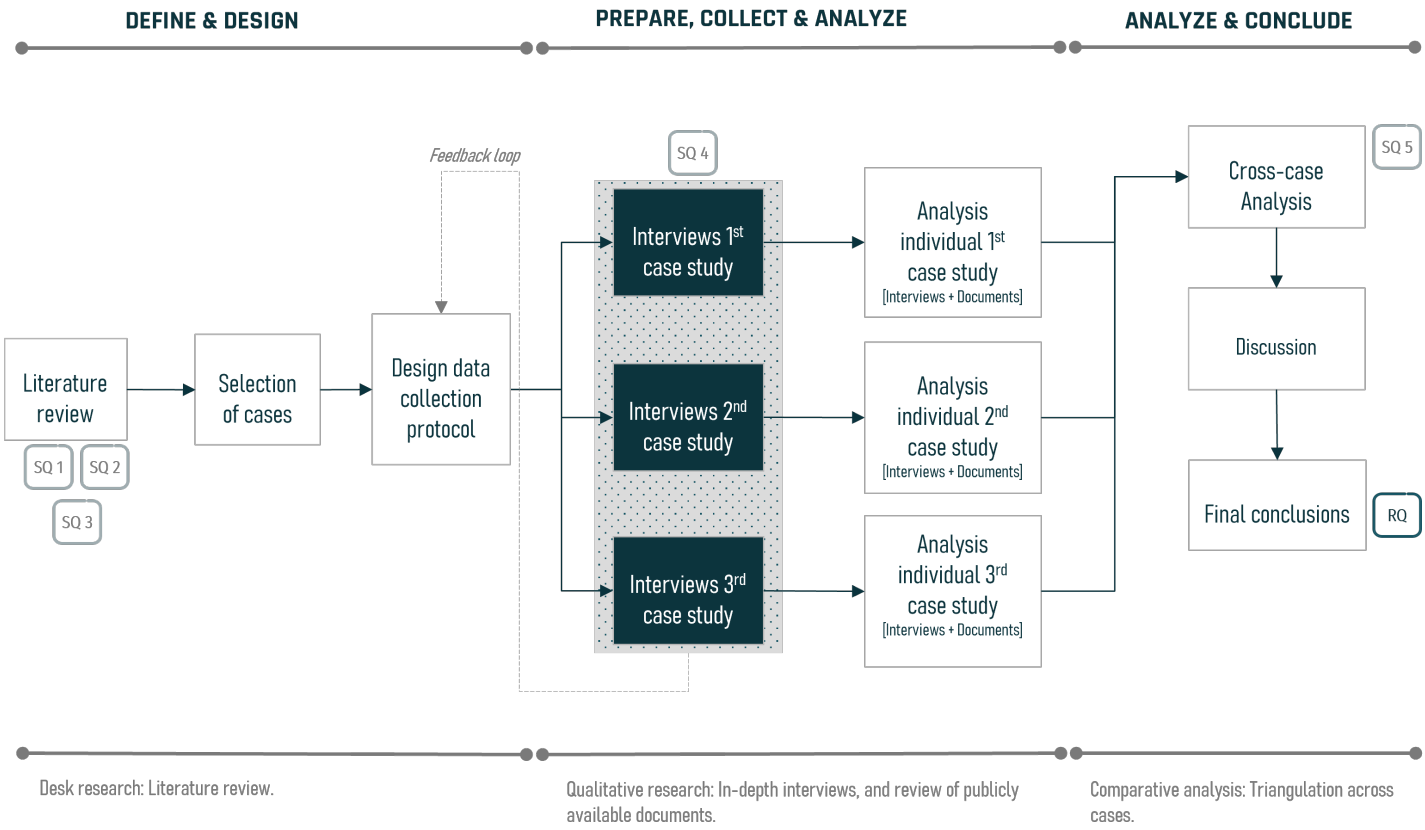


Figure 1.1: Research Design. Based on: Bickman and Rog (2009) and Yin (2003).

1.6. Thesis outline

Chapter 2 begins detailing the research methods, from start to finish, including the process to conduct the literature review and the methods for data collection, processing, analysis, and interpretation. It also incorporates selecting the case studies using the established criteria. Thereafter, the concepts of the circular economy in the built environment, the role of public clients and main contractors, inter-organizational collaboration, and the significance of the front-end phase to facilitate circular outcomes in building projects are all discussed in **Chapter 3** which is essential to the development of the research. Also included in this chapter is a comprehensive literature review on IOC (inter-organizational collaboration) in building projects and circular economy in the built environment. After that, **Chapter 4** contains a brief description of the selected cases, together with the results obtained from the individuals and cross-case analysis. Next, **Chapter 5** includes the discussion of the results according with the literature review and the findings in the qualitative research. Finally, **Chapter 6** concludes with concise responses to the main question and each of the sub-questions, together with the limitation of the research and recommendations for future investigations and practices. The flowchart in Figure 1.2 is designed to better show the thesis outline.

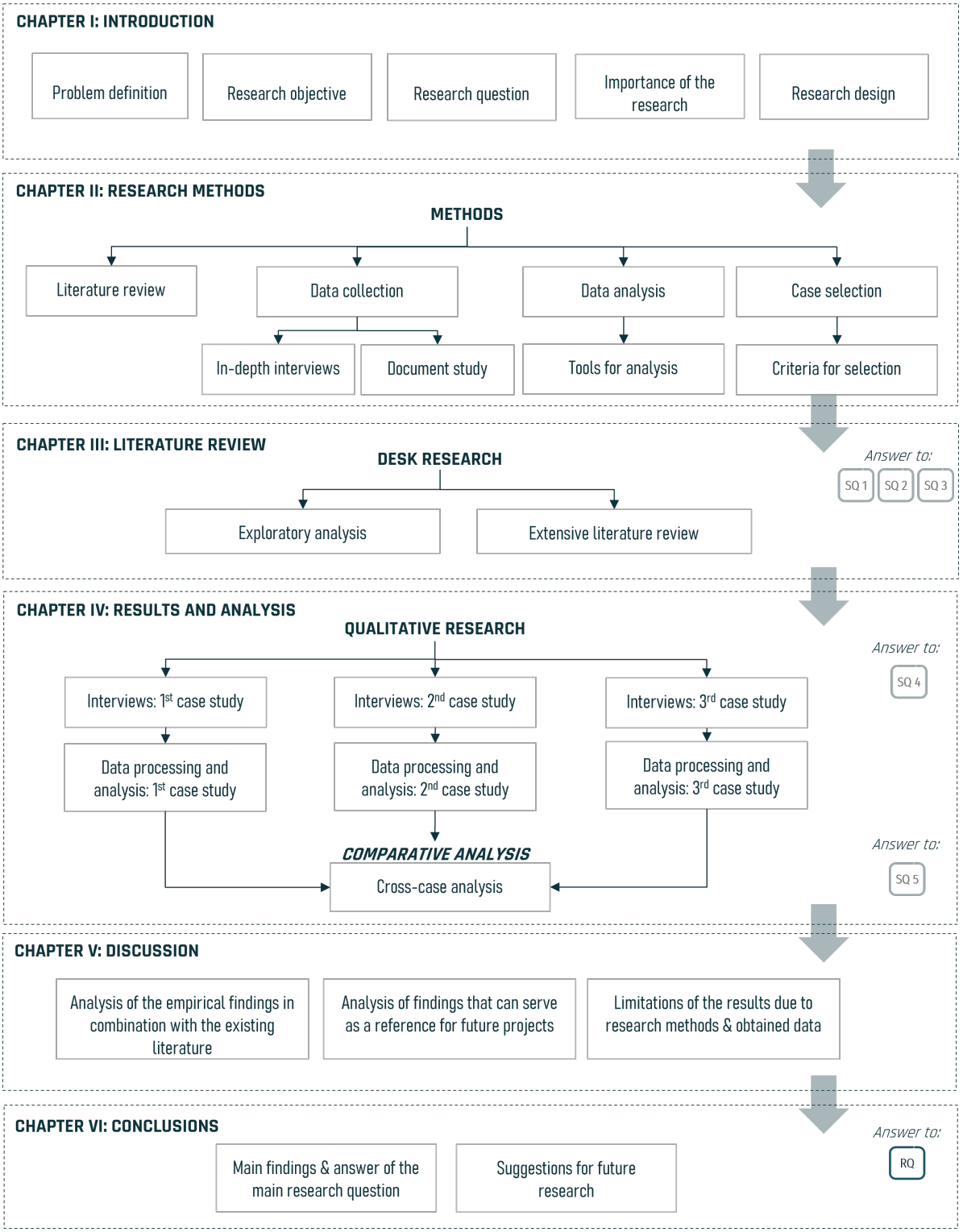
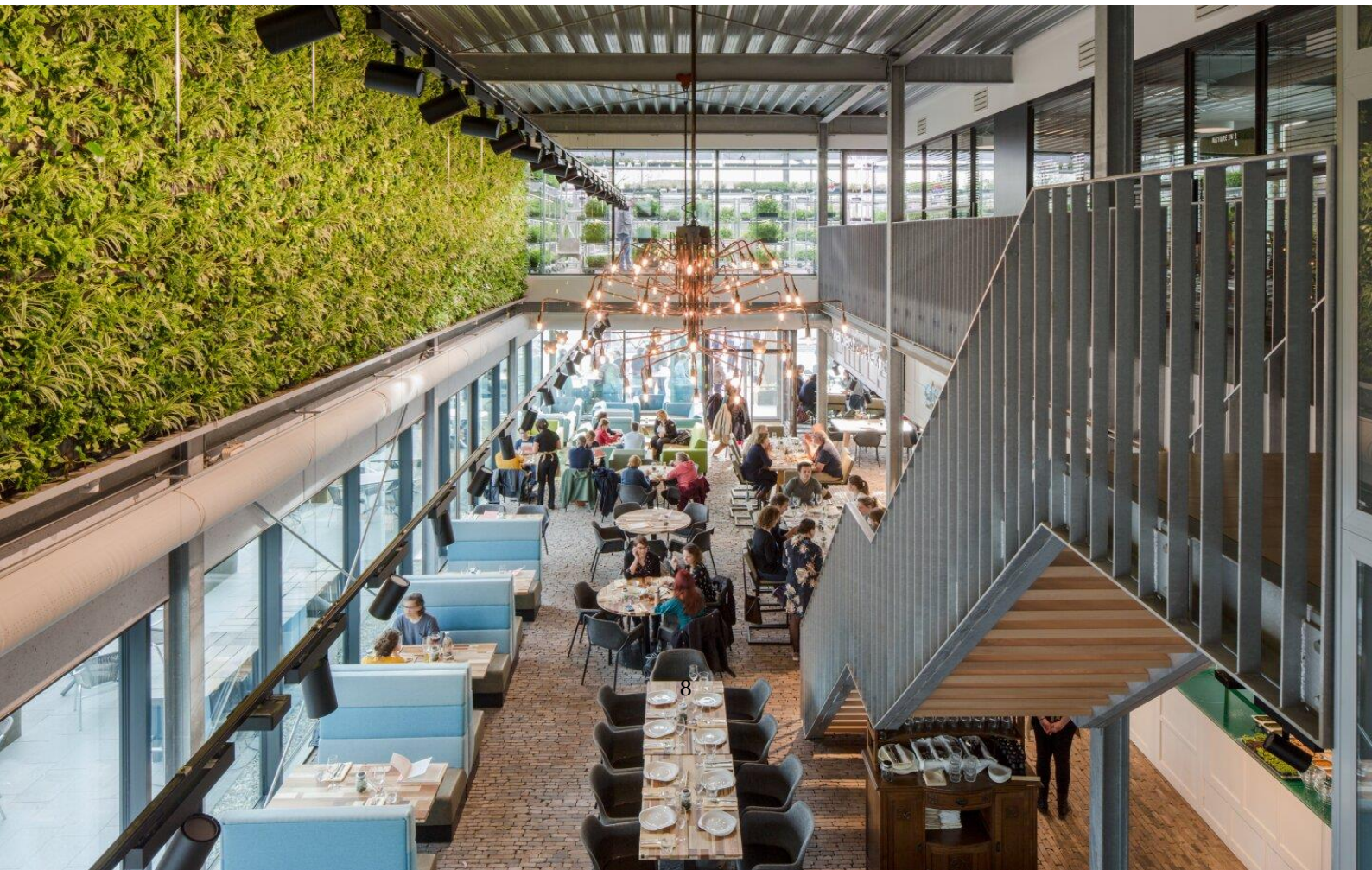


Figure 1.2: Thesis outline

2

Research Methods

Various methods were employed to address the different sub questions posed in this research. Consequently, this chapter describes these methods. Section 2.1 begins with a description of the literature review that gives insight on the two important subjects: circular practices in building projects and governance mechanisms in IOC. Section 2.2 describes the collection of data via document analysis and in-depth interviews. Similarly, the method and tools for data analysis are also explained in Section 2.3. Lastly, Section 2.4 explains the method for selecting the case studies and defines the three cases chosen for this study.



Cepezed (2020a)

The research question begins with "how," indicating its exploratory nature (Yin, 2018). This research included both an inductive and a deductive method. The systematic literature review on the governance mechanisms in inter-organizational collaboration and circular practices in building projects was inductive because it included a study of the concepts and principles in general. In contrast, the multiple case study was deductive in character because it investigated in depth the governance mechanisms of specific circular projects. This approach of multiple case study was selected over a single case study because the majority of multiple case designs are anticipated to be more robust than single-case designs. Therefore, attempting to use more than two specific cases as opposed to a single case study was a reasonable objective in order to create a more compelling and strong overall study (Yin, 2003).

2.1. Literature review method

The literature review was crucial to move the research towards the different phases described, it provided valuable input for developing the data collection protocol for the in-depth interviews. First, given the current ambiguity in the definition of circular building projects, the literature helped to clarify this concept. Second, although there is a deficiency in the knowledge of the governance mechanisms that are proven as beneficial for inter-organizational collaboration in circular building projects, today, there is theoretical and practical knowledge about which governance mechanisms may lead to increased performance in construction projects worldwide. Therefore, the literature review started by identifying a proper framework that capture the different possible dimensions for the structure of the research. Then, the literature focused on the aspects of inter-organizational collaboration mentioned in the construction sector. These widely used and mentioned collaboration aspects together with the governance framework, were the basis for collecting information in the case studies.

- **Literature review on circular building projects:** To answer sub-question 1 [**SQ1**], a literature review was conducted following two stages. The first stage consisted on a search on the scientific articles that match the query "TITLE-ABS-KEY ("higher level" OR satisfactory OR level OR achievement OR performance) AND TITLE-ABS-KEY ("circular economy" OR "circular practices" OR "circular intervention" OR "circular") AND TITLE-ABS-KEY (construction OR "built environment" OR "building projects" OR "infrastructure projects")", which contained 417 document results. The filtering process for the results was performed first, based on the title analysis. Second, based on abstract analysis, which sought to identify articles that included topics related to circular economy in the construction sector, and circular practices or interventions in construction projects. Then, the third and last filter consisted of complete content analysis, thus allowing to include only the articles that mentioned relevant information about general knowledge on circular economy in the construction sector, and current circular practices in construction projects. This last filter also allowed to retrieve other documents included as references in the articles that were analyzed.

  Additionally, for the second stage of this search, not only academic literature was used, but also gray literature. That is, information produced at all levels of government, academia, business, and industry in electronic and print formats not controlled by commercial publishing. It allowed for a broader and more up-to-date overview on the practicality of the transition to a circular economy in construction projects.

  Following the summary approach, the circular practices identified throughout these two-stage searches were displayed in this study. The summary relied on selecting research that complement one another, providing the reviewer robust information in addressing the various circular construction practices for the purpose of this investigation. Similarly, following the aggregation logic, the circular goals identified during this literature review, were displayed in this study. The logic of aggregation relies on selecting studies that complement one another and, as a result, provide the reviewer with greater assurance regarding the extent and variability of the investigated phenomenon.

- **Literature review on inter-organizational collaboration:** To access the studies governance mechanisms for inter-organizational collaboration in the construction sector, the indexed scientific literature was retrieved by making two searches in the SCOPUS database. The first search was done in a more general way to address the entire construction sector, while the second search was focused on finding literature directly related to the circular economy in the construction sector. Thus, the first search was carried out with the query "TITLE-ABS-KEY("inter-organizational collaboration" OR "inter-organizational cooperation" "inter- organizational relationship" OR "collaborative working" OR "collaborative relationship" OR "client-contractor collaboration" OR "owner-contractor collaboration" OR "cross-sector collaboration" OR "cross-sector cooperation" or "cross-sector relationship" OR "inter-firm collaboration" OR "inter-firm cooperation" OR "inter-firm relationship" OR "public private partnership" OR "collaborative governance" OR "front-end collaboration" OR "front-end cooperation") AND TITLE-ABS-KEY("construction projects" OR "built environment" OR "engineering projects" OR "building projects" OR "infrastructure projects" OR "project performance" OR "public management")", which contained 459 matches. The second search was made with the query "TITLE-ABS-KEY("circular economy" OR "circular practices" OR "circular intervention" OR "circular") TITLE-ABS-KEY("construction projects" OR "built environment" OR "building projects" OR " infrastructure projects" OR "engineering projects" OR "project performance" OR "public management")", which contained 46 matches.

  As can be seen in Figure 2.1 the results were initially filtered with the inclusion of only peer-reviewed articles in order to guarantee the quality and validity of the information relevant to the research. Therefore, it reduced the number to 294 published articles. A structured *Excel Database* was created comprising the 294 articles. Then, three more filters were performed consecutively: The first filter was conducted based on the title analysis, which allowed keeping only those upfront articles related to the research topic, reducing the number to 60. Later, the second filter was performed based on abstract analysis, which sought to identify articles that included topics related to mechanisms, factors, processes, elements, or collaboration tools in the construction sector. With this filter, the number of articles was reduced to 37. Then, the third and last filter consisted of complete content analysis, thus allowing to include only the articles that mentioned relevant mechanisms, factors, processes, elements, or collaboration tools. This last filter also allowed to retrieve other documents included as references in the 37 articles that were analyzed. In this way, 25 articles for the literature review were obtained. Consequently, the literature review on collaboration factors for the construction sector sought to answer the sub-questions 2 and 3, **[SQ2]** and **[SQ3]**.

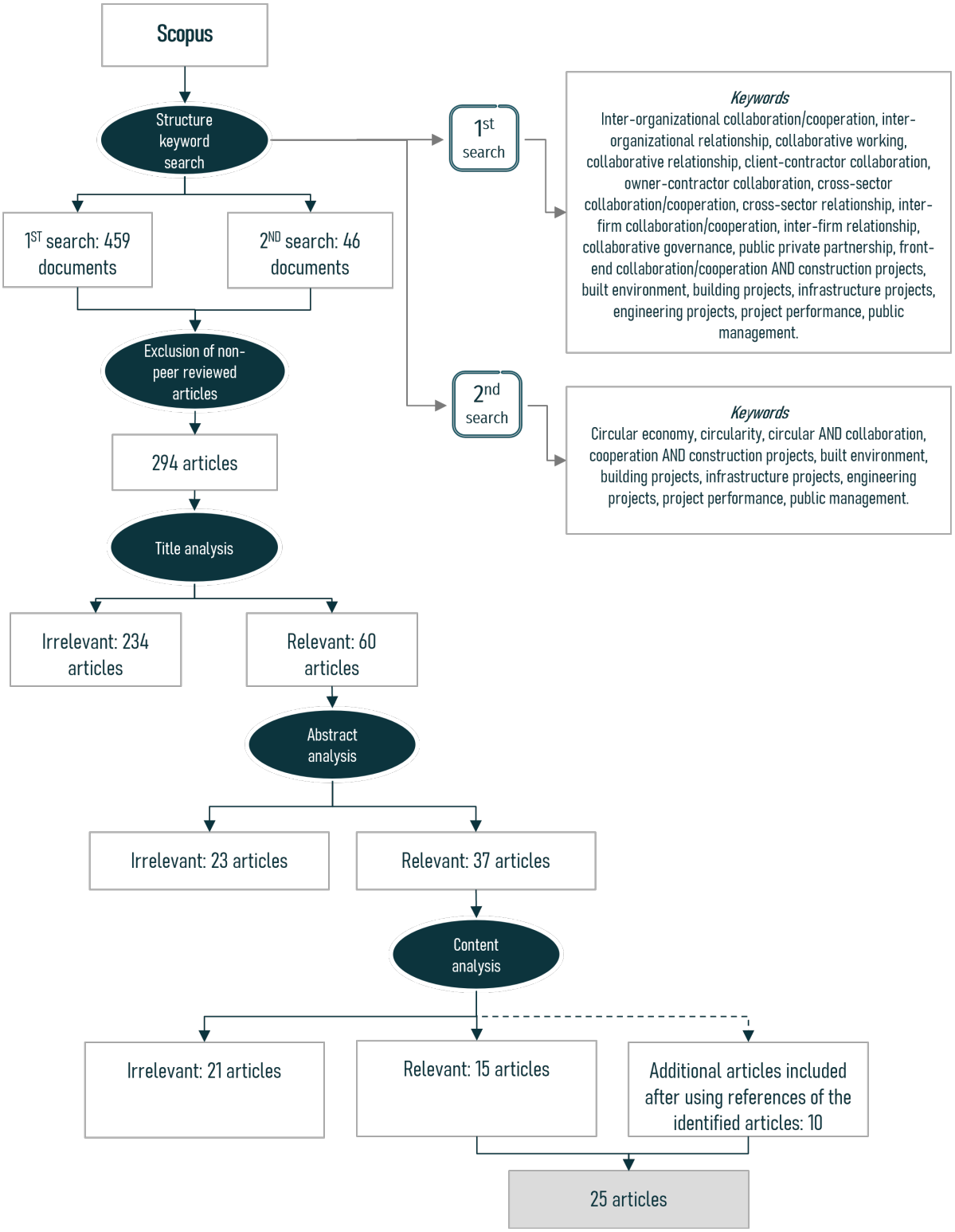


Figure 2.1: Systemic review in inter-organizational collaboration

– **Exploratory analysis:** During the literature review, the *Atlas.ti* software was used, which allows analyzing unstructured and non-numerical data in various formats while helping to keep the data and processes organized, transparent and integrated. Once the 25 selected articles were added to the *Atlas.ti* system, the exploratory analysis started by mapping the

content of the information. This information mapping was done with the *Atlas.ti Word Cloud tool* and facilitated the brainstorming approach to open up the research to all the potential and possible governance approaches in inter-organizational collaboration contained in the literature (see word cloud in Figure A.1, Appendix A). This initial exploratory analysis helped prevent foreclosure in only the predefined framework because it forced to think outside the frame; that is to say, it allowed the investigation to set aside preconceived notions about what was expected to find and let the data and interpretation guide the analysis.

– **Open coding:** Then, *inductive* analysis was performed using open coding. In this case, the inductive analysis seeks to identify the governance aspects in inter-organizational collaboration mentioned in the literature that were later used to enlarge and enrich the selected framework. Open coding is a dynamic and flexible process that allowed inter-organizational collaboration aspects to be subtracted from the literature based on how often they were emphasized in the articles. The coding process had two stages. The first stage looked for the context of the most recurrent words according to the word cloud to identify their importance for the research. Thus, approximately 60 relevant first-order codes were found that corresponded to single words. The second stage consisted of classifying the first-order codes into 20 second-order, which in turn were understood *deductively* as the subcategories for governance dimensions previously defined in the selected framework (definite codes). Representative sentences, lines, and even complete paragraphs were coded based on the defined codes (See codes in Table A.1, Appendix A).

– **Categorization:** In order to categorize the codes, a previously selected framework from the literature was utilized. Nevertheless, the literature findings were not limited to the current framework. Hence, it was acceptable to update the framework if a new dimension or subcategory (subdimension) was identified. The most recent framework for existing governance mechanisms in inter-organizational collaboration in building projects was Kujala et al. (2021)'s framework, which included twenty subcategories and six essential categories (see categorization in Table A.1).

Accordingly, the material obtained in the literature review was synthesized by coding in *atlas.ti* according to the dimensions of the framework. This categorization and classification made it possible to organize the information from the various scientific articles to give it a logical meaning and to relate them in terms of mechanisms, factors, arrangements, processes, and tools of governance in inter-organizational collaboration.

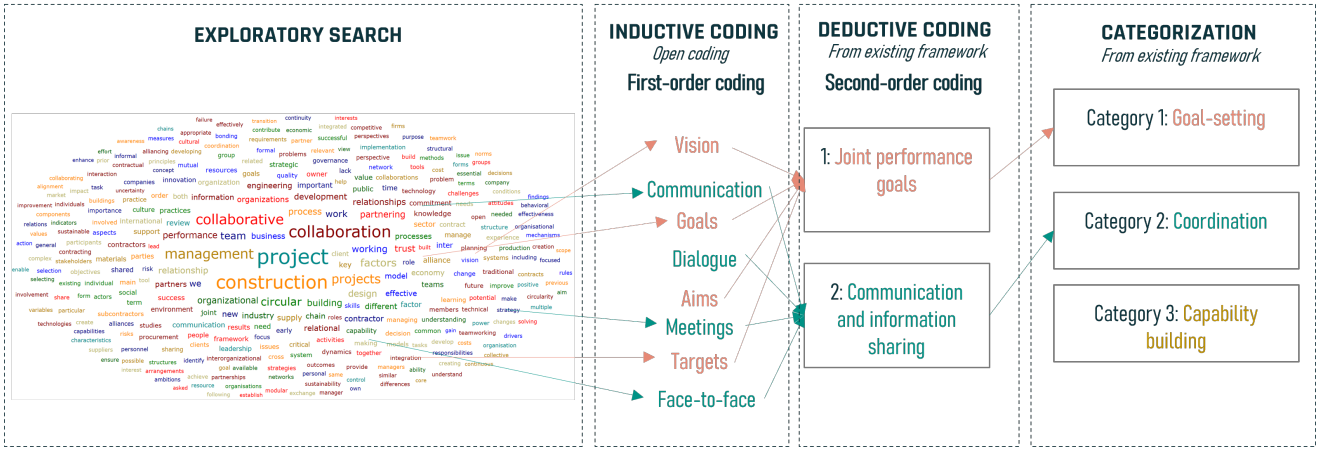


Figure 2.2: Illustrative coding process

2.2. Data collection

The data collection was performed through two qualitative methods, in-depth interviews and publicly available information. Based on the literature review, the content of the in-depth interviews was defined. Later on, the in-depth interviews consisted of semi-structured interviews with expert professionals working on the circular building project cases. They were selected through *purposive sampling* and the aim was to interview professionals from both public organizations (public clients) and private companies or consortium (contractors) for each case study, since this approach helped to reveal contrasts between organizations.

The interviews were conducted on an hybrid manner. Some interviews were conducted face-to-face, and when it was not possible, the interview were scheduled via digital platforms. In both situations the interviews were audio-recorded to facilitate the transcription of the information. Being of a flexible nature, these interviews allowed covering the guiding topics while, in turn, allowing interaction with the interviewees to understand their construct reality and what were their attitude, perception, and behavior concerning the project (Bickman & Rog, 2009).

On the other hand, the collection of public information was as far as possible, requested directly from the actors involved in the project, obtained from different websites or digital reports of the client, contractor and designer. The Appendix B contains the data collection protocol. This method sought to answer the sub-question 4 **[SQ4]**.

2.2.1. Selection criteria for the interviewees

The selection of the interviewees was conducted through *purposive sampling* and the following selection criteria was set up:

1. They are representative of the public client organization or the contractor organization.
2. They must have varying positions within the project to bring as many perspectives as possible. Therefore, the following roles are intended:
    - Project managers;
    - Process leaders;
    - Contract managers / tender managers;
    - Technical managers;
    - Designers / architects / developers;
    - Sustainability / circular experts;
3. They must have participated during the front-end phase of the selected projects and have been involved in exchanges between the organizations of the public client and the contractors.

In addition, an application was submitted to the Human Research Ethics Committee (HREC) at Delft University of Technology to guarantee that the respondents' ethical protections were upheld and that the intended study posed less than minimum risk. In this application, a data management plan, an informed consent form, and a risk assessment and mitigation plan were designed. The application validated the interviewees' voluntary participation, recognition of potential risks and mitigation actions. Similarly, the specifications for data storage, access, and reuse. The committee approved the application without requesting additional modifications to the study.

2.3. Data analysis

As mentioned, the data analysis within the multiple case study strategy consisted of *hierarchical analysis*. Therefore, the data analysis was performed in two stages. First, a separate analysis of each study case. Second, a comparative analysis, also called cross-case analysis. For the individual analysis, the responses of the interviewee were qualitatively analyzed through Atlas.ti. This process was repeated for each of the case studies.

Later on, the cross-case analysis was developed based on the results from the individual analysis and with the implementation of a *pattern-matching* approach. It consisted of contrasting the information of all the cases and identifying similarities and differences in the implementation of governance mechanisms and the outcome obtained with respect to the achievement of circular values in building projects (Vershuren & Doorewaard, 2010).

Yin (2003) discusses *pattern-matching* as the most desirable analytic strategy in multiple case study investigations. The *atlas.ti* software was utilized again, but this time for a deductive analysis, in order to do a comprehensive examination of the collected data. For deductive analysis, the codes assigned in the literature review were predefined, and these were searched for in the information provided by the semi-structured interviews (See codes in Appendix A). Codes were connected to the answers of the respondents which helped link the various answers. The coding obtaining from the literature review was open to be modified, adapted or enriched during this stage to bring new empirical knowledge. Therefore, the best way to name the analysis was *deductive-adaptive*. The data analysis sought to answer the sub-question 5 **[SQ5]**.

2.4. Selection of cases

In order to make sure that the comparison between the cases was valuable and meaningful for the research question, it was necessary to follow some strategies for case selection (Flyvbjerg, 2006). Inasmuch as the objective is to achieve the greatest possible amount of information on a given problem or phenomenon, a representative case or a random sample may not be the most appropriate strategy (Flyvbjerg, 2006). In this way, the decision to undertake a specific case was not decided lightly, since every case should serve a specific purpose within the overall scope of the objectives. The cases were chosen considering they tend to follow a 'replication' logic, which is different from a 'sampling' logic (Yin, 2003).

From the literature, it was possible to find several methods for selecting case studies. Seawright and Gerring (2008) expose at least seven different methods that vary depending on the analysis sought to be developed. These methods are typical, diverse, extreme, deviant, influential, most similar, and most different. Although they can be used to perform a multiple case analysis, only some allow representative study cases to be obtained and the possibility to generalize findings. Therefore, since this research seeks to make an analytical generalization from the results obtained, the *most similar method* was chosen. This method consists of looking for cases with minimal variations as selecting very different cases, makes it difficult to obtain generally descriptive assertions or the possibility to link up the various phenomena (Vershuren & Doorewaard, 2010).

Therefore, for the selection of the cases, the different circular interventions found in the literature to achieve circular building projects were used as criteria. With this information obtained from the literature, a qualitative evaluation of the different *circular public building projects* found in the Netherlands were conceived. Those three projects that had more similar circular interventions were the projects chosen for the object of this investigation.

In order to determine the various circular practices utilized in the potentially pre-selected projects, a thorough *desk research* was conducted. The desk research consisted of finding online documentation of the projects that defined the practices implemented at the various stages of the project. The official websites of the contractors, public clients, and other subcontractors who could have participated in the development of the project were also accessible. Similarly, corporate publications and official project presentations that explored the circular aspects of the projects were utilized to obtain a complete description of circular practices per case.

2.4.1. Selection criteria

The empirical component of the study seeks to understand how public clients and contractors are governed by mechanisms during the front-end phase of circular building projects. Therefore, three comparative case studies are chosen to prevent the possibility of deductively confirming the theory and generalizing the observations (Yin, 2018). Moreover, in order to ensure that the comparison between these cases is valuable, the case studies were selected with the circular practical interventions throughout the building's life cycle.

The cases are chosen based on the following criteria:

1. **A project where the client is the Central Government Real Estate Agency:** The three projects must belong to a unique public client, hence the Central Government Real Estate Agency's projects were selected. The public clients are the initiators and advocates of projects; therefore, the purpose of this research is to determine how public clients might support the transition to a circular economy in the built environment through governance mechanisms with the main contractors. This is why private organizations cannot own the projects. In addition, as the most similar approach was chosen to address the cases, it was determined that the three projects must belong to the same public client. It in order to avoid comparing the cases based on the inherent differences between government organizations, thereby limiting the pattern matching to merely governance mechanisms that promote inter-organizational collaboration.
2. **A building project distinguished by including circular aspects:** As the research focused on identifying governance mechanisms that facilitated circular practices in building projects, the case studies should be categorized as circular projects. These must have contained circular aspects, such as circular interventions or objectives, to distinguish the project from conventional ones.
3. **A completed project or being in the process of completion:** The projects must have finished construction or be more than 50 percent complete in this phase. This is because the cases must demonstrate that the expected circular goals have been achieved in whole or in part. A project that does not satisfy the execution percentage will not be able to guarantee that the circular practices will be implemented or that the stated circular goals will be attained; hence, they cannot be compared across case studies.
4. **The three projects that adhere to the *most similar* approach regarding circular practices:** To do this, potential cases were examined based on the literature in circular building projects, and those with the most recurrent circular interventions in each project stage were chosen. Consequently, the selected cases must display similarities in the circular practices categorized under the building life-cycle, as described in Section 3.2.3.

Potential case studies
According to the first two selection criteria, the Central Government Real Estate Agency has at least six potential projects that can be considered. The phases of the six cases are depicted in Table 2.1. Then, the selection of the three case studies is detailed, followed by an examination of the circular practices applied in each stage of the building project's useful life to validate compliance with point 4 of the criteria. Figure 2.3 illustrates an overview of how various projects coincide with one or more circular practices across the building's life-cycle.

Table 2.1: Potential case studies

N°	Project	Location	Phase
1	**Permanent building with temporal function**	Amsterdam	Use
2	**The green building**	Utrecht	Use
3	**The government office**	Utrecht	Use
4	**The stadium**	Eindhoven	Commissioning
5	**Government office renovation**	Haarlem	Construction
6	**Building made with waste**	Katwijk	Front-end

For each potential case, the circular building practices implemented during each phase of construction were determined. Wherein the greatest number of circular practices were observed for **potential cases 1, 2, and 5**, coinciding with the adoption of similar practices at the different building stages. During the *design phase*, design for adaptation and flexibility, and design for disassembly were some practices in common. Similarly, during the *manufacture and supply phase*, reuse of secondary materials, change in ownership models, and standardization of components and elements were emphasized. Then, optimization using prefabrication techniques during *construction phase*. Moreover, adaptable and flexible use during *operation phase*. Furthermore, for the *end-of-life phase*, some practices consisted of disassembly and deconstruction.

In contrast, although cases 3, 4, and 6 also exhibited certain circular practices, these practices were minor and not evident across the building's different phases. Case 3 is an example of a building that was intended to have maximum flexibility in its use but did not include any definition of circular practices for when those uses ended. The same is applicable for case 4, which focuses primarily on the reuse of outdated building materials and the adoption of a material passport. Still, there was no clear emphasis on circular strategies for the operation and end-of-life of the building. Finally, case 6 is a building with ambitions in the reuse and recycling of materials; however, it does not identify end-of-life strategies, and the project is in its early phases (front-end phase), resulting in the inability to demonstrate the achievement of circular goals (see Appendix C).

Phase	Circular practice	1	2	3	4	5	6
DESIGN	Water collection and re-circulation		■		■		
	Use & production of renewable energy		■			■	
	Modularity	■	■			■	
	Design for adaptability and flexibility	■	■			■	
	Design for Disassembly (DfD)	■	■			■	
	Specify secondary raw materials		■		■	■	■
	Use of information systems	■	■			■	
	Specify better-performance materials		■	■	■	■	
	Passive building design						
MANUFACTURE & SUPPLY	Material passport				■		
	Change ownership models	■		■			
	Reuse of secondary materials		■	■		■	■
	Product standardization	■	■			■	
	Design for product disassembly						
	Optimize material use	■	■			■	
	Reverse logistics						
CONSTRUCTION	Off-site construction / prefabrication	■	■			■	
	Reuse of materials	■	■	■	■	■	■
	Recycle materials	■	■	■	■	■	■
OPERATION	Water management practices		■				
	Use & production of renewable energy		■			■	
	Shared spaces / dynamic functionalities		■			■	
	Optimize maintenance						
	Adaptable and flexible use	■	■	■		■	■
	Passive cooling and heating						
	Passive lighting and ventilation					■	
END OF LIFE	Deconstruction / Disassembly	■	■			■	
	Selective demolition	■	■			■	
	Reuse and recycling of components	■	■	■	■		

Figure 2.3: Selection of case studies based on circular economy practices. Based on: Alba Concepts (2019), Archdaily (2018), BAM (2021), BREEAM (2019), Cepezed (2018, 2020b, 2022a, 2022b), De Circulaire bouweconomie (2022a, 2022b), Due Prie (2017), Duurzaam Gebowd (2021), Maasdam (2016), MVSA Architects (2022), Nationale Staalprijs (2022), and Rijksvastgoedbedrijf (2015a, 2015b, 2020, 2022a, 2022b, 2022c).

3

Literature review

This chapter presents the available knowledge in the literature about the variables of *governance, collaboration, public clients, main contractors* and *circular buildings* that are considered in this research. Some concepts are defined and framed in a way that enables the orientation of the investigation towards the accomplishment of the expected objectives. Therefore, Section 3.1 starts by defining the scope of the research on the front-end phase of building projects. Then, Section 3.2 defines circular economy in the built environment and circular practices in buildings project. After, Section 3.3 shows the inter-organizational collaboration applied or required in construction projects and circular building projects. Later, Section 3.4 briefly illustrates the conceptual model where all concepts are interconnected.

Cepezed (2020a)

3.1. Front-end phase in building projects

A building project consists of five basic phases that define the building's life cycle. These phases are initiation, planning & design, implementation & execution, operation & maintenance, and lastly, closing phase. According to the Project Management Institute (2021), the feasibility of the project is part of the initiation phase, which determines if the project is valid and if the organization has the potential to provide the desired outcome. Then, during the planning & design process, an analysis is established that enables the building to achieve the intended design based on its objectives and goals. Next, the implementation & execution phase considers the construction of the building in accordance with the preceding phases' specifications. After, the operation & maintenance phase relates to the usage of the building and its sustain through preventive and corrective maintenance actions that ensure the functionality throughout its useful life. In the closing phase, the building's functional life is concluded, necessitating its removal via various ways.

Project management literature frequently refers to the *Front-End* phase, which includes multiple sub-phases. Despite its importance, this phase's borders remain fuzzy and ambiguous in practice, making it difficult to nail down precisely what kinds of activities fall under its domain. The truth is that the term *front-end* is commonly presented as a structured flow of processes that go from the genesis of the project idea, to the set up of the project for execution. For example, the most common definition is based on the differentiation of permanent organizations such as clients, and temporary organizations such as contractors. Thus, it is said that the front-end encompasses all the activities and processes performed by the permanent organization in the initial phases of the project, and this front-end phase ends once the temporary organization undertakes the project (Williams et al., 2019). Although this definition fits well in projects conceived in a traditional way, the concept loses validity in complex projects or integrated projects in which there are not necessarily separate organizations but rather inter-organizational relationships. Therefore, for the purpose of this research and considering the complexity and necessary inter-organizational collaboration in circular projects, the front-end phase will include the first two phases of initiation and planning & design, as can be seen in Figure 3.1. According with practitioners, the stages of concept design and definitive design included in the front-end phase are decisive for the project since 80% of the choices are made within these stages (Kooter et al., 2021).

Consequently, this research will concentrate on the front-end phase as the goal of this phase is to cover all the aspects that include project identification, selection of partners, design basis, project estimation, design development and construction planning. It implies that the front-end phase includes the creation of sufficient strategic information for the actors involved (in this case, public client and main contractor) to co-create benefits, develop notions of identity, address risks, make decisions, commit resources, and influence changes with the aim to maximize the potential for innovation and favorable performance (Construction Industry Institution, 2012; Olsson & Samset, 2006; Williams et al., 2019).

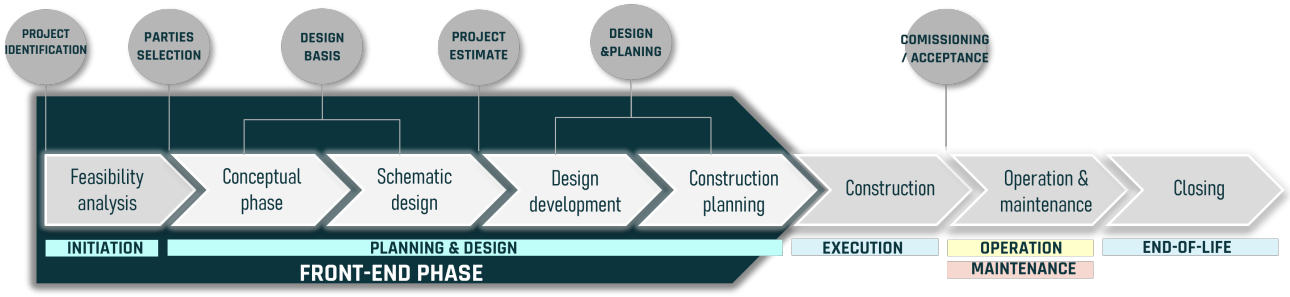


Figure 3.1: Front-end phase in building projects. Based on: Construction Industry Institution (2012), Olsson and Samset (2006), and Project Management Institute (2021).

3.2. Circular economy

The world population is at risk due to climate change that threatens the possibility of a future for society on planet earth. The increased demand for resources has caused land degradation, deterioration of water sources, local damage, and many more severe negative impacts on the environment. The negative impacts are caused due to the current dynamics of production and consumption based on a linear economy focused on 'take, make, use and dispose'. Therefore, the circular economy is exhibited as an alternative with a better business case and added value (Brown et al., 2021; van Buren et al., 2016).

In the literature and practice, the economy is distinguished into three main models, linear economy, classic sustainability or recycling economy (van Buren et al., 2016), and circular economy (See Figure 3.2). The linear economy is well known as the permanent use of raw material for production, followed by its disposal after use. On the other hand, although they tend to resemble each other, the classic sustainability and the circular economy have significant differences since the classic sustainability still involves the input of raw materials and the generation of waste, despite complying with the slowdown and narrowing of the loops. This classic sustainability conceives the use, reuse, and recycling of materials as a separate optimization step, which seeks to minimize the consequences of still deliberated decisions in the design, production, and consumption phases of a product. Although this model goes one step further than the linear model, it is less valuable than the circular model as it still considers down-cycling and the same amount of waste at the end of life-cycles. In contrast, the circular economy implies closing the loops and up-cycling by integrating circular and regenerative strategies in the different phases (design, production, use, maintenance and end-of-use) to optimize the product's functionality, pursuing the creation of high-quality secondary resources from all waste streams (van Buren et al., 2016).

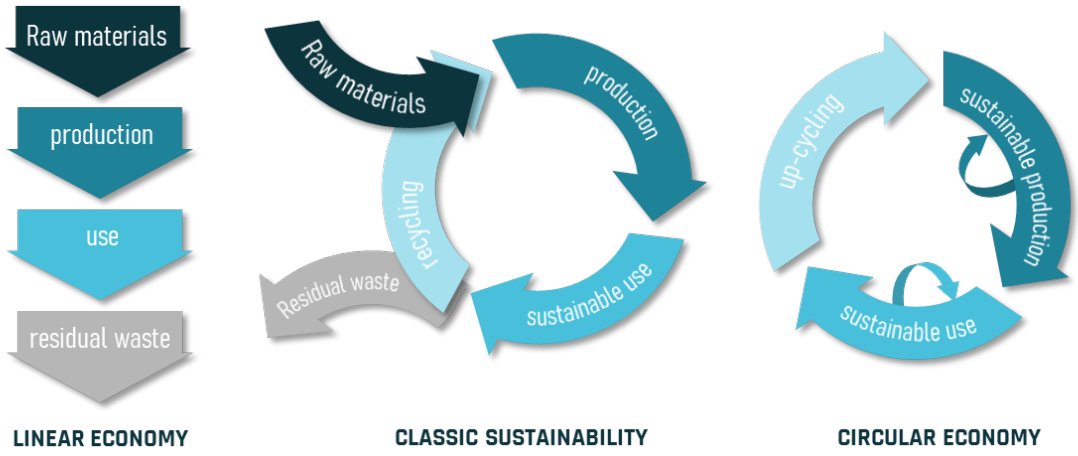


Figure 3.2: Differences between linear economy, recycling economy, and circular economy. Based on: PBL (2019) and van Buren et al. (2016).

The call for a transition to a circular economy has been present in all economic sectors, including academics, politicians, policymakers, and business leaders worldwide. This is because studies have shown that the circular economy will bring substantial advantages to all parties involved. The first advantage is the possibility of complying with several of the 17 Sustainable Development Goals (SDGs) adopted by the United Nations to end poverty, protect the planet and ensure prosperity for all. Likewise, other advantages involve eliminating the dependence to resort to exploitation of raw materials and preventing that "value" (e.g., resources) from just exiting the economy (van Buren et al., 2016).

The concept of circular economy is strongly recognized between industry and academia, and it is influenced by many schools of thought, such as *performance economy* (product-service systems), *cradle-to-cradle* (design for future), *biomimicry* (innovation inspired by nature), *industrial ecology*

(closed-loop for water,energy, and waste), *natural capitalism* (productivity of natural resource), *blue economy* (waste as resource), and *regenerative design* (design positively, restoring, renewing, and revitalizing resources and the environment) (Ellen MacArthur Foundation, 2019a). The CE concept is also based on ideas that include industrial symbiosis, cleaner production, and zero emissions (López Ruiz et al., 2020). Currently, the concept of CE contains more than 114 definitions and with it a wide variety of applications, interpretations, practices and processes to achieve it (Kirchherr et al., 2017). Although there is no single definition of circular economy, Ellen MacArthur Foundation (2015a) defines it thoroughly and concisely as:

"A circular economy is a systemic approach to economic development designed to benefit businesses, society, and the environment. In contrast to the 'take- make-waste' linear model, a circular economy is regenerative by design and aims to gradually decouple growth from the consumption of finite resources." and *"...aims to keep products, components, and materials at their highest utility and value at all times, distinguishing between technical and biological cycles"* (Ellen MacArthur Foundation, 2015b).

Consequently, Ellen MacArthur Foundation (2019b) defined three fundamental principles to guarantee the circular economy. The first principle is to *preserve and enhance natural capital* through design without negatively affecting human health and natural systems. It involves controlling the flow of finite resources and replacing it with renewable resources that return nutrients to the natural environment. Therefore, this principle pursues to address fossil fuels, hazardous substances, and the release of GHG emissions that pollute the air, water, and land. The second principle is to *optimize resource yields* by keeping the products and materials in use with the highest utility in the technical or biological cycle, as appropriate. This principle involves designing for durability, reuse, re-manufacturing and recycling to keep materials in the loop. Then, the third principle is *foster system effectiveness* by designing without negative externalities and, on the contrary, pursuing regeneration while inducing benefits to the environment (Ellen MacArthur Foundation, 2015a, 2019a).

3.2.1. Circular economy in the built environment

The construction sector is one of the largest consumers of natural resources and is accountable for about 30% of all waste in the European Union (Adams et al., 2017; Hjaltadóttir & Hild, 2021). Construction activities under the linear economy are mainly responsible for the scarcity of natural resources, the use and contamination of water sources, high energy consumption, and air pollution due to aggregate crushing, on-site construction, and demolition (Çimen, 2021). Additionally, the construction sector alone contributes approximately 23% of C02 emissions. Therefore, the construction ruled by linear economy models negatively impacts society, the global economy, and the environment, making it one of the main target sectors for the transition to a circular economy.

In the construction sector in the Netherlands, several organizations concerned about the transition to a circular economy have spoken out in favor of proposing initiatives, actions, and strategic plans that best lead to a change in the economic model. Some of these organizations are PIANOo, Circular Construction Economy Transition Team (2020), Copper8 (2020), Holland Circular Hotspot (2018), and Platform CB'23 (2021b), which also proposed their own definitions, so circular construction has no single definition. However, all are in favor of achieving a comprehensive definition that preserves the principles of the circular economy. For example, PIANOo, together with Platform CB'23 (2021a), give a definition that has been adopted from the Transition Agenda for a Circular Construction Economy. Thereby, circular construction is defined as:

"Developing, using and reusing buildings, areas and infrastructure, without unnecessarily depleting natural resources, polluting the living environment and damaging ecosystems. Building on a manner that is economically responsible and contributes to the welfare of humans and animals. Here and there, now and later".

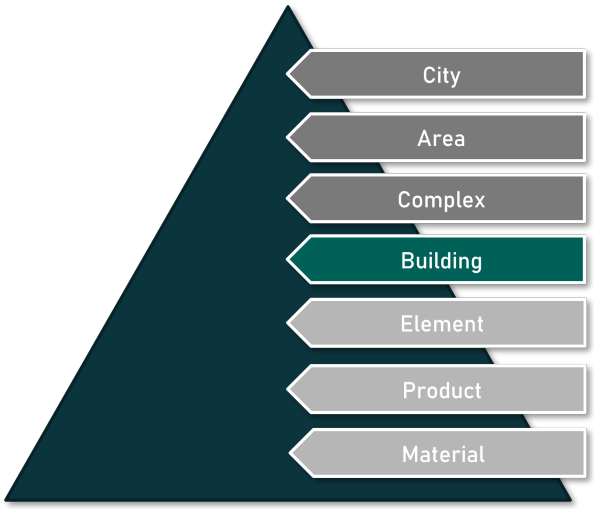


Figure 3.3: Scale levels of the built environment for the application of circular principles. Adapted from: Çimen (2021) and Platform CB'23 (2019).

Additionally, it is necessary to consider that circular economy can be applied at different scales in the built environment as seen in Figure 3.3. Starting from the scale of *materials*, this refers to the use of alternative materials and raw materials that are processed to manufacture construction products. Construction *products* are those that, after a process, form part of an element, such as windows, doors, heating, and lighting. In the case of prefabrication, the products are manufactured in elements before being delivered to the construction site (also are mentioned as components). Then, the *elements* are unified to create a building that fulfills a specific function, being it for residential use, offices, education, logistics, or other uses. Then, the *complex* scale frames a particular set of buildings and other structures that perform a greater function, such as airports and shopping center complexes. Then, *area* includes the greenery/land adjacent to the complexes (Çimen, 2021; Platform CB'23, 2019). Finally, *city* includes a set of connecting areas and infrastructure.

Consequently, considering the identification of the different scales in the built environment, Platform CB'23 (2019) defines a circular building as *"A building that is designed and executed in accordance with circular design principles; and is realized with circular elements, products and materials"*. However, the definition contains the expression "design principles" without and exact clarification, thereby, the definition of Circle Economy et al. (2018) helps to meticulously extend the meaning of design principles. So a circular building is defined by Circle Economy et al. (2018) as:

"A building that is developed, used and reused without unnecessary resource depletion, environmental pollution and ecosystem degradation. It is constructed in an economically responsible way and contributes to the well being of people and the biosphere. Here and there, now and later. Technical elements are demountable and reusable, and biological elements can also be brought back into the biological cycle".

3.2.2. Circular building projects

Circular building projects are linked to the ambitions and goals outlined in each particular project. It is understood that circular building projects may be framed by the achievement of defined and measurable objectives. Thus, these defined objectives give a specific direction and tangible circular practices as a mean to achieve circular goals that, at the same time, is measured or assessed with targets and indicators. Although each building project defines its circular goals, in the literature and in practice, three common principles are constantly spoken that attempt to transit towards a circular economy: preserve and enhance natural capital, optimize resource yields, and foster system effectiveness (Ellen MacArthur Foundation, 2015a, 2019a). Wherein, the purposes of circular buildings translate into five tangible themes achievable during the different phases of the building. As a re-

sult of literature aggregation, the five themes that frame circular goals in building projects have been defined as people or users of the building, materials used in construction, energy, water, and future-proof goals. (C2C Expo LAB, 2016; Ellen MacArthur Foundation, 2015a). Figure 3.4 shows the five themes of circular buildings.

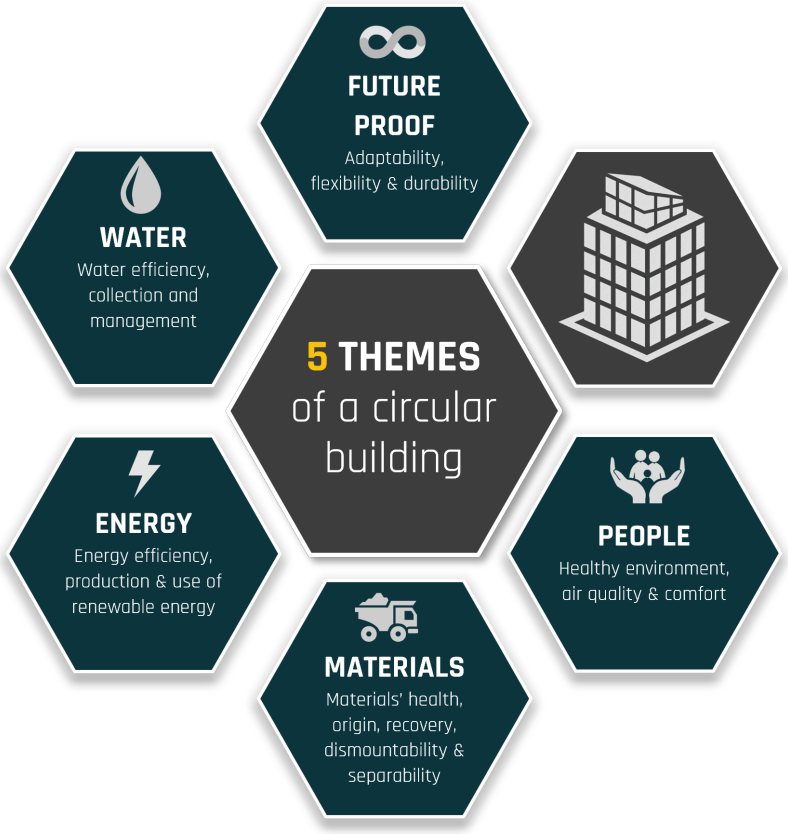


Figure 3.4: Principles of the circular economy applied to buildings. Based on: C2C Expo LAB (2016) and Ellen MacArthur Foundation (2015a).

People relate to the users of the building that aspire to improve indoor and outdoor health. Within health, it is possible to talk about improving air quality and reducing or eliminating the release of chemicals from the elements of the building. Similarly, comfort, biodiversity, aesthetics, and productivity are part of this theme. The building should provide comfortable indoor temperature, ventilation, and introduce spaces for the proliferation of species, such as green areas, design aesthetic, and productive spaces that engage the user to make optimal use of the building (C2C Expo LAB, 2016).

Materials are seen from six main aspects: health, origin, recovery, dismountability, separability, and embodied carbon footprint (EPEA, 2021). Problematic substances in materials harm the environment and are increasingly detected in the human body, causing diseases. As a result, material selection should aim not just for legal limit value compliance and "less bad" chemistry but also for positively specified chemicals for their safe usage in building elements and components. Also, It is critical to determine the source of materials because raw material extraction usually has a detrimental influence on the environment, and the usage of non-circular materials will prevent close loops of materials. Similarly, building design must address material recovery once the building's life cycle has ended. Then, regarding dismountability and separability, the building must contemplate component and element dismantling at a functional level and the ability to detach materials for recycling purposes. Lastly, the selection of materials must be made with an eye toward minimizing their carbon footprint.

The theme of *energy* refers to the efficient energy consumption in buildings and the use of renewable resources. Building designs can encourage reduced energy use through integrated solutions, such as energy-saving devices and passive practices for cooling, heating, ventilation, lighting, and more. Similarly, buildings can produce renewable energy to relieve the energy demand on the building. As a result, energy is an issue of great importance that influences climate change, given that 55% of current emissions are generated due to the (inefficient) use of non-renewable energy. Therefore, efficient and renewable energy in buildings is expressed as one of the main goals of a circular economy in the built environment (Ellen MacArthur Foundation, 2021).

Water from the circular building perspective aims to tackle efficient use, collection, and management of water. Efficient use can be obtained from saving-water devices that reduce the amount of water in daily use. The collection is obtained from rainwater systems that capture and treat the water to be used for the non-drinkable needs of the building. Then, the management facilitates filtering and treatment of greywater to make it apt for reuse in order to reduce the unnecessary use of potable water from the primary grid.

Future proof is highly related to two main aspects, climate change, and asset management. The circular economy in buildings aims to promote the design and construction of buildings that are capable of resisting climate change while at the same time being more durable over time. The inner loop in the circular economy is aligned with the prolongation of use with the minimum need for maintenance. Longer-lasting buildings, however, must adapt to the user's needs over time, which is why the development of versatile, flexible, and adaptable structures is promoted.

3.2.3. Circular practices in building projects

The current linear economy is characterized by the continuous use of the resources that the planet offers, as the population increases and its needs arise. But, resources are running out and scarcity begins to affect project costs and times, while creating environmental injuries, which is why the circular economy is presented as an alternative to the widely used linear economy model (Benachio et al., 2020). Commonly, the concept of circular economy in the construction sector is limited to the minimization and recycling of resources, whereas limited literature addresses more complex concepts that seek to promote new business models that enable the generation of added value to supply chains, through retention of high residual values in materials. These new business models provide the opportunity to reduce the use of raw materials, reduce the carbon footprint, while in turn, bringing socioeconomic benefits to the projects and those who participate in them. For example, the Ellen MacArthur Foundation estimated in 2015 that by implementing a circular economy in the built environment across Europe, by 2030, quantified benefits of approximately £300 billion could be achieved, from savings in primary resources and savings of energy, which represents a direct benefit for the parties involved (Adams et al., 2017).

However, there is still a limitation in the research that allows implementing on a large scale circular economy applications in the built environment that contemplate not only the recycling of construction and demolition waste but also the conscious design of buildings suitable for deconstruction and reuse (Adams et al., 2017). Thus, Benachio et al. (2020) bring together different CE practices throughout the life cycle stages of design, manufacture, construction, operation, and reincorporation to the cycle, which are partially applied in the construction industry. These practices were recognized through the literature review, however, they are not limited to those mentioned below.

The circular practices in the design phase contemplate the design for adaptability, disassembly, modularity, use of life cycle analysis, among others. In the manufacturing phase, there are practices regarding the change of ownership to the manufacturer and the development of material passports. Then, in the construction phase, prefabrication practices (off-site), waste reduction, and reuse of materials. In the operation phase, circular practices include the use of tools to assess the condition of materials and components during their lifespan, together with maintenance activities that aim to preserve the functionality. Finally, in the end-of-life phase, circular practices consist of analyzing the potential for reuse, recycling and recovery of materials and components, as well as the management

of demolition waste.

The application of one or more of these circular practices in building projects is a function of the particularity, characteristics, scope of each project and willingness of parties involved, so the expression 'circular building project' depends largely on the individual definition given for the specific project and the understanding of the CE concept by different stakeholders (Corona et al., 2019). Therefore, the expected circular practices in a project are agreed between the parties involved that for the purposes of this investigation it will be the public client and the main contractor.

For the purposes of this research, the literature review on circular economy in building projects served to find the most specific and identifiable circular practices present throughout the life cycle of building project. There were at least three authors who outlined these practices/interventions in their scientific articles (Adams et al., 2017; Akhimien et al., 2021; Benachio et al., 2020). As a result, these findings were examined, contrasted, and summarized to obtain a comprehensive list of circular practices for this research. Since circular interventions in building projects was evaluated qualitatively, the identification of specific circular economy practices for each stage of the project life cycle facilitated in-depth comparative analysis of circular interventions in the building projects addressed in the research. Therefore, Table 3.1 summarizes and organizes the circular practical interventions observed in construction projects across the building life cycle.

Table 3.1: Circular economy practices in building projects

Life-cycle stages	Circular practices	Sources
DESIGN	D1: Water collection and re-circulation	Ellen MacArthur Foundation (2019a)
	D2: Use & production of renewable energy	Ellen MacArthur Foundation (2019a) and Lewandowski (2018)
	D3: Modularity	Adams et al. (2017), Benachio et al. (2020), and Ellen MacArthur Foundation (2019a)
	D4: Design for adaptability and flexibility	Adams et al. (2017), Benachio et al. (2020), and Ellen MacArthur Foundation (2019a)
	D5: Design for Disassembly (DfD)	Adams et al. (2017), Akhimien et al. (2021), and Benachio et al. (2020)
	D6: Specify secondary raw materials	Adams et al. (2017), Akhimien et al. (2021), Benachio et al. (2020), Ellen MacArthur Foundation (2019a), and Lewandowski (2018)
	D7: Use of information systems	Benachio et al. (2020) and Lewandowski (2018)
	D8: Specify better-performance materials	Ellen MacArthur Foundation (2019a) and Lewandowski (2018)
MANUFACTURE AND SUPPLY	M1: Material passport	Akhimien et al. (2021) and Benachio et al. (2020)
	M2: Change ownership models	Adams et al. (2017), Akhimien et al. (2021), Benachio et al. (2020), and Lewandowski (2018)
	M3: Reuse of secondary materials	Adams et al. (2017), Akhimien et al. (2021), Benachio et al. (2020), and Lewandowski (2018)
	M4: Product standardization	Adams et al. (2017) and Akhimien et al. (2021)
	M5: Design for product disassembly	Adams et al. (2017) and Akhimien et al. (2021)
	M6: Optimize material use	Adams et al. (2017) and Lewandowski (2018)
	M7: Reverse logistics	Adams et al. (2017) and Ellen MacArthur Foundation (2019a)
CONSTRUCTION	C1: Off-site construction / prefabrication	Adams et al. (2017), Akhimien et al. (2021), and Benachio et al. (2020)
	C2: Reuse of materials	Adams et al. (2017), Benachio et al. (2020), and Ellen MacArthur Foundation (2019a)
	C3: Recycle materials	Adams et al. (2017) and Ellen MacArthur Foundation (2019a)
OPERATION	O1: Water management practices	Benachio et al. (2020) and Ellen MacArthur Foundation (2019a)
	O2: Use & production of renewable energy	Ellen MacArthur Foundation (2019a)
	O3: Shared spaces / dynamic functionalities	Lewandowski (2018)
	O4: Optimize maintenance	Adams et al. (2017), Akhimien et al. (2021), Benachio et al. (2020), and Ellen MacArthur Foundation (2019a)
	O5: Adaptable and flexible use	Adams et al. (2017) and Ellen MacArthur Foundation (2019a)
	O6: Passive cooling and heating	Ellen MacArthur Foundation (2019a)
	O7: Passive lighting and ventilation	Ellen MacArthur Foundation (2019a)
END OF LIFE	E1: Deconstruction / Disassembly	Adams et al. (2017), Akhimien et al. (2021), and Benachio et al. (2020)
	E2: Selective demolition	Adams et al. (2017), Akhimien et al. (2021), Benachio et al. (2020), and Ellen MacArthur Foundation (2019a)
	E3: Reuse and recycling of components	Adams et al. (2017), Akhimien et al. (2021), Benachio et al. (2020), and Lewandowski (2018)

3.3. Inter-organizational collaboration in construction projects

Inter-organizational ollaboration is how the interaction between organizations results in the pooling of resources, which in turn enables the creation and dissemination of new knowledge that is advantageous to all parties concerned (Hardy et al., 2003). This type of collaboration is viewed as a process through which partners with varied knowledge and responsibilities can constructively explore their differences and seek solutions to challenges that exceed their capacity. Suprapto et al. (2015) defines client-contractor collaboration as “the behavioral interaction between the client and the contractor working together to achieve specific project and business objectives by effectively utilizing the specific resources and capabilities of each party based on shared values and norms.” Consequently, the objective of such organizations is to achieve a form of ‘collaborative advantage’ that is mutually ad-

vantageous for all parties (Vangen & Huxham, 2003).

Inter-organizational collaboration is also commonly referred to as cross-sector collaboration (Alonso-Almeida et al., 2021; Bryson et al., 2015; Oskam et al., 2021; Pedersen et al., 2021), inter-firm collaboration, inter-firm relationship/partnering (Buckley & De Mattos, 2021; Jha & Cottam, 2021; Khouja et al., 2021; Muhamad Halil et al., 2021), or even collaborative governance (Butković et al., 2021; Chakkol et al., 2018; Christensen, 2021; Malekpour et al., 2021; Vazquez-Brust et al., 2020). It functions in complex contexts, such as sustainable development, that contain ambiguity, multidisciplinary societal participation, and issues that cannot be entirely resolved by a single actor (Sharma & Kearins, 2011; Vazquez-Brust et al., 2020). In general, the challenges that these sorts of collaboration strive to solve are complex public issues that necessitate medium- to long-term engagement (Bryson et al., 2015). Chakkol et al. (2018), for instance, describes complex projects as having three distinct features. First, the temporary nature of the project-based partnership which makes collaboration more difficult due to the limited time available to establish shared standards and confidence. Second, the uniqueness, unpredictability, and necessity for various organizations posed by the projects' complexity. Third, organizational structures and hierarchies that are ambiguous due to the involvement of numerous organizations, teams, and individuals (Chakkol et al., 2018).

Collaboration amongst participating groups is vital for circular building initiatives (Berardi & Brito, 2021; Brown et al., 2021; Leising et al., 2018). Circular building projects are typically ephemeral, they oppose traditional and fragmented work practices due to their uniqueness, volatility, and specific requirements. They require different organizations with diverse structures and hierarchies. In addition, the new challenges in circular projects range from the recycling and reuse of construction materials to the creation of disruptive designs and the formulation of new business models, which entail gradually decoupling economic activity from the consumption of finite resources and eliminating system waste. Based on a switch to renewable energy sources, the circular model promises to develop economic, natural, and social capital.

Likewise, the complexity of a construction project increases when the circular model is applied, and collaboration on a complex project is considered particularly challenging, so it must be effectively governed (Chakkol et al., 2018). Consequently, *governance mechanisms* are meant to guide the coordination, adaptation, and safeguarding of collaboration between the principal parties of inter- organizational projects. This, through the establishment of a shared set of rules, arrangements, and processes that all participating parties are expected to follow (Kujala et al., 2021). Consequently, the implementation of relational and contractual governance mechanisms can lead to better inter-organizational relationship. Thereby, better results in the performance of a project, which reflects more possibilities of circular outcomes.

3.3.1. The role of public clients and main contractors

- **Public clients:** Public construction clients are legal agents who take the initiative in the construction of goods and services since they have the role of providing accommodation or infrastructure to users. They differ from private clients in terms of spending public funds and complying with specific European regulations for public entities (Eisma & Volker, 2014). Public clients are seen as initiators and promoters of projects, that is why Kanters (2020) finds client's commitment a critical factor in the transition to CE in building projects. For example, government organizations are also important clients that guide the other actors involved, such as the main contractor, towards the path of CE implementation in the construction sector (Hjaltadóttir & Hild, 2021).

  The public client can stimulate the transition to a circular built environment through actions and decisions, for instance, in procurement and contracting procedures. A more specific example may be circular public procurement. It s a process wherein public authorities purchase works, goods, or services that contribute to close and slow down resource loops within supply

chains while minimizing or, in the best case, avoiding environmental impacts and waste creation across their life-cycle (CLIMATE-KIC, 2019). Similarly, project delivery models (PDMs) that contain more collaborative contracts, longer term relationships, value chain engagement and clearer vision for CE, can incentives contractors to participate in the transition to circular built environment (Hart et al., 2019).

- **Main contractors:** According to the literature, a contractor can be either a natural or juridical person, or also a group of companies who come together in a consortium to be generally responsible for the execution of a construction project. These are also defined as main contractors, original contractors, principal contractors, or prime contractors, and may have subcontractors that provide services and products (specialized subcontractors). The public client selects contractors to perform specific activities within a construction project. This contracting is given because the public client does not have the skills, experiences, and resources to carry out the activities independently. Therefore, the contractors undertake a contract with the public client and receive a payment for the execution of the responsibilities agreed in this contract. The contractors are mostly project-based firms which refer to the different functions that these contractors can perform, including on-site service providers, consultants, property operators/developers, real estate agents, specialists, among many others (Blayse & Manley, 2004). Consequently, contractors have a primary role in the construction project since by obtaining a contract, they are acquiring a risk that is transferred from the public client, which can be of a technical, economic, or even social nature, to perform the tasks as established by agreements.

  Contractors are of great importance in the transition towards a circular economy in building projects as they must be the adopters of innovations and changes in processes. They are responsible for implementing the change in each of the traditional tasks they have been performing, from the construction procedures, through the type of circular actions that can be implemented on-site, to the selection of the type of resources and market with whom they will interact. Therefore, contractors are fundamental actors to enable closing the cycle of materials, avoiding waste and reducing contamination of unwanted components in construction. It largely depends on them to choose markets and suppliers that are also focused on complying with a circular economy in their processes.

  Moreover, the collaboration between public client and contractor enable even further broadening the perspective towards a circular economy and encompassing other preliminary areas such as the front-end phase. Thus, the conscious selection and use of materials, the operation features, deconstruction characteristics, and the end-of-life of the building, are some aspects that the contractor must consider during the front-end phase to pursue the close of loops and elimination of waste (Charef & Lu, 2021).

  To conclude, the main contractors are pivotal player within the circular built environment due to the need for close collaboration and interdependence with public clients and other stakeholders to jointly commit to reduce the indicators of waste, pollution, and exploitation of raw materials currently caused by linear economy (Pham et al., 2021). For the purpose of this study, the research will be mainly focused on the main contractor responsible for the execution phase as it has the highest participation in the building projects and acts as linking entity with the rest of the supply chain.

3.3.2. Governance mechanisms in IOC

Governance mechanisms are seen as the arrangements, structures, and processes for the coordination, adaption, and safeguarding of inter-organizational collaboration exchanges (Kujala et al., 2021). Those, enforce collaboration of multiple actors to come together, perform and steer norms to align their effort towards a shared goal (Vazquez-Brust et al., 2020). Inter-organizational relationships are governed by contractual and relational mechanisms, which are mutually reinforcing. *Contractual governance* refers to the legal and explicit way of binding agreements that define the roles, responsibilities, and rights between the parties involved to safeguard against opportunism. Collaborative

contracts, for instance, as a type of collaborative governance, also include a variety of clauses regarding coordination and adaptation, which differ from traditional contractual forms based only on cost and time drivers. Therefore, in addition to the definition of roles and responsibilities and conflict resolution, contractual governance also includes a variety of collaboration factors and mechanisms such as joint decision-making, working in a collective trust environment, early contractor involvement, and the establishment of common processes to facilitate the achievement of goals in complex projects. On the other hand, *relational governance* is multidimensional and includes more emergent collaboration mechanisms derived from social and tacit arrangements, such as trust, commitment, common interests, shared values, and shared understanding, which are considered essential factors that must forge the inter-organizational relationship (Chakkol et al., 2018; Roehrich et al., 2020). Both, contractual and relational governance are complemented in order to achieve and manage collaboration under ethical, cohesive and transparent terms to achieve the objectives of the project. Therefore governance is seen as an important phenomenon that influence the performance of focal parties involved (Kujala et al., 2021; Roehrich et al., 2020).

In the literature, several arrangements, processes and mechanisms associated with stakeholders' relationships have been identified in the construction sector. Among the most mentioned approaches are the processes for joint actions such as, collaborative agendas, and collaborative planning (Bryson et al., 2015; Hjaltadóttir & Hild, 2021; Sharma & Kearins, 2011), incentives and disincentives (Bayliss et al., 2004; Bryson et al., 2015; Eriksson et al., 2019; Suprapto, 2016), communication and shared knowledge tools (Bryson et al., 2015; Shelbourn et al., 2007), intra-personal communication and trusting relationships, stakeholder engagement (Eriksson, 2015; Shelbourn et al., 2007; Suprapto, 2016), project culture (Australian Government, 2015; Suprapto, 2016), team building actions (Eriksson, 2010, 2015; Suprapto, 2016), risk-sharing models (Australian Government, 2015; Eriksson, 2010, 2015; Suprapto, 2016), among others. Nevertheless, these governance mechanisms are still a "black-box" regarding the relationship between public client and contractor to perform building projects under circular economy interventions.

3.3.3. A framework for governance mechanisms in IOC

The Kujala et al. (2021) framework was created to analyze the approaches for coordination, adaptation, and safeguarding of exchanges between the focal parties of inter-organizational construction projects. The framework enables a better analysis of the type of governance mechanisms that projects of an inter-organizational nature must consider when performing with complexity or outside the traditional scopes, which applies in the case of circular building projects. The research of Kujala et al. (2021) was performed from the perspective of governance in project networks and with a focus on the challenges posed by inter-organizational relationships in which each party may have its own objectives related to the project and its own way of achieving those goals. Therefore, the framework proposes six key governance dimensions subject to certain specific governance mechanisms found in the literature. These mechanisms, in turn, manage to cover all the findings in this section of the research regarding inter-organizational collaboration in construction projects. In addition, the Kujala et al. (2021)'s framework allows to narrow the findings on the collaboration from the governance approach. For this reason, the Kujala et al. (2021) framework was selected to synthesize the inter-organizational collaboration defined from a governance perspective.

Figure 3.5: Framework for governance mechanisms in inter-organizational projects. Adapted from: Kujala et al. (2021).

The *Goal-setting* dimension seeks to establish inter-organizational governance mechanisms that enable the parties to jointly define clear goals and with some level of flexibility. Thus, these mechanisms allow for cohesion and collective interest between the parties, motivated by an individual willing to work together to achieve a common goal. Hence, aspects such as aligned and clarity of vision and goals and commitment are inter-organizational collaboration factors that fit under this governance mechanism to reduce opportunistic behavior and enforce good performance. For the definition of goals for the project, the literature emphasizes the importance of early participation of the parties in this process so that the different sources of knowledge come together and establish achievable objectives and optimal solutions that include all possible perspectives. Besides, early involvement makes actors feel like they are a fundamental part of the process, which leads them to commit and motivate themselves to outperform results.

Capability-building mechanisms ensure that the parties involved in the project have the ability and power to meet the expected performance of the project. Through contractual and relational governance mechanisms, it is ensured that the parties have the skills, experience, and knowledge to participate in the project from an early stage. For example, competitive tendering processes and selection criteria are of great importance in capability building. Similarly, the literature identifies collaborative factors such as strategic engagement that aim to optimize the participation of relevant actors (involvement of the right party at the right moment) to bring fundamental knowledge to moments where crucial decisions must be made. Other factors applied to the inter-organizational relationship, such as training and continuous learning, can also enhance team capacity.

The *Roles and decision-making* dimension include mechanisms that enable the parties involved to have clarity and transparency about their responsibilities while obtaining the necessary information to understand the effect of their decisions on the project. This understanding enable them to make the right decisions with the most negligible negative impact on meeting goals. The governance mechanisms for the definition of roles and responsibilities are generally contractual, however, there is an emerging collaborative governance that strives for dynamic roles due to uncertainties in complex projects. Hence, the mechanisms for decision-making can be both contractual and relational. An adequate project management structure for decision-making is defined contractually, whereas other collaborative governance promotes decentralized power by distributing decision-making power among the actors involved or even among teams. Here, collaboration factors found in the literature, such as equitable relationships and flexible governance structures, provide spaces for balanced contribution in decision-making, where power rotates towards the parties that best understand the situation due to their experience. Nevertheless, for it, the inter-organizational relationship must include other factors such as mutual respect and mutual understanding, which brace for a common language and for each party to understand the different perspectives and scope of the others.

Rewarding mechanisms are types of incentives and disincentives that aim to align goals and guarantee the execution of the project with the expected performance. These collaborative mechanisms may include rewards or penalties based on financial or non-financial structures and the allocation

of risks between the parties involved. In general, unlike traditional mechanisms, more collaborative mechanisms seek to align performance, share or balance risks, and jointly apply for rewards, or, in the case of unfavorable situations, jointly bear sanctions. The collaboration factors found in the literature, such as incentives and disincentives, and joint risk management protect and support inter-organizational collaboration in business models to steer efforts towards collective goals. Similarly, formal ownership structures can be seen here as well, in which key players in the project own a stake in the organization formed to execute the project. It entails balanced equity, share in arrangements, and outcomes. Likewise, in order to establish a sense of belonging and motivation, rewarding mechanisms are built on retaining an ownership stake in the asset, which might be through new service-based business models (take-back models) instead of product-based approaches as is currently seen in building projects with circular values.

Coordination mechanisms align the behavior and work of the parties so that the project can be developed jointly. Coordination implies the adaptation of tools, forms of work, processes, and information so that a shared behavior is formed, oriented towards achieving the expected performance. Various coordination mechanisms are identified here, including common project management practices, shared culture, values and norms, communication and information sharing, change management, and conflict resolution. Project management practices involve inclusive processes that strive to achieve synchronization and compatibility in the way activities and actions are executed. Shared culture is achieved by establishing project culture that makes possible the emergence of a team spirit, a shared identity, and a best-for-project mentality. Likewise, shared knowledge, learning, and up-to-date communication are essential collaboration factors that require mechanisms that not only allow access to reliable, transparent and latest information between the parties, but also, the creation of joint knowledge. Similarly, the inter-organizational relationship requires a certain flexibility that admits changes, identifies improvements, and develops new ideas, all focused on attaining the project's goals. Then, mechanisms for conflict resolution strive to avoid the breakdown of the interaction and work between the parties involved.

The *Monitoring* dimension seeks to encompass mechanisms that guarantee the consistent behavior and performance of all the actors involved in the fulfillment of the goals. Ongoing control and monitoring in project management are crucial to achieving milestones and safeguarding parties against the constant potential for opportunism. Formal and informal structures can give monitoring and control mechanisms. While formal structures are based on key performance indicators, some informal structures, such as overseeing overall progress, providing guidance and positive feedback, forge more indirect monitoring practices while enriching effective inter-organizational collaboration. In relational governance, for instance, progress meetings or 'big room' meetings facilitate the informal monitoring of the status of individuals or organizations in connection to the activities they are undertaking. In these spaces, interaction between partners, consultation, support, and clarification of doubts are enabled, hence offering opportunities for performance correction, improvements and the formation of a shared understanding.

To expand knowledge on the forms and types of inter-organizational relationships that lead to collaboration in construction projects, a systematic literature review was conducted to identify the aspects of inter-organizational collaboration contained in each of the aforementioned dimensions for the governance mechanisms. The twenty five (25) scientific articles mainly related to the research topic were selected (Akintan & Morledge, 2013; Akintoye & Main, 2007; Benachio et al., 2020; Bresnen & Marshall, 2000a; Brown et al., 2021; Bryson et al., 2015; Cheng et al., 2000; Davis & Love, 2011; Faris et al., 2019; Hietajärvi et al., 2017; Hughes et al., 2012; Kooter et al., 2021; Kozuch & Sienkiewicz-Malyjurek, 2016; Kujala et al., 2021; Kwofie et al., 2019; Leising et al., 2018; Patel et al., 2012; Rahman & Kumaraswamy, 2005; Sarkar et al., 1998; Saukko et al., 2020; Schruijer, 2020; Shelbourn et al., 2007; Suprapto et al., 2015; Wuni & Shen, 2022; Xue et al., 2010). These articles were listed and compared to find the most relevant collaboration aspects within the governance dimensions. Consequently, different mechanisms, arrangements, processes and collaborative practices were identified as currently applied in construction projects to achieve better performance and address diverse challenges in complex projects. Table 3.2 contains these most noted inter-organizational collaboration aspects, along with characteristic descriptions mentioned by the authors in their scientific articles.

Table 3.2: Aspects of Inter-organizational collaboration for each governance dimension

Governance dimension	Description from sources
Goal-setting	
Joint performance goal	• Congruence in objectives and scope definition (Saukko et al., 2020). • Early involvement of parties to jointly define goals (Faris et al., 2019; Hughes et al., 2012; Saukko et al., 2020; Wuni & Shen, 2022; Xue et al., 2010). • Alignment of partners on shared purpose (Brown et al., 2021). • Joint agreement on aims, objectives and targets (Cheng et al., 2000; Faris et al., 2019; Kozuch & Sienkiewicz-Malyjurek, 2016). • Development of collective interest, goals, and actions (Hietajärvi et al., 2017; Kozuch & Sienkiewicz-Malyjurek, 2016). • Connect goals, motivations and interrelationships between parties (Davis & Love, 2011; Kooter et al., 2021; Patel et al., 2012). • Cohesion in the sense of "we-ness" between parties, or individual willingness to work together to achieve a common goal (Suprapto et al., 2015). • Mutual mission, vision and goals (Brown et al., 2021; Davis & Love, 2011; Faris et al., 2019; Kozuch & Sienkiewicz-Malyjurek, 2016; Patel et al., 2012; Saukko et al., 2020).
Clarity of goals	• Clarity of vision and goals (Brown et al., 2021; Kozuch & Sienkiewicz-Malyjurek, 2016; Schruijer, 2020; Suprapto et al., 2015). • Explicit shared goal or vision on circular objectives (Kooter et al., 2021). • Clearly defined task milestones (Akintoye & Main, 2007).
Flexibility of goals	• Flexibility versus stability (Bryson et al., 2015). • Limited flexibility to change work processes, constraints collaboration (Bryson et al., 2015).
Capability building	
Actor selection	• Collaborative capability building relies on the recruitment of people with a collaborative mentality, education and training, authentic leadership, trust and personal relationships, as well as the cultivation of a positive project spirit (Saukko et al., 2020). • Early cross-disciplinary interaction (Saukko et al., 2020). • Early involvement of key parties such as contractors to raise constructability, bring practical knowledge, and maximize value engineering (Faris et al., 2019; Hughes et al., 2012; Saukko et al., 2020; Wuni & Shen, 2022; Xue et al., 2010). • "Progressive engagement" (Davis & Love, 2011). • Strategic engagement to commit resources and collaborative working (Akintoye & Main, 2007; Xue et al., 2010). • Resource complementarity to obtain a more bonded relationship (Sarkar et al., 1998). • Commitment and willingness to cooperate and exert effort (Faris et al., 2019; Kozuch & Sienkiewicz-Malyjurek, 2016). • Involvement of intrinsically motivated people (Kooter et al., 2021). • Continuity in staffing to guarantee that knowledge remains within the team (Kooter et al., 2021).
Training and continuous improvement	• Joint-learning spaces to foster internal trust (Bryson et al., 2015). • Development of a core knowledge base and training in new skills (Hietajärvi et al., 2017). • Team-building to achieve performance improvement (Akintoye & Main, 2007). • Lessons learned to improve future project (Kooter et al., 2021; Patel et al., 2012; Suprapto et al., 2015; Wuni & Shen, 2022). • Resilience and reassessments through ongoing learning (Bryson et al., 2015).

Governance dimension	Description from sources
Roles and decision-making	
Definition of roles and responsibilities	• Clearly defined roles and responsibilities of parties involved since circular objectives entails new roles combined with the traditional responsibilities (Kooter et al., 2021). • Clear understanding and distribution of authorities and roles (Bryson et al., 2015). • Cognitive legitimacy, mutual understanding of each others' objectives, expectations, values, working practices and norms (Brown et al., 2021; Bryson et al., 2015; Kozuch & Sienkiewicz-Malyjurek, 2016; Rahman & Kumaraswamy, 2005).
Management structures	• Some degree of flexibility in role definition to avoid the lack of support between team members (Faris et al., 2019). • Problem-solving environment (Hughes et al., 2012). • Joint governance structure (Brown et al., 2021; Hietajärvi et al., 2017). • Integration leadership (Hietajärvi et al., 2017).
Authority for decision-making	• Governance relies on expert power, wherein decisions are made by those who best understand the situation rather than relying on a hierarchy of authority (Patel et al., 2012). • Joint problem solving and decision-making (Kozuch & Sienkiewicz-Malyjurek, 2016; Saukko et al., 2020; Suprapto et al., 2015). • Decision-making by consensus (Hietajärvi et al., 2017; Saukko et al., 2020). • Empowerment of the project team (Sarkar et al., 1998). • In decision-making situations, stakeholders have the impression that they were given a "fair hearing" (Bryson et al., 2015). • Structural ambidexterity (Bryson et al., 2015). Shared authority (Davis & Love, 2011). • Equity contributions on organizational knowledge, technology, and human resources (Akintoye & Main, 2007; Xue et al., 2010).
Rewarding	
Rewards tied to performance	• Incentives can guard and ground collaboration in the business model by deliberately incorporating interests of all stakeholders towards a collective goal (Leising et al., 2018). • Parties respond to incentives and adapt their behavior accordingly (Patel et al., 2012). • Perceived fairness in rewards (Sarkar et al., 1998). • Benefits between collaborators are "evenly" distributed (Akintoye & Main, 2007). • Shared rewards / Pain and gain incentives to motivate partners (Faris et al., 2019; Hughes et al., 2012; Xue et al., 2010). • Consequential incentives (Bryson et al., 2015). • Implement shared incentives and avoid fragmented incentives (Leising et al., 2018).
Risk allocation	• Joint risk management and risk-bearing (Saukko et al., 2020). • Fair risk allocation (Faris et al., 2019; Hughes et al., 2012). • Potential collaborative risks (Akintoye & Main, 2007; Faris et al., 2019). • Risk-shifting increases when partners' trust and desire to collaborate grows (Davis & Love, 2011).
Ownership structure	• The transition to a circular construction industry largely relies on new business models, some of which may entail the transfer of material and product ownership as well as the provision of maintenance services, where buildings function as a "Material bank"(Leising et al., 2018). • Change of use of materials by granting the manufacturers the right to reuse the materials after the building's useful life (Benachio et al., 2020).
Reputation	• Reputation instills in individuals a sense of esteem and encourages them to attain success (Suprapto et al., 2015). • Reputation is seen as a key relational factor for selecting contractors/consultants (Rahman & Kumaraswamy, 2005). • A partner with a "good" reputation is more likely to be trusted, as reputation is others' expectations about others behavior in a partnering relationship (Akintoye & Main, 2007). • Reputation is substituted for experience while making assessments (Davis & Love, 2011).

Governance dimension	Description from sources
Coordination	
Common PM practices	• Common processes / Inclusive processes / Defined and jointly agreed processes (Kozuch & Sienkiewicz-Malyjurek, 2016; Suprapto et al., 2015). • Synchronization and alignment on overall project activities and actions between team members (Suprapto et al., 2015). • Joint thinking of the activities required to achieve the common goals. Collective work planning (Saukko et al., 2020). Cooperative planning (Davis & Love, 2011). • Congruence between parties in terms of procedural orientations (Brown et al., 2021). • Robust structure with centralized leadership (Akintoye & Main, 2007). • Create a common language and open exchange on perspectives to balance individual thoughts (Brown et al., 2021). • Dynamic capabilities in which all parties contribute or benefits according to their specific potential or needs, respectively, to create competitiveness (Cheng et al., 2000; Davis & Love, 2011; Hughes et al., 2012; Kooter et al., 2021; Suprapto et al., 2015; Xue et al., 2010). • Flexibility of resources to cope with sudden demand (Davis & Love, 2011). • Share scarce resources (Akintoye & Main, 2007). • Optimize joint resources - Strategic combination of resources. Synergistic and complementary strengths (Kwofie et al., 2018; Patel et al., 2012; Sarkar et al., 1998; Xue et al., 2010). • Recognized interdependence (Bryson et al., 2015).
Shared culture, values and norms	• Congruence between parties in terms of cultural orientations (Sarkar et al., 1998). • Group cohesion (Suprapto et al., 2015). • Create cooperative team spirit between parties involved and a shared identity or project team identity (Bryson et al., 2015; Cheng et al., 2000; Hietajärvi et al., 2017; Kooter et al., 2021; Suprapto et al., 2015). • Common best-for-project mindset (Brown et al., 2021; Hietajärvi et al., 2017). • Establish a collective trust-based relationship and ensure to solve issues as a joint team (Hietajärvi et al., 2017; Rahman & Kumaraswamy, 2005; Sarkar et al., 1998; Saukko et al., 2020). • Mutual trust reflected in perceived inter-dependency, credibility, integrity, fairness, and non-opportunistic behavior toward each other (Akintoye & Main, 2007; Schruijer, 2020; Suprapto et al., 2015; Xue et al., 2010). • Parties perform their actions, irrespective of the ability to be monitored or controlled in those actions (Kooter et al., 2021). • Deep-rooted belief in a partner's altruism and in the moral order of the relationship (Sarkar et al., 1998). Sense of goodwill (Bryson et al., 2015; Sarkar et al., 1998; Suprapto et al., 2015). • Manage inter-organizational tensions as a result of facing diversity (Schruijer, 2020).
Communication and information sharing	• Meaningful communication (Bryson et al., 2015). Share knowledge, up-to-date information, expertise across organizations (Patel et al., 2012). • Adequate information flows among the collaborating organizations (Akintan & Morledge, 2013; Faris et al., 2019). • Reliable access to the latest technological and management knowledge for open and constant communication (Akintoye & Main, 2007; Shelbourn et al., 2007). • Create shared data and effective two-way information sharing models (Brown et al., 2021; Hughes et al., 2012; Sarkar et al., 1998). • Unrestricted cross-sharing of information and contribution of relevant knowledge and expertise (Leising et al., 2018; Suprapto et al., 2015; Wuni & Shen, 2022). • A common means of communication approved by all participants in the collaboration (Shelbourn et al., 2007). • Equal information accessibility (Hughes et al., 2012; Saukko et al., 2020). • Joint knowledge creation (Xue et al., 2010). • Frequent dialogues and regular meetings (Hietajärvi et al., 2017; Hughes et al., 2012; Leising et al., 2018). • Frequent consultation between client and contractor (Akintoye & Main, 2007).

Governance dimension	Description from sources
Change management	
	• Adaptability, flexibility and openness to change work requirements (Kozuch & Sienkiewicz-Malyjurek, 2016).
Conflict resolution	
	• Joint dispute handling (Suprapto et al., 2015). • Project conflict management (Bresnen & Marshall, 2000b; Faris et al., 2019; Hughes et al., 2012). • Constructive conflict management (Suprapto et al., 2015). • Effective issue resolution mechanism based on an agreed-upon process for dispute resolution, a consented mechanism for performance evaluation, and an understanding of risks and rewards (Rahman & Kumaraswamy, 2005). • A proper conflict resolution system to resolve tense situations and avoid a total breakdown of the interaction and work between parties involved (Faris et al., 2019). • Resolution of conflicts and disputes at the lowest possible levels (Bresnen & Marshall, 2000a). • Mediator roles to prevent and settle conflicts (Xue et al., 2010).
Monitoring *Formal, informal and third-party monitoring*	• Monitor performance requires more elaborated governance and senior management involvement to be successful (Akintoye & Main, 2007). • The client should monitor the CE metrics with contractor and supply chain stakeholders (Wuni & Shen, 2022). • Traditional command and control structures make difficult to instill or sustain changes (Bresnen & Marshall, 2000a). • The governance of collaboration typically emerges through frequent, structured exchanges that develop network level values, norms, and trust enabling social mechanisms to coordinate and monitor behavior (Bryson et al., 2015). • In a trusting relationship, a party expects that another party will perform particular actions, irrespective of the ability to monitor or control those actions (Kooter et al., 2021). • Effective teams monitor one other's work while doing their own to prevent or rapidly fix errors. This can only happen if teams share understanding of roles, common ground, and trust each other (Patel et al., 2012).

Then, based on the literature obtained and following the structure of Kujala et al. (2021)'s framework, Table 3.3 has been created, which served as a starting point for the elaboration of the interview protocol and the definition of the documents necessary to obtain the information. Lastly, this table implicitly guided the analysis of the results for each of the governance dimensions.

Table 3.3: Overview of the governance aspects to be analyzed in the case studies and documentation. Based on: Kujala et al. (2021).

Main governance dimension	sub-dimension	Guiding topics for analysis
Goal Setting	1 Joint performance goal. 2 Clarity of goals. 3 Flexibility of goals.	• Definition of the project goals • Clarity of the project goals among the parties • Opportunity from the parties to influence and participate in setting project goals • Type of challenges during the project due to misunderstanding of goals • Experience of changes in the goals and responses to overcome these changes
Capability building	4 Actor selection. 5 Training and continuous learning.	• Stage when key parties are involved in the project • Definition of capabilities required from the parties to meet the performance expectations of the project • Criteria for the distribution of resources to provide among the parties • Existence of spaces for the transfer of knowledge and training • Distribution and update of lessons learned among parties
Roles and decision-making	6 Definition of roles and responsibilities. 7 Management structure. 8 Authority for decision-making.	• Definition of roles and responsibilities among the parties • Decision-make processes • Project management structure
Rewarding	9 Rewards tied to performance. 10 Risk allocation. 11 Ownership structure. 12 Reputation and future business.	• Type of rewards and relation of those with actors' performance in meeting their own goals or project goals • Involvement of both the public client and the contractor in the incentives and disincentives • Identification, assessment and action plan for the risks • Stake or ownership of the parties in the project product • Mindset of the parties to do a good job on the project to maintain a good reputation or maintain relationships with other actors in the project network
Coordination	13 Common project management practices. 14 Shared culture, values and norms. 15 Communication and information sharing. 16 Change management. 17 Conflict resolution.	• Type of jointly project management practices agreed by the parties • Tools and work processes to enable the parties to work together effectively • Similarities and differences between work practices and norms of each party • Existence of a shared culture developed during the project • Conflict resolution processes • Defined practices to ensure up-to-date, transparent and immediate-available information to all parties • Systems to detect deviations from the plan early and effective change management process
Monitoring	18 Formal control and monitoring. 19 Third party monitoring and auditing. 20 Informal monitoring.	• Formal and informal practices to monitor each actor during the front end phase • Monitoring system to track the project and the performance of each actor during the front-end phase • Existence of a third-party auditing and monitoring practices to track performance

3.4. Conceptual model

Public clients and contractors linked to mutual collaboration will achieve circular building projects. Figure 3.6 represents the conceptual model that relates each of the concepts defined in the research. The model can be explained as follows:

> *The inter-organizational collaboration between public clients and main contractors that is governed by mechanisms, facilitates the implementation of circular practices in building projects, as these governance mechanisms steer aspects such as safeguarding, adaptation, and coordination during the front-end phase of the project.*

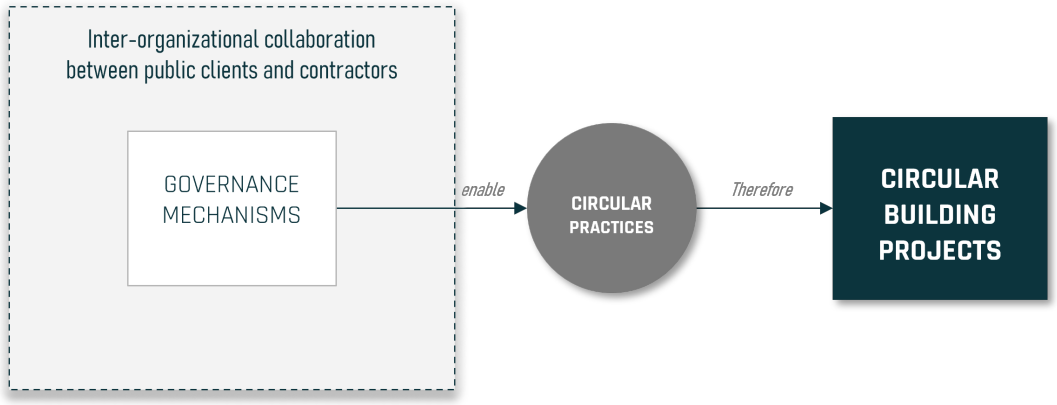
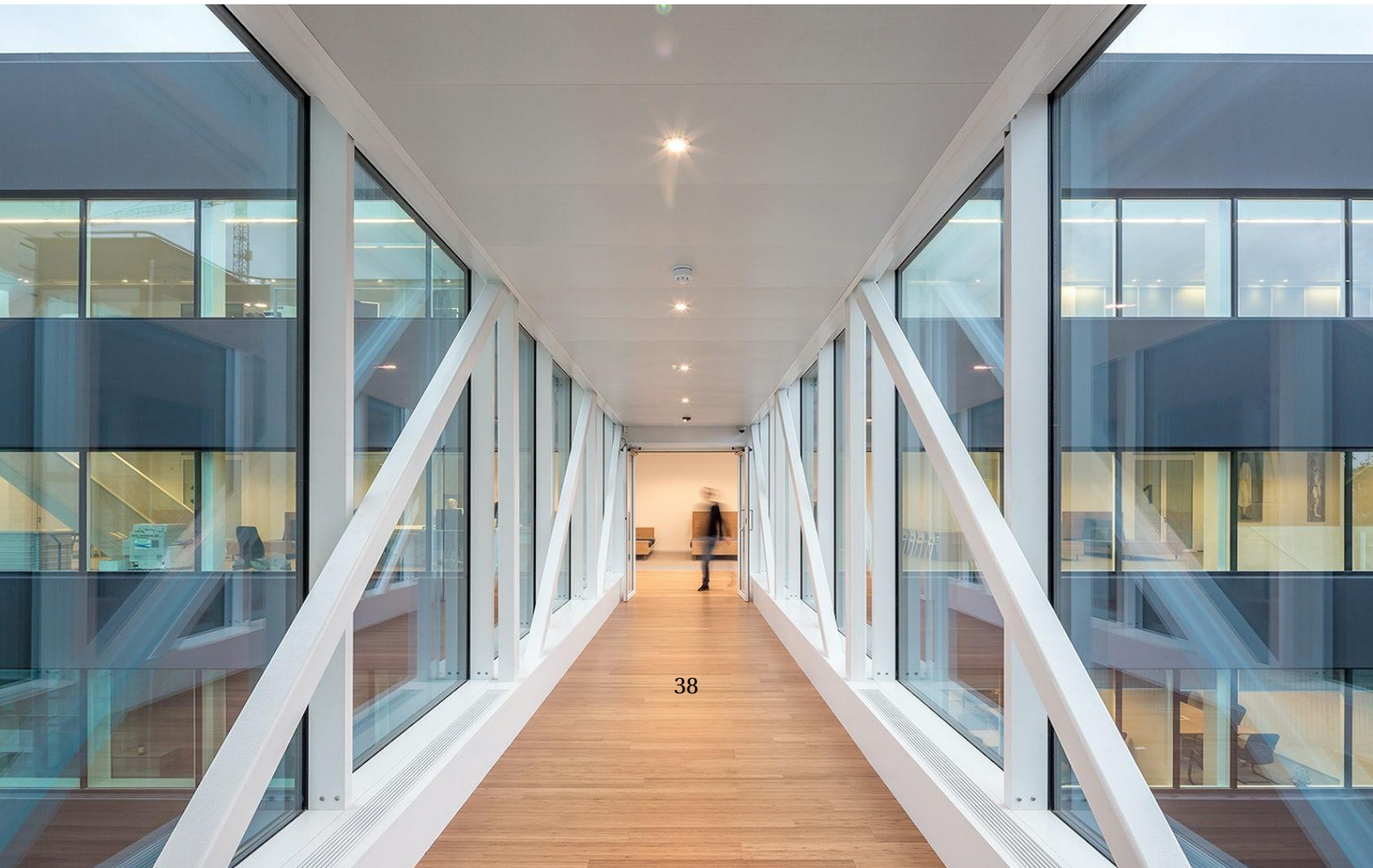


Figure 3.6: Conceptual model

4

Results and analysis

In this Chapter, Sections 4.1, 4.2, and 4.3 provide an empirical analysis of the results, including the mechanisms, tools, arrangements, processes, and significant moments encountered in each case study via documentation and interviews. The structure of this analysis is guided by the framework for governance dimensions in IOC outlined in the literature review. Then, Section 4.4 finishes with the cross-case analysis, which compares and contrasts the three case studies to examine commonalities in the governance mechanisms implemented in circular building projects.



Cepezed (2020b)

4.1. Case study A: Permanent building with temporal function

4.1.1. Case introduction

The building was realized under a Design, Build, Finance, Maintain and Remove (DBFMR) delivery model. This delivery model aimed at preventing waste and maximizing the residual value of the building after the period of use. The 5.400-square-meter building was designed for disassembly in order to facilitate the change of locations and users in the future.

Front-end phase

For project A, there was evidence that the contractor began his engagement through competitive dialogue from the beginning of the conceptual design phase, allowing him to propose innovative ideas oriented toward fulfilling the clients' requirements. Similarly, Figure 4.1 illustrates that the contractor maintained his involvement in the project throughout construction, maintenance, and the completion of the building life-cycle.

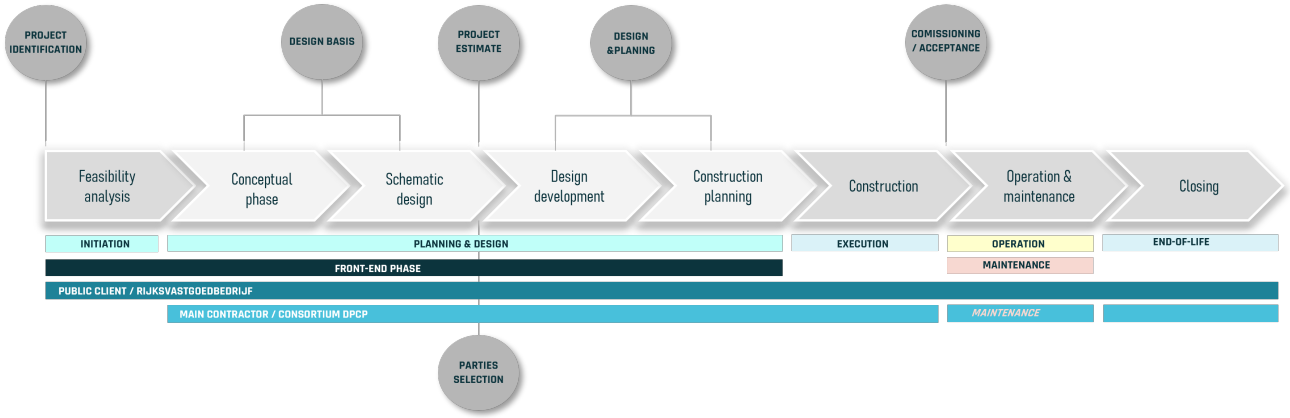


Figure 4.1: Phases of the case study A with the definition of parties involved during the phases

Inter-organizational structure

The inter-organizational structure is defined by the contractual relationship between the client and the main contractor, a consortium of two parties. The contractual agreement is governed by a DBFMR type of contract that makes the contractor responsible from the design phase until the demolition of the building, but not for its operation. The consortium is comprised of two equal parties, one of which is primarily a construction company and the other a project developer. Later, a party responsible for the design as well as the party responsible for the execution of the project were added internally to the consortium from the two mother organizations, as seen in Figure 4.2.

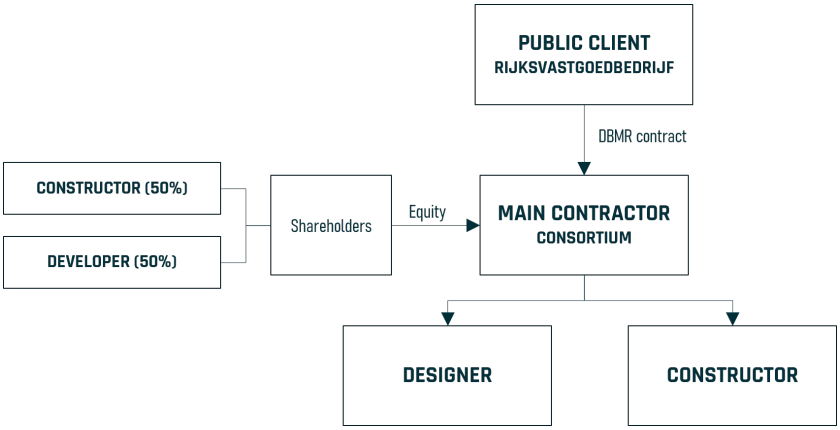


Figure 4.2: Organizational structure of the case study A

4.1.2. Circular practices and goals

Circular practices
Case A contains circular practices along the building's lifecycle. For design, the designers aimed to keep the loop of materials, elements, and components at a low speed, and while maximizing their use. Therefore, design for adaptability, flexibility and disassembly were applied. According with the respondents [3] [4], the use of information systems for monitoring an control was crucial to improve design, optimize materials and instill integration of the parties involved in the design. While, BIM platforms enabled timely decision-making, decreased on-site reprocessing, and lowered costs and waste. Similarly, the information systems positively impacted the registration of information for the building's disassembly, as it was created as an easily assembled, disassembled, and reassembled kit of parts digitally identifiable.

Then, in the manufacture and supply phase, this case utilized a new ownership model in which the contractor became the owner of the building's materials (however, he was not the owner of the building). This ownership model prompted the contractor to strive for high-quality materials and components that would extend the building's economic viability and reduce its maintenance expenses. According with the respondents [2] [3], this ownership model transferred long-term risk to the contractor, but at the same time encouraged him to pursue the selection of better materials. Besides this practice, product standardization was incorporated to guarantee the easy transportation to a different place of the products, components and materials once the useful life of the building had come to an end. Additionally, optimization strategies were evident during this phases as the elements, products, and materials have been produced in such a way that they can be reused without reducing the cycle after five years of use. The design of the building, however, was not meant only for the recycling of building components but for the reuse of the entire building. Therefore, the building was converted entirely into a closed loop.

Moreover, the construction included prefabrication, reuse and recycle of materials on-site. Later, the operation included adaptable and flexible use of the spaces in order to comply with the client demands and future demands of prospect clients, as the building was thought to be resold after the five or six years [3]. Lastly, end of life included the disassembly as first resource and selective demolition as the last resource.

Circular goals

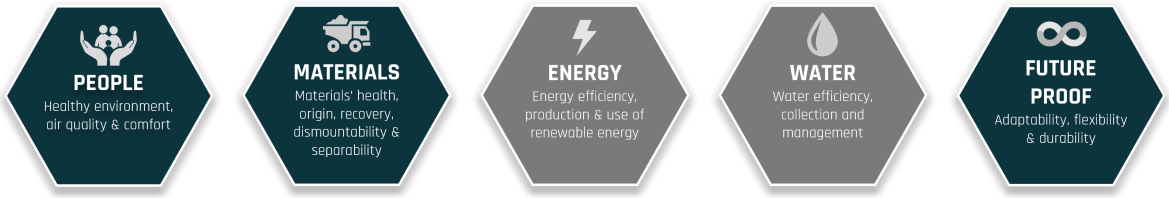


Figure 4.3: Circular goals achieved on Case A

Case A outlined three circular goals out of the five specified by the literature review. *People*, *Materials* and *future-proofing* were the three prominent themes in the case, although numerous respondents claimed that the client had not explicitly defined circular goals. According to one respondent, "circular ambitions were not so explicit, but the main ambition was to avoid waste because the building was only there for five to six years."[4]. This goal defined by the public client implicitly had circular objectives in search of eliminating material waste at the end of the useful life of the building. Hence, most materials, components, and elements satisfied the origin, recovery, dismountability, and separability characteristics.

Regarding origin, the 5R rule of circular priority was applied, focusing on rejecting, reducing, and reusing materials from the design phase. Then, in terms of recovery, the building was built to be repurposed in a quality manner, where elements, components, and materials could be reused as a whole system without down-cycling. For the dismountability aspect, the main structure consisted of a steel skeleton composed of standard columns and beams with demountable knots. Through a unique coding on a 3D model and a 3D scan, the precise location of each component was known to ensure the fully reuse. Similarly, for separability, the contractor collaborated with experts to develop a particular mounting mechanism for hollow-core flooring that optimally facilitated the subsequent decoupling and reuse of the slabs.

Moreover, as several respondents mentioned, "it was all about avoiding waste, and we introduced the circular concept, not on a material level, but the entire building level" [3], the business case was successful in considering the complete reuse of the building instead of reusing or recycling the different components, elements, and materials of the building separately, which led to the circular future proof building goal. Thus, the *future-proof* building is related to two main aspects, climate change and asset management. In this case, the building meets the definition of longer-lasting buildings that adapt to the needs of the owner/users over time through versatility and flexibility, which makes it a permanent building with temporary and flexible use.

4.1.3. Governance mechanisms

[A] Goal-setting
For the Goal-setting process, the public client unilaterally defined project goals and communicated them to the contractor throughout the tendering process. The goals, though, were unambiguous and straightforward: "So, they asked a very simple question to the market. Make a proposition where you can show us that you minimize waste over this period of five, six years." [4]. In addition to this simple and direct question, the client defined five critical success factors (CSF) in order to guarantee the continuous functioning of the building's activities, minimize the financial impact, reduce materials, maintain good relations with the community by avoiding disruptions, meet the deadline and adhere to the quality standards that a public building with this functionality requires [3]. According with the client's respondents, the reasoning behind the unilateral definition of goal was attributed to legal environment in which public clients are subject. Therefore, the client sought to pre-define the needs, high requirement and set methods to steer decisions in the tender procedure.

Nonetheless, the contractor had more leeway in "how to think the project, how to design it, and how to execute it" because the public client stated what they wanted to achieve with the building and five factors to take into consideration (CSF). Still, the solution to the question of "how to do it" was delegated to be answered during the tendering process by the bidders. All of the interviewees recognized that the goal of the project was to construct a building that would serve its purpose for five years and that at the end of this period, the materials would have a high residual value so they could be reused and recycled with minimal loss in their properties. This simplicity of the requirements clarified the need and purpose of the project so that all parties could comprehend it whereas added flexibility to the achievement of goals.

Goals were recognized with early collaboration from key stakeholders, who brought unique experiences and helped articulate the individual needs and the collective needs of the consortium and the public client. This governance approach of having all key parties involved on early stages helped incorporate circular practices such as: modularity (D3), design for adaptability and flexibility (D4), design for disassembly (D5), optimization of material use (M6), prefabrication (C1), Deconstruction (E1). Accordingly, the respondents guaranteed that the client, the developer, and the contractor all collaborated on the same level from the start to determine the optimal means for how to design and execute the building:

> "What was very contributed to the success is that from the very beginning, we [the developers], the designers and contractors really working together at the same responsibility at the same respect level, same input level. So they were really working together and that was we made it possible because in the consortium we were also equally involved in the project, so that was important." [4].

According to the respondents, the reason why the early involvement was inculcated by the key stakeholders was due to the particularity of the project. As the particularities of temporality, high residual value, and low cost required novel and "early enough" approaches to obtain a solution that met the joint goals. For the client, the task was simple, but it required prompt joint consideration, that depended on time, specialized knowledge, and creative skills [1].

Moreover, while the parties' goals were clarified, the contractor understood that for the building to be successful, there had to be an alignment on the business case, as proper business cases assist changing mindset to pursue shared goals. Thus, for the client, the primary business case was to reduce waste and costs. So, using the same guiding idea, the contractor sought to maximize the building's residual value once its useful life had come to an end, which led to the design of a building with the minimum possible waste and cost. Therefore, to accomplish this, the contractor transformed the five CSFs into more developed key success factors (KSF) that considered the design in such a way that the building could be reused 1-on-1 after completion, as well as a quality system that guaranteed the building met high quality standards [3]. Hence, the respondent from the public client group asserted that:

> "It was a small projects that turned out above expectations in what came out of the market. And, even eight years later, I think it is still a very good example of how it can work with a good business model that does not need to have extra attention or a lot of extra money. It came out of it because it was the best solution for us and at the end as well for the contractor." [1].

Then, the respondent from the contractor group reinforced the statement:

> "I think the main element of success of this project is that we all had the same goal [...] Our interest was to make a high quality building because then it will be of more value in the future. And that was very parallel to the main interest of the client. They also wanted a high quality building." [4].

[B] Capability building
Capability building ensures that the necessary skills and experience for the project are identified at an early stage. Hence, Case A engaged in a competitive dialogue that included circular value discounts. For the selection of the contractor, these discounts were granted on the basis of high-quality circular interventions. To do this, the public client hired an expert to implement the 'Environmental Performance of Buildings' MPG method, which entailed developing a circular model to determine the outcome of the competition. Therefore, the selection criteria included circular calculations to prevent waste at the end of the building's life cycle as well as the most economically advantageous proposal [2].

This MPG method required of data from the bidders to make the circular calculations. Therefore the client provided a GKI (Resource Chain Information) model as a means of comparison, which all candidates were required to complete. In this model, for all the elements of the structure, the number of tons used in each element of the structure such as bearing structure, steel structure, facade and roof, among others, had to be specified. Additionally, the number of tons obtained as secondary material and the number of tons that would be reused after the building lasted for five years had to be specified. This comparison also included a breakdown of the number of tons that would be recycled biologically or technically after five years. Thus, the higher the proportion of reuse of secondary materials and the longer the useful life of the elements, materials and components after five years, the higher was the score. This selection mechanism was designed to boost competition and recognize candidates with the technical ability to perform the work. Consequently, the contractor scored very highly with the 1-on-1 reuse of the entire building [3]. This selection mechanism prompted competitors to apply the practices used to reduce waste and maximize residual values. Thus, circular practices such as modularity (D3), design for disassembly (D5), standardization (M4), optimization of material use (M6), prefabrication (C1), and reuse and recycle of materials (C2, C3, E3) were present in the proposals.

Similarly, the consortium (contractor) internally had to ensure that the parties had the capability, experience, and authority to meet the client's needs. Therefore, the selection of partners for the formation of the consortium was primarily influenced by the pre-existing relationship and trust between parties. According to one of the interviewees, "we knew each other very well [...] and I wanted someone who I could trust and who I could work together with!" [4]. According to him, the parties had previously collaborated on other construction projects, and the working method was known in advance. This prompted the formation of a consortium based on more collaborative relationships and less control, which would enable both parties to take part in the project with less opportunistic behavior.

According to the interviewees, this pre-existing relationship also helped to shorten the learning curve as the parties already knew the execution procedures, the information system tools, and the control processes. For example, both parties knew how to work with BIM tools and the level of detail and requirements required to guarantee the traceability and support of the information in a two-way flow. In light of the acknowledge of the developer's design-driven approach, the builder softened the control over the building's design (relaxed the control measures). Similarly, the builder relied on the developer's inclusion of technical considerations, resulting in less rigorous design control. Likewise, the type of information that both parties were required to include in their joint information systems was previously understood, and no command was necessary to ensure strict compliance with these internal standards. As mentioned by the respondents [3], they had already worked together under the same digital information systems, with the same orientation to sustainable building design, and under horizontal authority structures, resulting in a time and resource benefit.

This governance mechanism for the internal selection of partners promoted the implementation of circular practices focused on the use of information systems (D7) to bring a large number of benefits to the project. Those benefits were seen as the reduction of reprocessing that involved the consumption of materials on site, the optimization of the use of materials (M6), the possibility of standardization (M4), and the design of the building that was easily simulated to test its behavior against certain materials and functionalities (D4).

Moreover, the selection of consortium members was influenced by the fact they were looking for partnership with companies of roughly the same size and level of commitment to the project. Given that larger corporations may be more capable of absorbing project risks, they may not see this type of project with the same passion and motivation, thereby creating an imbalance within the consortium in terms of risks, responsibilities, and interest.

[C] Roles and decision-making
Different governance mechanisms used throughout the front-end phase were found concerning roles and decision-making. During the tendering process, the responsibilities were formally assigned to the contractor. However, these decisions were influenced by the public client; as stated by one of the interviewees, "Of course, we tried to influence them with the way we put score points on reuse in high level." [2]. Thus, the way of influence was mainly through the weight assigned in the tender to different aspects. It helped steer the decisions towards what the public client considered the best approach for building development. At the same time, the decisions made by the contractor always addressed the goals of bringing a high residual value to the building, both for the fulfillment of the project objectives (best-for-project) and the individual objectives of the consortium:

> "Every decision that is made during the entire development and building, or, and design and building process is always with a mindset of how can we make sure that what we do now, what we create now, can be our value in the future." [4].

Then, according to one of the contractor's participants, equity between the consortium parties was not only maintained in the percentage of financial participation but also in decision-making and associated responsibilities. Thus, he explains that not all consortium members' responsibilities and obligations were written in the contract, but rather, they evolved organically in response to the nature of the work being done. This was largely due to the pre-existing relationship between consortium members, who had already established their ways of collaboration. Meanwhile, decisions were made using similar principles. Flexible and decentralized governance structures were applied during the project where the governance relied on the expert in the subject. Instead of deferring solely to a top-down hierarchy, choices were reached through the contribution of people with the most relevant expertise:

> "Normally you have a contractor who owns the project and then you might have an architect who works for its own salary, but that is not an equal input and I do not say that you have to give every architect equal input because they also need to have the knowledge and the experience" [...] "In the beginning, the design team was leading and they asked to the construction team every now and then to look with them at the design. Then, when the building started, it shifted towards the construction team and they were in the lead [...] And other advisors joining every now and then when it was necessary." [4].

In addition, different structures, such as the management design team, management implementation team, expert teams, steering committee and leadership roles, played a significant influence in decision making and project development. On both sides of client and contractor, a management team of four to five people was present to conduct monthly meetings. This management team discussed the project's main general aspects [4]. Whereas, the top - notch solutions were tasked to expert teams, "we were always very transparent, if we saw any opportunity, we presented it to the client together with the experts from both parties. From these expert sessions, new solutions came out." [4]. And the leading role of one of the contractor's actors gained strength to allow cohesion between the parties, "[...] during the entire time he was the spider in the web, the one in control of all the parties." [4].

Furthermore, the decision-making authority was light, with one interviewee remarking that part the project's success was attributable to the commitment at the highest level and the short lines of communication that encouraged rapid and effective decision-making. Here, commitment at the highest level means that support from higher levels of the project organization prevailed by believing in the word and expertise of those team members for the matter of decision-making. In other words, it is expressed as the existence of support from the management team:

> "One party of the consortium was responsible for the implementation and the other for the design and project management. Both parties were closely involved in the project from a management level and were the driving force behind the circular goals. This commitment at the highest level and short communication lines were part of the success of this circular project." [3].

[D] Rewarding
Forms of rewarding were established at the contractual level as new ownership model was made available by the type of DBFMR project delivery model whose final letter R stands for remove. One of the contract's clauses stipulated that the contractor would be the sole owner of the materials and alone responsible for removing them from the building once the temporary building had outlasted its purpose. This clause not only granted them the right to recover materials with a high residual value, but also obliged them to fulfill this requirement. The client could penalize the contractor financially if this obligation were not met. Accordingly, this contractual mechanism embraced the circular practice: change ownership models (M2), because at the end of the life-cycle, the contractor became the owner of the materials that make up the building, as stated by one of the actors of the public client and the contractor itself, respectively:

> "For this model we did not become the owner of the materials of the building, we only used it. We had a used period of more or less five years, and then it was up to the contractor to do something new and that is what they did. They sold the building to another party that is going to use it for some time." [1]

> "This is the only contract that I know which is organized this way. So the removal of the building is already part of the entire contract. And even though we had the right to take the materials after five, or six years, we were also obliged to do it [...] it is complicated to explain that to avoid the real estate transfer and all the fiscal accountability, we managed it as an obligation for the demolition of the building. But at the same time, we were using materials again to build a new building." [3]

Consequently, the final value of the building was adopted as a reward model for the contractor, making it easier for the incentive to be subject to the high quality of the building. Thus, both the contractor and the client deemed that the business model was favorable for both parties: "[...] so, the reward for us was the value of the building after the use [...] therefore, if we had a circular building with high quality, it was also a healthy business model" [4]. Nevertheless, a number of respondents from the contractor group believed that although the client-contractor business model was aligned, the contractor was still exposed to uneven long-term risks:

> "We offered the building to the public client with discount, so, if the building was for example, 10 million worth, we offered it for 8 million. Then, the gap of the 2 million was for us in the value of the building at the end. So, we had to get it back by selling the building, and that was the risk that we took. Although it worked out fine, it could also have been the case that nobody wanted to buy the building" [4].

In addition to the risk to which the contractor was exposed as he could not repay his investment over the long term (during five to six years), reputation was also viewed as a risk factor rather than a reward driver, "that was the main risk that we took, so not only the long-term financial risk, but also our reputational risk that we promised to make a building that was easy dismountable." [4].

In addition to these non-monetary rewards, the client emphasizes that, due to the nature of the public organization, monetary incentives were not the common. Although progress has been made in the research of new types of collaboration based on incentives, this type of public client has not yet implemented them in his projects.

Furthermore, the project itself posed a number of dilemmas that the contractor had to address: temporality versus high quality and low cost versus high residual value. The first dilemma pertains to

the fact that temporary buildings do not incorporate high-quality materials due to the limited time these materials will be functional. The second issue emphasizes that if the building is constructed using low-cost materials that meet its functionality in the near term, the building's residual value will be low, which neither the contractor nor the client desire. Consequently, the contractor had to find a balance in these dilemmas by exploring the implications of the decisions made. However, as he expressed, there was always a risk [3] [4].

Thus, the exploration of the implications of the decisions made were analyzed together with the designer and the constructor in joint meetings held within the consortium during the tender phase. This allowed them to jointly accept how much risk they could absorb from the beginning and how they could cushion the financial risk in the worst case-scenario at the end of six years:

> "We did our best to design and build a building that was easy dismountable. But we had to see if all what we thought of in the design phase would work out. So, that was our main nightmare scenario, that we could not find anyone who wanted to buy the building. So, we would have had to demolish it in a traditional way. And even that was very good as it would have been very recyclable because all the materials were separated, so we could really have a nice pile of steel, nice pile of concrete, nice pile of glass, nice pile of aluminum. Although, it would have been in the worst case scenario, it still would have been the best recyclable building in the last time. But our ambition were obviously high, so we did not want to recycle it. We went for the R of reuse in the R ladder, a 100% reuse." [4].

Consequently, the way they managed to mitigate the risks, made possible to emerge other circular practices focused on easy dismountability and the use of high-quality materials: deconstruction (E1), reuse and recycling of high-quality materials/components (E3).

[E] Coordination
Different methods were used to coordinate the behavior of each actor, including common project management practices, a shared culture with norms and values, communication tools, shared information systems, change management and dispute resolution procedures.

The shared culture evolved over the course of the project. It took the partners some while to develop a shared set of principles and beliefs for how to approach the project. Individuals were skeptical at first, but they gradually became more enthusiastic about the type of project and its potential success. Because trust existed within the consortium, the next step was to establish a cooperative team spirit among the parties involved. It was possible by demonstrating the project's technical feasibility and the positive public attention it would bring [4]. One of the respondents emphasized the common motivation that arose in the project between the actors as a result of the project's potential for innovation and its capability to stand out for its uniqueness in the near future:

> "Something that is very abstract and is not very controllable is the enthusiasm of the team. We found that we all the client, contractor and developer had that same drive of making this project succeed and not only focusing on profits optimization or to have costs as little as possible. And that is something that you cannot organize or maybe you can, but I would like to know how, because sometimes you have also these three parties that do not shared enthusiasm and things are more difficult to organize." [4]

To implant this culture among the stakeholders, for instance, the consortium provided numerous presentations on what they were doing, how they intended to achieve the goals, the overall project concept, and the novel concept of 'buildings as products with the highest level of value retention'. Thus, one of the respondents affirms: "We had to make a lot of presentations everywhere, always explaining what we were doing, how we were doing it, the concept of the whole project to treat the building as a product [...] so, that gave momentum for very positive presentations, the ball kept rolling, getting more momentum, and everybody got more enthusiastic about the project and its approach." [4]. And according to the respondents, this shared culture with its norms and values was not present at the beginning but was extremely required to guarantee a consistent motivation and to ensure that all parties shared the same beliefs.

Instead, the communication and information exchange strategies were contractually outlined from the very beginning of the project. These strategies were primarily based on regular meetings, integrated teams (consisting of the three principal actors: project manager, technical manager, and contract manager), and online database management systems. Several respondents in the public client group believed that the communication established in the contract was sufficient by assuring that: "the communication was not exceptional as well. It is a norm. It was a normal project, and we shared what we wanted to share." [1]. While the contractor respondents assured that in addition to this formalized client-defined communication, there were more relational kinds of communication advocated by the consortium. Thus, relational governance mechanisms for communication are formed due to evidence of insufficient communication or because the contractor or individuals of the public client, based on their prior experience, share the communication mechanisms that were successful on past projects. Contractual communication mechanisms are governed by a standard, whereas relational communication mechanisms might be unique for the project and are intended to enhance the norm.

Additionally, building information modeling (BIM) facilitated information management, and all parties were required to utilize the platforms and acquire expertise on BIM. It enabled access to the most recent information and brought information accessibility parity amongst stakeholders, "The parties involved had to work from the very beginning in the BIM environment. Not for everybody was that easy, but afterward they learned, so it allowed all parties to be on the same level of information." [4].

Moreover, although the client delivered the online database system to visualize the project requirements, the contractor enhanced it to not only fill in the requirements' compliance but also to provide traceability for the actions taken to meet these requirements [2] [4]. What improved formal and relational information exchange practices: "At any moment, our client could look at the website and see how many passed [requirements] were, and how many were not done as expected because there were better things to do... it was a very transparent way of communication that gave them confidence in our work. Moreover, it gave us confidence since we were very closely monitoring the demands of the clients to make sure that what we were doing was what they asked for." [4]. The consortium built a method known as 'Docstream' for the sharing of documents. Including version management, all project documentation were centralized and accessible online. However, access was restricted by strict policy server locations [3].

Change management was another crucial aspect of coordination that was treated in a relational manner. Respondents from both the public client and the contractor assert that modifications were permitted so far as the building's philosophy of high residual value and quality remained intact. For instance one of the client's respondent says: "So, we allowed them to make some changes when the philosophy was still there at the end, and they did that, they really did their best to deliver what they promised. And I think they did this over the whole project. Even now they still do it because now we are in the end phase that they have to remove the building" [1].

Lastly, formal conflict resolution procedures were established in the contract. However, the respondents did not elaborated on the specific procedures, as they manifested that these protocols were not always applied, and when disputes arose, dialogue sessions between parties was sufficient to reach a consensus [1] [2] [4]. According to a number of responses, these conflict resolution procedures are outlined in the contract clauses, and the contractor accepts these clauses as norm. Consequently, these formal dispute resolution processes offer the greatest protection for both parties against opportunism or uncertainty linked with the parties' behavior.

[F] Monitoring
The respondents agreed that the formal monitoring consisted of reporting compliance with the client's requirements and steering groups. For the reporting, the client formally provided the contractor with a list of requirements, and the contractor established an online verification validation environment called 'Briefbuilder' to monitor each requirement. In addition, the requirements and compliance with these demands were linked with BIM to maintain the consistency of each requirement's actions.

[4]. Then, steering groups were conducted frequently to guard progress in outline [3]. Meanwhile, due to the nature of the contract DBFMR, no third parties monitored the contractor, and the contractor was responsible for his own control and validation process [1] [2] [3] [4].

> "Testing and acceptance documents were requested as part of the assignment during the process. Further assurance of the requirements was made via the verification process (Briefbuilder). Both [client and contractor] have been adapted to the contractor's work process to fit in with our working method, and the client had the desired insight without disrupting the process." [3].

Table 4.1: Overview governance approaches for IOC in Case A

Governance dimension	Governance approaches in Case A
Goal-setting	
Joint performance goal	Alignment of business case. The client's primary goal was to reduce waste, and this translated into a building with the highest residual value after use. As a result, the contractor aimed for the same result: the highest possible value of the building at the completion of its use [1][4]. Early involvement of key actors. From the very beginning the client, developer and contractor worked together at the same level to come with the best solution through Building workshops [4].
Clarity of goals	Simple and clear goal. The goal for the project was defined at the beginning by the public client and it was quite simple and abstract. The client stated what they wanted and the question 'how to make it' was transferred to the contractors [4]. Critical success factors (CSFs) were defined by the client and the contractor transformed them into more specific and achievable key success factors (KSFs) [3].
Flexibility of goals	The question of "how to do it" was delegated to be answered during the tendering process by the bidders [4].
Capability building	
Actor selection	Discounts for circular values in tender. Discounts were applied based on a circular model made to calculate the outcome of the competition. The tender considered circular calculations to avoid waste at the end of life-cycle of the building [1] [3]. Pre-existing relations for the selection of the consortium parties. Selection of partners for the creation of the consortium was mainly drove by the pre-existing relationship, trust and past positive experiences [4].
Roles and decision-making	
Definition of roles and responsibilities	Equality between the parties within the consortium. The roles within the consortium were shared. Both the constructor and the developer have equal participation and responsibilities. No all the roles and responsibilities were strictly written down in the contract, some were emerging according with the tasks [4].
Management structures	A Management team from both sides was present in the project to conduct regular monthly meetings [1] [2] [3] [4]. Expert sessions to advice based on experience and make the best decisions [3] [4]. Leadership role that acted as catalyst between the parties and the main point of inter-organizational communication [3] [4].
Authority for decision-making	Flexible governance structures were applied during the project where the governance relies on the expert in the subject. The decisions were made with those who best knowledge have, rather than relying merely on a hierarchical authority [4]. Decisions based on best-for-project. Decisions made by the contractor were always addressing the goals of bringing high residual value of the building [4].

Governance dimension	Governance approaches in Case A
Rewarding	
Rewarding tied to performance	End value of the building as a reward. The reward can be seen as the value of the building after it was used for the public client during the five years. So the reward was very tied to the high quality of the building [4].
Risk allocation	Long-term risks allocated to the contractor due to the responsibility of removing the building after five years [4].
Ownership structure	Ownership of materials. At the end of the life-cycle, the contractor became the owner of the materials that make up the building [1].
Reputation	Reputation seen as a risk. The promise to make a building easily dismuountable and fully reused with high residual value [4].
Coordination	
Common PM practices	Cross-functional coordination team (core team): project manager, technical manager, and contract manager. Steering committees with public client and contractor to guard progress in outline [3].
Shared culture, values and norms	Project culture develop along the project. It took some time for the project culture to emerge among the parties. There was skepticism at first, but people gradually became increasingly passionate about the type of project and its potential success [4]. Shared motivation and commitment from the management level [3] [4].
Communication and information sharing	Updated information through a online database systems called 'Docstream' for document sharing and 'Brief-builder' for validation of requirements [2] [3] [4]. Information sharing via BIM. It allowed to have access to the latest information and bring equal information accessibility between parties [4]. Informative presentations. To instill this culture among the parties, the consortium presented numerous presentations outlining what they were doing, how they planned to do it, the overall project concept, and the concept of buildings as products with the highest level of value retention [4].
Change management	Flexibility in changes was allowed when the philosophy was still there for the building [1].
Conflict resolution	Formal procedures to solve conflicts. The public client had already defined procedures for conflict resolution that were described in the contract. However, those procedures were not always used. The conflicts that arose were always solved with dialogue [2] [4].
Monitoring	
Formal monitoring	Verification validation environment. The formal monitoring consisted of reporting the compliance with the requirements set by the client [4].
Informal monitoring	Steering groups to guard progress in outline [3].

4.2. Case study B: The green building

4.2.1. Case introduction

The green building is a temporary building constructed in a void between two buildings in urban development. The public client wanted a 15-year temporary solution for this site, as the final use of this location will be determined after this period. The contractor submitted a plan for a demountable structure comprised of reused and recycled materials, in accordance with circular principles. The project followed a Design, Build, Finance, Maintain and Operate (DBFMO) delivery model.

Front-end phase

For project B, it was explicit that the contractor began his commitment through the best value procurement approach at the onset of the conceptual design phase, enabling him to submit circular proposals that exceeded the client's expectations. Similarly, Figure 4.4 depicts that the contractor remained engaged with the project throughout the building's life-cycle. It is also noted that the designer was present from the beginning of the conceptual phase until construction planning, despite not being a member of the winning consortium.

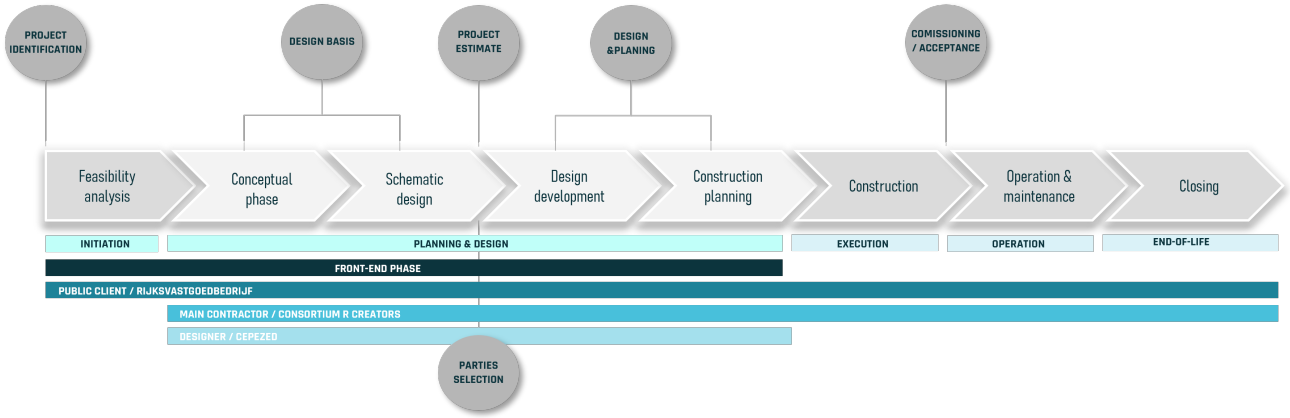


Figure 4.4: Phases of the case study B with the definition of parties involved during the phases

Inter-organizational structure

The inter-organizational structure is defined by the contractual relationship between the client and the main contractor, a two-part consortium. The contractual agreement is governed by a type of DBFMO contract that makes the contractor responsible for all phases of the building, but not for its demolition. A construction company and a facility company constitute 80% and 20%, respectively, of the consortium. Subsequently, an external firm responsible for the design and one for the execution of the project were added, with the latter consisting of two internal companies and a third external company dedicated solely to construction, as seen in Figure 4.4.

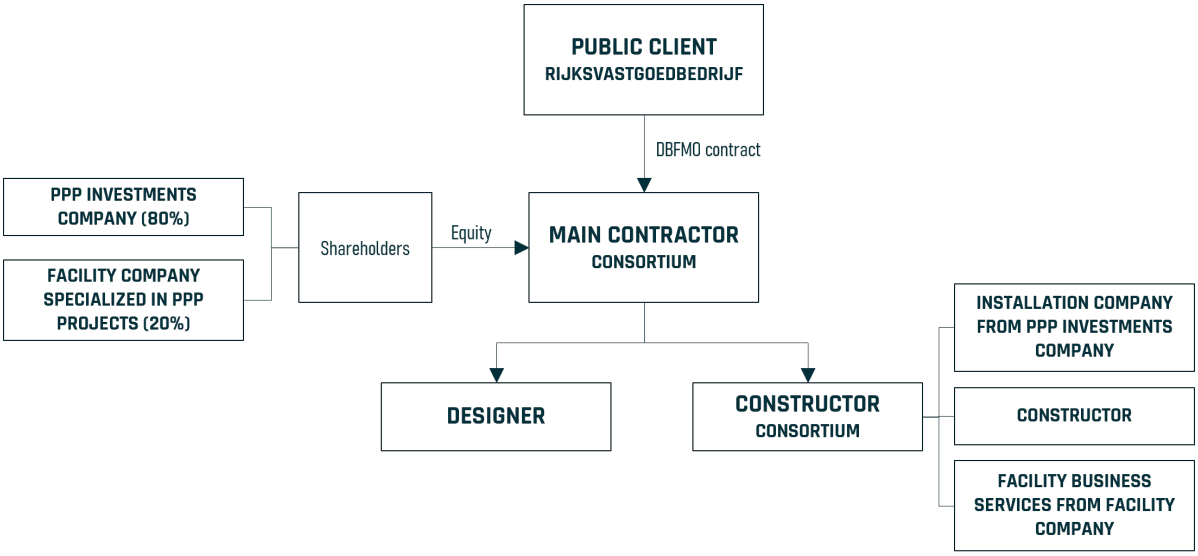


Figure 4.5: Organizational structure of the case study B

4.2.2. Circular practices and goals

Circular practices
Case B presents circular practices throughout the different phases of the building. During the design phase, the case included several interventions such as mechanisms for water collection and recirculation to be reused in some areas of the building such as the indoor gardens and sanitary system. Also, the use and production of renewable energy generated by solar panels installed on the top of the building. It helps reduce the dependency on non-renewable energy from the service grid. Then, strategies for sharing were implemented through the design of adaptable multi-functional spaces.

Also, the building was designed for disassembly, the entire structure is detachable, making it reusable. Hence, it remains within the innermost loop. Moreover, the design was created to ensure the transportability and modularity of the components. The building's foundations were comprised of precast concrete slabs in place of concrete piles, making them entirely dismountable. Furthermore, from the design phase initiatives considered the use of higher-performing materials and products that have been built with circular purposes in mind. For instance, prefabricated timber frame construction panels were used for the first floor's closed parts of the façade. These are one hundred percent recyclable and free of (H)CFCs, which guarantees compliance with circular goals focused on reusing materials and the health of the people who use the building.

Similarly, during the manufacture and supply phase, relevant parties actively pursued reusing secondary materials from surrounding buildings or urban mining [5] [6] [8] [9]. For example, the exterior cladding originally came from the adjacent building. In addition, antique doors and windows were used to beautify the restaurant area, among other items. Moreover, standardization of components and elements was introduced from the manufacture and supply phase to enable their future disassembly and transport. Similarly, elements such as beams, columns, and panels were prefabricated for this project, therefore, facilitating the construction processes.

Likewise, during operation phase the architecture of the building helped incorporate large, flexible, and open shared spaces according to the user's needs. Through the shared use of infrastructure and appliances, it was possible to increase the efficiency of energy, water, materials, and spaces. In this case study, therefore, the shared space concept stands out. Lastly, during end of life, the building was thought to be fully disassembled and reassembled in a different location. Nonetheless, materials or components no needed in the new location are available to be reused and recycled.

Circular goals

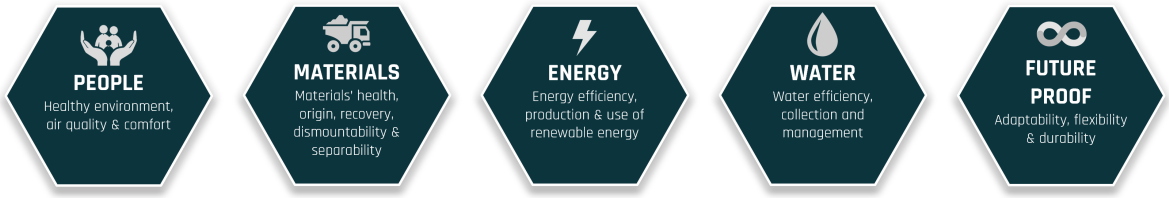


Figure 4.6: Circular goals achieved on Case B

In Case B, circular interventions were not included in the project's ambitions; therefore the public client did not anticipate any circular goals. As mentioned by one of the respondents from the public client group "I did not really consider it as a circular project because what can be said about circular practices is really a coincidence. We did not set it as a goal because it was not in an understanding, it was not a subject when we started in 2012, and the definition of 'circular' still had to be made." [5]. Nevertheless, due to the simplicity of the client's goals, the contractor was free to adopt sustainable methods in pursuit of improved economic outcomes in the future. Regarding *people*, the building materials safeguarded the health of its users, and the building incorporated comfort, biodiversity, aesthetics, and productivity as part of this idea from the design phase.

In terms of *materials*, the contractors chose for repurposed and remanufactured secondary materials for the façade, interior walls, flooring, decoration, and mechanical installations. The recovery of the materials once the useful life of the building has ended could be done separately. However, the objective set by the contractor was to reuse the building in another place ultimately. That is why the foundations were designed to be removed and re-assembled at another location to be specified in the future. Based on it, the building fulfills *future-proof* circular goals, which imply flexibility in the building's use, functionality, and durability.

In addition, the building incorporated goals for *energy* efficiency, production, and utilization of renewable energy. This goal was made feasible by two significant factors: solar energy generation and the technique oriented on a service-based approach. First, by installing solar panels on the roof, the building reduced its nonrenewable energy consumption from the network. Second, a service-based approach (pay-per-use) was used to address the energy of the restaurant and other areas, for instance, making consumers conscious of avoiding unnecessary energy use.

Similarly, *water* management in the building emerged as another goal for the building. The design incorporated a rainwater collection system on the roof, where the water was subsequently filtered and stored for the building's internal use and gardening. It reduced the unnecessary consumption of potable water from the primary grid.

4.2.3. Governance mechanisms

[A] Goal-setting
The governance in relation to the definition of the project objectives for Case B was characterized by its flexibility and the presence of mechanisms that allowed the parties engaged to align their individual and collective objectives. Circular practices were not a criterion during the bidding phase, as the only demand was to construct a building that would function for 15 years. This simplicity allowed the contractor to generate a wide range of ideas and approaches for the project. Thus, the proposal contained innovative solutions bringing circular approaches on board, driven by his designer. In this regard, several respondents from the contractor side agree by stating:

> "One interesting thing is because there were no goals, that was the way we could fill in our

> own goals without anybody controlling it." [...] "you could say that every goal mentioned in a contract, will decrease the innovation on the project" [6].

> "this project is a very atypical project in the sense that it was actually no ambitions, but due to it, the project has become innovative, which is interesting because this innovation came along the way." [8].

> "The goal of course was not really a program of demands. The only demand was to design a building with a specific area , with a public function and to be removed after a certain period. So, the consortium thought it would be nice to put a nice restaurant at the ground floor level and some meeting facilities at the first floor. And that suddenly became the concept of greenhouse and we together designed it already in the tendering phase." [9].

Simultaneously one of the respondents from the client suggested that circular practices emerged as a result of extensive dialogue throughout the tender, wherein the parties discussed via workshops how the building could be durable and sustainable. Therefore, the circular assignment was proposed by the contractor and the public client accepted the challenge to make it as circular as possible [5]. This in turn inferred that goals can be set from the beginning, but also goals can be dynamic and attempt work in progress to leave greater room for the implementation of cutting-edge circular practices, innovations, and later developments [6].

Making a building as circular as possible was the challenge set forth by all of the members as a whole, which encouraged the consideration of a wide range of circular practices. The following practices stand out: the design of an adaptable, flexible building (D4) and disassembled (D5), given that its use will not exceed 15 years. The use of better-performance materials (D8) and the use of secondary raw materials (D6, C2, C3).

Then, just as the extensive dialogues during the tendering phase made it possible to outline common circular objectives for the building, processes such as building workshops and debates took place during the design and planning phase to define in detail the design and the materials that would be used in the building to contribute to these circular objectives, "We had some design meetings and building workshops, and there we discussed of course our way of working and our way of designing. And it really went well." [9]. Although none of the respondents viewed these workshops as pressure-cooker sessions, they are comparable in that they aimed to connect personal goals with collective goals, guiding participants down the same path toward the same goal, "In projects you always work with people, and people always have own objectives and shared objectives. The trick is to know their own objectives in order to approach the general objective." [7]. This pressure-cooker format for goal alignment was created by one of the public client's leaders and implemented as regular sessions to not only maintain synergy, but also improve different aspects of the project, such as the adoption of circular practices along the project. According to this respondent [5], the long duration of the integrated contract entitles more efforts in achieving common goals and shared knowledge. Therefore, the design meetings and frequent building workshops were a starting point for it.

[B] Capability building
The best value procurement procedure was chosen so that the actors would be selected after careful consideration of their individual qualifications and expertise in partnership. The best value procurement strategy, suggested by the process manager, would make partnership a key consideration during the selection process. This procedure required of extra investment during the tendering phase and occurred because the public client required a partner for the whole project life cycle, which would last approximately 20 years. Hence, the process for the tender of the DBFMO-type contract was conducted by interviewing numerous organizations and questioning them about topics, such as the exploitation phase and partnership skills in the face of unforeseen events as well as those requiring collaborative efforts between the parties. The jury was responsible for deliberating and reporting on the interviews they conducted.

> "So, we had not a dialogue only on the building, but also a dialogue on how we could be partners [...] and, the nice thing to see is that parties that would have qualified easily just

> with their experience, did not qualify this time because they had facilitators that were not very good at convincing the jury of their qualities on that part [partnership]" [5].

The contractor also emphasized that before participating in the selection process, collaboration was a necessary condition for the formation of the consortium. According to the respondents from the contractor, collaboration was a difficult criterion to measure; however, it had 25% of the weight for the selection criteria. This criterion was included because, in practice, candidates look for other contractors just to increase their chances of winning the tender, rather than considering the high probability that they will spend the next two decades working together and sharing the risks of each phase of the project. Therefore, this method of collaboration was sought for adoption in an effort to lessen future disagreements [6]. Nevertheless, incorporating collaboration (partnership) as an explicit criterion in the tender could pose some disadvantages for circular values. For instance, the consortium that won the project proved to be the most suitable for establishing a long-term relationship with the client over the contract's twenty-year duration. However, he lacked experience implementing circular practices and had no intention at the beginning on developing the project adopting circular principles. The architect, who was not a direct member of the consortium, was then the proponent of these ideas aimed at achieving global sustainable goals and later, those ideas were adopted by the contractor, as he expressed.

Furthermore, maintaining consistency among the actors was another factor taken into consideration when selecting the individuals. Although not everything is spelled out in the contract, ensuring continuity of individuals will help maintain the intentions and the 'spirit of the contract', reflecting the relational agreements made for the project.

> "You are a slave of the contract. It is foolish to be because I always say that making a contract is a really tricky issue because it is nothing more than a brave effort to write down what your intentions have been. However, it is prone to fail because you can never foresee what will happen. What will be contradictory in the future to what you have written down now? [...] Consequently, a major issue for us was also giving continuity in the occupation of the actors because if I would have been changed by someone else, then he would go to the contract and not to the intentions." [5].

Later, regarding learning and continuous improvement, case B implemented periodic training of individuals to teach them two aspects: how to give constructive feedback and how to open up to the public and share their problems. These trainings were designed by specialists within the same group of public clients and contractors to educate others how to approach other people in a way that does not cause discomfort or hostility by interacting in dialogue, expressing opinions, and providing constructive feedback. Similarly, the training assisted individuals in reducing their workloads by nurturing more open communication, which helped them to identify solutions with parties who were more knowledgeable on the topic.

> "trainings to help share difficulties and let others take part in solving the problems, instead of keeping it at their chest while the trouble is growing until the point that it is not possible to solve it anymore." [5]

[C] Roles and decision-making

For case B, the roles were determined at the outset of the project. Management teams were defined by the contractor following the management structure pre-defined by the client. Leadership roles were not defined but emerged spontaneously throughout the project, where one member from the contractor took the leadership to steer the relationship between the parties. Moreover, a dynamic integrator/moderator role was established. It consisted of a team member (either from the public client or the contractor) who assumed the integrator role during meetings and was responsible for spotting partnership weaknesses in order to strengthen them.

Decision-making during the front-end phase was based on three primary approaches. First, most decisions were based on the best-for-project approach, and although the consortium had the power

to decide, these decisions could be influenced by the public client and the designer. Albeit the relationship between the public client and the designer was merely functional (the designer had a contractual relationship only with the contractor), this relationship was forged through continuous communication and the exchange of innovative ideas for the project, which promoted the influence of the designer for making more accurate decisions with circular objectives.

> "we [architects] also had meetings with the public client and these meetings helped us to influence on the decisions by asking the public client to push the contractor to go for a little bit better circular ideas or keep maintaining functional quality in the designs." [8].

Second, integral discussion sessions were established to address problems present in the project or concerns regarding essential decisions to be made. These integral sessions would allow people with diverse experiences to sit together to think of solutions that would favor the project in terms of design, materials, procedures; therefore, reaching a consensus. Although a participant stated that, at first, people were doubtful about the validity and effectiveness of this decision-making mechanism, the widely used practice of process management 'offer room for exit' softened the members' reluctance.

> "There were some skepticism on the part of the contractor, because he was afraid that we would use a lot of time discussing about it without reaching any goal. For them, it was new and they were afraid that It would only cost time and bring us nowhere. So, we said, let's just start doing it and see how it goes, if you are not satisfied with it, then we will stop. So, we had these integral teams asking questions and they were to the point and they helped the contractor to see the difficulties to be met." [5].

Third, decision-making was delegated to those who understood the situation the best. Thus, decisions were frequently pushed to the highest levels of the power hierarchy in discussion sessions, but those were sent back to the ones who best understood the situation. Consequently, the decision-making model was supported by listening to those with more knowledge about the problem. Then, those responsible made a decision based on that knowledge, always keeping the goal and its fulfillment in mind [5]. Hence, this approach created an empowerment of the project team.

Circular approaches could now be used in the project on a daily basis and on a smaller scale thanks to the delegation of decision-making. For instance, the respondent [8] asserts that the design and construction teams collaborated to choose elements from the neighboring building that could be used to give the building's finishing a distinctive appearance. As a result, sturdy reused materials and components (D6, M3, M6), such window and door frames, were employed to give it a second chance inside the new building.

[D] Rewarding
The rewards tied to performance were handled with contractual mechanisms and relational mechanisms. To ensure that the contractor concentrated on achieving the objectives and avoiding non-compliance with any requirement, the contractual mechanism envisaged sanctions based on the key performance areas. This penalty mechanism or 'punishment due to poor performance' was rigidly outlined at the outset of the tendering process by the public client [6].

Nevertheless, the relational mechanisms aimed to encourage the parties and individuals to excel in completing their responsibilities. One respondent from the public client group argues that celebrating small wins and arranging frequent small meetings were two significant informal mechanisms for enhancing performance in the project's initial phase. Celebrating small wins were not stipulated in the contractual agreements but mostly depended on the leaders. The process leader learned from experience that celebration of small wins motivates the team to enhance performance. The team will feel that they are doing well, inspiring them to strive for more celebrations. During these celebrations, specific actors were recognized for making special actions or outstandingly executing their responsibilities.

As the respondent stated, "You must not go further without celebrating, you must celebrate what you have achieved" [5]. The respondent affirms that these leadership approaches foster a sense of

satisfaction and inspire individuals and groups to pursue more achievement, as small victories on a daily basis can make all the difference in how the individuals feel and perform. Moreover, the frequent small gatherings consisted of having lunch together or sharing snacks [5]. Despite the short duration of these events, they were essential for fostering relationships and informally exchanging the possible issues happening on the project.

Then, risks were identified separately but addressed collectively. Each party was independently responsible for risk registration, risk analysis, and risk management. As a result, each party possessed a list of all potential and experienced risks across various categories, including political, governance, economic, and societal risks. The parties subsequently discussed their risk identification and management strategies to determine how they could assist one another.

> "Each party had an inventory of all the risks, we made a separate list of that. And every two or three weeks, we talked about how the risk management was and with which risks we could help each other." [5].

Regardless of that the DBFMO contract type stated that risks were allocated to the contractor, the risk files were regularly shared amongst the parties so that everyone was informed of the many sorts of risks that could emerge during the project phases. In addition to regular communication and the project culture, the up-to-date risk information encouraged participants who were not directly responsible for the risk to work together to address issues wherever possible. For instance, one respondent stated:

> "Not for every risk, it is possible to help the other party, but for some risks, it is. We [public client] had risks that could be managed by them [contractor], so, we had talks about what we were experiencing as a risks and the background behind it. [...] Sometimes the other party can manage to make the problem smaller. And this is all about, the willingness to help the other party as he is a partner of you [...] this was the start of growing in that [mutual help in risks], because we had many issues that required of good problem solving, and we could not solve it on our own. We needed each other. That is something we mentioned each other often: 'we need each other to make a project success. We cannot do it without each other's experience, each other's information, and each other's goodwill' That is what we talked about a lot." [5].

Although the building belonged to the public client, a contract that includes not only design and construction, but also financing, maintenance and operation, supports an additional sense of ownership (stimulation merely). The contractor fosters a sense of ownership in such a way that design alternatives are examined to acquire the highest level of quality, the least maintenance and the most efficient use of resources such as water and electricity throughout the operation (O1, O2). This model is visible throughout the entire project, from start to finish, as the contractor continually looks for ways to improve the building and enforce preventive maintenance. [6]. Thus, the respondents on the part of the contractor are accurate when they state:

> "The mechanism is not about the public sector, who is punishing you or who is paying more, if you use less energy. The only thing is that you have to pay for your own energy. So, you do everything to decrease the use of energy because that is directly result for your own company [...] I think is the best mechanism, so improved business Case By ourselves and not by not by rules or project goals." [6]

> "One mechanism in the contract is that it is a contract of 20 years. So, every five year your are challenging about services and energy. For instance, in the five years, the contractor can improve his performances by using less energy or improving the efficiency, and this effort is for their own enterprise and the results are for the contractor. So after every five years the contractor set new goals [...] thus, both parties [contractor and public client] have benefits about improvements" [7].

Thus, the implementation of circular practices that sought long-term advantages during operation and maintenance was influenced by the type of integrated contract. For instance, the use of energy

and water was anticipated during the design phase. Therefore practices to reduce these costs were suggested during the building workshops. As a result, the use & production of renewable energy (D2) as well as the collection & re-circulation of water (D1) were approved. Likewise, water management practices (O1) and optimization of maintenance (O4) were established for the operation.

[E] Coordination
Within project management practices, three common practices were identified during the front-end phase. A cooperation plan, project follow-ups for partnership and a dynamic integrator / observant role. One of the objectives during the tender was to draft a plan for good cooperation between parties. "It was a part of the contract, requested by the contract authority and the contractor had to cooperate according this plan during the engineering phase. All parties took the the plan and elaborated it to a more detailed plan. And we applied this plan several times and each time it worked perfectly" [7].

Then after the tendering process, routine project follow-ups were conducted with an emphasis on partnership. Therefore, the focus of these meetings was on the process of collaboration among the project's members rather than on the technical details of the work being done [9].

Simultaneously, a team member (either from the public client or the contractor) took on the position of integrator and was in charge of identifying flaws in the partnership in order to strengthen it. "There was a main guy who steered and managed the connection with the consortium," [9]. This integrator, or observant, as some other respondents referred to him, was analyzing the meeting and identifying the formal meetings' strengths and weaknesses. Then, at the end of the meeting, was in the position of giving a short report detailing the points to improve in future meetings about communication, information sharing, collaboration style, and any other component of the partnership [6].

In terms of communication, formal reports were contractual mechanisms stipulated to present project progress. Similarly, an informal communication style was supplemented and defined as 'legs on the table,' which comprised of discussion sessions to show progress, difficulties, new ideas, and request decision-making advice.

> "Formal arrangement that were described in the contract did not really be sufficient. And sometimes over arranged. So we minimized when we could, and we made extra arrangements with an informal quality as complementing of that." [5].

A significant amount of effort was invested in developing a shared culture at the start of the project. Respondents agree that for this project culture to evolve, all actors must work from the outset on the project goals, provide ideas to accomplish the goals, and propose circular practices to meet the established contractor's objective.

> "Creating a project culture was important because otherwise the team that was working on the project can be influenced by the boards of the underlying organizations. Once they won the tender, the organizations can be inclined afterwards to go for simplification of the building in order to save some money. So, it make the building less interesting and having less quality. That is the normal inclination of parties to have after winning the tender." [5].

Thus, according to the respondent, creating a shared culture in the project allowed circular practices to continue, even if it was not the easiest way. As mentioned by the respondent on behalf of the client [5], once the tender has been won, the contractors tend to choose the simpler route to take while completing tasks. However, the inter-organizational team continued to strive for the adoption of circular practices due to the shared culture created within the team. The usage of water collection and re-circulation systems (D1), the utilization and generation of renewable energy sources through solar panels (D2), and the specification of higher-performance materials (D8) were some of these circular practices that, despite the higher costs and extra effort, were adopted.

Similarly, one of the public client respondents believes that trust was part of this shared culture; nevertheless, this did not occur from the start but grew through time. A collective trust is an essential characteristic that must be addressed carefully since it makes it feasible to cede control and let other parties act as they better know.

> "it is a process [trust], and it grows over time. At the end of the project, we felt sorry to have to separate ways because at that time the team was the best team. We could say that we started as two separated teams, and we ended as one team." [5].

A mechanism that characterized the creation of shared culture and trust as a fundamental part of this culture was the positive and non-slashing feedback, which is viewed as a source of improvement for the progress of projects and strengthens interpersonal relationships. For this feedback to be stimulating, however, respondents asserted that actors must be communicative, receptive, and open-minded.

The public client then demanded conflict management procedures from the contractor. The public client arranged some sessions to finalize the conflict management system as a mutual system after it had been drafted. It became a shared tool for resolving conflicts. Therefore, when disagreements or conflicts emerged within the team, a member of each party with expertise in the process aspects was brought in to help minimize the discussion and overcome the problem within the project.

> "The system was meant to keep the discussions in the project and not go outside the project can be necessary, but arrange it, organize it so that it will be as long as possible in the project and not outside, because if it goes outside, it takes a long time and discussion goes over your head and you do not know the outcome and can be really awful and costs a lot of money and will be very formal." [5].

> "If you do not succeed in solving the problem and getting a mutual vision on it, then get someone of the project to help you each party can have some, someone extra and then it will be more easy to still have a mutual vision on the subject. This extra person is someone who is not responsible for the content, but for the process. And if that also does not solve the conflict, then you go to the the project leader to have a discussion on their own and solve the matter." [5].

Nonetheless, relational mechanisms prevailed over contractual conflict resolution systems, which consisted of open and casual discussions to expand points of view on how the problem is related to other issues and thus find the optimal solution. The 'zooming out the conflict' mechanism would permit these perspectives to be widened by incorporating actors that are not solely specialized in the technical aspect of the problem, but also process specialists or process leaders with a more comprehensive view of the project. [5]].

[F] Monitoring
Formal, informal and third-party control were part of the monitoring mechanisms in the project. A contract module was established as a formal monitoring mechanism for compliance with the requirements. However, the contractor had the freedom to include more information, such as the latest legislation, technical information, subcontracting information, and more, to keep everything in one system. The module was managed in a decentralized manner, with each department responsible for keeping its own component up-to-date and having a person assigned to oversee and ensure veracity [8]. Parallel to formal monitoring systems, informal conversations and personal relationships allowed the public client to understand individual goals, individual performances and individual ways of working. It serves not only to carry an informal control, but also to stimulate actors to outstand in their responsibilities since they felt listened and included.

> "We could talk a lot of time about the monitoring. The most important thing about monitoring systems is that it is not about punishing, it is about collaboration. So it is more about evaluations like 'What are you doing to improve?' [...] for instance, one of the agenda points was about how are we going together and what are we doing to improve things in the project" [6].

> "The lesson is that you really have to be interested in what are the background of all the members of the team that you are working with [...] at least to talk about the company intentions or the professional intentions that people have and the professional challenges that

> they feel. If you are really curious about that from the heart, not from the head that is very helpful to build the relationship." [5].

Similarly, third partied were hired by the public client to steer the design and help during the initial workshops in the materialization of goals. As one of the respondent from the contractor group stated: "He [the third party organization] was also involved from the workshop stage to do checks and also help of course" [8].

Table 4.2: Overview governance approaches for IOC in Case B

Governance dimension	Governance approaches in Case B
Goal-setting	
Joint performance goal	Alignment of individual and collective goals. Individual and collective objectives are present in projects. By dialogue, it is possible to grasp what those particular goals are and try to integrate them into the overall goal in such a way that all or most of them may be addressed [7].
Clarity of goals	Pressure-cooker. Building workshops and debates took place during the design and planning phase to define common circular goals [9].
Flexibility of goals	Flexible goals during the tender phase. During the tender of the project, the only requirement was to make a building functional for 15 years and circular practices were not a requirement. This flexibility allowed the contractor to developed different ideas and approaches in the project [6]. Freedom in how to achieve the goals. Circular practices emerged as a result of extensive dialogue throughout the tender, wherein the parties discussed how the building could be durable and sustainable [5].
Capability building	
Actor selection	Best value procurement. The project manager proposed the best value procurement approach in order to make partnership a primary criterion of the tender process [5]. Collaboration as a criterion for partner selection in the consortium. This criterion was included as in practice, parties search for other parties to merely win the tender but they do not look at the 20 years they have to be together collaborating [6]. Ensure continuity of the actors. Not everything is written in the contract, so ensuring continuity of the actors involved, helped keep the intentions and relational agreement made for the project [5].
Learning and continuous improvement	Feedback trainings to help with openness. Feedback trainings were designed by experienced people for all parties involved to teach them how to deliver good feedback to their coworkers. Also, trainings to assist in sharing challenges and allowing others to participate in problem solving [5].
Roles and decision-making	
Definition of roles and responsibilities	Roles and responsibilities set from the onset of the project, during integral dialogues [5] [6] [7].
Management structures	Core management structures from the contractor and public client side [5]. Leadership role [5] [6]. Dynamic integrator / observant role [5] [7]. Team of experts [7].
Authority for decision-making	Decisions were made by those who best understand the situation. Decisions were commonly sent up to the top of the hierarchy of authority, but those were sent back to the ones who best understood the situation [5]. Integral discussion sessions. Influence on decisions by the public client and contractor to pursue circular practices [8].

Governance dimension	Governance approaches in Case B
Rewarding	
Rewarding tied to performance	Pain mechanisms were applied to force that the main objective for the contractor was not to have claims or reduced payments when a requirement was not complied. Those payment mechanisms were already set by the public client, with no room for flexibility. [6]. Celebrating small wins. These celebrations are not stipulated in the contract but mostly depend on the project leader. Celebration of small wins brought motivation to the team to outperform [5]. Small gatherings with all actors. The gatherings consisted of having lunch together, something small but important to build on the relationship and bring the sense of rewarding [5].
Risk allocation	Individual risk identification, then collective risks management. Each party was separately responsible for risk registration, risk analysis, and risk management. The parties then share their risk identification and risk management to see how they may help each other [5]. Risks allocation to the contractor with non-bonding collaboration in managing the risk when the public client was able to manage the risk [5].
Ownership structure	Stimulation and sense of ownership by the integrated type of contract [6].
Reputation	Key actors recognized that with the compliance of this circular project, there was a good potential for further projects with the same circular characteristics.
Coordination	
Common PM Practices	Cross-functional coordination team (core team): project manager, technical manager, and contract manager. Cooperation plan created by the contractor to outline the way of inter-organizational cooperation [7]. Project follow-up and integrator role. Project follow-ups were routinely undertaken to emphasize partnership [5] [9]. Assigned observant in formal meetings. The assigned observant consist of a person from the team (either from the public client or the contractor) that is responsible for observing the meeting and identifying the strengths and weaknesses of the formal meetings [6]. Steering the meeting and teams behavior through a dynamic integrator / observant role [5] [7].
Shared culture, values and norms	Trust was crucial to move from control to commit. Trust grew over time and made possible to release control and let other parties to act as they know [5]. Project culture. To achieve this project culture, the starting point was to work together from the beginning on the goals for the project [5]. Vulnerability as a culture. It is not about separated problems but about collective problems that require mutual cooperation [5].
Communication and information sharing	Formal procedures for communication and information sharing. Formal reports to show progress [5] [7]. 'Legs on the table discussions' as informal way of communication.
Change management	The project was flexible in the changes since it did not interrupt with the fulfillment of the goals specified by the client.
Conflict resolution	Conflict management system. This management system was requested by the public client to the contractor. After the conflict management system was sketched, the public client came to set some sessions to finalized it as a mutual system [5]. Disputes settled by process mediators. When disagreements or conflicts arose in the team, the method was to bring in one extra person from each party with experience in the process aspects to help limit the discussion and settle the problem within the project [5]. Zooming out the conflict. This mechanism is relational and is used to expand the points of view of the conflict to see how the issue relates to other issues and find the best solution [5].
Monitoring	
Formal monitoring	Contract module to monitor the compliance of the requirements [8].
Informal monitoring	Informal processes and personal relationships. Personal relationships allowed the public client to understand individual goals, individual performances and individual ways of working. It serves not only to carry an informal control, but also to motivate actors [5].
Third party monitoring	Third parties were hired from the public client to steer the design and help during workshops [8].

4.3. Case study C: Government office renovation

4.3.1. Case introduction

The project involves the expansion and renovation of an outdated public building. Circular practices aiming at rethinking, reusing, and recycling were used into the renovation and expansion. To achieve this, the client and contractor collaborated via a D&B contract model to identify the residual potential of the original building's materials, elements, and components in order to incorporate them into the renovated building. In addition, the expansion was designed such that the structure could be disassembled and reassembled in other location if necessary in the future.

Front-end phase

For project C, the contractor began his engagement through competitive dialogue from the beginning of the conceptual design phase, allowing him to prepare a conceptual design for the renovation and expansion of the outdated building. Similarly, Figure 4.7 illustrates that the contractor maintained his involvement in the project throughout the design and construction.

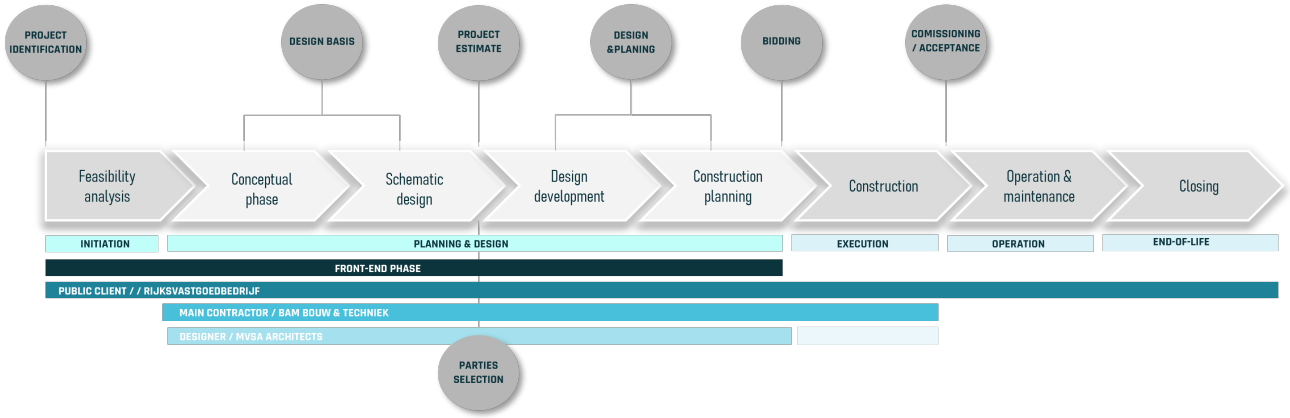


Figure 4.7: Phases of the case study C with the definition of parties involved during the phases

Inter-organizational structure

The inter-organizational structure is defined by the contractual relationship between the client and the main contractor, where the main client is a construction company. The contractual agreement is governed by a type of D&B contract that makes the contractor responsible for the design and construction phases. Besides, the contract contemplates a small maintenance addition for two years, to ensure the proper functioning of the renovated building. For the design, the contractor contracted an external design company, which was present with an active participation in the design stage, and with an on-demand participation in the construction phase.

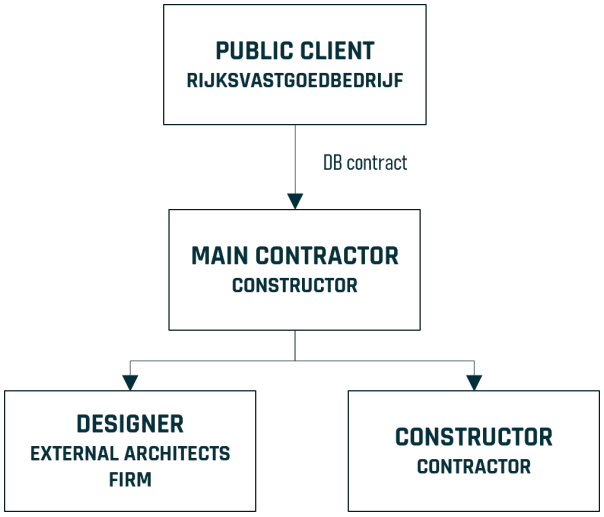


Figure 4.8: Organizational structure of the case study C

4.3.2. Circular practices and goals

Circular practices
Case C presents circular practices at different building life cycle stages. The design incorporated the adaptability and flexibility of the structure to extend the building's usable life. Also, the design for the renovation and expansion comprised the usage of renewable energy generated by solar panels installed on the top of the building, as it helped reduce the dependency on non-renewable energy from the service grid. Moreover, better performance materials were addressed for the efficiency improvement of the building's lighting, ventilation, and heating systems. Therefore, designs of the interior spaces were considered that would maximize the utilization of natural light. Similarly, more effective insulating materials were used to prevent heat or cold losses in the spaces, decreasing the building's energy usage.

Manufacturing and supply phase included reusing secondary resources. Most inner walls, mechanical installations, electrical components, and information and communication technologies (ICT) systems in the renovated building were recovered from the existing structure and refurbished for reuse. In addition, standardization of components and elements was employed in manufacturing to eliminate waste. The building then incorporated prefabricated wooden elements, facilitating on-site construction and avoiding waste.

For the operation, the designer, constructor and public client envisaged the development of dynamically functional shared areas. One of the guiding ideas of the entire design was 'Open Up,' which entails the transformation of the existing building into a bright and visible workplace. Then, for the end of life, circular practices were incorporated for the building extension because the structure is entirely removable and constructed of wood. This design approach for disassembly prioritizes the innermost loop so that the structure can be reassembled in its entirety rather than in fragments once its useful life has concluded.

Circular Goals

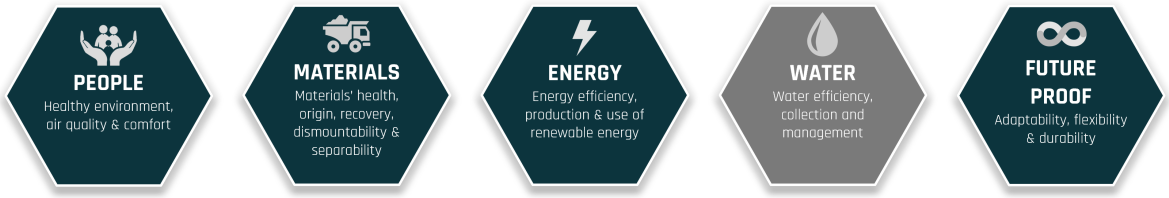


Figure 4.9: Circular goals achieved on Case C

For Case C, the goals initially defined by the client were based on using secondary materials from the old building. Therefore, circular goals focused on people, energy, water, and future proof were not conceived at the beginning of the project. Only after the contractor's involvement were the goals expanded and managed to include the realization of a comfortable building for people, the use of renewable energies, and the expansion of the building following future-proof goals.

The design of open, expansive, and comfortable places for users was inspired by goals relating to *people*. It was accomplished by eliminating unnecessary interior walls and establishing recreational spaces in the extension area, which created an atmosphere conducive to interaction and conversation. For instance, the work offices were remodeled with lighting and noise regulations in mind to give a better environment for users, and the exterior was designed with green areas and places to sit and converse.

The client and the contractor were then continually pushed to hunt for existing secondary *materials* in the old building that could be reused or refurbished for inclusion in the renovated building. This motivation was rooted mainly in reducing costs when purchasing new materials and equipment. However, in several cases, such as electrical installations that did not meet the requirements and standards, they had to be new. According to the responses of the group of contractors, the acquisition of new materials, elements, and equipment was minimized by conducting a thorough inventory of the existing elements and equipment in the old building. This time was considered into the project's scheduling, allowing a substantial portion of the existing building to be preserved.

In addition to improved *energy* efficiency, the structure produced and used renewable energy sources. In order to decrease energy consumption from the network, the contractor suggested installing solar panels on the roof. Furthermore, improved insulating spaces were incorporated into the design and selection of materials to prevent heating and cooling losses. It required purchasing new materials for the insulating system but promised increased energy efficiency.

Then, the building's expansion structure was designed with an eye toward *future-proof*. The existing structure would have a useful life of approximately 25 years more, whereas the new structure would have a longer useful life. Consequently, the contractor contemplated delivering a longer-lasting building that could be totally disassembled and reassembled elsewhere, if necessary, with different functionality.

4.3.3. Governance mechanisms

[A] Goal-setting
Early contractor involvement and joint definition of circular goals were some of the mechanisms considered for aligning the circular goals on the project. The contractor was involved from the tendering process in defining the general goals and proposing circular practices. For the joint definition of the circular goals, a collaborative process was used where the contractor examined the existing materials in the building for reuse with the client's assistance. This process incorporated circular practices

such as, specification of secondary raw materials (D6), reuse of secondary materials (M3), and optimization of material use (M6). Thus, both the public client and the contractor agree, respectively:

> "The initial phase was quite a collaboration phase where we together defined what was in the building might be reusable. And we tried to evaluate whether the components were usable through a site check. So, the contractor did a quite thorough check on location if the components were reusable, and then, we went through the list of components to check whether or not they were usable." [10].

> "In the definition phase, there were dialogues organized by the client, and that was, I think, the first time the contractor was able to set goals together with the client. But that was when it was still in competition when it was not our project yet, but when we competed with other contractors. " [12].

Similarly, openness in the definition of goals was an approach that fostered collaboration between the parties while aligning behaviors and expectations. For this, the public client constantly motivated the contractor to speak out from the beginning of the project about the organizational goals as contractors and the organizational goals as clients, to articulate them with the project goals jointly. Therefore, the public client always emphasized the need to achieve a building with less possible costs by implementing circular practices and keeping the standards of a public office building. As the respondent from the public client states:

> "We tried to minimize our efforts and costs for the building but to make it as usable as possible. That was, in my opinion, one of the biggest circular efforts in the project. And, from that perspective, we tried to use as much as possible we already have in the building" [10].

Moreover, dialogue sessions were other critical mechanisms in the tender phase to ensure that goals were explicitly clear. "I think it took us one or two dialogues to clarify it for everyone. There were one or two meetings necessary to understand all the goals, all the client wishes and to make sure we could make a plan to fill in those demands the best." [12]. During these dialogues, efforts were made to reduce the cost of the project by introducing circular practices that tried to reuse existing materials and components. Similarly, the implementation of interventions such as water collection & re-circulation (D1), the use & production of renewable energy (D2), the design for adaptability and flexibility (D4), and the specification of higher-performance materials (D8) that reduce the building's long-term operation cost were pursuit.

Finally, the flexibility in how to comply with the goals was another approach that allowed the contractor to anchor his own interest with the collective interests. This freedom was seen as room for innovation, exploration, and trust over control, which the contractors very much appreciated.

> "I think one of the things that worked best for us is the freedom that we get. For example, with reusing the carpet tiles, we can say we will reuse them, but we do not know how it will work out in practice. So, we said our intention is to reuse them, but later, if we discover that it cannot be done, we will inform the client. And then, we will look for our second-best option. Therefore, a process like that in place really help with the circular approach because we felt the freedom to really look at the things." [13].

[B] Capability building

The public client aimed to find the most competitive tender based on the lowest price and the sustainability proposal. For this reason, a competitive dialogue was encouraged to find a circular design for the expansion of the building that included the optimal use and reuse of the existing materials in the building, together with the most economically offer. Therefore, sustainability and quality were introduced as criteria through discounts that the bids could get due to added quality and circular attributes in the design and development. Both the public client and contractor agreed, respectively:

> "This was a standard tender process in a way that we set the goals in front of the project and the demands. Then the contractor made a design, and they also had to give us a plan

> for the project, how to approach the project, and how to reach sustainability measures. So, the plan that they [contractor] presented was evaluated by us in the tender phase using the sustainability criteria and the lowest price" [10].

> "We could get a discount by getting points so that we could get an effective discount on our price. And, with that discount, we got the lowest price. Then, another aspect was also the circular goals since the strategy we had contemplated to demolish as little as possible" [13].

The contractor managed to present a design with the highest reuse of the existing building, resulting in significant cost savings. While the design of the expansion of the building incorporated circular approaches focused on complying with future-proof goals. The design considered practices such as modularity (D3), design for adaptability and flexibility (D4), and design for disassembly (D5). Similarly, the operation aimed to apply circular practices to attain future-proof goals. The practices proposed for the operation phase were described as shared/dynamic functionalities (O3), and adaptable and flexible use (O5).

Moreover, a unique collaboration component drew the attention of the public client: "Now, what we heard back from the client, was that there were two things important. One, our collaboration proposal, so, with those sessions and measurements every quarter, etcetera. And, the other was the circular approach to the renovation of this building. I think, those were the two main factors that made us stand apart from our competitors." [12].

[C] Roles and decision-making
Just after the project was awarded, the mechanism for defining the roles and responsibilities was based on a collaborative approach. Here, the public client proposed to the contractor to develop the hard side for cooperation such as rules, procedures, systems, and resources, but also the division of responsibilities, authorities, tasks, and risks. This collaborative strategy would promote the clear understanding and distribution of project tasks, authorities, and roles. As a result, an escalated structure for decision-making was settled where simple decisions were made at the lowest level. However, when actors from the lowest level could not agree on the solution, the issue was escalated to the next level. Here, the lowest level refers to the technical level that is working daily on the project development, while the next level concerns the process leader responsible for the processes and collaboration between the parties.

> "The escalation line was already at the first meeting. So, we discussed how escalation should be and when to re-escalate topics to a higher-level authority" [12].

Additionally, the definition of roles took place where a management team was defined to be the main point of communication between both parties. Moreover, to ensure a highly linked project structure, the contractor offered a role as integrator/mediator for the project. To aid in the growth of the client-contractor relationship, the mediator was a specialist actor in collaborative processes involved in practically all projects from the mother organization.

Furthermore, meetings with experts were defined to influence decision-making. The experts who belonged to the project could schedule meetings where they suggested other ways of carrying out the circular objectives or technical aspects of the project, and the responsibility for the decision made depended on the contractor. It gave the contractor a broader and more knowledgeable vision of possible solutions.

> "We had some expert meetings with the contractor about circular approaches. So, we had some thoughts about what to use or what not to use. And, we sat together with lead engineers from the contractor and the project manager to discuss these thoughts. However, those discussions were not binding because the contractor is responsible, but our thoughts give the contractor some insight into what is important for us. Moreover, we want to see how the contractor was going to reach our demands. So, we wanted to check and verify in these meetings." [10].

Through these meetings with experts, it was possible to determine, for instance, that passive ventilation and lighting (O7) may be implemented in the renovated offices during the construction phase. In order to improve energy consumption, the experts advised workplace interventions that aim to keep automated control of natural and artificial light. Similarly, noise control through the use of better-performance materials (D8) was advocated by experts. These materials selected to fulfill acoustic functions, were selected in such a way that they were less harmful to the environment.

[D] Rewarding
The client implemented unilaterally formal mechanisms based on sanctions to ensure compliance with the goals. In contrast, jointly-established relational mechanisms made it possible to alleviate the tensions caused by punishment in the event of poor performance or non-compliance. The penalties consisted of reductions in the payment in case of non-compliance with the goals stipulated in the contract.

Moreover, the contractual risk allocation stressed the allocation to the contractor due to the nature of the type of contract D&B, but some risks were assigned to the client when he made requests that were not addressed or planned by the main contractor. To minimize misinterpretation, these occasional requests were formally documented.

> "No, there were no financial rewards. We only have the negative form of that. So, if they do not reach our contracts parts, we have some penalties, but there were no financial rewards in the project for reaching sustainability levels" [10].

> "The contract form is like that we are responsible for everything, except for the things that the client has told us in a set of documents" [13].

Nonetheless, the soft side of this contract was conducted though mechanisms for the reassignment of risks, as it was clear to the client that projects with circular goals are still uncertain and require flexibility. Therefore, even if the risks were assigned to the contractor based on the terms and type of contract, certain risks had been identified and communicated to the public client. Consequently, certain flexibility allowed parties to negotiate the reassignment of the risks to those who can best deal with them. These reflected a joint problem-solving approach. In those circumstances, the contractor formally submitted a document explaining why some specific risks were not bearded by him, followed by an open discussion to align the understanding of the issue [10].

The respondent from the public client agrees with this relational approach by stating:

> "I think the main difference between a normal contract and this type of contract is that it is a circular project, so we have to accept risks that normally are the responsibility of the contractor. So, there is a constant negotiation about that" [10].

Some risks were not visible at the moment of the tender. For example, most respondents described that some components were selected as potential to be reused. However, after the dismantling, the contractor and the client realized that those components were not reusable. As a result, there were changes in the plans that the contractor did not know about from the onset, translating into the client's acceptance to bear this risk [10].

Simultaneously, the respondents from the group of the contractor mentioned the same concept that the clients referred to, 'the spirit of the contract', which they defined as the property that the parties involved achieve to see beyond the words clearly written in the contract. That is, analyze together the goals, the ways to achieve them and how each party can collaborate to find the optimal way to develop the project. For example, some of the respondents emphasized that this relational approach emerged from the dialogue for the solution of the risks:

> "The risk management is more in the spirit of the contract than in the letter of the contract, that they work together. I have seen that the 60 to 70% of the time they are really trying to fix this [risks] together" [12].

> "There were risks in the beginning and also during the start of the project that were unclear, but because we were actively working on it, we discussed them with the client. We always solved that very quickly to know if something happened who was responsible for it. So, in general, it was very clear what risks were ours and which were the client's, but there is always some gray area that depends on interpretation and requires dialogue." [13].

Risks and problems were resolved in a manner that supported the deployment of circular practices that entailed a degree of uncertainty. For instance, even though it was envisaged that the energy distribution systems from the previous building would be preserved, the contractor saw the possibility of incorporating new systems that would enable the life cycle capacity to be regulated by tracking the usability. This would enable management of the system's maintenance and operational status (D8, O4). Therefore, the client was able to assume the extra cost of the new energy distribution systems due to the relational management of risks. By maintaining the existing systems, it was anticipated that they would eventually reach the end of their cycle and cause a building malfunction [12].

Then, both client and contractor respondents agreed that exposure played an essential role as a reward and motivator. The fact of being a circular public project that continually sought the reuse of existing materials in the building, made the eyes of the press and academics focus on how to develop the project. For this reason, the recognition served as a motor to promote continuous improvement in circular practices and achieve the objectives within the time, budget and quality required.

> "Unfortunately, this case is traditional, but there are some non-financial rewards. I would say that because we tend to give more communication and attention for the project, they do their best to reach more sustainability levels. So, there are publications on like websites or news sites. So that is a form of reward." [10].

> "Of course, there is a reward. When we deliver the project in time and with the customer satisfied, we get a satisfaction letter, and we can use it in future projects to help other clients select ourselves." [12].

[E] Coordination
Significant effort was devoted to cross-functional cooperation in project C. Three distinct mechanisms were implemented to ensure common project management practices. First, the ambition cooperation document was defined as a formal document created at the beginning of the project to settle the cooperation processes between organizations. The cooperation document defined that working together means that each party has an eye for the different interests of those involved. A shared vision is fostered to arrive at a common mission that expresses the project's interests.

Second, as it was mentioned in the roles and decision-making dimension, the contractor proposed an integrator / mediator role. This role was responsible for ensuring a deeply integrated project structure. The mediator consisted of a specialized actor in collaboration processes involved in nearly all projects from the mother organization to assist in the grow of the client-contractor relationship. His role as an outsider made it easier for him to have a complete perspective of the state of collaboration between the parties to propose initiatives aimed at improving aspects of the communication, coordination practices, values, and project changes.

> "We have a person from the company who is specialized in collaboration. So, he is involved in many projects and helps the client and contractor become best friends. So, he was involved from the start of the project, and he is still helping our relationship with the public client to be as good as possible." [11].

> "That's the luxury of not being in the project day by day. So, you can see it from a distance, you are not infected by all those thoughts, and you can stay neutral [...] So, I suggest, and they follow my suggestions every time. So, that is something I agreed on in the beginning with both the client and about contractor. I can only do my job if you let me intervene. " [12].

Third, the contractor also offered collaboration sessions to preserve a close and stable relationship between the parties and prevent deviations or distancing from collaboration. These collaboration sessions were orchestrated by the mentioned mediator role. Thus, every three months, a collaboration session took place in the project were actors from the core team discussed how the collaboration was going and what aspects could be improved. The actors from the core team need to fill out a particular questionnaire with questions about behaviors and actions during the project. Then, those questions are analyzed by the collaboration expert, and some graphics and percentages are given as a result. Then, a session with all actors involved is conducted to discuss the values obtained and the existing deviations. In the end, both public client and contractor need to define actions to follow to align those deviations in thoughts, performance, or interests.

> "They define the action, and I am facilitating the session. So, I say when it is necessary to define an action for a problem, for a process, or how can we do better together [..] Sometimes it is a process action, and sometimes it is just a meeting were to discuss more deeply " [12]

Then, the respondents were correct that a shared culture emerged from these collaboration sessions, where the main characteristics of this project culture were honesty, service, and pride. Being open with thoughts and ideas encouraged an atmosphere of helpfulness and honesty where the actors were not hesitant to express their opinions and propose ideas. Similarly, the sessions helped strengthen the bond between the public client and the contractor, given that, for instance, when both parties responded the same to a specific question in the questionnaire, both felt proud of that level of synchronization in thoughts and orientations in the project [12].

> "I always make graphics, and after a couple of times, we can see trends to show. So, we could see that we were getting better together with each other. And, if you can show that based on data, that makes people happy. So, people were saying: 'I am doing a great job!' or 'we together as a team are doing a great job!' so, there was a proudness between us." [12].

The communication methods, on the other hand, were largely described as progress reports and knowledge-sharing meetings. The contractor was obliged to make formal progress reports to show the updated circular practices implemented in the project. Meanwhile, knowledge-sharing sessions with the client fostered the dissemination of lessons learned from the project to increase knowledge on circular building projects. Contractors were responsible for explaining why certain practices were selected over others and the novel circular practices explored in the project.

> "I think we have made three reports on how the circular practices are progressing. Also, there are a lot of informal talks between the core teams from the client and the contractor. So, the team is talking with each other about it [circular progress], but we also have some formal reports that we make on the circular achievements." [13]

In a manner analogous to the common goals, a change management procedure was defined from the outset to construct mutual process that would specify the steps to follow and the estimated duration to conduct the change. Due to the circular nature of the project, which made the implementation of certain actions unclear, the process leader took the initiative in developing this approach. Consequently, she incorporated dialogue sessions prior to the emergence of a change, the production of a proposal, and an examination of the change within a semi-standardized time frame, given that the client was prone to request more in-depth investigations and demanding resources. In addition to the proposal, strategies for execution, financial, and risks were requested to ensure a smooth transition to the new scenario.

Concerning the resolution of conflicts, the public client had standardized dispute resolution systems. However, all respondents affirm that in the event of disagreement, alternative relational mechanisms such as dialogue were chosen, along with the decision or agreement reached being memorialized in writing.

> "When you talk with each other in a normal way, then it is not a conflict with it" [11].

> "In case of conflict, those two people will meet and talk it over to ensure they have the same vision. And, we also agreed on just writing it down because then it is clear to everyone what has been said." [12].

[F] Monitoring
The project relied heavily on reporting procedures, steering groups, information technology systems, and site visits to verify that all parties behaved as expected. The respondents agree that the contractor was in charge of control and monitoring due to the D&B type of contract, with a minor M for maintenance. Nevertheless, the public client monitored the process through periodic progress reports and steering groups that discussed mainly circular subjects. Besides, the digital shared platform enabled the visualization of demand specifications and compliance with requirements, as the contractor was responsible for updating the tool with the actions taken to address each demand. Moreover, the public client undertook periodic occasional site visits to assure that designs and plans were implemented as intended.

Table 4.3: Overview governance approaches for IOC in Case C

Governance dimension	Governance approaches in Case C
Goal-setting	
Joint performance goal	Joint definition of circular goals. At the start of the project, a collaborative process was used to define the circular goals. The contractor, with the client's assistance, examined the existing materials in the building for reuse [10]. Early contractor involvement. The contractor was involved from the tendering process in the definition of the goals and circular practices for the project [12]. Openness in definition of goals. The public client motivated the contractor to speak out from the beginning of the project about the organizational goals to articulate them with the project goals jointly. Collective interests over individual interests. The cooperation document stated that if people are aware of each other's interests and background information, understanding can be achieved for the mutual situation.
Clarity of goals	Clarity of goals through dialogue sessions in the tender phase [12].
Flexibility of goals	Flexibility in how to comply with the goals [13].
Capability building	
Actor selection	Competitive dialogue to select the actors and encourage early contractor involvement. Lowest price. The lowest price was the criteria that made the contractor win the tender. The circular design for the expansion of the building resulted in the most economical offer with the optimal use and reuse of materials [11] [13]. Discount for the bid. The bid got a discount due to added quality and circular practices, therefore, it makes of the tender the most competitive price [10].
Roles and decision-making	
Definition of roles and responsibilities	Jointly definition of roles and responsibilities. The public client proposed after the award of the tender, to jointly develop the hard side of cooperation, such as rules, procedures, systems and resources, but also the division of responsibilities, authorities, tasks and risks [12].
Management structures	Management team / core team from contractor and public client side including project manager, technical manager, and contract manager [11] [13]. Expert meetings to influence in decisions [10]. Leadership role (mediator) spatially separated from the project organization, who helps in coping with collaboration and avoiding disputes between parties [11] [12] [13].
Authority for decision-making	Scalation structure for decision-making. Simple decisions are made at the lowest level, but when actors from the lowest level cannot agree on the solution. The issue is scalated to the next level [12].

Governance dimension	Governance approaches in Case C
Rewarding	
Rewarding tied to performance	Punishment in case of poor performance set by the client with no flexibility [10].
Risk allocation	Contractual risk allocation. According with the type of contract, the contractor bear the risks, except when the public client has made specific requests. Those requests are formally documented to avoid misinterpretation [13]. Reassignment of risks and joint problem-solving. Although the risks are assigned to the contractor based on the terms and the type of contract, certain risks have been identified and communicated with the public client due to the nature of the risk. The contractually defined risk management allow for a certain degree of flexibility and can be negotiated between the parties in order to reassign risks or jointly attend risks [10].
Ownership structure	Ownership was based on more awareness-raising due to the integrated type of contract.
Reputation	Exposure was seen as a reward for key actors from the contractor side [11] [12] [13].
Coordination	
Common PM practices	Cross-functional coordination team (core team): project manager, technical manager, and contract manager. Ambition cooperation formal document. The ambition cooperation was a document created at the beginning of the project with the aim of settling the processes to cooperate between organizations. Definition of common processes. In the beginning collaboration sessions served to define common processes with regards to change management processes, and communication. A team collaboration specialist from the contractor side assisted the parties in improving their relationship, communication, and cooperation (mediator role). Moreover, this individual ensure a deeply integrated project structure and align the goals of the actors [11] [12].
Shared culture, values and norms	Shared culture based on honesty, service, and pride [12]. Collaboration sessions to discuss how collaboration is going and what aspects could be improved. Measurements about collaboration are made and presented to all parties involved to acknowledge how is the real collaboration between teams [11] [12] [13].
Communication and information sharing	Progress reports to update information. The contractor made periodical progress reports to show the updated circular practices implemented in the project [13]. Knowledge-sharing sessions with client. The client was interested in conducting lessons learned from the project to spread the knowledge on circular practices. On these sessions decisions were not made, but the explanation of some decisions is exposed to all actors involved [13].
Change management	Change management procedure. The change management procedure was defined from the beginning in order to create a common process that would establish the steps to follow and the estimated times [12].
Conflict resolution	Dialogue to solve disputes [11].
Monitoring	
Formal monitoring	Demand specification in online tool. The tool serve to monitor the compliance of the requirements [10]. Formal monitoring on process. The public client monitors on process through periodic progress reports and progress session [11] [13].
Informal monitoring	Site visits. Regular visits were made by the public client to ensure that designs and plans are working accordingly [10].

4.4. Cross Case Analysis

This section includes a cross-case study, which, according to Yin (2018), strives to compare the case studies in order to identify similarities and differences in the governance mechanisms employed during the front-end phase of the project to lead it to higher circular levels. Moreover, cross-Case Analysis enabled the identification of patterns in governance mechanisms and perspectives of both public clients and contractors towards circular considerations in building projects. Miles and Huberman (1994) offer certain techniques for processing qualitative data. His suggestions include a variety of approaches, such as tabular and graphical displays, to handle and show qualitative data without degrading the the meaning of the data through excessive coding. In order to simplify the governance mechanisms obtained for each dimension and project, tabulated information will be employed. Therefore, the following Tables 4.4, 4.5, 4.6, 4.7, 4.8, and 4.9 highlight in Black Color the most similar, while in Green Color the most different mechanisms encountered for each dimension.

4.4.1. Comparison of circular practices and goals

To compare the diverse circular practices utilized in the three projects, the following table is created based on 14 interviews, project information provided by partners, and external sources including the internet. It includes in Green the interventions applied by the three cases, in Yellow the interventions applied by two cases, and in Orange the interventions applied by only one case.

Phase	Circular practice	CASE A	CASE B	CASE C
DESIGN	Water collection and re-circulation			
	Use & production of renewable energy			
	Modularity			
	Design for adaptability and flexibility			
	Design for Disassembly (DfD)			
	Specify secondary raw materials			
	Use of information systems			
	Specify better-performance materials			
	Passive building design			
MANUFACTURE & SUPPLY	Material passport			
	Change ownership models			
	Reuse of secondary materials			
	Product standardization			
	Design for product disassembly			
	Optimize material use			
	Reverse logistics			
CONSTRUCTION	Off-site construction / prefabrication			
	Reuse of materials			
	Recycle materials			
OPERATION	Water management practices			
	Use & production of renewable energy			
	Shared spaces / dynamic functionalities			
	Optimize maintenance			
	Adaptable and flexible use			
	Passive cooling and heating			
	Passive lighting and ventilation			
END OF LIFE	Deconstruction / Disassembly			
	Selective demolition			
	Reuse and recycling of components			

Figure 4.10: Comparison of circular interventions applied between cases. Based on: Alba Concepts (2019), Archdaily (2018), BAM (2021), Cepezed (2020b, 2022a, 2022b), De Circulaire bouweconomie (2022a, 2022b), Due Prie (2017), Duurzaam Gebowd (2021), MVSA Architects (2022), Nationale Staalprijs (2022), and Rijksvastgoedbedrijf (2022b).

The three cases were characterized by mainly having similar circular interventions. Among these interventions, modularity, design for adaptability, flexibility, and disassembly are characterized from the design phase. According to the respondents, this design that included disassembly guaranteed that from the outset, the versatile functionality of the building was understood as a common goal in the effort to create future-proof buildings. Similarly, the contractor respondents highlighted the importance of employing information systems such as BIM platforms to facilitate decision-making and prevent reprocessing during the construction phase.

Then, case studies B and C shared other interventions for using and producing renewable energy, as well as the specification of secondary materials for the building. However, Case A differs in this practice from the other cases due to the high-quality demands and aesthetic requirements that the client demanded for the structure. This building would receive significant attention from the public and users, in addition to having a complex functionality that required materials, components, and elements that would guarantee the safety and comfort of users. Then, Case B differs from the others in that it applied water harvesting and re-circulation techniques, which allowed it to obtain circular goals focused on water use.

For the manufacturing phase, the three cases agreed that standardization of products such as columns, beams, panels, floors, and walls, among others, were incorporated to facilitate replication of these elements in the manufacturing and supply process. Moreover, this standardization guaranteed the reduction of waste. Then, for Case A, a change in the ownership model was adopted, prompting the contractor to carefully define the type of materials and the specifications for the production of elements to guarantee greater durability, less maintenance, and high quality.

All three case study respondents agreed that waste-reduction methods were implemented during the construction stage. Practices such as prefabrication were in line with design for disassembly and standardization in the manufacturing process. Furthermore, for the operation process, the three cases succeeded in the adaptable and flexible use of the building. In contrast, cases B and C went a step further by allowing for dynamic, multifunctional, and shared areas. These practices were aimed at optimizing the functionality of the building. Then, during operation, only Case C mentioned passive lighting and ventilation practices in their interviews, which sought to reduce energy consumption.

Finally, at the end of the useful life of the three buildings, it can be stated, according to those surveyed, that in the first stay they were all suitable for deconstruction/dismantling, allowing the building to endure over time with flexible functionalities and in unspecified locations. This practice is most associated with the circular goal of being future-proof. Only in the event that the disassembly could not be carried out due to the lack of prospective clients to take over the building, then, cases A and B, disassembly would proceed for the reuse and recycling separately of the components that still retain residual value.

4.4.2. Comparison of governance approaches

[A] Comparison of the goal-setting governance dimension between cases

The dimension of *goal-setting* had the highest degree of similarity between the three examined cases. In all three instances, respondents stressed the congruence of the client's and contractor's goals, i.e., that the contractor's purpose was not limited to maximizing income but also included other long-term goals. In Case A, for instance, the contractor set the building's high quality and residual value five years beyond the end of the temporary building's life cycle as his own objective. Similarly, the client's goal for Case B was straightforward: to construct a 15-year-long, functioning building in a location that belonged to the client. Given the contract's circumstances, which included design, build, finance, operation, and maintenance, the contractor was encouraged to embrace the same functionality goals as the client. In this Case B, the respondents concur that not only the contractor aimed to achieve the primary goals, but he was also inspired to create more adventurous and innovative goals

Table 4.4: Comparison of the goal-setting dimension between cases

Case A	Case B	Case C
• Early involvement of contractor • Clarity of goals • Simplicity of goals • Building workshops • Dialogue sessions • Alignment of business case	• Alignment of individual and collective goals • Simplicity of goals • Flexibility in how to comply with goals • Dialogue sessions • Building workshops and debates	• Alignment of individual and collective goals • Openness in definition of goals • Joint definition of circular goals • Early involvement of contractor • Flexibility in how to comply with goals • Dialogue sessions

that encompassed circular practices. Similarly, in Case C, the goal was to construct a building at the lowest possible cost while maintaining a level of quality that met public building regulations. Circular approach was the vehicle for cost reduction, which was also the client's aim. Therefore both parties started searching for circular practices that would reflect cost reductions and quality assurance.

Another significant commonality between the cases was the freedom to determine how to meet the goals. In all three cases, the goals were straightforward, allowing for various possible approaches. In addition, due to the method in which the delivery of goals was framed in the tender procedure, early contractor involvement and dialogue sessions, during which the contractor presented his point of view and ideas for the project, were necessary to foster a collaborative environment.

Nonetheless, each case featured unique methods or strategies that were not replicated in the other cases. For instance, Case A respondents simultaneously stated that the business case was aligned. Although it may appear similar to goal alignment, there are important distinctions since the business case shows the project's economic viability, which in this case was a good fit for both sides. This economic alignment was possible due to the building's defined ownership structure, in which the client was the owner of the building, whereas the contractor was the owner of the materials that comprised the building. According to one of the responses [4], the contractor had a retained value that might be recouped after five years, allowing him to offer the building to the client at a reduced cost. Although this ownership model triggered considerable attention at that time, it is now more commonly referred to as the take-back approach or service-based approach as contrasted to the product-based approach, in which the contractor or market offers rent for the products, components, and elements that comprise the building.

Furthermore, it was demonstrated that the circular goals were jointly defined in Case C. According to the answers, in this case, the client wished to incorporate circular practices as means to achieve economic and sustainable goals. In this manner, the client requested a jointly definition of circular practices, materials, elements, and components to be reused. This meant that the actions necessary to reach these goals were devised by both parties and forged along the way.

[B] Comparison of the capability building governance dimension between cases

Table 4.5: Comparison of the capability building dimension between cases

Case A	Case B	Case C
• Competitive dialogue • Discount for circular interventions and quality • Pre-existing relations for the selection of the consortium parties	• Best value procurement • Collaboration for the internal selection of the consortium parties • Continuity of the actors along the project • Feedback trainings	• Competitive dialogue • Discount for circular interventions and quality • Collaboration as a distinctive factor • Knowledge-sharing sessions (Lessons learned)

For the dimension of *capability building*, it was demonstrated that two of the cases (A and C) selected their contractors through competitive dialogue, whereas Case B established a best value procurement procedure that selected the contractor not only on the basis of experience and lower price but also based on their ability to form a partnership. The assertion made by one of the respondents that the public client desired a partner capable of keeping a collaborative relationship with the client for more than 15 years was crucial. Although several respondents from Case C claimed that collaboration was a distinguishing factor among other contractors, the collaboration did not play a decisive role in the evaluation for the selection of the actors.

In addition, the respondents discussed their internal process for the formation of the consortium. Relying on the respondents' perceptions, it can be deduced that Case A was based on positive pre-existing relationships, whereas cases B and C pursued organizations whose functions complemented each other and which had a greater chance of winning the tender.

Moreover, another particular focus of Case B was the periodic training in feedback, and the building workshops and debates. The feedback training helped actors to give positive feedback which serves as source of improvement for the progress of the project and strengthens interpersonal relationships. But, unfortunately, the other two cases did not mention the utilization of this practice during the front-end phase.

[C] Comparison of the roles and decision-making governance dimension between cases

Regarding the dimension of *roles and decision-making*, processes and approaches for defining roles and decision-making had substantial commonalities. The management teams for each of the three projects concentrated on three distinct areas: management, technical, and contractual. Thus, each project had a core team consisting of the project manager, technical manager, and contract manager. This core team comprised members from both the public client and contractor organizations, creating explicit mirror structures that eased communication and provided a single point of accountability between organizations. In other words, the technical manager of the contractor was tied to the technical manager of the government client, and so on. Moreover, in place of democratic decision-making, the contractor for the three cases pushed a leadership role that attempted to bring together the public client and consortium members to align their perspectives and reach a consensus.

Decisions based on the best-for-project approach constituted a second similarity. Each case highlighted that decisions were always made with the project's goals, requirements, and demands in mind. Both organizations (client and contractor) had embraced the best-for-project strategy. Similarly, ex-

Table 4.6: Comparison of the roles and decision-making dimension between cases

Case A	Case B	Case C
• Decisions on the contractor with influence from public client • Decisions based on best-for-project • Equality between parties within the consortium • Flexible governance structures within the consortium • Management team (core team) • Expert team to give advice and influence decisions • Leadership role	• Decisions based on best-for-project • Integral discussion sessions • Expert power for decision-making • Management team (core team) • Leadership role • Dynamic integrator / observant role	• Joint definition of roles and responsibilities • Escalation structure for decision-making • Expert meetings to give advice and influence decisions • Management team (core team) • Leadership role • Integrator / Mediator role

pert groups supported the decisions of each project. For Case A, it was determined that these experts had general technical expertise; however for cases B and C, circular-focused technical experts were consulted, resulting in more favorable decisions for circular practices.

However, there were further distinguishing mechanisms that were unique to some cases. Case A, for instance, had a 50/50 balance between the partners in the consortium, requiring both the constructor and the designer to monitor the project's decisions. In place of democratic decision-making, the contractor pushed a leadership role that attempted to bring together the public client and consortium members to align their perspectives and reach a consensus.

Case C had a similarly comprehensive process for defining roles and hierarchical structures. Respondents indicate that, from the outset of the project, all parties participated in meetings to define each participant's roles to avoid future misunderstandings or disagreements. According to the respondents, this session on joint role definition was crucial for streamlining subsequent project meetings and decisions.

[D] Comparison of the rewarding governance dimension between cases

Table 4.7: Comparison of the rewarding dimension between cases

Case A	Case B	Case C
• Ownership of materials • Long-term risks allocated to the contractor • Pain mechanisms • Reputation as a double-edged sword: reward and risk • No monetary rewards	• Pain mechanisms • Exposure as a reward • Celebration of small wins • Small gatherings with actors involved • Individual risk identification and collective risk management • Risks allocation with non-bonding collaboration • Ownership sense by the type of contract • No monetary rewards	• Pain mechanisms • Exposure as a reward • Contractual risk allocation • Flexibility in the reassignment of risks: Joint problem-solving • No monetary rewards

In the *rewarding* dimension of the three case studies, the client enforced pain mechanisms that pushed the fulfillment of the goals. If indeed the requirements and demands were not accomplished, the penalties consisted of a reduction in payments. Case B respondents, additionally, sought alternative methods to reward the project's partners favorably. Thus, Case B incorporated several distinct reward mechanisms that incentivized and directed the parties to work with honesty and transparency. For instance, the celebration of small wins was a mechanism that, despite being simple and casual, significantly affected how the actors performed since it motivated them to pursue more victories continuously. Similarly, the informal gatherings contributed to the development of a culture of honesty and openness with others.

The three cases agreed once more that the risks were assigned to the contractor due to the integrated contract type. Case A was, nevertheless, the project that retained this risk allocation method as contractually stipulated the most. Whereas cases B and C tended to increase the flexibility of risk management and allocation, respectively. In other words, Case B was more flexible in the sense that the client came in to help manage the risks when it was easier for him and vice versa. Therefore, a non-bonding collaboration that benefited both parties in risk management was formed. Then, for Case C, this risk flexibility was extended as the client agreed to be directly liable for various project risks, in addition to assisting in managing other risks. According to respondents from C, including circular practices in the building were the precursor to said change in risk management and allocation since the parties understood that circular interventions meant uncertainty. If the client wanted to include circular practices as a means to achieve goals, he had to collaborate with the contractor to address the risks that arose throughout the project phases. Therefore, for case C, it is seen as a collaborative approach to joint problem-solving that focuses on working side-by-side to define, analyze, and resolve their problems. This allows for both parties optimizing their capabilities to tackle risks.

Reputation or exposure was also identified as a mechanism applicable to all three projects. All contractors from the cases stated that their reputations and prospects in the construction sector depended on the successful completion of the project. In Case A, reputation was viewed as both an opportunity and a threat on multiple occasions. This type of public project with practices of entire disassembly and contractor ownership of materials was the first of its kind in the country; therefore, the construction sector, the academia, and the media were focused on the project's potential outcomes. Consequently, the contractors in Case A placed their reputations at stake for five years until they could demonstrate the success of the business case. Then, Case B mentioned that reputation was something the contractors looked for, so they were motivated to add circular goals to the project. Then, Case C contractors remarked that the reputation as a rewarding mechanism took them by surprise, as they had not anticipated such a positive response from the client and the general public, nor that it would generate so much interest in knowledge dissemination. Therefore, it can be asserted that reputation was a mechanism that triumphed positively across the three projects in order to ensure compliance with circular interventions.

Contrary, ownership model was present in one case. Case A proposed a model of ownership based on the possession of building materials. In other words, the contractor of project A was the legal owner of the building's materials, components, and elements (however, he did not own the building). Then, for cases B and C, the stimulation was more from an awareness-raising focus, as the DBFMO and D&B (with two years of maintenance) contract types caused the contractors to create a sense of ownership over the building. For instance, because the contractors in Case B were required to perform maintenance and operation functions, they continuously searched for ways to increase resource efficiency. Consequently, the ownership model in Case A, and the sense of ownership developed for the projects B and C enabled high quality and circular positiveness in all three projects.

[E] Comparison of the coordination governance dimension between cases

Table 4.8: Comparison of the coordination dimension between cases

Case A	Case B	Case C
• Cross-functional coordination team • Steering committees • Shared motivation • Formal progress reports • Project culture • Formal canals of communication • Informative presentations • Online database system for updated information • Information via BIM • Flexibility in changes • Formal conflict management system	• Cross-functional coordination team • Cooperation plan • Project follow-up sessions • Dynamic observation of meeting to search for improvements • Formal progress reports • Project culture • 'Legs on the table' discussions • Formal conflict management system • Process mediators for conflict resolution • Zooming-out the conflict technique	• Cross-functional coordination team • Ambition cooperation document • Definition of common processes • Formal progress reports • Project culture • Change management procedure • Collaboration sessions • Dialogue to solve disputes • Formal conflict management system

In all three cases, the cross-functional coordination team was one of the dominant mechanisms in the *coordination* dimension. This team, also known as the core team, was implicit in the organizational structures of both the public client and contractors, which allowed for a highly integrated project structure and a common decision-making framework. Moreover, the three cases were characterized by having an integrative role responsible for being 'the spider in the web', as mentioned by one of the respondents. This position was essential for maintaining the parties' unity and providing them with a clear view of the direction they had to pursue together. However, the integrator position varied from project to project; as in cases A and B, this role grew organically from one of the contractor's organization's actors and was entirely dedicated to the project. In Case C, the contractor proposed this role from the outset, where the said actor was not fully involved in the project but was part of the contractor's mother organization. Based on the interviewees' responses, it can be concluded that the integrating actors of each project fulfilled their tasks satisfactorily. Nonetheless, the actor of Case C specialized in collaboration between organizations through collaboration sessions, and his position as an outsider in the project allowed him always to maintain neutrality which facilitated the taking of actions to improve the relationship.

Additionally, a shared culture and work habits emerged for all three projects. Although the respondents of all three projects referred to this culture as the equivalent of a common motivation centered on exploring and exceeding circular aspects, Case B provided a more thorough explanation of how this project culture was established. As a result, the contractor for this project designed mechanisms such as feedback training and informal gatherings so that everyone could learn to share their thoughts and feelings with others. Therefore, the organizations became more familiar after multiple training sessions and could share their views freely. In light of the aforementioned, it is possible to assert that shared culture can arise and be created by processes that seek genuine and respectful relationships among the parties. Case B also stood out for having an observer who constantly observed and corrected the form of the parties' relationship. According to the respondents, this job was dynamic and internal to the contractor's organization.

The communication and information sharing mechanisms are other similarities. Progress reports and regular meetings were the formal communication that updated the public client on the project's status, progress, objectives accomplished, and challenges. Shared information technology tools facilitated the ongoing and real-time information interchange on circular designs and practices. According to the answers, the public client proposed these collaborative information platforms, but each contractor was free to provide as much information as desired. Case A, for instance, combined the

BIM information with the client-provided tool to enrich the information and ensure the traceability of the actions taken to achieve the goals.

In contrast, the cases differed in the relational mechanisms implemented to facilitate successful communication and information exchange. Case B, for instance, utilized mechanisms such as 'legs on the table' dialogues to conduct informal and relaxed conversations with the client regarding the project's difficulties and accomplishments. Cases A and C also provided educational presentations and knowledge-sharing sessions, respectively. This was done to spread the gained circular knowledge and thereby build confidence and support for the project.

Regarding mechanisms for dispute resolution, the public client developed formal conflict resolution procedures for all three projects. However, the three cases also arranged their own procedures for conflict resolution based on communication, open discussions, and the assistance of subject-matter specialists who provided coherent and impartial advice on potential solutions.

[F] Comparison of the monitoring governance dimension between cases

Table 4.9: Comparison of the monitoring dimension between cases

Case A	Case B	Case C
• Verification validation environment system • Testing and acceptance documents • Steering sessions	• Contract module system • Informal conversations and personal relationships • Third party monitoring	• Reporting procedures • Steering sessions • Information technology systems

In terms of monitoring, all three cases acknowledged that monitoring was the contractor's obligation due to the nature of the integrated contract. Therefore, the contractor was required to develop internal control systems that would allow him to continuously assess compliance with goals. However, in each of the three cases, the client implemented a formal monitoring system utilizing computer tools.

In Case B, a third-party monitor was used, which, according to the respondents, played a more supportive role in the design phase than actual control.

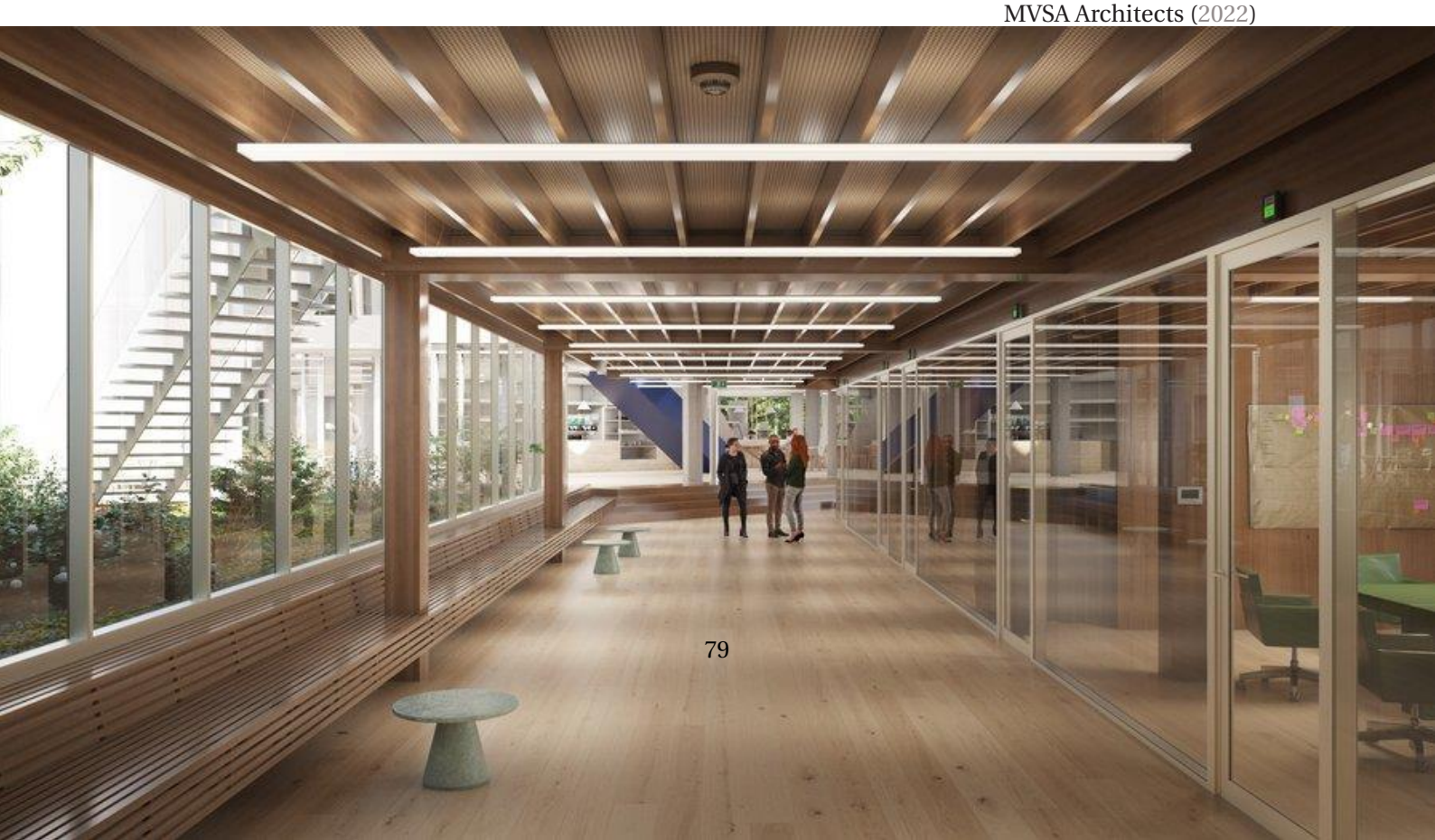
In cases A and C, monitoring was complemented by relational mechanisms based on periodic steering sessions and formal reports, and testing and acceptance documents. Case B, meanwhile, is reinforced by relational mechanisms based on informal conversations and personal relationships that helped understand the individual and collective skills and challenges to implicitly monitor actors.

5

Discussion

This research has uncovered similarities and complementarities between the theory identified in the literature review and the practice examined using the multiple case study strategy. There are parallels between how the literature states the necessity for particular governance mechanisms and how the practice organically uses these mechanisms to achieve overall project objectives. This research enables the exchange of viewpoints, the growth of processes, and the examination of how theory and practice can mutually enrich one another. What can theory contribute to practice? Furthermore, what can practice contribute to theory? In this chapter, therefore, the mechanisms described in Chapter 4 are used to supplement, support, and contrast, the literature review from Chapter 3. Section 5.1 provides a discussion on specific points with the aim to address the contribution to the current knowledge and practice: (i) the influence of governance mechanisms on the adoption of circular practices; (ii) Governance mechanisms for the CE schools of thought in building projects; (iii) The joint effect of governance mechanisms on inter-organizational collaboration; (iv) The perceptual differences between public clients and contractors for the implementation of governance mechanisms; (v) The role of project delivery model on the selection of governance mechanisms; and (vi) The influence of antecedents on the implementation of governance mechanisms. Next, Section 5.2 evidences the internal and external validity of the research. Later, Section 5.3 presents the study limitations generated by the used research method and the obtained data.

MVSA Architects (2022)



5.1. Discussion points

5.1.1. Influence of governance mechanisms on the adoption of circular practices

This study contributes to both the current literature and practice by examining the impact of governance mechanisms on adopting circular building practices. In circular projects, governance mechanisms at the inter-organizational level have been addressed, but their effect on the implementation of circular practices has not been formally examined. Therefore, the three circular case studies evaluated from a governance perspective revealed a variety of circular practices categorized along six characteristics. According to the respondents, these mechanisms may have facilitated or hindered the implementation of circular practices across the project's different phases.

Goal-setting and the relation with circular practices
According to the findings, mechanisms focusing on the co-creation process through early contractor involvement, building workshops, and dialogue sessions enhanced the adoption of circular practices in the goal-setting dimension. Similarly, the congruence of the business case and the flexibility in the definition of objectives promoted the early adoption of circular practices.

According to the literature Williams et al. (2019), the co-creation process involves multiple people collaborating in the early stages of project development to identify goals, gather information about available resources, and provide ideas. This research complements the literature (Akintoye & Main, 2007; Bryson et al., 2015; Cheng et al., 2000; Davis & Love, 2011; Faris et al., 2019; Hughes et al., 2012), as it found that inclusive participation during the goal-setting phase was conducted through *building workshops* (Case A, B), *debates* (Case B), and *dialogue sessions* (Case A, C), which enable developing a shared understanding of the problem, establishing circular solutions, and bringing up the various points of view and diverse knowledge present in each part. For instance, building workshops and dialogue sessions held in Case B, allowed the design of the building following circular principles and selecting reused and recycled materials. These mechanisms relied on communication and teamwork between the client and the contractor from the beginning of each project to establish their specific goals and the means by which they would be achieved. Thus, through these mechanisms, circular practices emerged, such as modularity (D3), flexibility and adaptability (D4), design for disassembly (D5), use of better-performance materials (D8), standardization (M4), optimization of material use (M6), prefabrication (C1), and reuse and recycle of materials (D6, C2, C3)

Capability building and the relation with circular practices
Then, this study identified governance mechanisms in the dimension of capability building, such as the selection of partners based on circular or sustainable values, which encouraged the participants to pursue circular solutions for the project's development. For instance, the partner selection mechanisms of cases A and C consisting of *competitive dialogue* with discounts for quality and sustainability, enabled the deployment of circular tactics starting from the tendering phase. Utilizing high-performance materials (D8) and reusing and recycling materials were two of the most frequent practices related to the partner selection procedure (D6, C2, C3).

The study also demonstrated that one of the parties might proceeded further into the R-strategies (Case A) by employing the "rethink" strategy, which consisted of rethinking the design of the entire building for it to be totally reused. This design was built on practices including design for adaptability and flexibility (D4), design for disassembly (D5), and the usage of information systems (D7). In this way, these practices served to meet the client's goals focused on high residual value and low cost for the building.

Roles and decision-making and the relation with circular practices
Similarly, this study explored the governance dimension of roles and decision-making and its influence on the implementation of circular practices. In this regard, the research contributes to the current body of knowledge by identifying various governance mechanisms that facilitate the selection and implementation of circular practices. Consequently, mechanisms like flexible governance structures, expert teams, and leadership roles stand out in this matter.

Case A exhibited *flexible governance structures*. According to the literature referenced by Davis and Love (2011), a commitment environment is characterized by shared authority between the parties. Case A consisted of managing power structures that were separated in time (the designer having decision-making power in the design phase and the contractor getting decision-making power in the construction phase). In contrast to a rigidly hierarchical organization, these flexible governance structures permitted management to be delegated to subject-matter experts. In this specific instance, the contractor created this agreement at the commencement of the project to maximize the utilization of knowledge and experience. Consequently, this flexibility permitted the design to include modularity (D3), adaptability (D4), and design for disassembly (D5) (D5), as those are practices commonly used by the designer (one of the main parties).

Then, in each of the three instances, there was evidence of *expert teams* responsible for offering recommendations or assisting with the outcome. Therefore, the expert teams would ensure that knowledge and experience guided decision-making. According to specialists in sustainability and circularity, this mechanism favored circular practices.

Leadership roles in construction projects can be aimed at different goals, such as strengthening team collaboration, bringing motivation, and aligning the behavior and thinking of the people involved. However, this study supports that a leader intrinsically motivated to obtain circular values, as was the case B, is a leader who will facilitate the implementation of circular practices. This finding supports the literature, where according to Kooter et al. (2021), team members' intrinsic motivation is critical for three reasons. First, circular buildings need out-of-the-box thinking so motivated parties can continually ask how to improve or change. This was the case with the contractor in case B because, although circular practices were not part of the circular aims, the contractor's intrinsic motivation caused him to constantly question how he could improve the project and transform a building into a greenhouse. Second, innovation needs to explore uncharted territory. Thus, the members of the contractor, particularly the leader and the designers, constantly sought innovative ideas that would enable them to recycle, reuse, and rethink the building's materials and components. Third, like-minded people on a project might encourage circular interventions.

Rewarding and the relation with circular practices

Then, the rewarding dimension provides knowledge of four specific governance mechanisms that encourage the adoption of circular practices. These were ownership of materials, the personal satisfaction, exposure, and joint problem-solving due to the flexibility in the risk allocation. However, contractual governance mechanisms such as the pain mechanism and monetary punishment limited the intention to propose circular practices. Thus, pain and financial penalty can be understood as inhibitors of CE.

Concerning the first of the mechanisms found in this dimension, *new ownership models*, Leising et al. (2018) mentions that the development of circular buildings necessitates specific factors. One is the creation of new businesses and ownership models. Among his ideas, he recommends models of ownership in which the materials are temporarily used while being stored in the building to be eventually later returned to the owner with the highest possible residual value for reuse. Other authors also refer to this idea as a "material bank" (Benachio et al., 2020; Wuni & Shen, 2022). Consequently, this research exemplifies this ownership stake in the asset by describing the take-back approach employed in case study A, which served to rethink the building's design and promote the early reduction of materials, reuse, and recycling (M6, C2, C3). Similarly, the ownership of materials model advocates using digital technologies to maintain the traceability of materials and the information necessary for component and element disassembly (D5, D7).

Then, the literature discusses various reward mechanisms, including monetary incentives and *non-monetary personal satisfaction* (Bresnen & Marshall, 2000b; Rahman & Kumaraswamy, 2005). Nonetheless, although the literature emphasizes that reward mechanisms are advised to drive the parties and establish commitment, they are not typically used in projects with conventional contractual terms that involves public clients, according to this research. Therefore, the results of the interviews indi-

cate that contractual awards, pushed by the client, were not established in the projects.

However, members of the public client group implemented those non-monetary benefits on a relational level. Relational mechanisms such as *collaboration workshops, jointly organized social/cultural activities, quick wins, personal relationships, and small gatherings* were related to "socialization," which aimed not only to incentives but also to get to know one another, discover personal interests, and discuss and agree on a variety of topics in order to steer the actions to follow. These relational mechanisms are strongly related with the literature on how leaders influence employees innovative behavior. For intance, De Jong and Den Hartog (2007) talk about the mechanism of giving praise such as compliments, certificates of achievement, ceremonies with public speeches, and celebrations to those individuals taking the initiative to improve performance. Similarly, Tawse et al. (2019) describe how the celebration of little victories or 'quick wins' promotes the rewards of achievement. Small victories on a daily basis can make all the difference in how the individuals feel and perform.

In addition to giving ownership to the contractor, and incentivizing the parties through social activities, the *reputation* is another rewarding mechanism encountered in this study that boost the application of circular tactics. According with the literature, the "Shadow of the Future" (Kujala et al., 2021) or "Possibility of Future Works" (Rahman & Kumaraswamy, 2005) is a sort of compensation sought by many contractors. In this case, the organization's reputation as a developer/constructor of circular buildings also had a significant influence since exposure gives employees a sense of belonging and alienates them for achieving success (Suprapto, 2016).

Then, the study reveals that a flexible reassignment of risks (Case C) allowed the client and contractor to collaborate on problem-solving. Therefore, this joint management of problems, primarily at the beginning of the project, motivated the contractor to actively look for existing building materials, components, and parts that might be reused in the new building (D6, C2, C3). Similarly, it drove the contractors and their expert team to look for higher-performance materials (D8), given that the client, when presented with a sufficient explanation, may contribute in the additional expenses that this circular choice would entail.

Nevertheless, it is evident that the existence of pain mechanisms in the three case studies impeded the implementation of certain circular practices since the contractors were constrained in terms of time and activities to achieve the primary goals.

Coordination and the relation with circular practices

The governance mechanisms shown in the coordination dimension were more focused on enhancing inter-organizational relationships. Nonetheless, the study demonstrates that the establishment of a *shared culture*, *informative presentations* and *knowledge-sharing sessions* were crucial mechanisms for instilling circular thinking in the various project actors. Thus, both the client and the contractor can form a voluntary behavior centered on constantly reusing, recycling, and maximizing the use of materials within the project (M3, M6, C2, C3).

While it is true that the literature emphasizes the importance of a shared culture and the creation of a collective identity for achieving the project's goals, it fails to describe the mechanisms, processes, arrangements, and practices that enabled the team's culture and identity. This research extends beyond the literature and supplements it, as it was possible to find processes for circular projects, such as "legs on the table debates," periodic informal conversations, personal relationships, regular dialogues, and social activities. Individuals were able to create stronger relationships through non-contractual interactions that fostered honesty, openness, vulnerability, and trust, while facilitating in-depth familiarity with circular practices.

Similarly, the informative presentations (Case A) and the knowledge sharing sessions (Case C) were triggers of circular values in the project. The presentations in the early phases of the project helped the various project participants understand the concept of a building's high residual value. This demonstrated to the actors that it is possible to design and construct a building using future-proof principles. Then, the knowledge sharing sessions granted previously tested and evaluated circular

practices to be disseminated to the general public. This enables the public client to participate more actively in the future in the proposal of ideas and circular interventions that have a beneficial influence on circular goals.

Monitoring and the relation with circular practices
Furthermore, the study is consistent with the current literature because it demonstrates that there are monitoring mechanisms that help the application of circular practices, whilst there are other mechanisms that hinder this implementation.

Several monitoring aspects are mentioned in the literature as being crucial for construction projects. Akintoye and Main (2007) indicate that monitoring performance requires actors positioned at the top of the hierarchical structure. On the contrary, Bresnen and Marshall (2000a) say that traditional control mechanisms limit changes, and according to this research, changes toward a circular economy are essential. Then Bryson et al. (2015), Kooter et al. (2021), and Patel et al. (2012) mention that more than constant and strict monitoring between the parties, there should be a relationship based on trust, values, and shared norms. It accordingly, enables control measures to be relaxed and actors to explore and be confident about new ideas.

In the findings of this research, combined experiences can be evidenced, namely, formal control mechanisms that restrict new circular practices and relational mechanisms that strive to relax these control measures and opt for the exploration of circular practices. For example, all cases had control mechanisms stipulated in the contract, such as *verification and validation environments, a contract module system, formal reporting, testing, and acceptance documents.* At the same time, the mechanisms such as *informal conversations, personal relationships, and steering sessions* established trust and mutual understanding while fostering new circular ideas.

5.1.2. Governance mechanisms for the circular economy schools of thought in building projects

This study also contributes to uncovering the circular economy schools of thought prevalent in the analyzed building projects and how these schools conceive governance between the parties. According to the literature, the notion of circular economy is widely accepted in industry and academia and is influenced by numerous schools of thought. There are seven different philosophies: performance economy, cradle-to-cradle, biomimicry, industrial ecology, natural capitalism, blue economy, and regenerative design. However, the topics covered by each school of thought are not mutually exclusive; rather, they are related, complement one another, and sometimes overlap. In this way, it will be feasible to conclude that circular practices might be associated with one or more schools of thought.

Case A evidenced circular practices associated with the cradle-to-cradle and industrial ecology schools of thought. *Cradle-to-cradle*, in this case, is evident since it implies the design of the products that make up the building and the building itself, designed to think about the future. The design of the building and its components was considered from the beginning for its complete recovery and reuse on a large scale, eliminating the concept of waste. Thus, practices such as modularity, design for assembly & disassembly, and design for adaptability & flexibility underpin this school of thought.

Likewise, the study infers a relationship with *industrial ecology* that strives to close loops, shifting to closed-loop processes in which waste serves as an input, thus eliminating the notion of an undesirable byproduct. It is possible in Case A through practices such as ownership of materials that commit the contractor to eliminate unwanted products from the used market after the useful life of the building has ended. Thus, the contractor chooses to close the cycle through the design and construction of a fully reused building.

Thus, there must have been underlying governance mechanisms that promoted the inclusion of such practices from different schools of thought. This study infers that the following mechanisms were contributors: 1) The definition of goals, given that the client exhibited the primary goal of waste reduction and the highest possible residual value at the end of the building cycle. 2) Then, the mech-

anism for selecting partners based on calculations of the quantity and types of materials used that could be biologically and technically recycled after their temporary function in the building. 3) The sessions with experts also promoted the optimization of the use of materials, where the elements, products, and materials were selected and produced in a way that they could be reused without down-cycling. 4) The flexible governance structures that made it possible for the building design phase to be governed by parties that know best about design. Thus, promoting goals such as being future-proof through flexibility, durability, and adaptability. 5) The ownership structure assigned the contractor as the materials' owner, promoting cautious thinking about the use and reuse of building materials, elements, and components.

Case B provides evidence of circular practices associated with regenerative design, cradle-to-cradle, industrial ecology, and performance economy schools of thought. The *regenerative design* was evidenced by the creation of the building that would achieve a positive impact on the environment and prevent adverse effects. Practices such as water collection and re-circulation, use & production of renewable energy, and specification of better-performing materials promoted building performance positively, restoring, renewing, and revitalizing resources.

Then, *cradle-to-cradle* was evidenced by designing the building with the future in mind and its possible complete reuse. Here, modularity, design for adaptability & flexibility, and design for disassembly were part of this school of thought. Similarly, the selection of certain products and materials (timber frames, panels, ventilation ducts, interior furniture) was chosen with consideration for the safety of human health, the environment, and their biological and technical recovery at the end of their useful lives.

Similarly, the review reveals the connection with *industrial ecology*, which examines the flow of materials within a system. The building's design was distinguished by a focus on identifying the flow of used resources in an effort to avoid existing and future waste. In order to eliminate the existing waste, the design sought means of incorporating secondary raw material in the manufacturing process. Similarly, the design aimed to avoid future waste by offering a fully reusable structure that could be relocated to any location using assembly and disassembly techniques.

Moreover, the prevalence of *performance economic* principles is acknowledged. During the building's operation, the presence of common areas with dynamic functionalities that are treated as the provision of services rather than products suggests this. The building was conceived and constructed with public-rentable flexible areas in mind, maximizing its utility throughout its useful life.

Thus, there must have been underlying governance mechanisms that promoted the inclusion of such practices from different schools of thought. This study suggests that the following mechanisms were contributors: 1) Goal flexibility played a crucial role. However, just as in this case, it turned out to be a driver for establishing circular ideas; it could have been a factor that worked against it. The flexibility in meeting the goals allowed the contractor to propose ways to develop a durable and sustainable building. 2) The leadership role focused on steering the team towards circular solutions. 3) The circularity expert team responsible for proposing practices focused on using renewable resources and reusing & recycling secondary components. 4) Stimulation and a sense of ownership were provided by the integrated type of contract, thus promoting the implementation of renewable energy use and water management practices.

Similar to case A, **Case C** shows circular practices related to the cradle-to-cradle and industrial ecological schools of thought. *Cradle-to-cradle* is evident in this case, as it involves both the design of the structure's components and the building itself to consider the future. The building and its components were conceived from the outset with total recovery and large-scale reuse in mind, eliminating the concept of waste. This school of thought is supported by principles such as modularity, design for assembly & disassembly, and design for adaptability & flexibility.

Likewise, the study infers the association with *industrial ecology*, which attempts to close loops by transitioning to closed-loop processes in which waste serves as an input. In this project, this is achiev-

able due to the design for the extension of the building structure, which allows for its disassembly and subsequent reassembly. Similarly, using fewer natural resources and finding new uses for waste materials or byproducts was achieved by reusing elements from the preceding building.

As a result, there must have been underlying governance processes that encouraged the inclusion of such practices from various schools of thought. This study suggests that the following mechanisms were contributors: 1) The joint definition of goals focused on obtaining circular values, allowing both parties to participate through a collaborative process in examining what practices could be addressed in the project. 2) Flexibility in how to meet goals, as evidenced in the previous case 3) Flexibility in risk reassignment and the joint problem-solving approach. According to the study, this mechanism was crucial to promoting the implementation of circular practices that represented a certain degree of risk. 4) The creation of a change management procedure with defined steps and times made it easier for change proposals to be well received and processed. Some of them favored improving the circular approach at different project stages. With this mechanism, the project emphasized proposals for change that included using second-hand equipment in the new building, therefore finding ways to use fewer natural resources and finding new uses for waste byproducts.

Consequently, this research manages to relate the governance mechanisms that were used in circular building projects that incorporated principles from schools of thought, such as cradle-to-cradle, regenerative design, industrial ecology, and performance economy.

5.1.3. Joint effect of governance mechanisms on inter-organizational collaboration

This study discusses and reveals how various governance mechanisms might interact differently in inter-organizational collaboration. Section 3.3 on literature increased understanding of the multiple forms and types of inter-organizational relationships that lead to collaboration on construction projects. The study was able to employ the existing Kujala et al. (2021)'s framework, which considered six dimensions, and for each dimension, it identified a variety of inter-organizational collaboration characteristics present in the literature. Specifically, 25 articles were systematically selected to provide knowledge in each of the dimensions. This literature, in conjunction with the empirical findings of the case studies, contributed to the advancement of current knowledge regarding the joint effect of governance mechanisms on inter-organizational collaboration.

For instance, it can be deduced that the dialogue sessions (goal-setting governance), in conjunction with the selection based on partnership, and the feedback training (capability-building governance), the observant role (roles and decision-making governance), the small gatherings and quick wins (rewarding governance), the collaboration sessions (coordination governance), and informal conversations and personal relationships (monitoring governance) strive to enhance collaboration between parties over project goals.

Whereas, it can also be inferred that the interaction of goal clarity (goal-setting governance), competitive dialogue (capability-building governance), management teams (roles and decision-making governance), pain due to poor performance (rewarding governance), formal progress reports (coordination governance), and verification validation environment systems (monitoring governance) attempt to maintain control over the accomplishment of project goals, regardless of the presence or lack of inter-organizational collaboration.

Moreover, this analysis concerns the interaction between formal and informal governance mechanisms in circular building projects. In each governance dimension, formal and informal governance mechanisms have been identified as a result of the interplay between collaboration and control. There are studies in the literature that describe their interaction and complementarity within projects. This study complements the literature by demonstrating that, for each governance dimension, contractual and relational mechanisms coexisted in the same setting and complemented each other to maintain a balance in terms of control and trust, respectively, within the project.

Therefore, it can be deduced that collaboration between organizations throughout the transition to a circular economy in building projects requires the interplay of several mechanisms in order to function. As it was discovered in the multiple cases that these mechanisms complement and imply one another. However, this study does not delve in what is the individual effect of one mechanism on the inter-organizational collaboration.

5.1.4. Perceptual differences between public clients and contractors for the implementation of governance mechanisms

Two contributions can be perceived in relation to the influence of the actors on the implementation of governance mechanisms. First is the public client's role as legal agents providing governance mechanisms in contracts. Second is the prime contractor role who is the primary entity accountable for the day-to-day execution of the projects and who pursue relational governance mechanisms (Blayse & Manley, 2004). According to the research, it is inferred that clients were likely to develop contractual governance mechanisms emphasizing control and diligent adherence to the objectives. On the other hand, the contractors were inclined to establish relational governance mechanisms aimed at enhancing the collaboration with the parties and instilling the motivation of the team so that they operate with a sense of goodwill day to day.

This study provides practical examples to substantiate the assertions made. For instance, the client was correct in proposing contractual mechanisms such as an ambition cooperation plan, pain mechanisms, formal progress reports, formal conflict management systems, and formal controls for the three projects. On the other hand, the contractors' responses support the notion that relational mechanisms such as shared culture, leadership roles, and open communication & updated information were mainly fostered by the contractors.

The contractors emphasized that shared culture and the formation of team identity are essential relational mechanisms for positive attitudes and the constant demonstration of trust and safety. They also stated that, although it is necessary to recognize the differences in individual and organizational cultures, more attention should be paid to building mutual understanding or team culture behavior that allows actors to act driven by motivation and a sense of belonging. Therefore, the contractor's responses support the literature that addresses the need for team identity in project success (Bresnen & Marshall, 2000b; Faris et al., 2019; Kooter et al., 2021; Suprapto et al., 2015; Williams et al., 2019; Xue et al., 2010), which can also be expressed as a collaborative culture (Suprapto, 2016), cooperative culture (Saukko et al., 2020), team culture (Bresnen & Marshall, 2000b), or best-for-project culture (Hietajärvi et al., 2017).

Then, the three cases exemplify the different types of leadership roles fostered by the contractors. Case A respondents indicate a sort of centralized leadership that aimed to bridge the government client and the contractor. This responsibility was performed by a member of the contractor's team who was tasked by the work team. Then, Case B respondents, on the other hand, noted the formation of spontaneous leadership (also mentioned before as the integrator role) that emerged in the early phases of the project. As stated by the literature, a leader must desire to be a leader, which was the case in B. The individual from the group of contractors inspired other project members to take the initiative and adopt circular mindsets that generated added value for the project. Then, for case C, the contractor assigned a mediator to guarantee collaboration. This role was external to the project and was crucial for preserving the players' conduct throughout the project. Therefore, the research explores the various leadership styles and explains how these roles arose in the projects from the contractor side.

Moreover, regarding open communication and updated information, the research partially contradicts the literature that states that communication mechanisms should be concentrated and centralized through top management positions. The projects can demonstrate the opposite by identifying the communication- and decentralization-promoting forms, and technologies proposed and implemented by the contractor. These tools for information exchange, such as "Information sharing via BIM" and "Docstream" for case A, "Digital contract module" for case B, and "information technology

systems" for case C, served to reduce asymmetry, inclusively maintain control of information, and provide up-to-date, reliable information.

5.1.5. Role of PDM on the selection of governance mechanisms

This study also discussed the role of the type of project delivery model on the selection of governance mechanisms. The literature states that project delivery models that contain more collaborative contracts, longer term relationships, value chain engagement and clearer vision for CE, can incentives contractors to participate in the transition to circular built environment (Hart et al., 2019). Similarly, This study evidence that each type of project delivery model might contain a series of predefined governance mechanisms. Therefore, this section aims to discuss the mechanisms that may have been predefined in the three types of integrated project delivery models used in these cases: DBFMR, DBFMO, and D&B.

Projects with integrated PDM are characterized by allowing the contractor's participation from the project's early phases in the *goal-setting*. This study demonstrates that the contractor contributed early in all three cases using mechanisms such as dialogue sessions and the alignment of individual and collective goals. To assure the engagement of contractors at this early period, however, particular partner selection mechanisms that promote their early involvement are required. Therefore, it is noticeable that integrated PDM prefers to employ competitive dialogue or best value procurement in one of the analyzed projects. These procurement strategies permit the client to express his requirements in a functional manner and the contractor to build the project on a more technical and thorough level, beginning with the functional objectives.

Then, the interviewees' responses suggest that the integrated PDM tends to create governance mechanisms for *roles and decision-making* that transfer responsibility to the contractor, notwithstanding the client's influence (or steering). The fact that a project follows a design, construction, maintenance, operation, or removal model indicates that the contractor will be in command of these phases. Therefore, relieving the client of decision-making obligations and repercussions. This outcome is consistent with the considerable literature that discusses the contractor's reliability in this type of integrated PDM.

Regarding *rewarding* mechanisms, it is implied that the integrated PDMs continue the risk allocation scheme through formal contractual arrangements. It means that the contractor is contractually obligated to assume the risks associated with each project phase for which he has accepted responsibility. Despite the resemblance between this study and the literature in terms of risk allocation, there are relational mechanisms that aim to lessen this contractual mechanism that imposes significant constraints on the contractor. For instance, it is possible to see how Case B describes this risk assigned to the contractor as being fixed. Still, there are collaborative actions from the public client's side that aim to assist in addressing risks with non-bonding consequences (the client helps attend to the risks and problems that are within its reach but is not responsible for the adverse effects that this may generate). Similarly, Case C demonstrates how the client makes this risk allocation more flexible and engages in risk-taking and supportive problem-solving.

Then another reward mechanism frequently stated in the literature is the development of a collective value capture model. Brown et al. (2021) and Hughes et al. (2012) explains that one of the challenges of circular-oriented innovations is the development of a collaborative value capture model that incorporates collective benefits to stimulate the transition of all involved parties to a circular economy. This study found, consistent with the literature, that it is difficult to create value capture models when the client-specified PDM predefines the allocation of risks for the contractor. For example, Case A was the only project with an aligned business case. It was discovered that a significant portion of the effort required to develop a business model that ensured a win-win was put into the client's project delivery model selection. In other words, the goal of constructing a temporary building with the largest residual value at the end of its useful life, in conjunction with the DBMFR model, was a catalyst for the alignment of the business model and, consequently, the capture of shared value.

Cases B and C, on the other hand, despite having traditional integrated project delivery models with similar building phases DB (F)(M), are consistent with the literature stating that a concept of shared responsibility for both positive and negative externalities is required to obtain collective values. In Case C, it was demonstrated that the reallocation of risks was more flexible, to the point where the client assumed responsibility for these risks in certain circumstances. In this case, what happened was consistent with what Davis and Love (2011) stated: 'the risk transfer increases as the partners' trust and desire to work increase'. Moreover, the authors explain that modifications to the risk profile may be formal or informal. Formal adjustments are contractually arranged, whereas informal adjustments are more ad hoc and occur in response to evolving circumstances.

Similarly, the study found that integrated PDM plays a crucial role in the selection of management practices within the *coordination* dimension. The patterns found in the three case studies suggest that integrated PDMs contain cross-functional coordination teams. Integrated PDMs feature core teams that fairly represent both parties, the public client and the main contractors. These cross-functional teams coordinate the project from the three spheres of management, Project management, technical management, and contract management.

5.1.6. Influence of antecedents on the implementation of governance mechanisms

The empirical findings of this study substantiate the literature by exhibiting cases where preconditions or antecedents may have influenced the implementation of governance mechanisms. Preconditions or antecedents refer to the preexisting background that influences the selection or emergence of types of governance in inter-organizational relationships (Bryson et al., 2015). As it is also called in the literature, this initial context can be positive or negative, and it encompasses a large number of influencing factors in the form of governance in projects. The literature mentions a wide variety of preconditions (Bryson et al., 2015; Kooter et al., 2021; Roehrich et al., 2020). However, this research encountered preconditions of institutional and organizational environment, task characteristics, sector and organizational cultures, preexisting relationships, and tensions and power structures, which are discussed below.

The results of the case studies indicate that the *institutional and organizational environment* influenced the selection of particular governance mechanisms. The institutional environment or context is of great importance for projects of a public nature that involve public clients since it includes extensive legal systems that orient the relationships between the parties involved in the collaboration.

Thus, it can be presumed from this study that this precondition may impact how contracts are forged (Bryson et al., 2015; Roehrich et al., 2020), for instance, in the sense of: (i) conditioning what types of rewards were acceptable; (ii) what formal conflict resolution systems should be applicable; and (iii) what types of collaborative mechanisms could be applied between inter-organizational parties. Thus, it is deduced that monetary reward mechanisms were not part of any of the three study cases because they were not common within the nature of the public client. Meanwhile, mechanisms focused on the punishment due to poor performance were common within the formality of the contract standardized by the institution. Likewise, it is inferred that the formal conflict management systems were forged from the standards of the agreement and were not subject to modification because they were part of the legal framework of the contract. Likewise, the dialogue sessions during the selection of partners, or steering sessions, were mechanisms implemented due to the institutional context that seeks a particular approach and indirect control of the contractors.

Similarly, based on the results of the interviews, it can be implied how the *nature of the task or issue* was likely to have a significant impact on the composition, structure, and procedures of collaboration between organizations. The three cases were projects with complex, interrelated tasks that depended on time and specialized or demanding resources. For instance, case A required a competitive dialogue based on a party selection process that paid close attention to high residual value and low-cost. Therefore, the nature of the assigned task prompted the implementation of mechanisms focused on calculating the environmental performance of the building (MPG) to determine the outcome of the competition. Then, case B shows another particular example where the interviewees

agree that the nature of the task involves exposure to risks in all phases of the building (design, build, finance, maintain, and operate). Therefore, relational mechanisms such as shared culture and vulnerability within this culture emerge that seek to change the mentality of people to understand that these are not separate problems but joint problems that require mutual cooperation. Thus, this mutual cooperation facilitates risk management. Likewise, the uncertainty represented by the reuse and recycling of materials and components in the existing building of Case C, represents the uncertain nature of the task. Therefore, relational mechanisms for risk management and joint problem solving emerge, supplementing the strict contractually stipulated risk delegation. Consequently, as the literature enunciates, the characteristics of the task are often a crucial precondition were analyzed in this research to comprehend the configuration of the inter-organizational relationship defined for a particular project (Bryson et al., 2015).

Then, *sector and organizational cultures* correspond to other initial contexts that persuade the type of collaboration and governance mechanism adopted in the project. The literature identifies two dominant factors within this context that impact inter-organizational relationships Kooter et al. (2021). The first aspect considers the cultures in the traditional construction sector, while the second aspect emphasizes the differences in the circular mindset between organizations. Thus, this study contradicts the first point and supports the second point of the literature, respectively.

Firstly, the literature mentions that the construction sector is one of the most traditional sectors that focuses on reducing risks, reducing costs, and obtaining benefits in the short term. Although it was also evident in this research, the contradictory part relies on the statement that the literature makes regarding contractors. The literature expresses that contractors continue to be perceived as profit-driven players with the least effort or interest in long-term products. However, the results evidenced that contractors were, in the three cases, the promoters of circular practices, and their proposals outperformed the client's expectations regarding circular values. This unexpected culture of commitment to circular values and compliance with goals resulted in being the opposite to what was stated in the literature.

Secondly, the study agrees with the literature, which expresses that the differences in circular mindset are based on the values, norms, knowledge, and practices of each organization, which influences how circular ambitions are going to be translated into project goals, together with how collaboration mechanisms are going to be defined to fulfill these goals. Therefore, learning and continuous improvement mechanisms might be implemented to deal with these differences.

Then, this study agrees with Bryson et al. (2015) and Roehrich et al. (2020) that express that *preexisting relationships* or *prior ties* are antecedents that, if positive, tend to influence more collaborative relations and less control. This research poses a practical example in Case A where preexisting relationships happened within the consortium. According to the literature and the study, more collaborative relationships and less control may be because the parties tend to judge the integrity and legitimacy of the other parties based on past experiences and reputations. Just as relationships in the past tend to leave residual trust, which allows the adoption of relational governance mechanisms based on commitment and trust, it is emphasized that repeated exchanges in inter-organizational relationships provide cooperative behavior and a reduction in opportunistic behavior in front of new joint endeavors.

Moreover, this study identifies the presence of antecedents such as *power and tensions*, which are also expressed in the literature (Bryson et al., 2015; Kooter et al., 2021). Kooter et al. (2021) state an important power issue concerning the dominance of clients, given that they have a decision-making role regarding the applicable governance mechanisms and the forms of collaboration expected with the other parties during the project. Same as Bryson et al. (2015) mention, the study recognizes the public clients as actors with special authority by virtue of representing the public. Despite the fact that the contractor constantly proposed relational mechanisms for inter-organizational collaboration, the client gave the last word due to his authority. So even though there is talk of a certain freedom, this freedom always had borders delimited by the client's objectives, established times, disposition, and legal conditions. Thus, the mechanisms evidenced in this study, such as decisions on the

contractor with influence from the public client (case A), formal progress reports, or steering sessions, are some of the mechanisms influenced by this antecedent.

Furthermore, it was evidence in practice of the need to remedy this power imbalance between public clients and contractors through common management practices. As seen in the literature, common management practices align the actors' behavior and promote collaborative work among the parties. The interviews revealed that cross-functional coordination between the public client and the contractor infer the attempt to keep symmetrical and balanced power structures. For instance, Case Study C suggests that the contractor recommended joint procedures through meetings and sessions from the outset of this project. It was, therefore, able to design common structures, mirror roles in organizations, dispute resolution procedures, and change management processes. Consequently, this study offers a practical example of governance mechanisms that emerged from the power imbalance and other mechanisms that were created to alleviate this power imbalance.

5.2. Internal and external validity

Internal and external research validity is examined. The internal validity of the research is determined by the methods used and the rigor with which the investigation is conducted to get sound conclusions. On the other hand, external validity depends on how generalizable the research's findings are.

Concerning the internal validity, the literature review utilized a structured approach to search SCOPUS's online academic databases. Two inquiries were undertaken using numerous distinct keywords in various combinations. Thus, to ensure the quality and validity of the information pertinent to the research, only peer-reviewed papers were included in the initial search results filter. In addition, the references of relevant publications were also searched for literature. Thus, the literature review comprised the most relevant scientific studies on inter-organizational collaboration in construction projects.

The use of triangulation substantially enhances this research's internal validity. Multiple methods, such as document analysis and interviews, combined with numerous inputs (various documents and interviews), contributed to the results. Therefore, it led to a supported conclusion within the scope of the research. Some documents could not be retrieved due to their confidentiality. Hence, the validity of the documentation is acceptable. Nonetheless, the documentation study is extensive, as the employment of analytic tools for qualitative data ensured a deep and exhaustive examination. All documents were evaluated using the same method, making comparisons easier because the same codes were used. As a moderately large number of interviews with more than five types of roles were conducted, the validity of the interview results is acceptable. The organizations they belong to are a well-known public entity, and renowned engineering and architectural firms specializing in building projects. Therefore, the various perspectives were captured and analyzed. For the cross-case analysis, also a structured way of analysis was applied with the help of coding and analytical tools. Each case included a list of documents and between 4 and 5 interviews, which increased validity as various perspectives and sources of information were compared.

The external validity is limited since this exploratory research focuses on building projects, which corresponds to a small portion of the construction sector as a whole. In addition, the number of cases and interviewees was based on three projects and 13 interviews, respectively. Therefore, the outcome of a single project or respondent highly influences the result. Although this is consistent with the qualitative nature of the study, it restricts the broader applicability of the research. Therefore, the findings on governance mechanisms should be carefully considered before being implemented on other projects with different contexts. Moreover, one public organization was considered for the three cases. So, to boost the external validity, studies on different organizations are recommended.

In conclusion, the research has a high degree of internal validity. Nonetheless, the external validity of the research is limited, and the results may not be applied to the entire construction sector because the research was conducted using only three cases from the building sector.

5.3. Study limitations

5.3.1. Limitation due to the research methods

- Multiple case study was chosen as the research strategy for the investigation, which involved the analysis of three case studies. Consequently, the outcome of a simple project constitutes the third portion of the results, which significantly impacts the research analysis.

- Similarly, although the selection of respondents based on the approach of purposive sampling that ensures the crucial individuals are interviewed, this study included a total of 13 interviewees for the three case studies. Therefore, there is always room for debating the size of the interviews that constitute an important marker of the quality of qualitative research.

- The research follows a self-reported nature of the data. Self-reported data corresponds in this study to the information obtained through interviews that reflects the interviewees' behavior, beliefs, thoughts, and attitudes. This self-reported data presents some limitations as respondents may exaggerate their situation to stand out over other situations. Similarly, respondents may under-report the severity of some issues to minimize the attention on those issues. Moreover, respondents may misremember details of the situation that can be crucial for the study.

- This research studies contemporary phenomena (the cases) within a real-world context. Therefore, each case contemplates particular contexts that can positively or negatively influence how inter-organizational collaboration is governed in projects. Moreover, it is known that qualitative research is context-sensitive, so the results and conclusions obtained from the research depend on the context. Thus, the context factors can be diverse and include aspects related to the environment and nature of the project, characteristics of the tasks, and organizational cultures, among others.

- The results are conclusive and logically focused on real case studies, therefore it is possible to make analytical generalizations. However, due to the qualitative character of the study, it may not be possible to make statistical generalization.

- The study included a single public client, in particular, that may have pre-established governance processes; this reveals tendencies in the various case studies that may not be reflected in other public client projects. Therefore, organizational bias must be recognized as a constraint.

- The research also covered projects that have been finished or are currently under construction. Thus, in the case of completed projects, the clarity and specifics of the mechanisms, arrangements, and processes utilized at the front-end phase may be vague and forgotten. Especially concerning the relational processes not documented in the official project documents hinder the ability to access comprehensive and detailed information.

5.3.2. Limitation of the obtained data

- In addition to the documentation used in this investigation for each of the cases, the investigation sought to gather additional information on the projects, such as contracts,project management plans, risk registers, and conflict management procedures. Nonetheless, the parties concerned were unable to disclose this information, limiting the investigation's coverage in these aspects. Even though the interviewees attempted to compensate up for this absence of information, it is impossible to guarantee that the investigation incorporates all of the information and analysis that these documents may have offered.

- Regarding the limitation of the data obtained in the interviews, this is influenced by the willingness of the experts to provide high-quality information concerning the research topic. For this

particular investigation, no corporation or organization was involved in this study that ensured interviewees with a positive disposition. That means that for this study, the interviewees were approached individually and directly invited to engage in a semi-structured interview, and only those willing to comply accepted the interview. This suggests that the experts cooperated voluntarily and were willing to contribute valuable knowledge to the study. Nonetheless, due to the unpredictability of strategic behavior, it is not easy to ensure the accuracy of the information provided by the interviewees.

- Even though the interviews were planned using semi-structured questions, they were guided by a predefined governance framework. Thus, the interviews were intended to address each of the six governance dimensions expressed in this framework. Nonetheless, it is probable that during the interviews it was omitted to mention certain critical aspects pertinent to the research that were not included in the pre-established governance dimensions.

- Before the interviews, each potential interviewee was given a consent form that outlined the confidentiality and anonymization of the interviewees in the investigation's findings. Hence, they could confidently convey all the positive and negative aspects of the project. Nonetheless, some questions may elicit sensitivity or recall unfavorable circumstances that respondents did not wish to discuss, affecting the data quality and the possibility of discovering important findings for the research. Therefore, social desirability bias may exist in this study.

6

Conclusions

This Chapter answers the research questions formulated in Chapter 1, *How do public clients and contractors are governed by contractual and relational mechanisms towards the delivery of circular building projects during the front-end phase?*, and synthesizes the most important findings of this thesis in Section 6.1. Likewise, Section 6.2 presents some recommendations and comments about future works to expand the research topic.

Cepezed (2020b)

6.1. Answer to the sub-questions and main research question

SQ1: What are the characteristics of building projects with circular values?
According to the available literature, the characteristics of a building project with circular values can be aggregated into five key themes and a wide range of circular practices. Thus, this study defines *circular themes* as goals, and *circular practices* as interventions in the different stages of the project to achieve those goals.

First, these circular themes were identified for this research based on the literature of C2C Expo LAB (2016) and Ellen MacArthur Foundation (2015a), which expresses crucial subjects in the building: people or users of the building, construction materials, energy, water, and future-proof goals. The matter of *people* relates to the notion that the building must offer its occupants health, comfort, biodiversity, aesthetics, and productivity. *Materials* refer to the selection of materials that satisfy particular criteria, including health, origin, recovery, disassembly, separability, and carbon footprint. Then, in terms of *energy*, the building must prioritize energy efficiency and renewable resources. This includes promoting energy production and building design that incorporates energy-saving solutions. Similarly, the *water* theme focuses on the efficient use, collection, and management of water within buildings. Lastly, *future-proof* is connected to two essential factors: climate change and asset management. The circular economy in construction aims to encourage the design and construction of climate-resilient buildings. In addition, asset management strives to ensure that buildings can satisfy users' needs over time, which involves adaptability, versatility, and versatility.

Second, the literature research analyzed how these major themes could be achieved throughout the building's useful life, applying circular practices. This study has compiled from the work of three authors the most remarkable circular building design, construction, operation, and decommissioning practices. Design for adaptation and flexibility, design for disassembly, the specification of higher-performance materials, material passport, new ownership models, prefabrication, adaptable and flexible use, and deconstruction are among the many other interventions mentioned in this research.

SQ2: What existing framework best represents the governance dimensions for inter- organizational collaboration in construction projects?
Based on the review of the relevant literature, it was possible to identify the Kujala et al. (2021)'s framework, which was designed to examine approaches for coordinating, adapting, and safeguarding exchanges between focal parties in inter-organizational construction projects. This framework proposes six important governance dimensions: goal-setting, capacity building, roles & decision-making, rewarding, coordination, and monitoring. Thus, these six dimensions offered an organized and comprehensive analysis of the types of governance that must be considered when inter- organizational projects act with complexity or outside the traditional scope, as is the case with circular building projects.

SQ3: What inter-organizational collaboration aspects can lead to better performance in construction projects?
In order to answer this question, systemic literature research was conducted in which 25 articles on the nature of inter-organizational collaboration in construction projects were selected. This literature facilitated the definition of inter-organizational collaboration as the interaction between organizations that results in the pooling of resources, enabling the favorable creation and dissemination of new knowledge for all parties involved. In order to establish this relationship that leads to improved performance in the construction industry, the literature identified a large number of aspects organized with the assistance of Atlas.ti to facilitate their categorization within the Kujala et al. (2021)'s framework.

For *goal-setting*, for instance, some aspects were identified, such as alignment and clarity of vision and goals, the requirement for coherence and a sense of "we-ness" between the parties, the creation of collective interest, and the connection between goals and motivation.

For *capability building*, the literature emphasized the early involvement of contractors, the selection of partners pursuing complementary resources, the selection of intrinsically motivated partners willing to cooperate, training and continuous improvement through learning spaces, team building, and the propagation of lessons learned.

Then, some aspects were encountered for the *roles & decision-making* dimension, such as a clear understanding and division of responsibilities, the use of shared practices for teamwork, joint governance structures, the facilitation of problem-solving environments, and governance delegated to the experts.

Then, the requirement for shared and equitably distributed incentives, models of sharing pain-gain risks, risk-shifting, and new ownership structures, including contractors in the supply chain, were identified for the *rewarding* dimension.

For the *coordination* dimension, the literature was extensive. It included project management practices such as the creation of a common language, synergy and complementarity in forces, recognition of interdependence, creation of a shared identity within the team, effective information sharing, and the development of conflict resolution systems, among others.

The literature concluded with a brief review of traditional *monitoring* systems centered on strict control and limitation of changes, as well as informal and flexible monitoring based on building trust and social mechanisms that inculcate common ground.

SQ4: Which governance mechanisms are used between public clients and contractors in circular building projects?
In order to answer this question, in-depth interviews and available documents from three case studies were processed using the qualitative data processing software Atlas.ti. In each governance dimension, the relationship between the public client and the contractor was established through a wide range of methods, arrangements, and processes.

For *goal-setting*, the public client can unilaterally establish the project's goals or request timely involvement from the contractors for the collaborative formulation of goals. In addition, the cases were distinguished by clear and straightforward goals. It was also shown that early contractor involvement enabled early objective recognition. In order to ensure this early involvement, the case studies utilized building workshops and discourse sessions as tools.

For *capability building*, methods were identified for selecting the contractor based on the most economically advantageous tender, with some discounts associated with sustainability and quality (as competitive dialogue) and partnership selection (as best value procurement). In addition, it was discovered that knowledge-sharing sessions for training and continuous improvement were adopted in some instances.

Then, for the dimension of *roles & decision-making*, there was evidence of predominantly assigned tasks to the contractor, with some indirect influence from the public client. In addition, decision-making based on the best-for-project approach gained notoriety, with the management team (core team) frequently serving as the responsible authority. Similarly, there was evidence of flexible governance structures in some contexts, which allowed the optimal use of knowledge. For informed decision-making, processes based on the influence of experts were crucial within this dimension.

In the *rewarding* dimension, mechanisms such as pain mechanisms, ownership models, the celebration of small victories, exposure as a reward, and contractual risk allocation were identified, with variants in the reallocation of risks and non-bonding collaboration by the public client in some cases only.

For the *coordination* dimension, a vast array of procedures, processes, and arrangements supporting coordination between the participants to attain circular goals were identified. The components that

stood out the most were the cross-functional coordination team, established collaboration plans, official communication channels supported by digital tools, progress reports, and formal conflict management procedures. Similarly, a collective culture was observed in relational communication and conflict resolution projects and mechanisms, such as informative presentations and mediators for dispute resolution.

Regarding the *monitoring* dimension, it was determined that in practice, monitoring mechanisms are maintained that focus on strict control of compliance with goals; thus, all projects had formalized control tools and processes, including verification and digital validation environments, formal reports, and information technology systems. Similarly, relational channels for goal guidance include informal steering meetings, discussions, and personal ties. There was no considerable engagement by third parties hired by the client to oversee front-end activities.

SQ5: What distinctions and similarities are observed between various circular building projects in relation to the governance mechanisms in inter-organizational collaboration?
In order to respond to this question, cross-case analysis was utilized. This study enabled the researcher to spot patterns and contrasts between the contractual and relational governance mechanisms used in the three cases.

The three investigated projects shared the highest degree of similarity in the dimension of *goal-setting*. The simple and unambiguous definition of goals by the client, the alignment of individual and collective goals by the contractor, and the delegation of the "how to do it" question to the contractor were found as patterns. On the other hand, variations in particular projects were observed. For instance, business case alignment, building workshops, and discussions during design and planning.

Regarding the *capability-building* dimension, two cases applied discounts for sustainable values and quality, while one project selected the contractor based on partnership. The selection of actors and the procedures utilized for training and continuous learning exhibited no discernible patterns.

Regarding roles and decision-making, procedures and approaches for defining *roles & decision-making* had numerous similarities. Each of the three project management teams focused on three distinct areas: managerial, technical, and contractual. They share the same roles regarding leadership and expert teams. Decisions based on a best-for-project approach represented a second similarity. Nevertheless, other distinguishing mechanisms were exclusive to certain circumstances. For example, establishing a consortium with equal equity and responsibility was unique. Similarly, another project had a leadership/integrator role separate from the project organization, which was not the case for the projects that witnessed the formation of internal leadership roles within the project organization.

In the *rewarding* dimension, there were patterns in the contractual processes, such as client-enforced pain mechanisms, that pushed the fulfillment of the goals. Likewise, the three projects agreed that the risks were assigned to the contractor due to the integrated contract type. However, certain degrees of flexibility allowed for the non-binding collaboration of the client in the resolution of risks and the reallocation of risks to this contracting authority. These distinguishing processes in flexibility in the face of risks made it possible to demonstrate that circular initiatives necessitate more collaborative approaches due to the inherent unpredictability of these projects. Moreover, exposure and recognition were identified as rewarding mechanisms within the patterns. On the other hand, different and exclusive mechanisms were identified for particular projects, including ownership of materials, the celebration of small victories, and personal relationship incentives.

For the *coordination* dimension, similar Project management structures were evidenced with specific patterns associated with the type of public clients, such as the core team, shared culture, formal reports, formal procedures to solve conflicts, dialogue sessions, and the philosophy of the project prevailing over change. Nonetheless, several differentiating mechanisms were identified, such as steering committees, observing roles, informal conversations, integrator roles, knowledge exchange sessions, and even collaborative sessions with measures.

Lastly, the *monitoring* aspect was also governed by contractual control mechanisms to ensure that the contractor met the goals and conditions specified by the integrated contract. Other differentiating mechanisms have been found, including third-party monitoring, casual interactions, and personal relationships.

RQ: How is the inter-organization collaboration between public clients and main contractors governed towards the delivery of circular building projects during the front-end phase?

This study has shown that governance mechanisms in inter-organizational collaboration between public clients and main contractors facilitate the adoption and implementation of circular practices in building projects. The results expressed that relational and contractual governance mechanisms complement one another in goal-setting, capability building, roles and decision-making, rewarding, coordination, and monitoring. Various governance mechanisms within each of these dimensions can be utilized to coordinate, adapt, and safeguard the inter-organizational exchange in circular construction projects. Thus:

Governance mechanisms for goal-setting: these mechanisms allow for cohesion and collective interest between the parties, motivated by an individual willing to work together to achieve a common goal. The early involvement of contractors, building workshops, debates, dialogue sessions, and the alignment between individual and collective goals were some of the mechanisms to foster a collaborative environment. Implementing these arrangements from the front-end phase enables developing a shared understanding of the problem and bringing up different experienced perspectives on how to enforce circular practices. Moreover, the flexibility in how to comply with the goals enables various possible approaches to develop the project, including setting new circular goals.

Governance mechanisms for capability building: through these mechanisms, it is ensured that the parties have the skills, experience, and knowledge to participate in the project from an early stage. Some mechanisms associated with this dimension are the procurement strategies, the partner selection processes, and the training and continuous learning. Thus, the study identified two procurement strategies: competitive dialogue and best-value procurement. The first strategy, which bases the selection on discounts for circular interventions and quality, might foster the transition to a CE, as potential contractors need to provide options to achieve circular values. Then, the second strategy based the selection on the best partnerships, where collaboration could be seen as the primary selection factor.

Therefore, mechanisms such as feedback training, the continuity of actors throughout the project, and knowledge-sharing sessions were included for training and continuous learning. The study then concludes that the feedback training helps to teach how to give positive feedback, which is a source of improvement for the project's progress and strengthens interpersonal relationships. Then, the continuity of actors along the project helps keep the intentions and relational agreement intact, as not everything is written in the contract. Likewise, knowledge-sharing sessions in the client's presence foster the dissemination of lessons learned from the project to increase knowledge on circular building projects.

Governance mechanisms for roles and decision-making: these mechanisms provide the parties involved with clarity and transparency regarding their responsibilities, as well as the information required to comprehend the impact of their decisions on the project. This study reveals that roles consisted mainly of flexible governance structures, core teams, expert teams, and leadership roles. Similarly, decisions were made by the contractor but with influence from the public client. However, decisions were based on a best-for-project approach. Therefore, the study demonstrates that to instill the transition to a CE, projects require flexible governance structures that base the decisions on the expertise of the subject. It gives more room to experts in CE to participate and steer the project to apply circular interventions in the different stages of the building. Also, core and expert teams make possible to task bright ideas to expert teams. Moreover, leadership roles, as the literature and practice state, are essential to defend a circular vision, attract resources, unite stakeholders, and direct collaborative activities while focusing on CE objectives.

Governance mechanisms for rewarding: are incentives and disincentives that strive to align goals and ensure that the project is carried out following its intended performance. Incentives highlighted in the study included material ownership, reputation, personal satisfaction, and joint problem-solving. Nonetheless, disincentives observed were the punishment due to poor performance, the absence of monetary rewards, and strict risk allocation. Therefore, the study identified those incentives as influencers of circular practices. The material ownership mechanism compels the contractor to reconsider the type of materials, elements, and products he will employ as he intends to receive them back in reasonable condition. Then, reputation is the shadow of the future, as said in the literature, since partners want to have exposure to circular projects to have the lead in the matter.

Moreover, personal satisfaction is a mechanism that aims to affect relationships and performance positively. Furthermore, joint problem-solving helps to deal with the uncertainty of some circular practices that require further tests and trials in projects. Consequently, this mechanism provides flexibility and permits the adoption of circular initiatives whose outcomes are unsure.

Governance mechanisms for coordination: entail the adaptation of methods, forms of work, procedures, and information to build a common behavior aimed at achieving the desired result. This study found extensive mechanisms for management practices, shared culture, communication, change management, and conflict resolution. Nonetheless, the analysis highlights project culture and informative presentations as crucial mechanisms for instilling circular thinking in the various project actors. Moreover, the study also includes processes for circular projects that foster honesty, openness, vulnerability, and trust while facilitating in-depth familiarity with circular practices. Those mechanisms include “legs on the table debates,” periodic informal conversations, personal relationships, regular dialogues, and social activities.

Governance mechanisms for monitoring: In both experience and theory, formal control and informal control mechanisms for monitoring were found. Control measures specified in the contract, such as the verification validation environment, contract module system, formal reporting, testing, and acceptance documentation, help guard progress in outline. Concurrently, informal conversations, personal interactions, and steering sessions create mutual trust and understanding, indirectly supervising the contractor.

6.2. Suggestions for further research

Future studies may adopt different approaches:

1. Involve diverse public organizations in research to discover the distinctions and similarities between the governance mechanisms established for circular building projects. Additionally, the circular goals and practices can be contrasted and correlated with these variations.
2. The research could employ quantitative methods to obtain data that can be used for generalization.
3. This study aimed to investigate governance mechanisms that have proven to be desirable / beneficial in the collaboration between public clients and main contractors, during the front-end phase in building projects with circular values. Future research can aim to demonstrate correlations between the governance mechanisms identified in this study and the circular values of the projects in order to provide governance mechanisms that clearly support the circular transition in building projects.
4. Future study could investigate performing and action-based research consisting of including a pilot case to accompany a circular building project during the front-end phase for the selection and application of contractually stipulated and emerging governance mechanisms.
5. The framework is comprised of six governance dimensions: goal-setting, capability development, roles and decision-making, rewarding, coordination, and monitoring. Each dimension could be approached separated with in-depth research aimed at investigating the governance mechanisms, their prerequisites and antecedents, and their efficacy in the transition to a circular economy in building projects.

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Coding for the literature review

Figure A.1: Word cloud obtained from Atlas.ti for the literature review.

Table A.1: Coding structure in Atlas.ti

First-order coding	**Second-order coding**	**Categories**
Regular expressions and recurrent vocabulary	***Definite codes***	***Dimensions***
Vision, goals, aims, objectives, targets, ambitions, workshops, involvement, performance, alignment. Vision, goals, aims, objectives, targets, ambitions, engagement Flexibility, goals, objectives, ambitions, bid, tender, requirements	**C1**: Joint performance goals **C2**: Clarity of goals **C3**: Flexibility of goals	Goal setting
Tender, actor selection, price, value, dialogue Training, knowledge, information, lessons, improvement, understanding	**C4**: Actor selection **C5**: Training and continuous improvement	Capability building
Governance structure, roles, responsibilities Management structure, power, leadership, experts, team Decision-making, problem solving, power, consensus, team	**C6**:Definition of roles and responsibilities **C7**: Management structures **C8**: Authority for decision-making	Roles and decision-making
Incentives, disincentives, rewards, gain-pain, tender, bonus, discount Risk, uncertainty, costs Ownership, service-based, equity, share Reputation, experience	**C9**: Rewarding tied to performance **C10**: Risk allocation **C11**: Ownership structure **C12**: Reputation	Rewarding
Processes, activities, procedures, group, coordination, committees, boards, leadership, systems Culture, identity, cohesion, spirit, best-for-project, team, openness, trust, goodwill Knowledge, information, accessibility, platforms, tools, information systems, technology, meetings Change, flexible, innovation Dispute, Conflict, negotiation, discussion, problem, resolution	**C13**: Common PM practices **C14**: Shared culture, values and norms **C15**: Communication and information sharing **C16**: Change management **C17**:Conflict resolution	Coordination
Audit, monitor Audit, monitor Audit, monitor	**C18**:Formal monitoring **C19**:Informal monitoring **C20**:Third-party monitoring	Monitoring

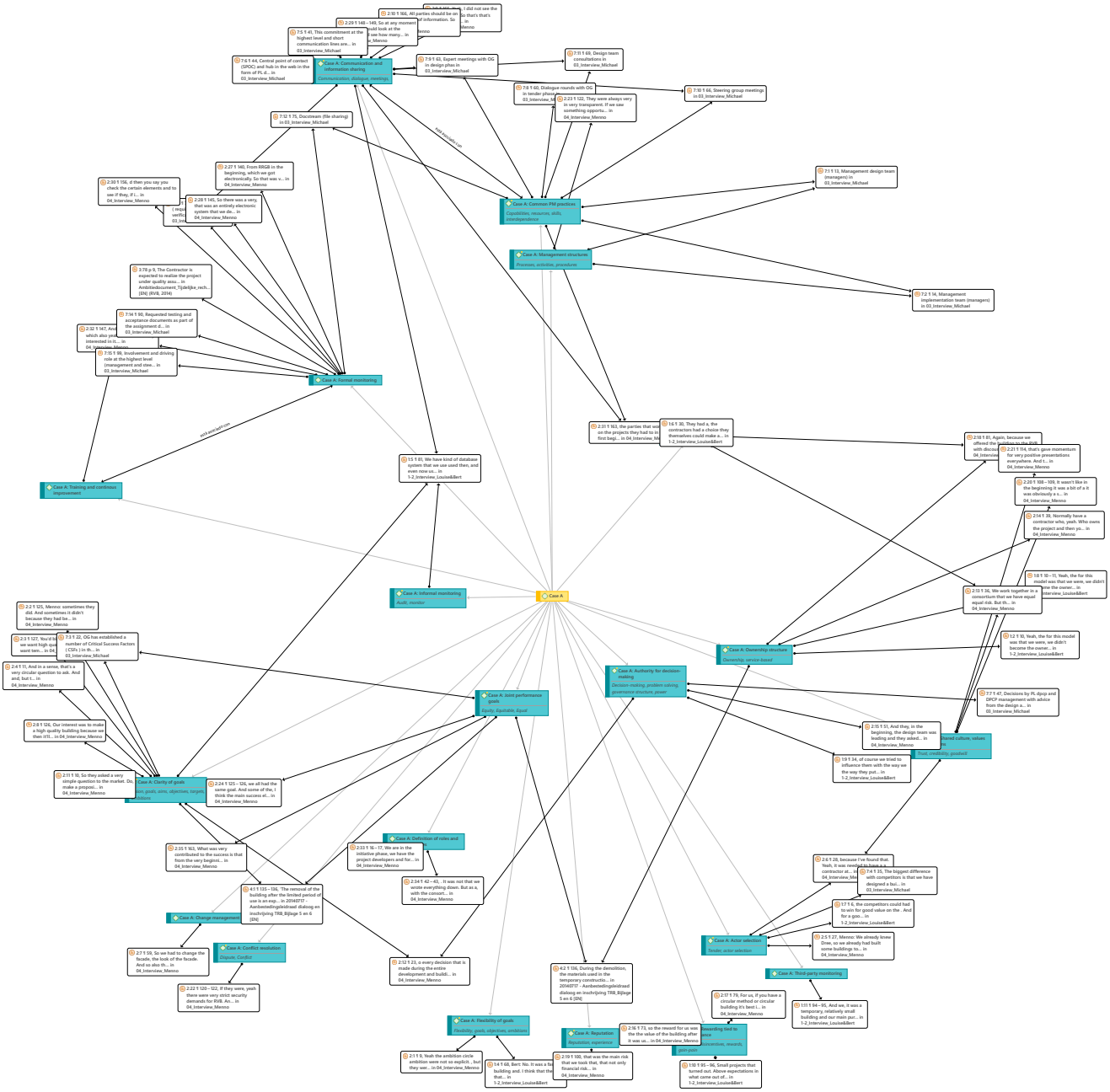

Figure A.2: Semantic network for Case A from Atlas.ti.

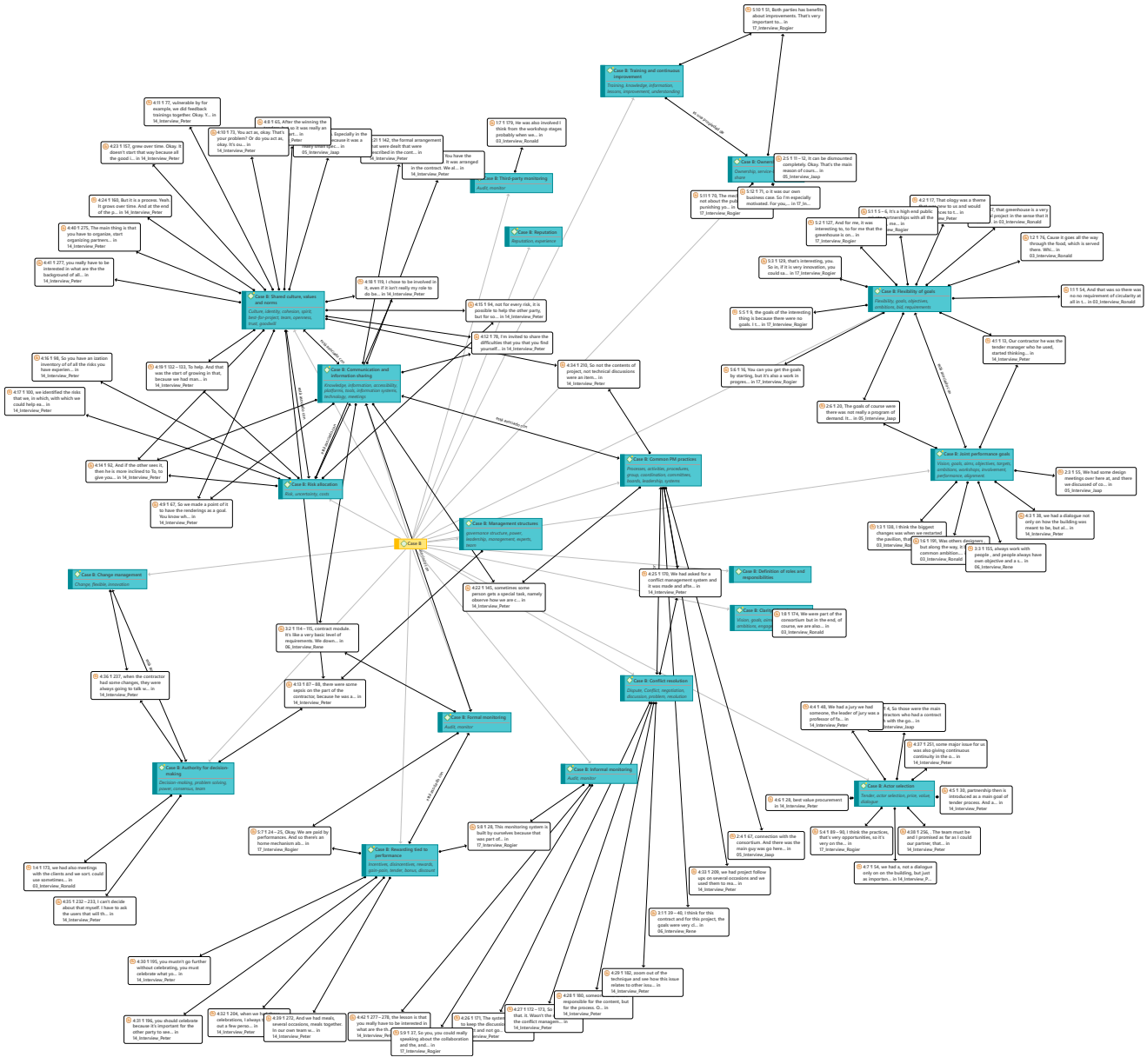

Figure A.3: Semantic network for Case B from Atlas.ti.

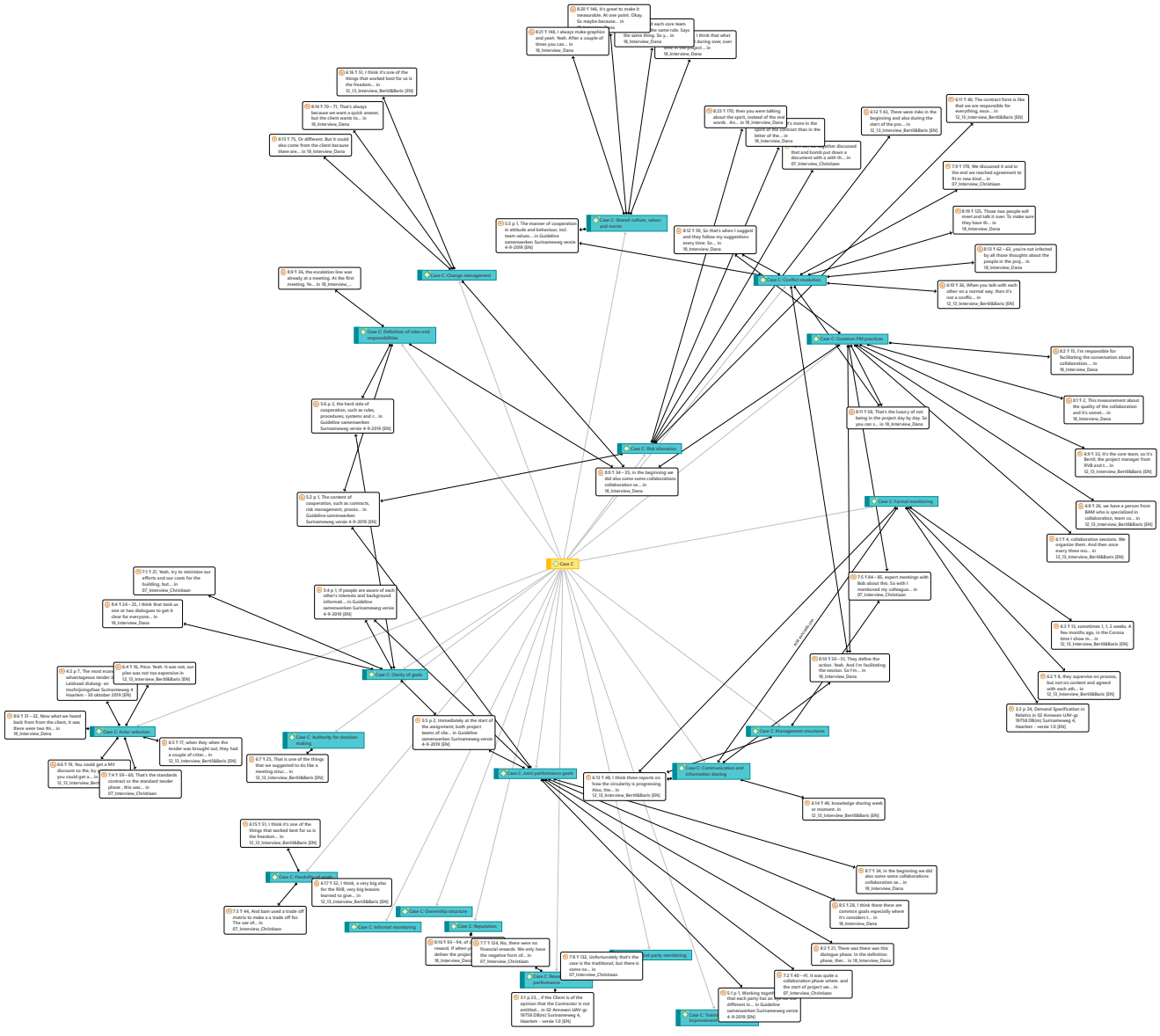

Figure A.4: Semantic network for Case C from Atlas.ti.

B

Data collection protocol

This research includes two methods to collect data, publicly available documents and semi-structured interviews. Concerning the publicly available information, the data is obtained directly from the existing network with the public client or contractor and from the internet. Then, the respondents for the interviews correspond to professionals who participated during the front-end phase of the projects and who are linked to either the public client or the contractor. The used public documents and the participants who participated in the interviews for the collection of data are summarized in Section B.2.

B.1. Publicly available documents

Table B.1: Publicly available documents

Project	Types of documents
Case study A	
	• Ambition document public project • Tender guidelines: for the dialogue and tender phase • Project report: Commissioning • Podcast: circular building podcast: 'don't throw away but loosen up'
Case study B	
	• Official Report from the architect • Presentation: sustainable and scalable circular business case • Video: Collaboration at the project
Case study C	
	• Tender guidelines: for the dialogue and tender phase • Guideline for cooperation in the project • Annexes from contract belonging to the Demand Specification • Basic agreement

B.1.1. Questions to answer in formal documents

The following questions can be obtained from the formal documents and will serve as an input to engage in the interviews. The questions were elaborated based on the six dimensions of governance.

- *General*
  - What type of project delivery method was applied in the project?
  - What type of contract bound the parties?
- *Goal setting*
  - What were the circular goals?
  - Who was involved in the definition of goals?
- *Rewarding*
  - What reward mechanisms were used to encourage better performance?
  - What financial incentives schemes were settled for the project?
  - How were risks shared/allocated among different parties?
  - How is established the ownership of the organization? for example, regarding agreements, investments and joint outcomes.
  - What take-back or service-based models were applied to the contractor (consortium) in the project to retain an ownership stake?
- *Monitoring*
  - What KPIs were used to monitor performance in circularity during the front-end phase?
  - Were third-party auditing and monitoring practices used to track performance in circularity?
- *Coordination*
  - How was communication between actors formally organized?
  - How was conflict resolution defined?
- *Roles and decision making*
  - What was the role and responsibilities of the public client in the project?
  - What was the role and responsibilities of the contractor (consortium) in the project?
  - What were the primary responsibilities of the public client?
  - What were the primary responsibilities of the contractor (consortium)?
  - How was the project management structure for the project?
  - Who had authority for decision-making in different domains?
  - What decisions were made in the front end about circularity?
- *Capability building*
  - What was the tender procedure and selection criteria for the contractor?
  - Are processes and practices for training, continuous improvement and learning defined in the project documents?

B.2. Interviews

The variety of interviewees provides a holistic perspective of the selection and use of governance mechanisms to shape collaboration in the project during the front-end phase. The semi-structured interviews have a total duration of approximately 45min to 70min and contain five predefined phases: introduction, general questions, questions associated with circular construction projects, governance mechanisms, and lastly, closure. The structuring of the interviews will thus allow for consistent information throughout all the interviews with a certain degree of similarity and comparative capacity. The interview protocol in Section B.2.1 contains semi-defined questions that have been organized in a logical order to guide the conversation while providing spaces for flexible and expanded responses. There will be room for follow-up questions. These open questions additionally aim to obtain personal feelings, new ideas and opinions, therefore, the interview must include time enough to allow

the interviewee pause, think, and reflect. A total of **13 interviews were conducted** in a hybrid way (online and on-site), where the information became saturated and no new information was obtained in the lasts interviews. Table B.2 shows the participants interviewed for each project, either from the public client or contractor side, and the date when the interviews were conducted.

Table B.2: Information from the interviewees

Project		Position	Date of interview
Case study A			
	1	Project manager / Public client	16/06/2022
	2	Technical manager / Public client	16/06/2022
	3	Project Leader / Contractor	08/08/2022
	4	Architect Leader / Contractor	30/06/2022
Case study B			
	5	Process Manager / Public client	19/07/2022
	6	Project Manager / Contractor	25/07/2022
	7	Contract Manager / Contractor	01/07/2022
	8	Project Leader / Contractor	29/06/2022
	9	Architect / Contractor	30/06/2022
Case study C			
	10	Technical Manager / Public client	06/07/2022
	11	Project Manager / Contractor	14/07/2022
	12	Process Leader / Contractor	04/08/2022
	13	Circular Advisor / Contractor	14/07/2022

B.2.1. Interview protocol for public clients

PART I: Introduction (< 5min)

The interview begins with a short introduction that includes:

- Researcher Introduction: Introduction of myself.
- Importance of the interview for the research: *The objective of this interview is to gain insight about the governance mechanisms used in inter-organizational relationships during the front-end phase for the delivery circular building projects*

PART II: General questions (< 5min)

Then, the interview proceeds to reinforce the general aspects of the interviewee and its relevance in the case study, for which the following question is raised:

1. What is your role and the associated responsibilities within the project? - *Emphasizing the specific role and responsibilities in the front-end phase.*

PART III: Circular building project (< 5min)

Given that the project (case study) is recognized for being circular, the following questions are posed to delve into this research variable and find other possible circular practices that were not identified in the publicly available information:

2. Why do you think this project can be classified as a circular project?

PART IV: Governance in inter-organizational relationships in practice to achieve circularity in building projects (40-50min)

In this part of the interview, the selected framework of dimensions in governance is used to structure the sequence of questions in a clear and logical way. Then, with the following questions, it is intended to identify how the governance mechanisms were applied, why these governance aspects were selected over others during the front-end phase, and how these mechanisms influenced collaboration and circularity in the building project.

- ***Goal setting***

  3. Joint performance goals: Who was involved in the goal setting process? - How were the circular goals defined? - Do you think that the goals could have been defined in a better way between the parties? how and why?
  4. Clarity of goals: To what extent were the project goals clear to all involved actors? Why?

- ***Capability building***

  5. Actor selection: What was the rationale for defining this selection mechanism for the parties? - What were the benefits and challenges of this specific tender procedure and criteria? - Did actors have the necessary capabilities, competences, resources and knowledge to perform? Why?
  6. Training and continuous learning: What practices for training, continuous improvement, and learning were applied in the front-end phase? - To what extent did these practices help with circularity?

- ***Roles and decision making***

  7. Definition of roles: How were the roles and responsibilities for the different actors defined? - To what extent do you think roles and responsibilities were well defined and supported the achievement of the circular ambitions? Why?
  8. Management structure: Why this project management structure was defined for the project? *(The structure is known beforehand from the formal documents)* - What were the benefits and challenges of the project management structures for the collaboration between the parties? *(e.g., leadership teams, management teams, central position of actors in the information network).*
  9. Authority for decision-making: *Based on the decisions made during the front-end phase regarding circularity:* Who was involved in the decision-making? - How it took place? - What were the limitations in the decision-making process? *(e.g., Limitations of time, power, knowledge, available information).*

- ***Rewarding***

  10. Rewards tied to performance: Why were these reward mechanisms selected? *(The reward mechanisms are known beforehand based on the formal documents)* - How did the reward mechanisms influence the collaboration?
  11. Risk allocation: Why were risks shared/allocated in this way between the parties? *(The risk allocation is known beforehand based on the formal documents)* - What were the benefits and challenges associated with this allocation of risks? - How were the risks managed?

12. Ownership structure: Why was ownership of the organization established in this way? - How did this ownership structure influence the collaboration and way of performing?
13. Reputation: What role does the contractor's reputation play in partner selection for this project and future projects?

- ***Coordination***

14. Common project management practices: What project management practices, tools and work processes allowed the public client to work together with contractors during the front-end phase? - Why were these defined? - What were the main benefits and challenges associated with these? *(For example: cross-functional coordination groups, committees, integrator roles, information systems).*
15. Shared culture, values, and norms: How was the project culture developed? - How did this shared culture help with the circular goals during the front-end phase?
16. Communication and information sharing: How did you experience the communication with your partners? Why? - What practices were used during the front-end phase to ensure that all information was up to date, transparent, and available to all parties?
17. Change management: What were the main changes? - How were the changes (goal-related and non-goal-related) in the project assimilated, for example, changes related to the circularity? - To what extend collaboration helped to deal with deviations? (*This question also involves Goal setting mechanism: flexibility of goals*)
18. Conflict resolution: How did you deal with the conflicts that emerged with the other parties during the front-end phase? *(e.g., disputes settled by a leader or expert, open discussion, formal statements, out-of-court negotiations)* - What were the limitations you experienced in terms of collaboration?

- ***Monitoring***

19. Formal and Informal monitoring: How was the performance measurement of actors and the project *formally* organized during the collaboration? - How was performance measurement of actors and the project *informally* conducted during collaboration? - How did these formal and informal monitoring mechanisms affect (either positively or negatively) the collaboration?
20. Third-party monitoring: To what extent were third parties used for auditing and monitoring the performance of actors and the project? - What was the reason to use a third party?

- **Others:**

21. What are your main collaborative lessons learned to achieve circular values in building projects?

PART V: Closing (< 5min)

In this final part, a short summary of what was discussed in the interview is made and the following aspects are mentioned:

- Do you consider that there is any other person from the project I should talk with in order to obtain more insights about the collaboration between parties that enabled circularity in the building project? - *whom?, could I mention your name when contacting him/her?*

The transcript of the interview will be sent for the approval of the interviewee, who must respond within the following two weeks in case of doubts or comments. In the case of not receiving feedback on the transcript, its veracity and acceptance will be taken for granted for the purposes of the investigation. Likewise, if the interviewees are interested in the final version of the research, they can let me know and I will gladly share the report once approved by the university.

B.2.2. Interview protocol for contractors

This section includes the interview protocol for the actors involved in the consortium such as, project managers and process managers. Minor adjustments to the protocol will be made depending on the specific role of the interviewees.

PART I: Introduction (< 5min)

The interview begins with a short introduction that includes:

- Researcher Introduction: Introduction of myself.
- Importance of the interview for the research: *The objective of this interview is to gain insight about the governance mechanisms used in inter-organizational relationships during the front-end phase for the delivery circular building projects*

PART II: General questions (< 5min)

Then, the interview proceeds to reinforce the general aspects of the interviewee and its relevance in the case study, for which the following question is raised:

1. What is your role and the associated responsibilities within the project? - *Emphasizing the specific role and responsibilities in the front-end phase.*

PART III: Circular building project (< 5min)

Given that the project (case study) is recognized for achieving circularity, the following questions are posed to delve into this research variable and find other possible circular practices that were not identified in the publicly available information:

2. Why do you think this project can be classified as a circular project?

PART IV: Governance in inter-organizational relationships in practice to achieve circularity in building projects (40-50min)

In this part of the interview, the selected framework of dimensions in governance is used to structure the sequence of questions in a clear and logical way. Then, with the following questions, it is intended to identify how the governance mechanisms were applied, why these governance aspects were selected over others during the front-end phase, and how these mechanisms influenced collaboration and circularity in the building project:

- ***Goal setting***

  3. Joint performance goals: How was the contractor involved in the definition of the circular goals? - Do you think that the goals could have been defined in a better way between the contractor and the client? how and why?
  4. Clarity of goals: To what extent were the project goals clear to all involved actors? Why?

- ***Capability building***

  5. Actor selection: How and when did you become involved as a contractor in the project? - What capabilities did you have that other competitors did not have to meet circular expectations? - What were the benefits and challenges of this specific tender procedure and criteria for you as a contractor?

6. Training and continuous learning: What practices for training, continuous improvement, and learning were applied in the front-end phase? - To what extent did these practices help with circularity?

- ***Roles and decision making***

7. Definition of roles: To what extent do you think roles and responsibilities were well defined and supported the achievement of the circular ambitions? Why?
8. Management structure: What were the benefits and challenges of the project management structures for the collaboration between the parties? *(e.g., leadership teams, management teams, central position of actors in the information network).*
9. Authority for decision-making: *Based on the decisions made during the front-end phase regarding circularity:* Who was involved in the decision-making? - How it took place? - What were the challenges during decision-making situations? *(e.g., Limitations of time, power, knowledge, available information).*

- ***Rewarding***

10. Rewards tied to performance: How did these rewards mechanisms change your team way of working towards circular goals? *(The reward mechanisms are known beforehand from formal documents)*
11. Risk allocation: What were the benefits and challenges associated with this risk allocation regarding collaboration? *(The risk sharing/allocation is known beforehand from formal documents)* - How were the risks managed?
12. Ownership structure: In the project it has been seen that ownership models changed with regards to traditional projects. What were the benefits and challenges associated with the way in which ownership was organized in this project? - What effect had this ownership structure on your motivation and performance? - How your participation in the decision making also had to change based on this?
13. Reputation: What was your perception of the need to do a good job on the project to maintain a good reputation or maintain relationships in the project network? For instance, do you consider that "the shadow of the future" was a motivator for better performance?

- ***Coordination***

14. Common project management practices: What project management practices, tools and work processes allowed the contractor to work together with the client during the front-end phase? - What were the main benefits and challenges associated with these management practices? *(For example: cross-functional coordination groups, committees, integrator roles, information systems).*
15. Shared culture, values and norms: How was the project culture developed? - How did this shared culture help with the circular goals during the front-end phase?
16. Communication and information sharing: How did you experience the communication with your partners? Why? - What practices were used during the front-end phase to ensure that all information was up to date, transparent, and available to all parties?
17. Change management: What were the main changes? - How were the changes (goal-related and non-goal-related) in the project assimilated, for example, changes related to the circularity? - To what extend collaboration helped to deal with deviations? (*This question also involves Goal setting mechanism: flexibility of goals*)
18. Conflict resolution: How did you deal with the conflicts that emerged with the other parties during the front-end phase? *(e.g., disputes settled by a leader or expert, open discussion, formal statements, out-of-court negotiations).* - What were the limitations you experienced in terms of collaboration?

- ***Monitoring***

19. Formal and Informal monitoring: How was the performance measurement of actors and the project *formally* organized during the collaboration? - How was performance measurement of actors and the project *informally* conducted during the collaboration? - How did these monitoring mechanisms affect (either positively or negatively) the collaboration with the public client?

20. Third-party monitoring: To what extent were third parties auditing and assisting you to achieve the circular goals? - How did this third-party monitoring affect collaboration?

- **Others:**

21. What are your main collaborative lessons learned to achieve circularity in building projects?

PART V: Closing (< 5min)

In this final part, a short summary of what was discussed in the interview is made and the following aspects are mentioned:

- Do you consider that there is any other person from the project I should talk with in order to obtain more insights about the collaboration between parties that enabled circular values in the building project? - *whom?, could I mention your name when contacting him/her?*

The transcript of the interview will be sent for the approval of the interviewee, who must respond within the following two weeks in case of doubts or comments. In the case of not receiving feedback on the transcript, its veracity and acceptance will be taken for granted for the purposes of the investigation. Likewise, if the interviewees are interested in the final version of the research, they can let me know and I will gladly share the report once approved by the university.

B.2.3. One-pager for interviewees

MASTER'S RESEARCH
DELFT UNIVERSITY OF TECHNOLOGY

TU Delft
Delft University of Technology

Investigating governance mechanisms that shape inter-organizational collaboration during the front-end phase to facilitate the transition towards a circular economy in the built environment

ANYELY MAZO-GOEZ • M.Sc. (s) Construction Management and Engineering

DEFINITION OF CONCEPTS

GOVERNANCE MECHANISMS

Governance mechanisms are seen as the arrangements, structures and processes for **coordination, adaptation** and **safeguarding** of exchanges in inter-organizational collaboration. Governance mechanisms include **contractual** and **relational** approaches that allow the multiple parties involved to promptly think together about the purpose of the project, the desired outcome, and to align their efforts towards a shared goal.

INTER-ORGANIZATIONAL COLLABORATION

Inter-organizational collaboration is the way in which parties with different knowledge and responsibilities can constructively explore their differences and **seek solutions to challenges that are beyond their capabilities**. Thus, the goal of an inter-organizational collaboration is to deal effectively with major problems that organizations present within an inter-organizational domain and that cannot be tackled by an organization acting on its own.

FRONT-END PHASE

For the purpose of this research, the front-end phase includes all the activities performed by the public client and other parties during the **initiation, planning** and **design**. The front-end phase finalizes once the project is ready for construction.

DIMENSIONS OF GOVERNANCE

1. GOAL SETTING
- Joint performance goals
- Clarity of goals
- Flexibility of goals

2. CAPABILITY BUILDING
- Actor selection
- Training and continuous learning

3. ROLES & DECISION-MAKING
- Definition of roles & responsibilities
- Management structure
- Authority for decision-making

4. REWARDING
- Risk allocation
- Rewards tied to performance
- Ownership structure
- Reputation

5. COORDINATION
- Common PM practices
- Shared culture, values and norms
- Communication and information sharing
- Change management
- Conflict resolution

6. MONITORING
- Formal & informal control and monitoring
- Third party monitoring and auditing

PURPOSE OF THE INTERVIEW

The purpose of the interview is to gain insight about the **selection and use of governance mechanisms** that have proven to be beneficial in inter-organizational collaboration during the front-end phase for the delivery of **circular building projects.**

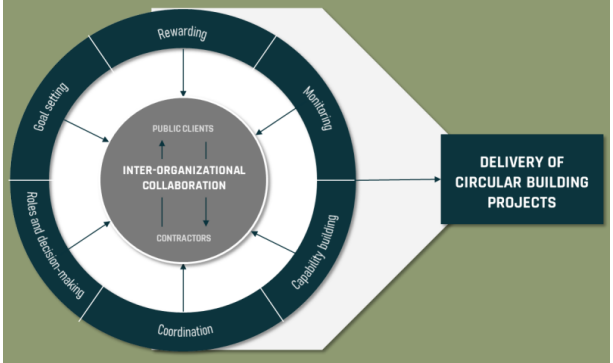

Figure B.1: One-pager for interviewees

C

Selection of the case studies

Nº	PROJECT	LOCATION	CLIENT	Phase	DESIGN	MANUFACTURE & SUPPLY	CONSTRUCTION	OPERATION
1	**Permanent building with temporal function**	Amsterdam	Rijksvastgoedbedrijf	Use	* Modularity, design for adaptability and flexibility. * Design for disassembly (DfD) * Use of information systems for dismountability: In order to render the structure as customizable and circular as possible, it was designed as a kit of parts that can as easily be assembled as disassembled and reassembled.	* Change ownership models * Standardization of components and elements. * Optimize material use: Elements, products and materials were produce in a way that can be reused without down-cycling; however, the design of the building was not thought only for the recycling of components, but for the reuse of the entire building.	* Reuse of materials * Off-site construction / prefabrication: In order to comply with the ambitions of maintaining the good neighborly relations (reduction in nuisance) and the design specifications, the components were prefabricated and assembled on-site. * Recycle of materials	* Adaptable and flexible use.
2	**The green building**	Utrecht	Rijksvastgoedbedrijf	Use	* The design considers solar panels to attend part of the energy demand. Also, includes water collection system to reuse the rainwater in the building. * Modularity, design for adaptability and flexibility. * Design for disassembly (DfD): The building is located behind the central station in Utrecht and will be here for the next fifteen years. The building is completely dismountable. In fifteen years it can be completely reused by being built up elsewhere. - The foundation is completely dismountable, chose not to include concrete piles, but rather precast concrete slabs. - The building is completely modular, so that it facilitates the dissasemble and provides flexibility for other uses. * Specify secondary raw materials. * Specify better-performance materials. - Prefabricated timber frame construction panels were used for the closed parts of the facade on the first floor. These are one hundred percent recyclable and (H)CFC-free. - Cradle Vent - Cradle to Cradle textile ducts for ventilation.	* Reuse of secondary materials: reused materials were used as much as possible. - The facade cladding, for example, comes from the button barracks that used to be next door. - Old doors have been used to decorate the facade of the bar. - Each meeting room has its own thematic design: from vintage Dutch design furniture to cradle-to-cradle interior. - Pavers from an old quay in Tiel replace the traditional poured ground floor. They lie on a compacted sand bed with underfloor heating. - The upper floor consists of prefabricated wooden elements. For the roof, the choice fell on a light steel plate that is also perforated and filled with insulation. With a glass curtain wall, the plinth of the pavilion is completely transparent. - Prefabricated timber frame construction panels were used for the closed parts of the facade on the first floor * Standardization of components and elements.	* Reuse of materials: reuse of materials from the next existing building that was under renovation. * Off-site construction / prefabrication: the building was constructed using prefabricated elements such as beams, columns, and panels. * Recycle of materials	* Adaptable and flexible use.
3	**The government office**	Utrecht	Rijksvastgoedbedrijf	Use	* Specify better-performance materials: The building has C2C interior finishing elements with no emissions, so that contribute to healthier indoor air quality.	* Reuse of secondary materials - The foundation consists of concrete slabs and concrete blocks, made from residual concrete in a precast concrete factory. - Waste has been used as raw material for some furniture and old items have been refurbished. - The glass facade cladding comes from the old Knoop barracks. * Change ownership models: C2C Certified materials and many products are leased or delivered according to use and thus remain in the possession of the supplier , resulting in a fully circular business model.	* Reuse of materials: Part has been demolished, while the remaining parts have undergone a major transformation and have been combined with new construction. Optimal reuse of the existing building matetials. * Recycle of materials	* Adaptable and flexible use: Building aimed at maximum flexibility so that the building and services can last for a long time (Future-proof): - Flexible and divisible conference and meeting center.
4	**The stadium**	Eindhoven	Rijksvastgoedbedrijf	Commissioning	* Specify secondary raw materials: The partial demolition of the building included plans to reuse as many materials as possible in the renovation of the building. * Specify better-performance materials: The furnishing materials such as floor coverings, adhesives and paints and varnishes in the building have been chosen in such a way that emissions of harmful 'volatile organic compounds' take place as little as possible.	* Material passport: The renovation included a Madaster Materials Passport to give an 'identity' to the materials used, which makes their reuse and recovery easier in the future. - For the facade the anodized aluminumis the main materials which is completely recyclable at the end of use. - Ceilings and interior walls are made with MD Expanded metal which is completely recyclabe at the end of use.	* Reuse of materials. * Recycle of materials.	
5	**Government office renovation**	Haarlem	Rijksvastgoedbedrijf	Construction	* Use of renewable energy. * Modularity, design for adaptability and flexibility. * Design for Disassembly (DfD): The extension of the building is fully demountable. The structure is made out of wood. Specify secondary raw materials. * Specify better performance materials: Insulation materials with better performance has been selected to reduce the energy consumption.	* Reuse of secondary materials: Materials and components from the existing building such as mechanical installations, electrical components, and ICT has been refurbished. * Standardization of components and elements.	* Reuse of materials. * Prefabrication: The extension of the building is prefabricated in wood. * Recycle of materials.	* Shared spaces / dynamic functionalities: offices are flexibles in use since one of the main principles for the entire design is the 'Open Up', which involves the transformation of the existing building from a closed bastion to a light and transparent working environment. * Passive lighting and ventilation: New design ensures working spaces with natural lighting, therefore, reducing energy consumptions.
6	**Building made with waste**	Katwijk	Rijksvastgoedbedrijf	Front-end	* Specify secondary raw materials: The renovation of the building aims to use as much as possible materials from the old naval building to halve the primary use of raw materials. For example, stones, windows, frames, interior doors, and ceiling panels. Then, the objectives also include the reuse of existing material in the surroundings of the building.	* Reuse of secondary materials. Materials and components from the former naval buildings has been collected in a patio to be used in the renovation of the building.	* Reuse of materials. * Recycle of materials.	* Adaptable and flexible use.

Figure C.1: Selection of the case studies based on the circular practices applied during the life-cycle