Stakeholder Involvement to Overcome Barriers in Circular Ambitions

A Case Study of the Bajeskwartier

CME5200: CME Masters thesis

Gijs Spruit

Delft University of Technology

TU Delft

Stakeholder Involvement to Overcome Barriers in Circular Ambitions

A Case Study of the Bajeskwartier

by

Gijs Spruit

Student Name	Student Number
Gijs Spruit	4654811

Chair coordinator:	Prof.Dr.ir. J.W.F. Wamelink
1st supervisor:	Dr.ing. G.A. van Bortel
2nd supervisor:	Dr. E.J. Houwing
Company supervisor:	Ir. S. Vernooij
Company supervisor:	Ir. T. Blankendaal
Project Duration:	March, 2024 - T.B.D., 2024
Faculty:	Faculty of Civil Engineering & Geosciences, Delft

Cover:	A render of the Bajeskwartier
Style:	TU Delft Report Style, with modifications by Daan Zwaneveld

TU Delft

Preface

This thesis was written as a final research project for the Master Construction, Management & Engineering at the Technical University of Delft. As a final deliverable, this master's thesis focused on the improvement of Circular Economy Ambitions within construction projects, highlighting barriers that hinder implementation of ambitions, and subsequently including factors that focus on negating said barriers.

After a long road, completing the Bachelors on Civil Engineering, proceeding with the master Construction, Management & Engineering, I am thrilled to complete my academic career surrounding a topic that I am highly interested in. When completing my Bachelors, I learned that the truly technical side of the construction sector was not my strong suit, while the construction sector itself, and more specifically the sustainable side of the sector, continued to fascinate me. Looking back, this master has provided me with a wonderful two years, learning many new things and making friends along the way. Although the previous months have presented me with difficult moments, I consider this thesis to be one of the most important learning points of my academic career.

I would like to express my gratitude to my thesis committee, the Chairman, Hans Wamelink for his valuable feedback during the proposal and midterm meetings, along with Supervisors 1 and 2, Gerard van Bortel and Erik-Jan Houwing, for their active involvement on a weekly basis. You have all been extremely valuable for the completion of this thesis, each meeting has improved my perception of what was considered important and relevant to incorporate within such a large project. I want to thank you giving me the motivation, suggestions and, in general, the time I needed to successfully complete this thesis. Additionally, I would like to thank Sander Vernooij and Tom Blankendaal for their warm welcome within BAM, in both the construction and Sustainability team. You both, along with colleagues in both teams, have generously helped me on multiple occasions, aiding with brainstorming sessions and providing me with valuable real-life knowledge on the construction sector.

I would also like to extend my gratitude towards my parents and sister, that have provided me with a tremendous amount of support in various ways. Not only during the writing of this thesis, but my entire academic career, which lasted for a little over 7 years. Finally, I would like to thank my girlfriend, Fé, the massive amount of support during these last few months has given me the strength to finish this thesis. It has not always been easy, especially the end phase: long days, and nights, where the main topic of conversation mostly surrounded this research. Therefore I want to thank you, not only for your help with improving my thesis and listening to me talk about this topic, but also being there during the more difficult times.

Gijs Spruit
Delft, October 2024

Summary

This thesis explores the challenges and solutions for integrating circular economy (CE) ambitions into building projects, with a focus on overcoming barriers through effective stakeholder engagement. The research was motivated by the increasing need for sustainable practices in the construction industry, particularly how to align diverse stakeholder interests with CE goals. The central research question addressed is: *How can effective stakeholder engagement strategies overcome barriers to implementing circular economy ambitions in building projects?*

The research was conducted using a qualitative research approach, combining case studies, document analysis and interviews with key stakeholders involved with CE ambitions in construction projects (Ma and Hao, 2024); architects, contractors, clients and a material recycling facility. Data was gathered from 9 interviews and analyzed to identify patterns in stakeholder knowledge, attitudes, and power dynamics related to CE implementation. The stakeholder mapping process included the models of Power-Interest-Attitude (Murray-Webster and Simon, 2006) and Salience (Mitchell et al., 1997) to assess alignment of stakeholders, their engagement levels within the management structure and overall barriers and Critical Success Factors that aided in finding a Stakeholder Engagement Strategy for improvement of CE ambition achievement.

The study revealed that knowledge gaps at project initiation, lack of technical feasibility measurement early on, frequent change in project teams and wavering commitment of these new project teams were considered important barriers that hindered effective implementation of CE ambitions in the Bajeskwartier. Consequently, various Critical Success Factors, such as early alignment of stakeholder knowledge and maintained commitment between stakeholders, are essential for achieving CE goals. Additionally, incorporating other stakeholders such as Investors into the decision-making process was found to be crucial for overcoming regulatory and financial obstacles, such as the lack of implementing circular business models. Finally, stakeholders with high power and interest, such as clients and contractors, were identified as critical for enforcing CE practices, while architects were considered to have a very high intrinsic motivation for implementing innovative CE ambitions.

The research concluded that an effective stakeholder engagement strategy involves early alignment of CE ambitions, clear communication of goals and ongoing collaboration between current and future stakeholders, and recurrent checking of ambitions and decision on technical, financial, regulatory and design levels can significantly reduce barriers that hinder effective CE implementation. The findings demonstrate that involving key stakeholders early and fostering a shared understanding of CE objectives and knowledge surrounding this topic leads to better project outcomes and stronger commitment to circular practices.

The limitations of this research include the focus on a limited number of stakeholders and the inclusion of only one specific construction project, which greatly limits generalizability. Future research could expand on this by examining similar construction projects, while incorporating new stakeholder groups such as advisors. Finally, various obtained barriers, not found within incorporated literature, were present in alternate literature excluded by this thesis' scope. It is therefore recommended future research highlights their literature research specifically on the topics of leadership, commitment and interests, and the general topics of finance, technical and design barriers and Critical Success Factors.

Contents

List of Figures

List of Tables

Nomenclature

Abbreviations

Abbreviation	Definition
CE	Circular Economy
CSF	Critical Success Factor
SES	Stakeholder Engagement Strategy
MRC	Material Recycling Company

1

Problem definition

1.1. Introduction

The construction industry stands at a critical section, facing increasing pressures to align with global sustainability measures outlined in the United Nations Sustainable Development Goals (SDGs). As the world struggles with pressing environmental challenges, the construction sector emerges as a significant contributor to resource depletion and waste generation, estimates are suggesting the construction sector generates up to 40% of carbon dioxide emissions (Kramer and Bueren, 2021). In an even more recent study, Zhang and Ahmed (2022) have shown that, to this day, 10 billion tons of waste is produced annually, where the Building Construction Industry is responsible for 40% of this large amount (Oluleye et al., 2023). This shows that the generation of waste has increased due to higher demand of construction.

In response to these environmental concerns, there is a growing imperative for the construction industry to transition towards more sustainable practices. Circular Economy (CE) principles offer a compelling framework to address these challenges by promoting resource efficiency, waste reduction, and environmental preservation (Murtagh et al., 2020). CE advocates for the transformation of linear ”take-make-waste” models into circular systems that prioritize the continuous use of resources through recycling, reuse, and regeneration.

Circular Economy (CE) represents a transformational economic system that challenges the traditional ”end-of-life” concept by prioritizing the reduction, reuse, recycling, and recovery of materials across production, distribution, and consumption processes (Kirchherr et al., 2017). It operates at multiple levels, including the micro level (individual products, companies, consumers), meso level (eco-industrial parks), and macro level (city, region, nation, and beyond), with the overarching goal of achieving sustainable development. CE aims to concurrently enhance environmental quality, foster economic prosperity, and promote social equity, benefiting both present and future generations. This definition, as established by Kirchherr et al. (2017), is considered relevant and justified for use in this study, given its comprehensive and inclusive nature.

1.2. Circular Economy in the building sector

The building sector plays a pivotal role in the transition to a circular economy, given its significant resource consumption and waste generation (Murtagh et al., 2020). Building projects, from inception to completion, entail vast material inputs and generate substantial amounts of construction and demolition waste. Embracing CE principles in the building sector requires a comprehensive understanding of the challenges and opportunities inherent in the construction life cycle. In recent years, many studies have been performed to improve the methods of implementing new CE frameworks in the construction sector. Unfortunately, not all new methods or research alternatives get a successful implementation when evaluating a project in hindsight. Often times financial or technological setbacks are the cause of a lack of implementation. However, there are also other important causes (Munaro and Tavares, 2023) such as barriers in informational or institutional sectors.

Many other factors also play a role, one of the most important ones is stakeholder collaboration and inclusion in construction projects (Durdyev et al., 2023; Zhidebekkyzy et al., 2023). Through information and contact at Royal BAM group, various team members highlighted that situations often arise where different stakeholders set their focus on various aspects of the construction. These groups can be both within the same company but also companies collaborating in the same project. These stakeholders often have different interests, ambitions and priorities within a construction project, leading to a decreasing effectiveness of successful implementation of CE goals set at the start. Literary knowledge on why these ambitions occasionally lack the push toward successful implementation is limited. However, as BAM contacts have explained, these groups mostly work on a specific part of the construction project. For example, the design team often works solely during the design phase, while others focus only on the tender phase with having little to no overlap. This gap in collaboration and communication results in future decisions being made without overview of initial plans, specifically toward the implementation of CE initiatives (Veen, 2023).

Through these differences in interests and knowledge, the implementation of initial ambitions becomes something that is difficult to adhere to throughout a project life cycle. A recent, still ongoing, construction project that has implemented old materials of an existing, out-of-date building into a new construction project is the Bajeskwartier. This case will be used in this thesis to review its successes, barriers and act as a general comparison to literature to determine how improvements to CE implementation can be made. To start off, the Bajeskwartier has successfully implemented a reuse of 98% of the old building on the site. This has been a challenge with hindrance throughout the project, as explained by contact of Royal BAM Group in exploratory communication. Despite the high stated ambition, the implementation of old materials can be implemented in various types of ways, and what this stated 'Reuse' is remains unclear. Reusing concrete walls as a new wall, or reusing by grinding it down can both be seen as 'Reuse'. The question that arises, related to how circular this implementation of 98% truly is in contrast to the initial plans, is: How can the level of circularity within such a project be measured? Additionally, it is necessary to measure the perception of other stakeholders on whether they differentiate between these different levels of circularity.

In order to determine a useful research direction surrounding this topic, the research of Sparrevik et al., 2021 shows a schematic and simplistic model of transitions that occur towards sustainability. Figure 1.1 shows various steps over time that increase the comprehensiveness, or in other words, understanding and effectiveness of sustainability. As CE is a section of sustainability, this schematic representation can still be seen as relevant. In the first two sections of the graph, research and understanding of materials (2a) and its implementation in building projects (2b) are shown. As CE initiatives in construction projects are explained to be successfully implemented, such as in the Bajeskwartier or Stadstuin Overtoom, indication exists that shows technical expertise should already be available. The next step, according to Sparrevik et al. (2021), is to look into measurement tools and deterministic models that can show how well the implementations of actual technological implementations actually work, focusing on organisational change. Such measurement tools have been researched through literature studies, some of which have been performed with a focus on locating barriers of these technological implementation (Wuni and Shen, 2022; Munaro and Tavares, 2023). They have concluded the importance of stakeholders and their collaboration through literature, where successful CE implementation has seemed to be lacking within the construction sector.

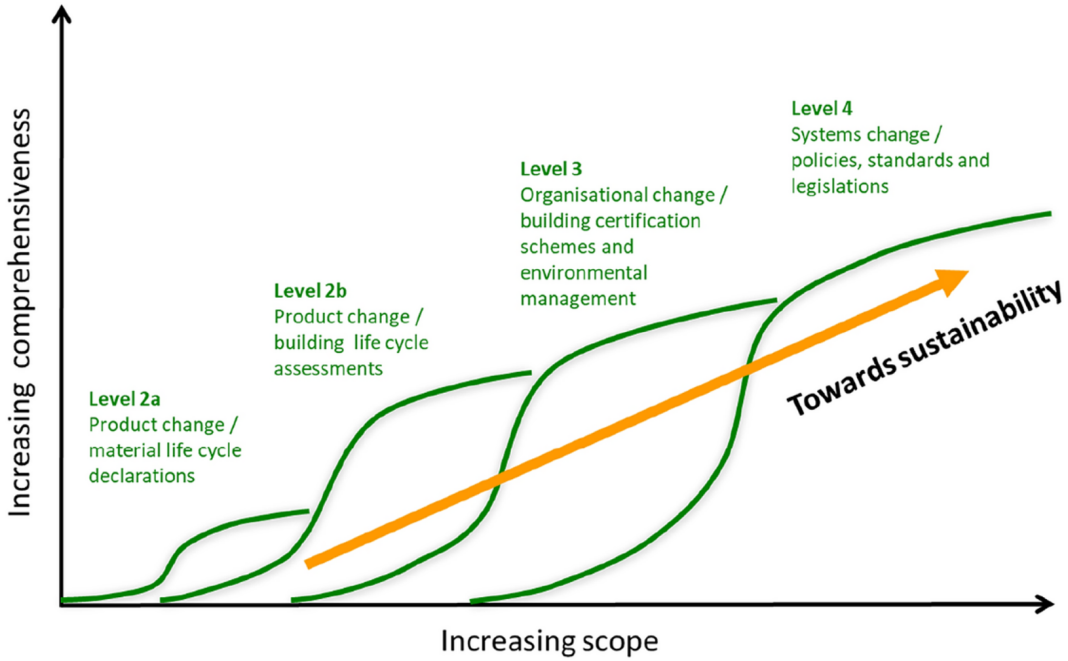


Figure 1.1: Steps toward sustainability (Sparrevik et al., 2021)

1.3. Stakeholders and the Circular Economy

For the implementation of CE in building projects and achieving the ambitions set at the start of projects, stakeholders play a vital role (Kaipainen et al., 2023; Blomberg et al., 2023; Ma and Hao, 2024). Across the construction value chain, including developers, architects, contractors, policymakers, and community members, they are the one's shaping sustainable outcomes (Zhidebekkyzy et al., 2023). Their engagement and collaboration are essential for overcoming barriers and fostering the adoption of CE principles throughout the construction life cycle, as explained in the previous section. Munaro and Tavares (2023) explains that stakeholders, such as the government, are shown to have a positive influence on overcoming barriers of CE implementation. For example, these positive influences are: the incorporation of circular vision plans, goals and targets, Subsidizing the market or implementing CE criteria in public procurement (Munaro and Tavares, 2023). Additionally, Kooter et al. (2021) explain the importance of various necessary steps during construction projects in their research. They include the importance of top-down support, linking back to the importance of governments, but also the importance of good leadership within projects. They also prioritize the importance of partnership based on increase equality and shared circular goals. In order to truly transition to a CE based construction, it is vital to have stakeholders as leading bodies that are able to influence change (Guerra and Leite, 2021), as circular strategies are often explained in literature, yet their effective implementation in practice can only be done by the stakeholders involved within such construction projects (Guerra and Leite, 2021). In order to do so, various methods can be applicable. As an encompassing term, Stakeholder Engagement Strategies (SES) are a viable solution to improve collaboration and effective communication between stakeholders (Kujala and Sachs, 2019; Kaipainen et al., 2023). It offers an insightful perspective to understand how stakeholders can align, even though their interests often do not. Kaipainen et al. (2023) explains an additional management stream, being a subsection of a SES, can also be seen as an ever changing ecosystem, that highlights the adaptation necessary for stakeholders to keep collaborating. This is what differs SES to traditional stakeholder strategy, the former is focused on engaging with stakeholder in a proactive manner, to increase knowledge alignment and effective collaboration, while the latter focused on the communication that stakeholders have. This is an example of why SES are necessary in the instance of CE within the construction sector. As the CE technology options and methods for reusing materials in general change, the collaboration to make this necessary evolves as a result (Kaipainen et al., 2023).

1.4. Research gap

Despite increasing awareness of CE principles in the construction industry, significant gaps persist between theoretical knowledge and practical implementation (Oluleye et al., 2023). This is specifically the case on the social side of CE implementation such as the collaboration between stakeholders (Hossain et al., 2020). Existing research provides insights into the potential benefits of CE but fails to offer comprehensive understanding regarding practical implementation and the challenges encountered. This is one of the important aspects of this thesis, the comparison of theoretical encounters expected to improve CE and a real life case study that has (partly) implemented CE ambitions. In order to see what has been performed well, how this has been done and what could be improved when using a theoretical framework in order to gain an even better result in future construction projects.

Additionally, stakeholders comprising of diverse entities ranging from industry players to policymakers, wield substantial influence in shaping construction projects and driving sustainability initiatives (Durdyev et al., 2023; Munaro and Tavares, 2023), as they have influence on many barriers presented throughout literature. Stakeholders within construction projects are the leading group that can make a change within the construction sector, while some enforce decisions within such projects, others advise and direct these stakeholders within the process. Their engagement is critical for overcoming barriers and achieving meaningful progress towards CE implementation, which is why the research on this topic is vital to be implemented in case study scenario's. Within literature on the topic (Kujala and Sachs, 2019; Kujala, Sachs, et al., 2022) many different research areas have been incorporated. Kaipainen et al. (2023) has used this as a basis for comparing case studies in various business ecosystems, one chosen case in their research focused on the construction project, as a whole. Within their research, Kaipainen et al. (2023) then created a general strategy approach which aimed to improve the ambition achievement of CE goals. However, research of SES in combination with CE, looking into an actual case study within the construction sector is lacking. As mentioned by Kaipainen et al. (2023), their recent study does provide an essential basis for contribution to the scope of stakeholder engagement research on CE, yet generalisations have been made due to a broader scope of cases in various sectors. To date, the specific case of a construction project has not been examined when using their methodology.

1.5. Research Question

To bridge existing knowledge gaps and address the challenges hindering CE adoption, this research aims to answer the following question:

How can effective Stakeholder Engagement Strategies overcome barriers to implementing circular economy ambitions in building projects?

1. What Circular Economy Principles are most relevant for implementation of CE Ambitions in building projects?
2. What are the key barriers and success factors to implementing CE ambitions in building projects?
3. What are the key stakeholders involved in different phases of building projects, and what are their roles and interests related to Circular Economy implementation?
4. What Stakeholder Engagement Strategies are present, which are most effective and how can this be evaluated?

1.5.1. Relevance

The relevance of this section is divided into two parts, the relevance on a social level, and the relevance on an academic level. These are both explained below.

Social Relevance

As a social relevance for this thesis, various options are relevant to mention. One of the most important ones is the improvement of environmental sustainability in the construction sector. Reducing waste generation and pollution by promoting the adoption of CE principles helps reduce the generation of waste, and the reduction of new materials within projects. Additionally, this study on CE focuses on retaining old materials that give the feeling and ambiance of old construction projects. As an example,

the rich history of the Bijlmer Bajes remains within the area due to the renovated and reused selection of materials.

Academic Relevance

For the academic relevance, other important additions are made. This study aims to improve the knowledge and implementation of the framework created by Kaipainen et al. (2023), by giving understanding of a practical implementation of this framework in a specific construction project with a focus on implementing CE. Additionally, this study aims to create a better insight into the knowledge barriers that are present in different stakeholder groups. This will either solve the barriers within this study, or make these barriers clear and solvable within future studies.

1.5.2. Structure

The structure of this thesis is as follows. In the current chapter, a general overview of context was sketched. Afterwards, the research questions have been stated to serve as the basis of this thesis. This is then followed by a short description of the methods used within this study, both the social and academic relevance. In the next chapter, a theoretical research is done in order to gain better understanding of relevant information that has already been uncovered, which is necessary to incorporate for the second part of the thesis. At the end of the theoretical chapter, a general overview of all theory that has been gathered will be presented in the form of a theoretical framework. Afterwards, the chapter methodology contains information that expands on the scope of the research, and the steps that will be made when preforming the case study research. Within this methodology, a step-by-step approach based on the initial theoretical framework will be made, incorporating the steps for the interview, along with concepts, coding methods, an overview of creating the Draft SES and a final validation. Second to last, the results of the case study will be explained in the fourth chapter. Lastly, Chapter 5 contains a conclusion and Chapter 6 contains a discussion.

2

Theoretical Research

This chapter explains the findings through theoretical research. It serves as the basis to determine what the knowledge of CE is currently at, what principles are most influential for the implementation of CE goals & ambitions, what barriers come to light when focusing on these goals in theory, what stakeholders are most important to adhere to these goals and barriers, ending with a study on what stakeholder engagement strategies are available and what their effects have on improving stakeholder collaboration and decision making, to make the achievement of CE goals a reality. This chapter will serve as the theoretical basis for answering the sub questions in the given order, alongside a creation of a conceptual framework to be used during the case study.

2.1. Circular Economy Principles

In this chapter, the Circular Economy Principles will be discussed, as these are important as effective measurement for determining how circular something truly is, and how it can be improved. Starting off with a literature review surrounding the topic of what principles are effective, what they can be used for to achieve goals and how. As an introduction, this section will focus on a limited number of CE Principles. Namely, R-Principles, as these conjoin many 'Design for' methods of construction focused on circularity (Charef, Lu, et al., 2022). As the latter are focused on the project and decision making itself, a different principle will be the Critical Success Factors. This section focuses on the addition of factors that specifically improve the collaboration, necessary for the section on stakeholders and their engagement to circularity.

In recent years, many literature studies have been performed on testing the effectiveness of various types of R-Principles, both in theory and real life situations. What the R-Principles are, is a combination of many various 'Design for ...' approaches. These are a small section of the vast field of circular methods, where 42 variants were classified in total (Charef, Lu, et al., 2022). The 'Design for ...' approaches, such as Design for Assembly, Design for Disassembly, Design for Dismantling, Design for Reuse, Design for Recycling, Design out Waste, and more, are all variations of a method to reduce, remove or transfer waste in ways that can be seen fit to CE standards. Yet, as one construction project mostly uses a combination of these, the R principles give a more effective overview. For example, the R for Reduce is a general approach that is a combination associated with minimizing waste, Reuse is a combination of methods that focuses on having old materials serve a new purpose, and not being down-, or recycled. Lastly, recycling is a combination of various methods for recreating old materials into new materials (Charef, Lu, et al., 2022).

2.1.1. R-Principles

Many ways to increase the lifetime of materials have been created, although similar, each method has a slightly different meaning. These methods have all come together to form the R principles. Although previously, many studies focused on the 3R principle, this has been shown less effective for true circularity of materials (Çimen, 2023; Charef, Lu, et al., 2022) A more recent study, by Çimen (2023), looked at the many varieties of R-principles and the relation this has to the different phases of building

projects. First of all, he mentions the importance of taking all phases into account before looking at the R-Principles. Most of his viewed studies only included the 3 phases of design, construction and operation. Yet he mentions the effectiveness of CE requires additional phases to be taken into account. One of the most important parts being the End-Of-Life (EOL) phase. In total, he created a list of 7 phases of the building project, listing 'Inception' as the first step before conducting feasibility studies and planning.

In Table 2.1, an overview of his list of R Principles is presented. This table also incorporates all considered stages, marking the amount of R Principles that are important per phase. Refill has been removed. Refill, meaning to make a product that is 'refillable' is not important for this study.

Table 2.1: Results of study on R Principles (Çimen, 2023)

R Principles	Initiation	Feasibility and Planning	Design	Construction	Handover	Operation	Circulation
Refuse	X	X	X	X	X	X	X
Rethink	X	X	X	X	X	X	X
Reduce		X	X	X	X	X	
Reuse		X	X	X	X	X	X
Repair					X	X	X
Refurbish						X	X
Remanufacture		X	X	X		X	X
Repurpose		X	X	X		X	X
Renew		X	X			X	
Replant			X				
Replace		X	X				
Recycle				X		X	X
Recover				X		X	X

Among the previously mentioned phases to take into account, the phase 'Circulation' or 'End-of-Life' is explained to be increasingly important. In traditional research, this phase is considered as the 'End', where demolition takes place. He proposes naming this phase 'Circulation', in order to introduce this change. An example within this last phase is implementing 'Refuse', to refuse material disposal for landfill. Rethinking material circulation for a next use. This phase is vital, as this phase takes place where demolishing or reusing materials comes into play. He mentions the importance of this phase as a comparison to frameworks like LEED or BREEAM, where this addition is less important. Incorporating effective R Principles is specifically important, as the various methods of circular implementation will give a more structured way to determine effective CE measures that stakeholders can apply.

A downside of using R principles, according to Charef, Lu, et al. (2022), as they mention in their research is that reuse can be seen as having a potential to be a circular method, however the actual amount of times an item can truly be reused greatly differs. Given examples of materials would be metal, which can rust, wood, which can rot or bricks, which can decay. Therefore it is very important to determine effective ways to truly measure how a building can be directed towards CE and more alternatives (in terms of R Principles) are necessary and methods to rate and rank materials is an important addition for new construction projects. Which, in a broad sense, would mean that more R's would mean better options for staying in the circular loop of materials, and giving more direction towards the circular goals a project would want to reach. In short, along with various authors they mention the 3R principle is obsolete and often leads to subtle forms of green washing. As such, more R's are necessary (Çimen, 2023). Charef, Lu, et al. (2022) also mention that the use of the 3R's, while part of a circular strategy, often lead to material down-cycling. Meaning a reduction of material quality in the long term. This term is more related to the recycling principle, rather than circularity (Charef, Ganjian, et al., 2021).

2.1.2. Most important CEP's in literature

Now that all information is present, it is possible to determine what Circular Economy Principle, or a combination of, is most effective to serve as a basis for conducting the future research on the topic.

As can be seen in the previous sections, the many different principles that adhere to the CE differ, while coming close in a way that can all be seen circular, there is a guideline as to what is more circular then other methods. As such, R-Principles as a measurement that can determine how 'circular' a method of construction is on the basis of previously agreed upon guidelines is a very effective way that encompasses many of the 42 circular design methods. It encompasses using existing materials in different methods using a step by step approach, by combining many different methods of design and thought (Charef, Lu, et al., 2022). These steps of the R-principle offer an effective guideline per phase of the project, just as the 'design for ...' strategies follow a general guideline of least to worst CE method. As Çimen (2023) has mentioned, these R's can differ in priority or effectiveness per phase. Theoretically, this will be the most important measurement tool to determine what changes were made in the case study approach later on.

2.2. Barriers

This section includes most important barriers of CE implementation during the project life cycle. To start off, as mentioned in the introductory chapter, Durdyev et al. (2023) mentions that a lack of information sharing in the form of not having knowledge and not being informed often has a large impact on persevering toward set ambitions. Using various pieces of literature, a comparison is made to determine most important barriers that are necessary to solve in order to successfully implement CE.

In the literature of Munaro and Tavares (2023) an overview of 41 barriers of CE implementation is found. These barriers have been found by using a literary research approach and can be considered a summation of all barriers linked to stakeholders. In the research of Munaro and Tavares (2023), barriers are linked to their respective stakeholders. These stakeholders are divided by a section of internal stakeholders (active within a construction project), along with external stakeholders such as the public and the government as a whole. The external stakeholders are affected by, or influence the project on a larger scale, while internal stakeholders either work within the project or provide funding. An overview of all stakeholders, and stakeholder groups they incorporate in their research is shown in Figure 2.1.

These stakeholder groups will introduce an effective measurement tool to determine which barriers can be negated by focusing on various stakeholders. This link between stakeholders and barriers is therefore considered necessary and important to include for incorporating CSF to overcome the barriers later in this chapter. Additionally, this will serve as a reference to compare barriers within an actual case study, in order to successfully present how SES are able to overcome these barriers in the future.

Level	Generic stakeholder	Abbreviation	Members
Internal (I)	Clients	cli.	owners, users, consumers
	Project professionals	proj. pro.	project managers, designers, architects, engineers, facilities managers, investors, subcontractors, real state agencies, builders, employees
	Suppliers	suppl.	manufacturers, process, and service providers
External (E)	Public	publ.	media, community representatives, neighbors, the press, the academy, pressure groups, civic institutions, visitors, the natural environment
	Government	gov.	legal authorities, regional development agencies, civic institutions, government establishments

Figure 2.1: Stakeholders used in Munaro and Tavares (2023)

In the analysis of Munaro and Tavares (2023), various categories of barriers are stated, linked to stakeholder groups in Figure 2.1. These barriers are explained per category below.

The first category of barriers is focused on economic difficulties. As the name suggests, some areas are fully focused on the financial effects of reusing materials, yet other aspects focus more on the lack of financial incentives, or in other words, collaboration between government bodies and other stakeholders in the construction projects.

Their main barrier focused on the lack of marketing strategies for the reinsertion of secondary materials. Linked to the lack of incentives for reuse of materials. Additionally, product prices do not incorporate the environmental and social costs of the processes of re manufacturing such materials for circular implementation (Munaro and Tavares, 2023).

1. Lack of market mechanisms for recovery/reuse of materials. (Akinade et al., 2020)
2. Product prices don't take environmental costs into account. (Selman and Gade, 2020)
3. Financial and risk aversion for circular business models (Charef and Emmitt, 2021)

These are three of the ten mentioned barriers on the economic side of the construction industry. Although these are still mainly focused on financial incentives and additions to legislation surrounding the use of used materials. They also share a large common ground with stakeholder collaboration barriers. The above mentioned have a connection to both the government/municipality and project professionals (i.e. Contractors, Engineers Architects, etc.), which shows that they would most likely benefit from discussion on how various parties can collaborate to achieve the CE goals set at initial moments within a construction project, but also to create more financial incentive for project organisations to make such construction methods more worthwhile in financial terms.

The second category focused on the introduction of informational barriers. As this is mainly directed towards the perception of the public, this research is considered less relevant for the improvement of stakeholder collaboration within a project. Nonetheless, their most important barrier of this section is considered to be the *lack of awareness and consumer demand*. However, as this barrier is directed solely towards 'the public' as a stakeholder, an additional barrier focused on the improvement of knowledge of CE is considered more important for this thesis.

1. Limited environmental management programs and facilities at academic institutions. (Williams, 2019)

This barrier, out of four, focuses on the lack of information surrounding the possibilities of CE. This barrier has effect on collaboration, as differences in background knowledge can affect decision making per stakeholder in various phases. Resulting in a decrease of CE goals in the end (Guerra and Leite, 2021). The stakeholder that can be linked to this barrier, can be summed up to stakeholders that are actively involved in spreading information. Munaro and Tavares (2023) states the stakeholder that is involved in this is the government/municipality and the public.

Next, the Institutional barriers are stated. Out of six barriers in Munaro and Tavares (2023), all six are relevant. They explain the main barrier within this section is the lack of collaborative dynamics between various stakeholders. This section is therefore considered extremely relevant for this thesis. A more specific barrier shows a cause of this barrier could be the outdated methods of collaboration, with multiple construction stakeholders active in separate phases and expertise's. This is considered outdated, as the linear 'Take-make-break' methods allow each stakeholder to very linearly focus on their own expertise, while within circular methods of collaboration there is a need for deep collaboration among all stakeholders, including designers, suppliers, and recyclers, which is less emphasized in traditional models (Leising et al., 2018). This is further reason for incorporating new and improved Stakeholder Engagement Strategies. According to Munaro and Tavares (2023), there is also a lack of knowledge sharing on various fields. To negate this, it is important to share information on what a good design for CE would mean, but also what tools are effective to use in order to get all stakeholders on the same page.

1. Conservative, competitive, and fragmented supply chains (Williams, 2019)
2. Lack of thinking about buying a service instead of having the ownership (Al Hosni et al., 2020)
3. Lack of information about Design for Demolition, green design, and end-of-life products (Akinade et al., 2020)

4. Lack of knowledge about circular tools (Environmental Product Declarations, Material Passports, certifications, etc.) (Akinade et al., 2020)
5. Insufficient application of waste hierarchy (overemphasizing recycling) (Ghisellini et al., 2018)
6. Lack of guidance and tools for implementation of circular buildings (Charef and Emmitt, 2021)

These barriers can all be linked to project professionals, such as Designers (Architects), Contractors (Engineers) and more. 2 and 3 are related to the client of a construction project, while 4 and 5 are linked to the suppliers of materials.

The next section lists a set of technological barriers that arise. These are often too technical to be fully researched within this study, yet various barriers are relevant, as collaboration increases the sharing of knowledge and in turn improving the availability of options that can be implemented within construction projects (Leising et al., 2018). Their main barrier for this category was the lack of a construction design standard for implementing a circular strategy. This had various reasons, examples are the lack of knowledge of the designers (Architects), and the Architect's, Contractor's and builder's conflicting views on Design for Demolition, or other 'Design for ...' methods. Lastly, the lack of quality of data reduced confidence in the sharing of information, in turn reducing the effectiveness of collaboration within projects (Munaro and Tavares, 2023). All of these barriers are applicable to the stakeholder groups; Project Professionals, and the Suppliers of the project.

1. Lack of tools for identifying, classifying, and certification of salvaged materials (Akinade et al., 2020)
2. Lack of effective green building design development (Wu et al., 2019)
3. Lack of quality and availability of data (privacy, trust, ownership, access) (Selman and Gade, 2020)
4. Lack of documentation of new and used building products (Selman and Gade, 2020)

An overview of 14 relevant barriers (Munaro and Tavares, 2023) and their inclusion of stakeholders within this context is shown in Table 2.2.

As can be seen, Project Professionals (combining many stakeholder) are relevant in all chosen barriers except one. Suppliers and the Government/Municipality are also considered important. It shows the public as least relevant stakeholder group, this group will not be incorporated in this research.

To compare Munaro and Tavares (2023) their research on barriers, a short list of broad challenges has been presented in the research of Guerra and Leite (2021), a research paper which Munaro and Tavares (2023) have not incorporated during their literary research. They conducted research in the US, which is relatively behind European countries in terms of research on CE (Guerra and Leite, 2021). Nonetheless, they mention various types of challenges that have proven to be difficult when implementing circular construction strategies. Namely,

1. Budget and upfront costs;
2. Schedule and project timeline;
3. Lack of awareness and change resistance;
4. Current construction business model;
5. Lack of regulations and implementation guidelines.

Although the US industry is relatively lacking in terms of CE (Guerra and Leite, 2021), similarities can be observed that show the general presence of barriers. Schedule and project timeline (2) is shown to be a vital aspect of improvement, which is linked to additional costs and adaption in project decisions if things go wrong, therefore it can be seen as a barrier within this sector. Lack of awareness and change resistance (3), is only partly a barrier in Dutch construction projects. As awareness surrounding CE in European countries, such as The Netherlands, is relatively more advanced (Guerra and Leite, 2021). However, the resistance to change can be seen as a large barrier that occurs in real life projects. To add to this, resistance has significantly reduced in most construction firms in general since publishing this article. The downside is, the difference in resistance between stakeholders is often a large issue. When one party is willing to change, yet another has different interests and is reluctant, this can cause

Table 2.2: An overview of barriers and their respective stakeholders (Munaro and Tavares, 2023)

Category	Barrier	Stakeholder
Economic	Lack of market mechanisms for recovery/reuse of materials.	Gov. / Project Pro.
	Product prices don't take . environmental costs into account	Gov. / Project Pro.
	Financial and risk aversion for circular business models	Gov. / Project Pro.
Informational	Limited environmental management programs and facilities at academic institutions	Public / Gov.
Institutional	Conservative, competitive, and fragmented supply chains	Project Pro. / Suppliers
	Lack of thinking about buying a service instead of having the ownership	Client / Project Pro.
	Lack of information about Design for Demolition, green design, and end-of-life products	Client / Project Pro.
	Lack of knowledge about circular tools (Environmental Product Declarations, Material Passports, certifications, etc.)	Project Pro. / Supplier
	Insufficient application of waste hierarchy (overemphasizing recycling)	Project Pro. / Supplier
	Lack of guidance and tools for implementation of circular buildings	Project Pro.
Technological	Lack of tools for identifying, classifying, and certification of salvaged materials	Project Pro. / Supplier
	Lack of effective green building design development	Project Pro. / Supplier
	Lack of quality and availability of data (privacy, trust, ownership, access)	Project Pro. / Supplier
	Lack of documentation of new and used building products	Project Pro. / Supplier

difficulties for achieving goals. Which can be linked back to *Lack of quality and availability of data (privacy, trust, ownership, access)* (Munaro and Tavares, 2023). The business model (4) is seen as an additional challenge. As an interviewee in the study of Guerra and Leite (2021) mentions, "construction developers' business plan does not necessarily follow the same lifespan to which the building is designed".

Leaning into the problem this has for the CE, such as modular construction as an alternative, the clients or developers often have a lack of incentive to build for a longer period of time than they feel necessary, linking back to aversion to circular business models as a barrier in Munaro and Tavares (2023).

Concluding this section, Munaro and Tavares (2023) their research has proven to be relevant as a theoretical foundation for next steps within this research, it not only shows comparison of barriers through literature, their introduction of stakeholders that affect them also show the relevance of improvement of stakeholder collaboration and knowledge improvement. Guerra and Leite (2021) highlights similar barriers, even though their research is based in the US, which further shows not only European/Dutch relevance but also relevance on a global scale. This answers the first part of SQ2, as it is now known what the key barriers, through literature, are toward implementation of CE ambitions.

2.2.1. Critical Success Factors

In order to negate the previously stated barriers, critical success factors (CSF), also called Drivers (Munaro and Tavares, 2023), have been created in order to improve the efficiency of implementing CE ambitions. CSF's can be seen as factors that are vital to take into account for achieving certain goals, in this case the successful implementation of CE ambitions within construction projects.

In a recent study, Wuni and Shen (2022) performed a study that showed a list of 21 critical success factors. Each of these factors, in order of importance, show important additions that should be considered in order to improve the achieving of CE goals. A list of the most important success factors of Wuni and Shen (2022) is shown in Table 2.3.

Table 2.3: Critical Success Factors for CE by Wuni and Shen (2022)

CSF Number	Critical Success Factor
1	Early design completion and freezing (of the initial goals)
2	Early understanding and commitment of the client
3	Effective leadership and support of a specialist contractor
4	Adequate knowledge and experience of the project team
5	Collaborative working and information sharing among project teams
6	Design for manufacture, assemble and circular economy
7	Early and active involvement of critical project stakeholders
8	Effective coordination and integration of stakeholders

This list, out of 21 CSF's, show the 8 highest ranked factors according to research on the topic. Using survey participants in the sector, Wuni and Shen (2022) were able to rate their importance. These CSF's have a directed focus on the usefulness of stakeholders, and more specifically, stakeholder engagement strategies as explained in the introduction of this thesis. Linking these CSF's to stakeholders has not been done explicitly within this research. For CSF 2 (Client) and 3 (Contactor) this relation can be considered straightforward, yet others depend on specific context of a project (Zwikael and Globerson, 2006). Which stakeholders can be considered to focus on Leadership, and which of these can be considered 'critical' stakeholders is currenty unknown. This is something to research further in future sections of this thesis

Additionally, in a more recent study of Wuni (2023), an additional 30 Critical Success factors have been found though various analyses. This research touches upon many specific factors, ranging from technical, institutional, stakeholder and supply chain which can help improve implementing CE in the construction sector. Using their research a summary of CSF's is made that incorporate collaboration, involvement and/or commitment of stakeholders, see Table 2.4. This is relevant for this study, as the before mentioned research of Munaro and Tavares (2023) shows the link between a large number of barriers and their respective stakeholders.

This research has not included an overview of links between the given success factors and their respective stakeholders for successful implementation, as done in the section on barriers (Munaro and Tavares, 2023). This should also be researched further in the future part of this thesis. This research can still be considered relevant, as it focuses on effective implementation of CE ambitions in the construction sector.

As a final addition of literature, the research of Munaro and Tavares (2023) also highlights effective solutions for the barriers they found through literature. Table 2.5 shows an overview of a collection of these so-called 'Drivers', comparable to CSF's.

Table 2.4: Critical Success Factors for CE by Wuni (2023)

Group	Critical Success factor
Organisational Success Factors	Adequate awareness, commitment, support and leadership of top management
	Adequate financial resources and sufficient funding
	Appropriate organizational structure, culture, readiness, capabilities and strategies
Stakeholder Success Factors	Sustained collaboration, communication and information sharing among stakeholders and project team members
	Early involvement and commitment of project team members and stakeholders
	Clearly defined and shared goals of circular construction projects among stakeholders
Supply Chain Success Factors	Strong coordination, collaboration, and vertical integration of supply chain partners

Table 2.5: Drivers for CE by Munaro and Tavares (2023)

Category	Driver	Stakeholder (Group)
Economic	Establishing a market for secondary materials	Government/ Municipality
Informational	Disclosure of best practice case studies, seminars, and workshops on sustainable development	Public & Government/ Municipality
	More CE academic research and projects should be done by developing guidelines	Public & Government/ Municipality
Institutional	Establish a culture of sorting on-site, separating, collecting, and treatment of the Construction Demolition Waste (CDW)	Project Pro./ Supplier
	Encourage designers and builders to reuse CDW and prioritize upcycling rather than recycling	Project Pro.
	Create links between demolition contractors and stockists to incentivize deconstruction and materials salvage	Project Pro./ Supplier
	Training stakeholders to increase the understanding of CE and sustainability	Project Pro./ Supplier
Technological	Early collaboration and inclusion of waste management in project sustainability tools and building control process	Project Pro.
	Development of guidance and tools for the assessment of building circularity	Project Pro.
	Incentive Design for adaptability and disassembly using design tools	Project Pro.
	Improving certification of recovered materials to reduce uncertainty and lack of trust	Project Pro./ Supplier

Table 2.5 presents an overview of important 'Drivers'. Within the research of Munaro and Tavares (2023), each of their mentioned categories is considered relevant for the improvement of CE ambition implementation. The Economic driver is most necessary to introduce a clear business case where all stakeholders can understand the financial possibilities surrounding the use of CE (Adams et al., 2017). For the informational driver, the most important effect this has is the improvement of knowledge surrounding the CE. As Munaro and Tavares (2023) states, "The CE transition will not be accomplished without significant research and development effort". Within this category, the addition of promoting partnerships between bodies of knowledge (i.e. Universities, Companies and Research Centers) is vital. For the Institutional Drivers, the most important addition is the creation of partnerships, this in turn ensures closing the loop for a true circular system where a chain of partnerships allows materials to be reused and reworked in a constant rate.

Comparing these to the CSF's of Wuni and Shen (2022), multiple aspects are interesting to note. First of all, the 'Drivers' have been successfully linked to stakeholders within the context of the construction sector, and comparison is made between these 'Drivers' and their 'Barrier' counterparts. This is not the case for the CSF's, however the CSF's highlight various other (broader) factors that have also been shown to have value for successful implementation of CE ambitions through literature (Wuni, 2023; Wuni and Shen, 2022).

That said, overlapping factors can be found. For example, all three sources emphasize the importance of early involvement and collaboration of stakeholders. This also includes involving stakeholders in early phases of the design, as this is crucial for setting expectations and aligning goals. Both the research of Wuni and Shen (2022), and Munaro and Tavares (2023) highlight the relevance to enhanced knowledge within the a project. Wuni and Shen (2022) lays emphasis on the need for adequate knowledge, awareness and leadership, while Munaro and Tavares (2023) focuses on training and academic research. Both CSF's and 'Drivers' lay a specific focus on incorporating alternative financial methods to enhance CE; Munaro and Tavares (2023) explains the necessity of establishing a secondary market, while Wuni (2023) simply prioritizes adequate financial resources. Finally, all research focuses on improvement of Leadership, Commitment and Support. This is implied by Munaro and Tavares (2023), by mentioning *"training stakeholders to increase the understanding of CE and sustainability"*, and *"development of guidance and tools for the assessment of building circularity"*

As a result, all mentioned CSF's are considered relevant to incorporate in this research for several reasons: they lay a justified theoretical foundation for determining new variations between theory and construction projects, it partly shows a large list of "Drivers" that have already been connected to stakeholders, showing the importance of "Drivers" in overcoming barriers within the context of CE. It also shows a list of broader CSF's that have not specifically been linked to stakeholders, which forms a gap in research to be developed further. In addition, this concludes SQ2

Table 2.6: A combination of Drivers and Critical Success Factors for CE

Theme	Driver (Munaro and Tavares, 2023)	CSF (Wuni and Shen, 2022; Wuni, 2023)
Early Involvement and Collaboration	Early collaboration and inclusion of waste management in project sustainability tools and building control process	Early design completion and freezing of initial goals
		Early and active involvement of critical project stakeholders
		Sustained collaboration, communication, and information sharing among stakeholders and project team members
Knowledge, Training, and Awareness	Training stakeholders to increase the understanding of CE and sustainability	Adequate knowledge and experience of the project team
	More CE academic research and projects should be done by developing guidelines	Adequate awareness, commitment, support, and leadership of top management
Market and Economic Considerations	Establishing a market for secondary materials	Adequate financial resources and sufficient funding
	Improving certification of recovered materials to reduce uncertainty and lack of trust	Clearly defined and shared goals of circular construction projects among stakeholders
Leadership, Commitment, and Support		Early understanding and commitment of the client
		Effective leadership and support of a specialist contractor
		Appropriate organizational structure, culture, readiness, capabilities, and strategies
Design and Innovation	Incentive Design for adaptability and disassembly using design tools	Design for manufacture, assemble, and circular economy
Practical Implementation and Tools	Development of guidance and tools for the assessment of building circularity	
	Create links between demolition contractors and stockists to incentivize deconstruction and materials salvage	

2.3. Stakeholders

The vast amount of stakeholders that is engaged in construction projects, often leads to a lack of communication between them. Generating errors, delays and additional waste that is often unnecessary, leading to a negative impact on the environment (Charef, Lu, et al., 2022). The information gathered in previous sections on Barriers and CSF's shows that collaboration between stakeholders and a holistic stakeholder approach (considering all stakeholders within the given context) are key to improving the effective implementation of CE within the construction sector (Çimen, 2023; Munaro and Tavares, 2023; Guerra and Leite, 2021; Wuni and Shen, 2022). In this chapter, additional research on stakeholders is done in order to determine which stakeholders have to be prioritised during the future section of this thesis.

2.3.1. Stakeholders within the project life cycle

In this section, the stakeholders that will be taken into account will be discussed.

In the research of Munaro and Tavares (2023), many stakeholders are presented in the form of Project Professionals, Government, Public, Suppliers, etc. This, on its own, is effective in showing the large number of stakeholders that exist within the context of the construction sector, Jones and Samy (2021) and Charef, Lu, et al. (2022) also confirm this. This broad variety shows the necessity for determining a select group of most important stakeholders, specifically for the implementation of CE ambitions. This is done in the literature of Ma and Hao (2024). This list is explained to be most important for the incorporation of CE goals in a project. Four of these are relatively common in general construction projects, while the addition of Material Recycling Facilities is specifically present, and increasingly important, for the implementation of CE.

1. Designers
2. Contractors
3. Project Investors/Initiators (Client)
4. Government
5. Material Recycling Facilities

This list, in comparison to the list within the research of Munaro and Tavares (2023), shows a favorable resemblance: in their research, Project Professionals are listed as important within almost all Barriers and Drivers. This group also consists of Designers, Contractors (as Engineers). Their research names the inclusion of the Client and the Government within this context. The only missing stakeholder is the inclusion of the Material Recycling Facility, which is where a gap in literature exists. This stakeholder is vital to include, especially surrounding CE implementation, as their knowledge and interest within accurate deconstruction of buildings will result more effective (high quality) reuse at the end of a buildings life cycle (Ma and Hao, 2024)

As explained in Jones and Samy (2021) and Charef, Lu, et al. (2022), the extensive field of stakeholders within a construction project is enormous. They mention the inclusion of policy makers, legislators, developers, real estate investors, architects, engineers, contractors, material suppliers and manufacturers as part of the construction project. Even end-users and occupiers/residents can be accounted for their inclusion. However, this inclusion is very limited when regarding CE implementation (Jones and Samy, 2021). As they confirm, the inclusion of so many stakeholders results in the loss of values that have been depicted at the start of the project, lack of communication can even increase this loss and end in conflicts. They mention stakeholder management is key to incorporating all separate ideas and knowledge fragments into one whole, in order to successfully conclude initial values. One important aspect to mention, is their addition of a vital stakeholder in the project, the stakeholder manager. This person or group has a sole priority to align all interests of stakeholders. The question arises, who should take up this task?

Lastly, Jones and Samy (2021) mentions the importance various stakeholders, one of them being a general term of 'Leader of the transition, which can bring forth great change within project with regard to CE. Yet the question of who is this 'Leader' remains unanswered, just like who should be the stakeholder manager. This would be one of the highlights of the second section of this thesis. Additionally, a very important stakeholder is the architect within the construction project. They are said to be the front runners that can bring awareness of Circular Economy Principles to the construction project (Jones and Samy, 2021). One of the interviewed architects in this study mentions the importance of the municipal authorities to ensure the CE implementations truly get realised. Which is knowledge that is important to include when looking for the 'Leader of the transition' in the next phase of the thesis.

As mentioned, stakeholders often have different priorities within a construction project. Often, these priorities lie in the phases of preparation, design and construction, and are all equally important (Charef, Lu, et al., 2022). Yet one of the more important sections that often gets excluded is the End-Of-Life (EOL). As explained in the research of Charef, Lu, et al. (2022), important stakeholders that fulfill most of this role are called the 'demolition contractor' and 'recovered materials players', which can also be seen as 'material recovery companies' (Ma and Hao, 2024). Which should be incorporated in the early stages of the project to expand the knowledge of demolition to designers and architects (Jayasinghe et al., 2019).

Within the literature surrounding this topic, little to none can be found linking the involvement of stakeholders to specific stages within the construction sector. An assumption is this varies per construction project. Additional research is necessary to determine this relation.

2.4. Stakeholder Engagement Strategies

This section of the report will be the basis for the empirical research, in other words, the case study of the Bajeskwartier. Using various research papers, a global understanding will be made as to what SES are, in a general sense, and why they are currently not good enough for incorporating the ambition achieving of CE within the context of the construction sector.

First off, it is relevant to mention why stakeholder engagement, which has generally been used for a long time, is increasingly relevant when implementing CE ambitions specifically in construction projects. This is because of the fact that successful implementation of CE ambitions require a long term vision of collaboration. As construction projects can be seen as long term, traditional stakeholder mapping techniques fail to encompass this factor of collaboration on a long term basis. As will be explained further on in this chapter, long term positive relations between stakeholders are they key to making these CE processes possible (Kaipainen et al., 2023). Therefore, initial and continuous stakeholder engagement is a necessity for successful achievement of CE ambitions (Wuni and Shen, 2022). This will be further explained in this chapter.

Using the research of Kaipainen et al. (2023), an understanding of various scenarios is sketched. One of these is focused on a large field of unconnected stakeholders and how to incorporate strategies in this context, another is a strategy where there is one general stakeholder that is responsible for incorporating other stakeholders, directing them to the set ambitions. The reason both these scenarios will be sketched, is because both are relevant for construction project (Blomberg et al., 2023). As depicted in the research of Kaipainen et al. (2023) where a study has been done on five different types of sectors, and the implementation of CE within each. The construction sector is shown to reside right in the middle of having aligned and non-aligned stakeholders, but leaning more toward a structure being self-organised instead of hub-centered. Although this is the case, a disagreement can be made on the basis of CE implementation. As mentioned in Ma and Hao (2024), using waste management facilities as an example, are required to fully make a construction project circular. This leans more toward a hub centered approach, as Kaipainen et al. (2023) explains *"The hub ... cannot reach the CE system-level goal alone and is therefore interested in new stakeholders" - (Kaipainen et al., 2023)*. This calls for comparison of both methods for incorporating stakeholders and broadening the knowledge sharing capacity.

2.4.1. Stakeholder Strategies

In the research of Kaipainen et al. (2023), a schematic representation of various steps is shown that they have used to track 1) Identification & prioritization of stakeholders, using their power, legitimacy & urgency. Kaipainen et al. (2023) had made use of the salience model to measure this, 2) Reaching out and securing the interests of stakeholders, 3) Applying practices for integrating and interacting with stakeholders using relationships, communication and learning and finally 4) Processing these outcomes to determine how to proceed. As shown in Figure 2.2.

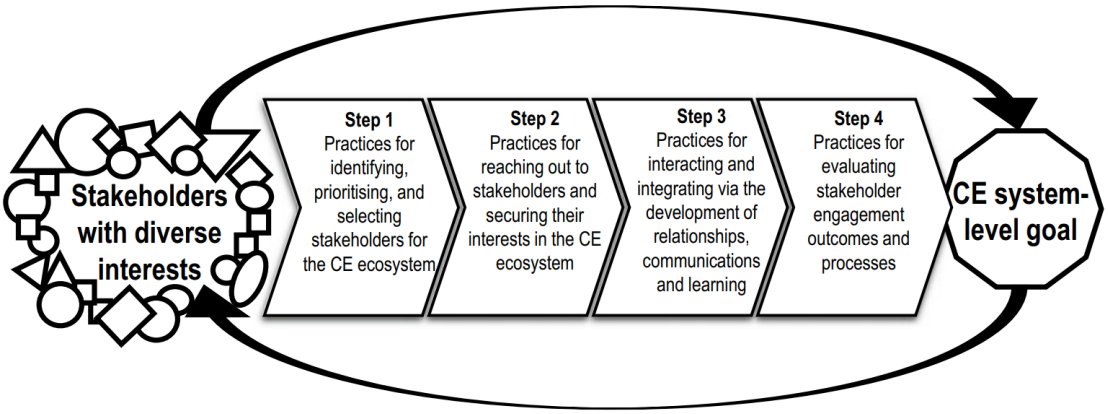


Figure 2.2: The four steps of stakeholder engagement (Kaipainen et al., 2023)

One of the methods that they have not included is additional reference to the R Principles, as an encompassing term of other circular design approaches. This should be included to make the method of researching stakeholders additionally relevant, as this gives a very complete overview of the waste hierarchy, such as the 'design for ..' principles (Charef, Lu, et al., 2022). This should be done in step 2, in order to include their interest will not only include the interest in CE, but also what they deem to be 'circular' even though they support the cause of implementing CE ambitions. Secondly, an additional section per stakeholder should be focused on researching whether they would prioritise a self-structured or hub-centric approach, who they would deem most effective for a hub-centric scenario and why. Lastly, adding a section in step 3 for incorporating performed actions during the project, that have lead to certain decisions regarding CE. This is important to add, due to the additional value it has comparing the interests of stakeholder groups.

Using the method of Kaipainen et al. (2023), four types of engagement strategies have been created . To use this as a basis for this research, an overview of is presented below.

As can be seen in Figure 2.3, the four strategies **Rush Hour**, **Chain Reaction**, **Sieve** and **Attracting Magnets** are shown. As mentioned above, these can all be seen as relevant methods because construction projects often reside in the middle of this graph. Between non-aligned and aligned, between self-organised and hub-centered. The downside to their study is the lack of data to back up whether these seem to truly be effective in a case study scenario, as the research of Kaipainen et al. (2023) has been focused on multiple cases. Four of which are outside of the construction sector scope. The interviewed participants in the construction case study were focused on the greater picture of implementing CE within construction. Yet no studies have inspected this method of implementation within an actual ongoing construction project. Below, a more detailed overview of the four strategies is given.

The **Rush Hour** strategy can be used for stakeholders that are not aligned with the common interests of the general ambitions. There is no group/hub that guides these stakeholders. Due to varying priorities and interests situations can occur that hinder the overall process. As these stakeholders progress, situations can also arise that align stakeholders, moving them all in a uniform and mutual direction.

In this scenario, initial steps can be made by an individual within a CE context to determine other stakeholders that may join this corresponding CE goal. Afterwards, experts within this context determine important goals and information, transferring these to the potential stakeholders depicted in the first step. The third step uses facilitator stakeholders for driving engagement between stakeholder by improving collaboration, seizing opportunities for them to network. At the same time, other stakeholders improve their own skills by sharing knowledge and engaging in dialogue to shift toward the CE goals. The last step incorporates stakeholder at a higher level (government or municipality) for implementing evaluations of outcomes versus stakeholders personal ambitions.

The **Chain Reaction** strategy focuses on a loose set of stakeholders that have aligned interests, making engagement easier to happen in a natural manner. As the name suggests, the chain reaction allows these small and natural forms of engagement to proceed, making the stakeholders more aligned as

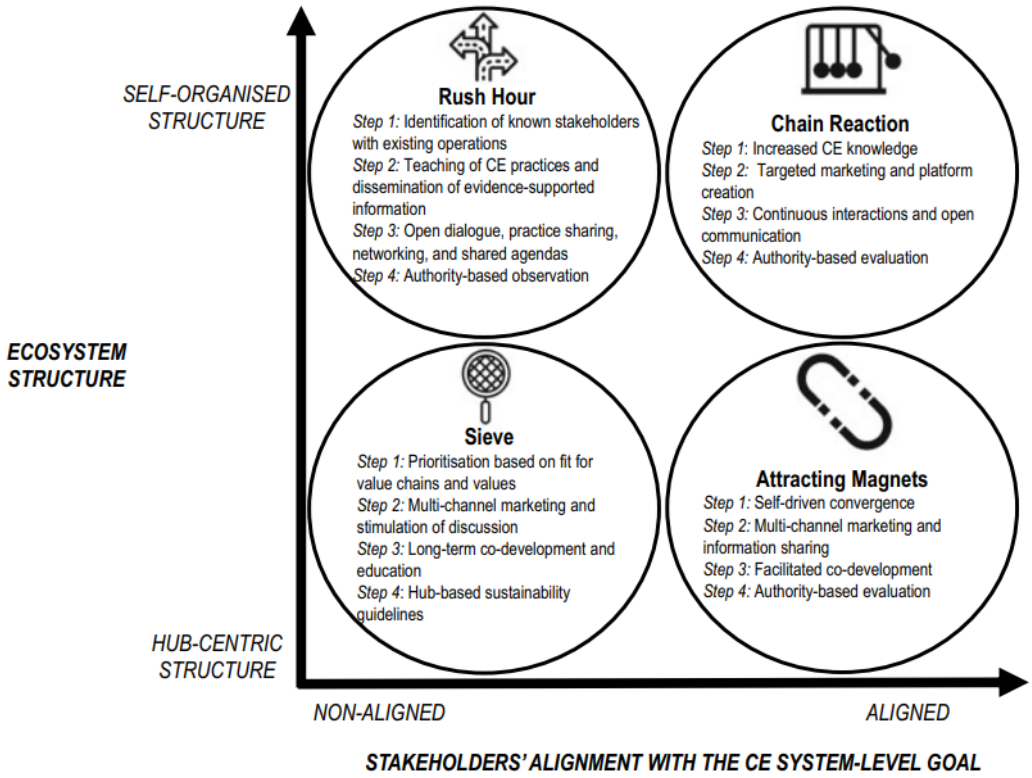


Figure 2.3: Four strategies (Kaipainen et al. (2023))

time progresses.

The steps that can be implemented to direct this method of engagement is to first use organisations that initially facilitate the CE goals which need to be achieved, these organisations are expected to have increase knowledge of CE. These organisations identify stakeholders through various means, such as seminars and past projects. Afterwards, the second step uses these organisations to locate stakeholders with the highest level of succeeding in the CE goals, using various means of communication to spread awareness of the goals. This is said to be performed within the construction case researched in this study (Kaipainen et al., 2023). The third step is to have all stakeholders interact, in order to build a mutual form of trust, allowing sharing of knowledge and information. This, in turn increases motivation within the project.

The **Sieve** strategy can be implemented when one stakeholder focuses as hub, choosing, or sieving, specific stakeholders that fit best in the project, using their help to achieve goals. In this sieving method, not all stakeholders are required to align toward the goal, yet they should not hinder the progress.

The first step begins with the hub identifying stakeholders that fit it's values and seem trustworthy, classifying stakeholders with a long term relationship as most important aspect. The second step the hub shares the CE vision through channels and discussion between stakeholders. The third step focuses on encouraging and educating other stakeholders, envisioning long term relationships in the process. Lastly, step four focuses on evaluating stakeholder engagement within the project toward the guidelines of set circularity ambitions.

The **Attracting magnets** strategy serves situations with two aligned stakeholder groups. These both serve as the hub that brings new stakeholders together, as it can not reach CE ambitions alone. Stakeholders therefore share interests and ambitions to improve and reach goals together.

The first step here is for each of the stakeholders to determine its own potential for aiding in the process of achievement. The second step has the hub incorporate the interests of potential stakeholders using an open knowledge sharing method to define CE issues. In step 3, the hub aims to improve co-

development of CE solutions towards the goals. The last step uses stakeholders with a role of authority, like municipality or government, to evaluate solutions and maintain the fulfilment of specific interests per stakeholder.

2.5. Theoretical Framework

As a conclusion to this chapter, a theoretical framework can be created to show the known and unknown variables located as a summation of this literature chapter. This framework is considered to be a bridge between theory chapter and the methodology chapter of this thesis. It starts listing found sections within literature, explaining performed steps in the process, finally ending with an explanation as to why empirical research is necessary to fill additional research gaps that were not obtained through literature.

As a complete overview, Figure 2.4: Theoretical Framework presents all steps within this chapter in a schematic manner. Within this image the square/rectangular boxes show steps that were taken within this chapter or reasoning as to why the steps are necessary. Additionally, the round text boxes show the thought process that took place.

2.5.1. The literature

Within the previous chapter, four subsections were divided, related to the four sub questions were necessary to research further, gaining knowledge on what was relevant and known within literature. These sections were partly necessary for the inclusion of the research of Kaipainen et al. (2023) on incorporating the most effective Stakeholder Engagement Strategy, while the section on most important stakeholders was added to laying a foundation for the empirical research section.

R-Principles

The first section consisted of research on the field of circular economy principles (CEP), which allowed for a better understanding of the broad spectrum of methods for incorporating CE within the construction sector. This section allowed for better understanding of what the CE is, and how to measure general knowledge of the CE. This can be done using a step by step depiction of circular strategies ranging from least to most circular (Charef, Lu, et al., 2022). The 14 R-Principles of Çimen (2023) are considered a perfect fit for this. He mentions the importance of adding many steps, in comparison to the traditional 3R or 5R principles, for subdividing specific CE methods. The inclusion of this topic was necessary, in order to determine the knowledge alignment of stakeholders, used for determining the most fitting strategy of Kaipainen et al. (2023).

Barriers and CSFs

The second section of the literature study focused on barriers within the general construction sector that hindered effective implementation of circular ambitions, and CSF's to negate these barriers. These were researched as a foundation to highlight what hinders of CE implementation are known on a theoretical level. Insight into initial barriers allowed for better combination with the CSF's. These allowed for effective (theoretical) measures to negate the barriers, in most cases. The research on barriers through literature presented many relations to various categories. These, considered the Conceptual Themes for future research, being: 1) Lacking knowledge, training and awareness, 2) Stakeholder collaboration and coordination, 3) A lack in market mechanisms and economic considerations, 4) A necessary focus on Tools and Standards fit for identifying materials, and 5) an emphasis on designing with a specific circular purpose in mind (Wuni and Shen, 2022; Wuni, 2023; Munaro and Tavares, 2023).

Additionally, Wuni and Shen (2022) and Wuni (2023) mentioned CSF's that can not be directly linked to the barriers of Munaro and Tavares (2023). These can still be considered highly relevant, as these CSF's focus on the improvement of CE ambition implementation in general. In the next section of this research, there is a possibility that new barriers can be found, or these CSF's have not been implemented at all. This last Conceptual Theme 6) Improving leadership and Commitment, is therefore another part on to focus on. All six Conceptual Themes can be seen in Table 2.7, which acts as a summary of Tables 2.2 (Showing Barriers and respective Stakeholders)2.6 (Showing a combination of Drivers and CSFs). All of the Conceptual Themes are again shown in 2.4.

Within Table 2.7, an overview is created of the Barriers from Munaro and Tavares (2023), along with their Drivers that accompany and potentially negate the barriers they have stated in their research.

Table 2.7: Comparison of Barriers, CSFs and Stakeholders for CE

Conceptual Theme	Barriers	Drivers and CSFs	Stakeholders
Knowledge, Training, and Awareness	Lack of knowledge about circular tools (Environmental Product Declarations, Material Passports, certifications, etc.)	Training stakeholders to increase the understanding of CE and sustainability	Project Pro. / Supplier
	Limited environmental management programs and facilities at academic institutions	More CE academic research and projects should be done by developing guidelines	Public / Gov.
	Lack of information about Design for Demolition, green design, and end-of-life products	Adequate knowledge and experience of the project team*	Client / Project Pro.
Stakeholder Collaboration and Coordination	Conservative, competitive, and fragmented supply chains	Early collaboration and inclusion of waste management in project sustainability tools and building control process	Project Pro. / Suppliers
	Lack of guidance and tools for implementation of circular buildings	Sustained collaboration, communication, and information sharing among stakeholders and project team members*	Project Pro.
	Lack of thinking about buying a service instead of having ownership	Early and active involvement of critical project stakeholders*	Client / Project Pro.
Market Mechanisms and Economic Considerations	Lack of market mechanisms for recovery/reuse of materials	Establishing a market for secondary materials	Gov. / Project Pro.
	Product prices don't take environmental costs into account	Adequate financial resources and sufficient funding*	Gov. / Project Pro.
	Financial and risk aversion for circular business models	Clearly defined and shared goals of circular construction projects among stakeholders*	Gov. / Project Pro.
Tools and Standards for Identifying Materials	Lack of tools for identifying, classifying, and certification of salvaged materials	Development of guidance and tools for the assessment of building circularity	Project Pro. / Supplier
	Lack of documentation of new and used building products	Improving certification of recovered materials to reduce uncertainty and lack of trust	Project Pro. / Supplier
	Lack of quality and availability of data (privacy, trust, ownership, access)	Create links between demolition contractors and stockists to incentivize deconstruction and materials salvage	Project Pro. / Supplier
Designing with a Circular Purpose	Lack of effective green building design development	Incentive Design for adaptability and disassembly using design tools	Project Pro. / Supplier
	Insufficient application of waste hierarchy (overemphasizing recycling)	Design for manufacture, assemble, and circular economy*	Project Pro. / Supplier
Leadership and Commitment	T.B.D.	Early design completion and freezing (of the initial goals)	T.B.D.
	T.B.D.	Early understanding and commitment of the client	T.B.D.
	T.B.D.	Effective leadership and support of a specialist contractor	T.B.D.

The CSF's of Wuni (2023) and Wuni and Shen (2022) have also been incorporated, however as these have not been linked to stakeholders, these have been annotated with an '*'. To present all found barriers and CSF's and group them to measurable themes, it is important to create one fitting table that accompanies all Barriers, CSF's and Drivers into one.

The last Conceptual Theme "Improving Leadership, Commitment and Support" was not a specific theme with links to the research of Munaro and Tavares (2023) on Barriers and Drivers. This section was added, as it was a general theme that came forth from the top three CSF's of Wuni and Shen (2022), which is considered equally relevant to Munaro and Tavares (2023), as Wuni and Shen (2022) conducted research on many CSF's that have a specific aim to improving CE ambitions in the construction sector, the main research goal of this thesis. Additionally, Jones and Samy (2021) confirms the importance of a 'Leader of the transition' within this context, one stakeholder that acts as the main driving force that pushes all other stakeholders. Thereby verifying the necessity of looking into Leadership.

Stakeholders

The third section of research focused on which stakeholders were considered important to include for a empirical research section. Previously, the stakeholders were annotated in groups, according to the research of Munaro and Tavares (2023), where the stakeholder groups consisted of a large body of different stakeholders (i.e. Project Professionals consisted of Project Managers, Designers, Architects, Engineers, Facilities Managers, Investors, Subcontractors, Real state agencies, Builders and Employees). After research on which stakeholders could be considered as most important, specifically for the successful implementation of CE: Client, Municipality/Government, Contractors, Architects and Material Recycling Companies (Ma and Hao, 2024; Jones and Samy, 2021) were found. The first four are incorporated within the research of Munaro and Tavares (2023), therefore using these stakeholders is justified. The last stakeholder, Material Recycling Companies, is not. While their importance is specifically highlighted within the research of Munaro and Tavares (2023). This is reason to believe this list of 5 stakeholders is a well grounded and justified base to use during the Empirical research of this thesis. Highlighted in the right side of Figure 2.4.

Stakeholder Engagement Strategy

The last section of this research incorporated research on Stakeholder Engagement Strategies, more specifically it envisioned what was necessary for effective determination of a most fitting strategy through literature. It was concluded that the research of Kaipainen et al. (2023) recommended looking into actual projects, such as construction projects, for implementation of their framework. In order to do so, it was necessary to look into how their framework could be implemented effectively: what was necessary to use Figure 2.3 in a good manner, while also introducing their four strategies shortly. Their research explains that (A) measurement of alignment of stakeholders towards the CE goals is necessary to determine whether the stakeholders within an ecosystem are aligned or not, while also (B) uncovering the structure of management within an ecosystem. The alignment (A) could be uncovered using the alignment of knowledge of stakeholders, and the alignment of interests and attitude of stakeholders to the goals. The alignment of knowledge, while not specifically highlighted in research of Kaipainen et al. (2023) effectively shows the gaps of knowledge between stakeholders, which is explained to be a CSF through literature (Munaro and Tavares, 2023; Wuni and Shen, 2022). The ecosystem structure (B) can be measured by looking into the ways of leadership within the project.

In order to create effective measurement systems to determine both alignment (A) and ecosystem structure (B), two sets of data are important to research: The alignment of the stakeholders (A), will be researched on the basis of their Knowledge (Conceptual Theme 1), and Interests and Commitment (Conceptual Theme 2). Additionally, (B) the Ecosystem Structure within the project is researched by either determining there is a 'Hub' Stakeholder, or determining the structure can be considered as 'Self Organised'. This section will be done by researching the Leadership and Commitment of stakeholders stakeholder (Conceptual Theme 6).

Until now, Conceptual Themes 3, 4 and 5 are not relevant for research on determining a most fitting Stakeholder Engagement Strategy. A reason being, they focus too much on implementations within the market structure, financial considerations and the implementation of tools for determining viability of materials for high quality reuse. That said, these barriers, and more specifically the CSF's and

Drivers connected to them, will be taken into account when designing the final Stakeholder Engagement Strategy and therefore add as an important variable in this research.

This concludes the steps performed within the literature study of this thesis, it ends with 6 Conceptual Themes that are linked to the measurement methods for implementing an effective Stakeholder Engagement Strategy

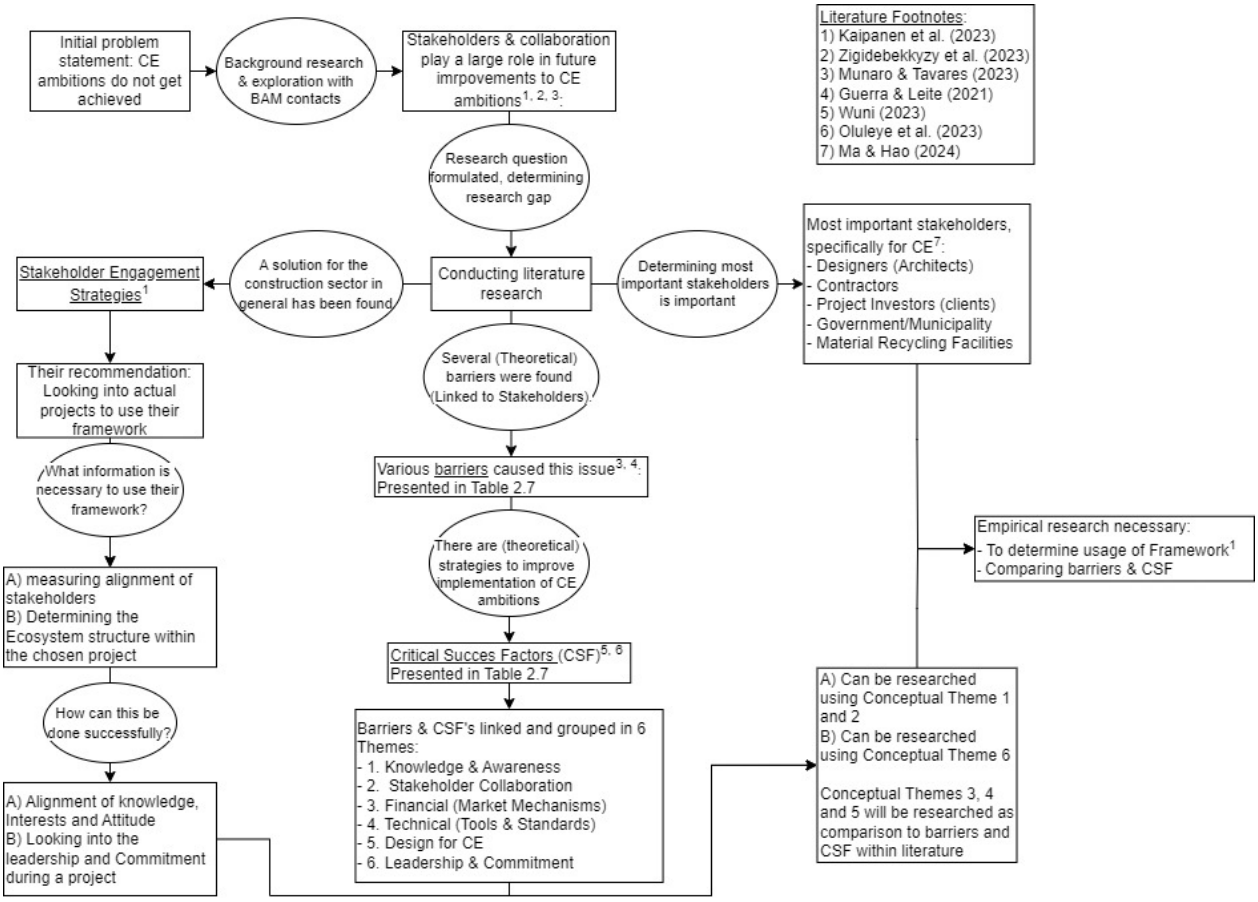


Figure 2.4: Theoretical Framework

3

Methodology

In this chapter the methodology of this research is explained, along with the scope. The scope of this research sets boundaries for the second section of this research, looking into an actual case study within the construction sector. The scope allows a focus on the sections of the total construction projects that were incorporated within this research and what stakeholders are (not) important to consider. The theoretical section consisted of a literature study on each of the separate sub questions, which ended in a conceptual framework. This framework is used as bridge between literature and the methodology, which will be further expanded on further on in this chapter. The method for empirical research consists of a case study approach, incorporating both documentary research of the Bajeskwartier project as well as a collection of semi-structured interviews, here both the interview setup is discussed, along with the methods for transcribing, coding and combining in order to get effective results.

3.1. Scope

In this Chapter, necessary boundaries of the empirical research are set. This part is divided to explain the various phases that the case study research has incorporated and the direction of barriers within this research.

3.1.1. Phases

Building projects progress through distinct phases, each presenting unique challenges and opportunities for CE integration (Noktehdan et al., 2019). From project initiation to completion, stakeholders must navigate complexities related to design, procurement, construction, and operation, while striving to minimize waste and maximize resource efficiency. In this study, the focus will be on the circular style of construction.

While the true circularity is most important at the end of a project life cycle (Çimen, 2023), it is very important to take the design and construction phase into consideration as well (Benachio et al., 2020). The reason for this is that circular building, as depicted in the previous chapter, is a process that takes materials, building methods and other aspects into consideration throughout their lifetime. In order to maximize the usefulness of circular concepts such as the R-principles, it is important to consider doing so at the earliest stages of the project (Çimen, 2023). In Table 2.1 an overview of R Principles per phase is shown. Looking at the amount of R Principles per phase, Feasibility and planning, Design, Construction, Operation and Circulation were considered as most important.

As the case study focused on the Bajeskwartier project, certain phases were not possible to include. This project was divided into various buildings, each with their own planning, and the phase of each building . While various buildings are close to finished, no project has entered the 'Operation' or 'Circulation' Phase. Although this case is highly relevant when comparing CE ambitions to their implementation, the lack of these phases is unfortunate. An alternative for the 'Operation' Phase cannot be included, however the circular ambitions of the old buildings within the Bajeskwartier project allows for the implementation and research of the 'Circulation' Phase. Nevertheless, this phase theoretically is part of

the old building's life cycle, incorporating this section will be part of the 'Initiation' and 'Feasibility and Planning' Phases.

Additionally, an other study explicitly mentions the addition of the 'Initiation' Phase (Neenu, 2017), which is currently missing. In the research of Çimen (2023), the first stage is called 'Inception' and is explained to only incorporate 'making the decision to start a building project' (Çimen, 2023) before feasibility studies can be done. The explicit phase to 'make the decision to start a construction project' can not be covered in this case study. The Initiation phase is therefore considered as more relevant, as it is explained that initial project boundaries are stated here (Neenu, 2017). To further explain why this phase is more important: earlier collaboration often follows through to more aligned knowledge of CE between stakeholders and a better general perception of what the set goals at the beginning of project include (Benachio et al., 2020; Wuni and Shen, 2022). In turn, this will increase effective circulation of resources at the later stages, such as a building's 'Circulation' phase, making this phase important to include within this research (Çimen, 2023).

The phases included in the scope of this research will therefore be:

1. Initiation Phase (Including Circulation of the old buildings)
2. Feasibility & Planning Phase
3. Design Phase
4. Construction Phase

3.1.2. Barriers

As a second section of the scope, it is important to mention what barriers are included in this thesis. As the barriers that can be found in literature vary, ranging from technological, Institutional, Informational, financial and political barriers. The same can be said regarding the Drivers/CSFs, often related to mentioned barriers (Munaro and Tavares, 2023; Wuni and Shen, 2022). This research looked at barriers, Critical Success Factors and other CE principles with a focus on collaboration and engagement of stakeholders within a construction project, as this is explained to be a very important section to improve (Durdyev et al., 2023; Zhidebekkyzy et al., 2023; Munaro and Tavares, 2023). This focus allows the implementation of SES of Kaipainen et al. (2023).

Other barriers were also present, examples include, but were not limited to: technological barriers that hinder advancement, financial barriers that hinder the implementation of circular strategies and Legislative restrictions that hinder implementation. Although these were not relevant for the SES, they were incorporated in the end result.

3.2. Empirical Research

In this chapter of the report, a case study was used to test the found theoretical knowledge of the literature section of the report to a real life scenario. The main focus of this part of this thesis was the inclusion of the Stakeholder Engagement Strategies of Kaipainen et al. (2023) within a construction project, which has not been performed prior to this research. Additionally, the comparison of Barriers, Drivers and CSFs and their inclusion of stakeholders is considered relevant (Munaro and Tavares, 2023), which was added for usage within the final SES, and comparison to literature.

A Case Study approach was considered a relevant research method as a case study allows for an in-depth exploration of difficult situations within certain real life contexts, providing a wide view of understanding that other research methods may not incorporate. By offering very specific and context-based descriptions, case studies capture the nuances and multiple perspectives (Cousin, 2005). This made a case study particularly useful for exploring dynamic and varying situations. This was relevant here, when researching a variety of stakeholders with differing opinions and interests.

3.2.1. The case study

In this sub-chapter, the Bajeskwartier case is introduced to provide essential background information. This includes its historical context, notable buildings that are key to the analysis, the stakeholders and companies involved, and a rationale explaining why this sole case was considered suitable for the successful completion of this research. Within this section, information was obtained through the

Masterplan Document that served as an initial representation of plans that were incorporated during the tender phase of the project.

Historical Context & Background information

The Bajeskwartier, formerly known as the Over-Amstel prison complex or BijlmerBajes, was initially designed by the architectural firm Pot-Keegstra, following initial plans by Rijksbouwmeester F. Sevenhuijsen. The complex housed inmates in 6 high rise towers, which were designed using the 'telephone-pole' principle in an innovative manner, a rare approach in prison architecture. Constructed in the 1970s, it reflects the period's structuralist and modernist influences, particularly in its spatial organization and focus on reintegration, a comparison to the traditional cellular prison model. The complex stands as a symbol of evolving attitudes toward inmate re socialization, blending functional architecture with forward-thinking social principles. The area of the prison contained several important buildings important for this thesis, as they were to be reused for historical context and improvement of the Circular Economy. In Figure 3.1 an overview is presented that highlights the original, historical, depiction of the Bajeskwartier area. subsequently, Figure 3.2 shows the current plans for redevelopment of the area.

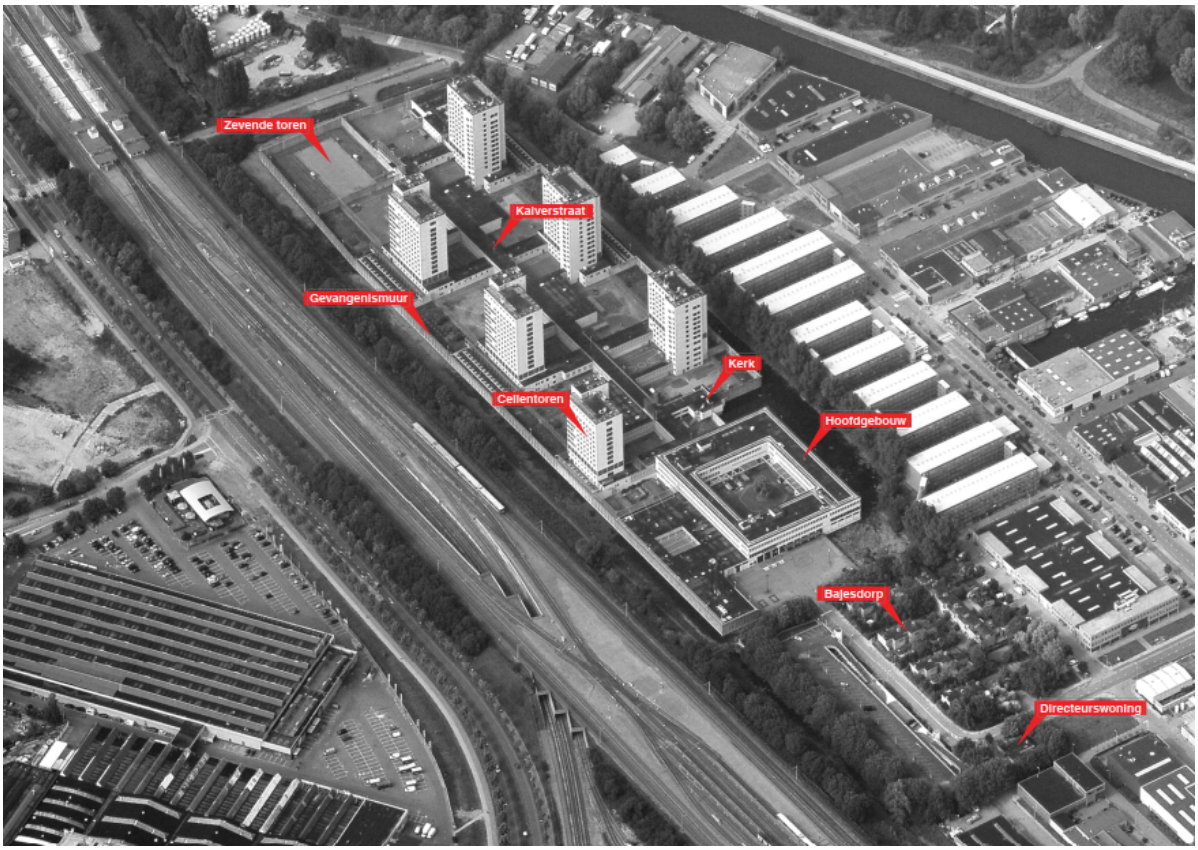


Figure 3.1: Layout of initial overview Bijlmerbajes (Bajeskwartier Masterplan)

Cell Towers

The area consists of six cell towers, each with thirteen floors. The ground floor houses the control room and staff spaces, while the upper floors contain inmate cells, with the top floor reserved for isolation cells. The design intended for each tower to form a cohesive community of inmates. On all building plots except one, new buildings are/will be created according to a structured planning of the entire area(BV, n.d.). More detailed information of current plans is presented in Figure 3.2.

Groene Toren

One of the most important buildings, within a CE context, is aimed towards the cell tower that was formerly called the 'Vrouwen Toren', or Female Tower, now called the 'Groene Toren', or Green Tower in current renovation plans of the Bajeskwartier, see Figure 3.2). This is the only tower tower, out of six, that remains in its original form and is therefore considered to have high value in terms of CE and

historical context. Within this tower, a 'vertical park' was considered as potential use.

Main Building
The main building, used for administrative functions and reception, features four wings, each three stories tall, arranged around a rectangular courtyard. The facade is constructed from prefabricated concrete panels with steel frames, displaying a subtle relief pattern of windows and planes, originally painted white with two shades of grey. This building remains in current plans, fully making use of the old structure.

Prison walls
Initially designed as a remand center rather than a penitentiary, the emphasis was on a 'humane' environment. It was considered whether the prison wall could be replaced with thorn bushes integrated into garden landscaping, but the wall was still added shortly after construction.

Church
The church consists of three interconnected square spaces with high, natural light. Folding walls separate the spaces. The church could be accessed from the first floor of the Kalverstraat and is connected to the outside by stairs. The interior walls are made of concrete blocks, and the ceilings are timbered. This structure also remains fully intact during the renovation for the Bajeskwartier.

Seventh Tower
Although the seventh tower was never built, it remained an integral part of the original design, holding significant historical relevance, especially at the urban planning level. The now developed building is called Building H, or The Jay, in current plans, this building's construction phase has come to an end.

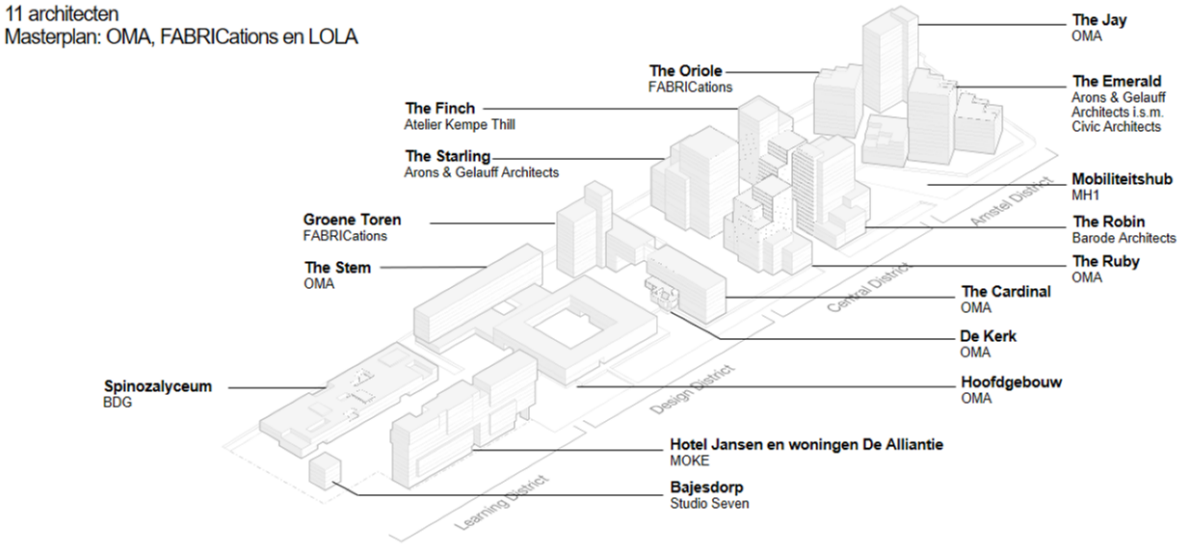


Figure 3.2: Current plans of the Bajeskwartier Project (Interim Report Bajeskwartier)

Invested Companies & Stakeholders

The stakeholders that were taken into account needed to be considered decision makers, or bodies of knowledge that could alter the implementation of CE within the construction project of Bajeskwartier. With regard to implementing CE in the construction sector, many stakeholders were therefore not important to include in this study. Examples of these important stakeholders are: the public, surrounding inhabitants and building's users. Such stakeholders do not influence decision making or add valuable knowledge surrounding the decisions made in general, but also specifically in terms of circular ambition implementation.

The final list of Stakeholders that was taken into account has been concluded in Chapter 2.5 and is shown below with additional information, a list of companies that are present within the Bajeskwartier project's important stakeholders according to literature. That said, within the results chapter the general names (e.g. Client, Architect) were used for a clear overview.

1. Designers/Architects
    (a) LOLA
    (b) OMA
    (c) FABRICations
2. Contractors
    (a) BAM
    (b) ABT
3. Project Investors/Initiators (Client)
    (a) AM
4. Regional Government/Municipality
    (a) Gemeente Amsterdam
5. Material Recycling Facilities
    (a) Beelen

Despite the incorporation of only these companies within this thesis, additional companies are present that fit similar roles. For example, AM is considered the main leading client within the role of Project Initiator, while other companies such as Schroders Capital or AT Capital are also considered in a similar role on a financial level (Project Investor). Since financial relevance was initially assumed to be less relevant within the scope of this research, the Schroders Capital and AT Capital were not included within this research.

Subsequently, Figure 3.2 presents various other Architects involved with certain buildings, these were also not included, as these firms were managed and lead by the three Architect firms LOLA, OMA and FABRICations which were most influential during decision-making. Along these lines, similar decisions were made when incorporating Beelen as lead Material Recycling Facility, and BAM and ABT as contractors.

Justification of only Bajeskwartier within case study

It is important to justify why the inclusion of only one case was adhered in this thesis. Although the Bajeskwartier project is managed by one client (group), it does consists of multiple buildings where other stakeholders, that varied per building, differed within the project and per phase. For example, there were/are many architect groups present, where the largest three were incorporated for performing interviews. It was possible to include various interview participants of one stakeholder group, within the same case but a different building or task, allowing for a diverse range of interests and comparisons of thoughts on collaboration and expertise. Additionally, because some buildings have been constructed at an earlier stage, while some are currently being constructed, it was possible to compare the differences between earlier and current communication and collaboration.

Finally, as the performed interviews already incorporated a diverse range of stakeholders within this single case, it was considered a sufficient amount for an effective in depth comparison of thought

patterns. A sufficient amount of interviews that should be conducted was considered between 6-12 interviews (Marshall et al., 2022). This allowed for inclusion of diverse information on collaboration and limitations within the project. Adding a second case and performing equal amount of interviews for a comparable analysis would have exceeded the time limit of this research, therefore no additional case could be incorporated in the empirical research of this thesis.

3.2.2. Interview Method

The purpose of this study was to find an effective solution for overcoming barriers to implementing circular economy goals in the construction sector, using stakeholder engagement strategies. Since circularity and achieving these ambitions is a relatively new and emerging field, there is little research on this phenomenon in combination with large-scale construction projects, as previously mentioned in the theoretical framework. Therefore, the research in this study was primarily exploratory. Qualitative and exploratory research methods provide the opportunity to collect and analyze in-depth data (Gillham, 2000).

Because this study focused on the experiences of various stakeholders in the construction sector, semi-structured interviews were an appropriate method. Compared to structured and unstructured interviews, semi-structured interviews offer researchers both flexibility and structure and is considered the most important form of interviewing for case studies (Gillham, 2000). The focus of the conversations was partly on reciprocity, but there was also an opportunity to discuss other feelings and experiences of engagement within context of construction projects. In other words, qualitative, exploratory, semi-structured interviews were an appropriate method for this research.

The interviews were performed using a recording device, or Teams meeting, in order to successfully transcribe the conversations. Within Teams, the recordings were automatically transcribed, however these were not always effective and still needed to be revised. Afterwards, the recordings were deleted, while the transcribed texts were kept for coding.

3.2.3. Concepts

To provide a clear overview of how the conceptual themes in Figure 2.4 from the theoretical framework were put to use during the interviews, Figure 3.3 gives a structured outline of Concepts, along with their respective Dimensions (or sub sub-themes). The right-hand column contains the variable that was measured within each dimension, in order to highlight what can be measured within each (sub-)theme. The Conceptual Themes from the previous chapter were divided according to the two main sections necessary for incorporating the SES; Alignment of stakeholders in terms of Knowledge (Conceptual Theme 1) and Interests & Attitude (Conceptual Theme 2) were combined within Concepts Knowledge & Alignment and Collaboration, the Ecosystem (Management) Structure within the project (Conceptual Theme 6) was measured using a comparison of Leadership, Commitment & Ambitions of stakeholders. Subsequently, the barriers and CSFs are stated as separate concepts here, although some overlap is present (i.e. Knowledge barriers with Knowledge alignment). This division was made for clarity purposes. Finally, a concept group for Stakeholder Engagement is present to determine the involvement of stakeholders during the project, and a concept on initial ambitions is added for all information surrounding the introductory section of the interviews.

By categorizing such Concepts to various dimensions and variables, this served as a basis for creating the interview questions in a proper manner. In doing so, a more structured comparison of all topics would be possible within the results section of this thesis.

Concepts	Dimensions	Variables
Barriers	Knowledge barriers	The availability of knowledge to implement circular practises
	Guideline barriers	The amount of guidelines that are present to steer the process of CE
	Data & Documentation barriers	The availability of data for other stakeholders to aid circular processes
	Market barriers	The mechanisms present to make full use of a circular strategy
	Financial barriers	The availability of finances that hinder the process of CE
	Technical barriers	The technical/feasability aspect that hinders the implementation of ambitions
	Supplychain barriers	Complexity of coordinating circular practices across the supply chain.
	Collaboration barriers	The presence of bad collaboration which negatively impacted ambitions
	Alignment barriers	The degree to which CE goals are alligned between stakeholders
	Leadership barriers	The level of commitment from a main organisation towards circular goals.
Knowledge alignment	Shared understanding	The degree to which stakeholders share understanding of the project goals and circular principles that are required
	Sharing of information	The amount of communication between stakeholders to inform others
	Prior training	The degree of training received before working on the Bajeskwartier project
	Training received	The degree of training received during the project, within own company
	Training	The degree of training received during the project, by other stakeholders
Collaboration	Interdisciplinary collaboration	The extent of collaboration between different stakeholders
	Trust and Respect	The level of trust and respect between stakeholders
	Joint Problem-Solving	Frequency of joint problemsolving sessions
Leadership, Commitment & Ambition	Visionary leadership	The presence of a clear vision for CE goals
	Commitment to CE	The amount of commitment toward the set goals for CE
	Empowerment of stakeholders	The degree to which leading stakeholders drive other stakeholders to achieve CE ambitions
Stakeholder Engagement	Participation	The level of participation during decisionmaking processes
	Feedback mechanisms	The availability and use of methods for feedback of other stakeholders

	Transparency within decision-making	Clarity of communication surrounding decision-making during the project
Critical Success Factors	Collaboration Success Factors	The presence of positive collaboration that is necessary / has allowed for successful implementation of CE ambitions
	Commitment Success Factors	The presence of positive commitment that is necessary / has allowed for successful implementation of CE ambitions
	Technical Success Factors	The presence of technical methods or steps that are necessary for successful implementation of CE ambitions
	Design Success Factors	The methods or steps in design to effectively implement CE ambitions
	Financial Success Factors	The presence of financial circumstances or methods that allowed for successful implementation of CE ambitions
Introductory	Initial Ambitions	The comparison to the made ambitions at the start of the project

Figure 3.3: An overview of Concepts

3.2.4. Interview Questions

The interview questions, are listed in Appendix A: Interview Questions. These questions were divided into the an introductory question, three main categories of Knowledge, collaboration and Knowledge sharing, and Leadership and Ambitions. Each Theme was divided into various Sub-Themes that are part of the overarching Theme.

The Sub-Themes consist of many more in-depth questions, which have been combined into two or three main questions per Theme for better comparison during the interviews. The remainder of the questions were only asked if a given answer is less valuable than expected, or a very important or relevant topic is explained by the participant.

Participants

In Figure 3.4: Participant overview, a list of the 9 participants is shown, along with two participants applicable for the validation at the end of this thesis. Each of the five stakeholder groups mentioned to be of importance for the process of incorporating CE in a construction project (Ma and Hao, 2024) were represented.

The reason these participants were chosen had various reasons: incorporating three Architects resulted from the fact that there were three main architecture firms present during the initial procedures of the project. These firms were part of the large decision makers from within the Bajeskwartier project. Choosing three Contractors was because of the participation of BAM, where two of three are employed. One additional Contractor was from another, similar company, ABT. This company had similar activities within the Bajeskwartier, which was assumed to yield interesting comparisons in terms of collaboration. The Client, AM, accounted for two participants, although they were employed in the same company, different expertise's and functions within the same company made this addition relevant for comparison of knowledge and presence during the project lifetime. One person from the Material Recycling Company, Beelen, was considered a sufficient amount, their company was the largest presence within their function of the project. This participant was most actively involved with collaboration with other stakeholders, out of their company. The Municipality had not been incorporated in this research due to lack of response and time limit restrictions.

Interview participant	Stakeholder group
Participant 1	Client 1
Participant 2	Client 2
Participant 3	Contractor 1
Participant 4	Contractor 2
Participant 5	Contractor 3
Participant 6	Architect 1
Participant 7	Architect 2
Participant 8	Architect 3
Participant 9	Material Recycling Company 1
Validation 1	CE Expert 1
	CE Expert 2

Figure 3.4: Overview of participants

In order to clearly state the terms of the interview, consent forms are to be filled in by all participants beforehand. By doing so, they consent to their recordings being transcribed, coded and used within this thesis. The consent form will be discussed in short, by highlighting some of the important aspects that are considered during the thesis. For a full overview, see Appendix B: Consent Form. The consent form highlights various topics:

1. General agreement to participation
2. Highlighting the potential risks of participating (Incl. Data protection)
3. Publication of anonymous quotations
4. Storage of data (transcribed texts)

3.2.5. Coding Method

In this section the coding method is explained. This section of the case study consists of three stages, once all interviews have been transcribed, using AtlasTI as a tool.

The first stage, called open coding, uses AtlasTI to examine the entire interview text. Marking any relevant topics, quotes and suggestions made by the participants. In doing so, 271 codes were found, listed in Appendix C. This list is a measurement tool to show frequencies of certain mentioned topics in order to gain better understanding of various reoccurring themes and insights. Using a semi-structured interview format, answers varied, which meant it was important for the codes to be rather specific.

After the open codes were determined, a final review of all codes was necessary to make sure no information was wasted before proceeding with the next step: Axial Coding. Here, the codes were grouped to give an overview on specific topics within to-be-created themes. In total, there are 25 code groups that combine the specific open codes. These would then be linked and compared to show relations, differences and more in order to look for causal relationships, contextual differences or concepts that are important for drawing conclusions within Chapter 4.

The last section, called Selective Coding, encompassed all categories and created a well structured base for explaining and expanding the results, classified in the Themes: Initial Ambitions, Knowledge & Alignment, Leadership & Commitment, Barriers and Success Factors. These themes encompass various code groups. An overview is stated in Table 3.1: Axial and Selective codes.

Table 3.1: Axial and Selective codes

Selective codes/Theme	Axial codes/Code groups
Initial Ambitions	Initial Ambitions (Masterplan) General Desire to Implement CE Circularity from a Historical Perspective Lack in Ambition Achievement Involvement of Stakeholders
Knowledge & Alignment	Stakeholder Knowledge Knowledge Gaining Knowledge Barriers Knowledge Sharing Collaboration of Stakeholders Collaboration Barriers Collaboration Success Factors
Leadership, Commitment & Ambitions	Leading the Transition Commitment Barriers Commitment Success Factors Ambition Barriers Architects & Ambitions
Barriers: A Comparison	Technical Barriers Financial Barriers Regulatory Barriers Design Barriers
Critical Success Factors: A Comparison	Technical Success Factors Financial Success Factors Design Success Factors

3.2.6. Draft Strategy & Validation

In this sub-chapter the results were further expanded to obtain an initial SES through Kaipainen et al. (2023). In doing so, the Alignment of stakeholders (x-axis in 2.3) and Ecosystem (Management) Structure (y-axis of 2.3) had to be determined.

Knowledge Alignment

To assess the alignment of knowledge among stakeholders, a comparative analysis was conducted based on interviews of all participants. This method involved evaluating each stakeholder's understanding of circular economy principles, their familiarity with specific CE challenges, and their level of expertise in relevant practices.

Stakeholder mapping: Interest Alignment & Ecosystem Structure

As explained in the theoretical chapter, it is necessary to determine alignment of stakeholders towards the set goals, and the general ecosystem structure of a construction project in order to find a fitting strategy. This was done by incorporating two stakeholder mapping techniques in order to create an effective basis for determining one of the four strategies.

For determining the alignment of stakeholders towards the goals, the Power-Interest-Attitude matrix (Murray-Webster and Simon, 2006) represented the alignment of the stakeholders towards the goal. This mapping matrix was filled in on the information obtained within the Theme 'Knowledge & alignment'. This stakeholder mapping technique is a followup of both the Power-Interest, and Power-Predictability matrices. It is therefore a more in depth technique that allows for additional information within one single stakeholder mapping method. It is an improvement toward prior methods, as these do not incorporate the 'Attitude' or intention of the stakeholder within the mapping tool (Murray-Webster and Simon, 2006).

Attitude is said to be focused on the effort and motivation a stakeholder has towards achieving the goal. Subsequently, this corresponds with the second step of the four steps in Figure 2.2, locating the interests of stakeholders. Relating this to the project at hand, the stakeholders within the project of the Bajeskwartier were not explicitly expected to have a truly 'negative' attitude toward the implementation

of CE, however some are truly in favor and others are more in the middle. This can be effectively used to make a comparison per stage.

As a second mapping technique, the salience model was used. This model can be used to show the priority of stakeholder claims by a leading party, which was interpreted as the measure in which one leading party takes notice and was aware of the interests of others, while maintaining the project ambitions and goals (Mitchell et al., 1997). This model was incorporated to determine the ecosystem structure of a general construction project by using the information from the Theme: 'Leadership, Commitment & Ambition'. With this information it was possible to determine which stakeholder was seen as most important for achieving goals and was considered to be a stakeholder fit for serving as the 'hub', or whether there is a loose structure within the construction company (Kaipainen et al., 2023). The implementation of this technique corresponds with the first step within 2.2 of Kaipainen et al. (2023).

As a qualitative style of research was performed, it was difficult to set specific measurement boundaries to determine the power, interest, attitude, legitimacy and urgency required for filling in both stakeholder mapping. Below, a description of how the boundaries were used as guidelines is shown.

Power:
This variable was determined by linking overall quotes and codes of stakeholders on decision making. This showed the power to influence the project in a specific method and was considered a viable method to determine power levels.

Interest:
This variable was determined by linking quotes and codes of stakeholders to their level of interest to achieving the CE goals, measured by being on a more 'active' or 'passive' level (Murray-Webster and Simon, 2006). This section focused in information obtained through the Theme 'Knowledge & Alignment'.

Attitude:
This variable was determined by linking quotes and codes on the attitude stakeholders have during collaboration and towards achieving the goals. This section is measured along the information obtained within the Theme 'Knowledge & Alignment'. It is considered a measurement of whether stakeholders 'Back' (support) or 'Block' (resist) the goals (Murray-Webster and Simon, 2006).

Legitimacy:
This variable was determined by linking quotes and codes as a measurement on how much of a 'right' stakeholders had to make requests or suggestions within the project (Harrin, 2023). This can be done on the basis of contractual or legal rights, but also an intrinsic moral motivation. This was measured by using the results obtained from Theme 'Leadership, Commitment & Ambitions'.

Urgency:
This variable was determined by linking quotes and codes on the amount of necessity a stakeholder has, otherwise explained to be linked to the amount of 'immediate action' a stakeholder has towards a claim (Harrin, 2023). This was highlighted along the lines of ownership, but also time-sensitive situations that a stakeholder was aware of. This was done by referring to obtained results within the Theme 'Leadership, Commitment & Ambitions'.

These mapping models were applied to locate and differentiate various stakeholders. As the total group of stakeholders was considered to be large (Ma and Hao, 2024) and the ambition and interests of stakeholders play a vital role in finding a 'Leader of the transition' (Jones and Samy, 2021). These models were used to determine the stances of stakeholders toward the goals, determining the most fitting SES to be used in the Draft Strategy. After usage for finding the fitting strategy, the mapping results were incorporated within the final strategy where possible.

Draft Strategy

After all interviews have been transcribed, coded and compared, it was time to complete the main research aim. Using the strategies, as shown in the research of Kaipainen et al., 2023, various scenario's could have occurred, leading to different outcomes. Looking into the general scene of the construction sector, stakeholder alignment and the organisational structure resulted in one of four strategies to focus on for the final section of the research. As mentioned, these strategies which are shown as separate

in Figure2.3, tend to overlap due to events and unforeseen circumstances. Because of this, the next phase of the case study research focused on the implementation, and combination, of the strategies.

Along the lines of the main strategy of Kaipainen et al. (2023), expansions were also made to introduce additional CSFs obtained from the case study, with CSFs obtained through literature. Combining both case study and literature CSFs was considered important, as missing stakeholder interviews (i.e. Municipality, but possibly others) could have allowed for potential gaps in data, and therefore missing important CSFs. In doing so, the four strategy steps of Kaipainen et al. (2023) could be improved to get a more effective and detailed strategy as a result.

Validation

As the draft strategy had been found and supplemented using CSF, a final (validation) interview with two experts on the topic of Circular Economy took place, this validation occurred simultaneously. Prior to this validation, a week in advance, the report up to the Draft Stakeholder Engagement Strategy was sent, along with specific priorities for parts to study and understand during the validation session. These parts consisted of: the section on the four strategies that were to be implemented highlighted in Chapter 2.4.1; Chapter 2.5, the conclusion of the literature chapter for an overview of found research; the conclusion sections per results Sub-Chapter, in order to give an overview of important quotes, thoughts that interviewees had and barriers and CSFs that were present; Chapter 4.3.3, as a most important section, as this chapter showed the draft SES created as a combination of initial steps ofKaipainen et al. (2023) along with found barriers and CSFs for improvement. Lack of time hindered creation of a presentation during this time, the validation session therefore started discussing the report as background knowledge. Looking into the actual Stakeholder Engagement Strategy (Draft), the steps that were listed by Kaipainen et al. (2023), along with the personal additions through literature and interviews on CSF were compared to the other potential strategies through discussion with the experts and to real life knowledge of the CE experts. The validation session was recorded and studied afterwards to implement the feedback, listed in Chapter 3.2.6.

3.2.7. Roadmap

All steps explained above are presented in Figure 3.5, a road map showing the steps that were taken during the remainder of this thesis.

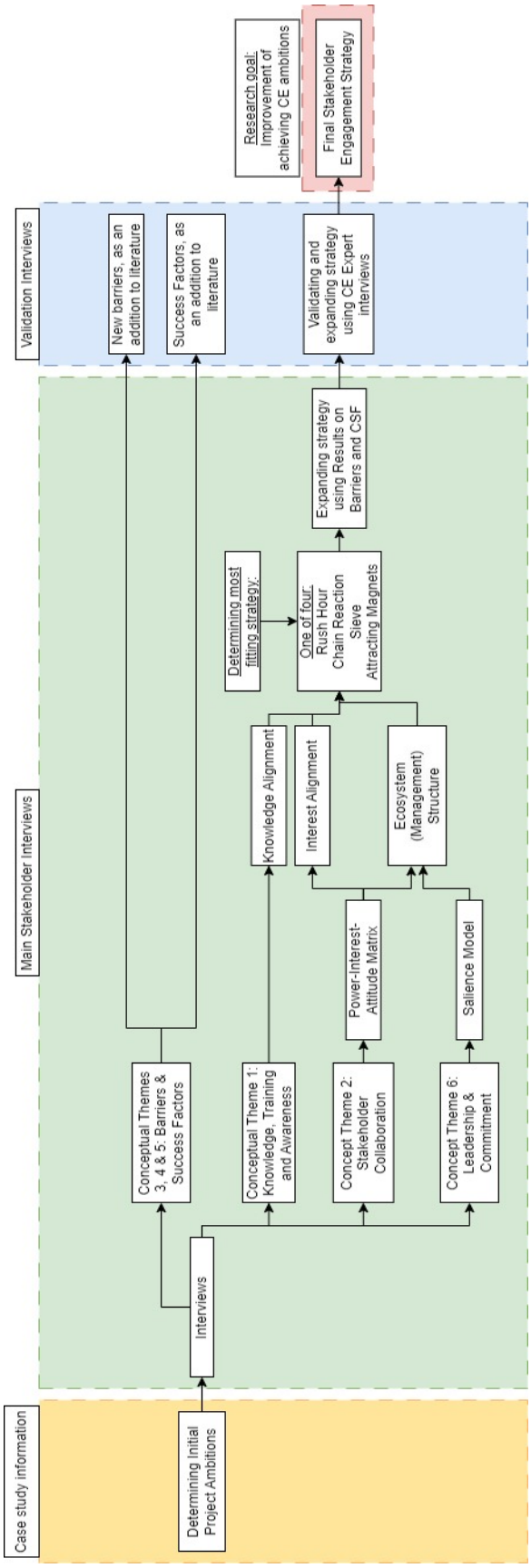


Figure 3.5: A Road map

4

Case Study Results

This chapter presents an overview of the case study information retrieved from the Bajeskwartier project. The information is found using interviews and is presented to serve as the main body of this research section. Using a semi-structured interview approach, this research gathers insights from various stakeholders on the Circular Economy (CE), highlighting the barriers to implementing CE ambitions and potential solutions to overcome them. Afterwards, the chapter proceeds by using the information obtained through interviews to choose a fitting Stakeholder Engagement Strategies (SES) that incorporates various CSF and Barriers, along with creating an overview of barriers and Critical Success Factors (CSFs) as a comparison to literature. Lastly, the chapter ends with a validation study using a panel of experts in order to conclude the gathered information, determining whether the created strategy is fit for use in a construction project. For a more detailed overview of steps during this section of the interview, see Chapter 3: Methodology. Subsequently, Figure 3.5 shows a summarized view of steps that will be performed.

The chapter is structured as follows: it begins with an overview of the collected case information, followed by an elaboration of the interview results, presented in Table 3.1. The interview section is organized according to these codes, providing a structured layout of obtained information. It explores various barriers listed by participants, examines differences in stakeholder knowledge, reviews perceptions of collaboration and communication between stakeholders, and highlights what participants believe is necessary for achieving CE ambitions.

4.1. Document Analysis

Here, documents highlighting initial ambitions (The Masterplan, in Appendix D) and interim results (Voortgangsrapportage, in appendix E), are analysed and compared.

Starting off, the Masterplan explains initial expectations that were set during the start of the project. Within this thesis, only ambitions surrounding Circularity are addressed. A summary of their ambitions is stated below:

1. A reuse percentage of 98%, not mentioning in what manner of reuse will be implemented.
2. They explain three buildings are to be kept whole, these being; the main building (Hoofdgebouw), the church and the Green Tower (Groene Toren).
3. Specific building elements are to be kept for high-quality reuse; comparable to 'Reuse' within R-Principles.
4. Recycling done locally
5. Materials chosen from a circular material list
6. Building material passports
7. Two buildings made in wooden construction

8. Including possibility for additional construction at later time (Aanbouw)
9. No pouring concrete, usage of prefab materials
10. Implementation of modular construction for future reuse of materials

As a comparison to the initial Master plan an interim results document was analysed, presented in Appendix E. Within this document, initial ambitions were revised and presence of setbacks within the project were stated, as a hindrance to successful ambition achievement. This document was published in 2020 during the 'VO' Phase; loosely translated to Temporary Design. It lies within the Feasibility & Planning phase according to this thesis' layout of a project life cycle.

According to this document, three main 'Promises' are compared, these being: reuse percentage of 98%, Reuse of concrete, doors and other materials, and the inclusion of building passports containing material information. They mention the successful 'harvesting' of old materials by Beelen (MRC), stating final evaluation needs to be completed after all demolition is complete. They mention 1030 items harvested for reuse, where various items have been placed within design plans at that time (e.g. prison bars as plant climbing frames; reused concrete parts within one specific building; channel plates as flooring on a public square). Finally, buildings have obtained material passports successfully.

Separately, they have highlighted 'lessons learnt' at that time, they highlight extreme difficulty surrounding implementation of building elements as a form of high-quality reuse, or simply 'reuse' when considering the R-Principles in Chapter 2. This difficulty arose due to new building norms for noise and fire safety.

Interesting comparisons between both documents are also present. For example, the Master plan highlights a very conceptual frame of the ambitions vision for circularity, while the interim results doc explains more detailed information. The Master plan gives no specific reference to collaboration with partners for the implementation of CE Ambitions, while the Interim document shows collaborations with various companies, such as Madaster and Hogeschool Amsterdam and other circularity makers: A trend towards collaboration. The implementation of CE also highlights differences, while the Master plan explains the design of buildings to focus on flexibility and disassembly, ensuring apartments can be combined and adapted in future scenarios. The specific mention of modular design stands out as a future-proof strategy. Within the Interim document, this specific mention of modular construction is not located within the chapter of Circularity. The document does incorporate plans for creation of building B (The Stem), linked to the original Main Building, and C as replacement of one of the towers, in wood, highlighting flexibility and adaptability within these plans. Finally, both documents highlight one of the towers to be built using recycled concrete.

4.2. Interview Results

In this section, the results obtained through interviews with the participants (Figure 3.4) are presented. In order to give a clear overview of the collected results, it was important do so in a structured manner. The selective and axial codes in Table 3.1, otherwise referred to as Themes and Code-Groups were a perfect fit as they effectively categorized the diverse responses from interview participants into distinct directions. Within this chapter, each sub-chapter therefore focuses on a specific theme, sharing all relevant information gathered from the interviews.

Although it is not necessary to include all specific barriers and CSFs in the stakeholder mapping or in the final decision on the SES, they are still grouped at the end of each sub-chapter. This provides a structured comparison of the information to barriers and CSFs in literature and allows for relevant additions to the final SES in this thesis.

4.2.1. Initial Ambitions & Stakeholder Involvement

This section presents an analysis and comparison of the initial goals and ambitions established during the early stages of the project, also explained to be the Master plan. It examines the initial plans along with changes that took place and strategies to assess the intended outcomes and how these align with the principles of circular economy (CE). Additionally, the level of stakeholder involvement is evaluated, in terms of its impact on the alignment with, and achievement of the initial ambitions.

Initial Ambitions (Master plan)

In this section, participants spoke of the initial ambitions that were stated, their thoughts and perceptions can now be compared. This section is presented as overview of what happened during the project as additional background information. First off, the tender for the Bajeskwartier was explained to be very open in terms of Sustainability & Circularity (Client 2), where there was no explicit mention of what was meant by incorporating Sustainability to the Master plan. The high starting ambitions were therefore added due to intrinsic motivation of the Client (Client 1, 2), which started with a bold statement: ”Initially, we felt the need for a bold statement. So, we started with the declaration that we wanted 98% reuse” (Client 1). Yet at the time, the Client was also not fully aware of what the initial statements actually entailed (Client 2, MRC). ”Because at that time, everyone was calling for 98% reuse, period. But what that actually entailed, no one had really questioned yet” (MRC). Which differs with other statements, as Architect 2 mentions ”So I think the master plan is very clearly defined. And then I think we stay very close to those principles through all these years”. Additionally, various participants mention the high starting ambitions ”Look, the master plan that was once created by OMA had very high ambitions in every aspect—architecture, challenges, and also in terms of circularity” (Contractor 1). These ambitions were generally the Architect’s choice: ”The direct reuse part was pretty straightforward in the sense that it was mostly the architect’s choice regarding what they did or did not want to bring back” (MRC). Which MRC also explained to be the reason for joining the project: ”We secured that contract at the time because we believed that we could fulfill the high circular ambitions set by AM in relation to the municipality. In the end, we more than accomplished that.”

These high ambitions were considered by some to be almost too ambitious, Contractor 2: ”[...] tends to go in a completely different direction. They really try to approach it in a very design-oriented way, with significant modifications. You can sense that it’s not going to work out.” While Architect 3 highlights the addition of Technical expertise was the cause of problems in the other direction: ”Then the builders came in, and they found it even more complicated, and it also became too expensive, and so on. As a result, those ambitions kind of fell by the wayside. But initially, we did make proposals for them.” Specifically talking about modular construction ambitions, which compared to statements within the Master plan

The Client started with determining what was already available, Client 2: ”But at the outset, we first looked at what we already had (in terms of materials). So, what could we keep? [...] That’s how we made our decisions.” Yet Contractor 2 does highlight that only a small fraction is true, high quality reuse (e.g. Reduce or Reuse within R-Principle steps): ”Because at Bajeskwartier, the Green Tower is actually the only part that’s truly circular, with real reuse of materials. Structural reuse, that is.” Yet Client 2 highlights ”98% reuse—by the way, you always achieve that. But of course, we had promised a few things.”, where MRC mentions ”But I don’t remember all the details clearly anymore, though I do recall that 98% of the material coming from the site was just concrete.” Which, corresponds with initial statement of Client 2. According to Client 1 the concrete was only reduced to a lower grade in the circular ladder as last alternative: ”Then it turns out that a section of the wall cannot be harvested in its entirety but only in small pieces. In that case, you might think, ’Okay, it does not fit into the design, so I’ll crush it into rubble’.”

Changes to ambitions

This section highlights less positive aspects surrounding initial high ambitions, as the initial statement was considered to be 98% reuse. MRC mentions: ”Because if you crush the concrete, you’ve technically reused it. But that’s obviously not what everyone is aiming for.” Which highlights the difficulty of the term ‘Reuse’ within the R-Principles. Contractor 2 mentions ”The reuse of the Green Tower is included, as well as the structural reuse of the high-rise building. And yes, they also reused some things like the old cell doors, and so on. But sometimes, I find that a bit of a token effort or something like that.” Which state ambitions, even though they were set high, were not always considered effective, and can be linked to the barrier: Insufficient application of waste hierarchy. Contractor 3 mentions something different, adding a comment on assumed Modular construction methods: ”The only thing you could call modular is Building H. It’s a prefab structure, but even that does not seem like it can be taken apart easily.” Highlighting a change in ambition, which is not mentioned in the Interim document. Reasons for the decrease in ambitions vary, Contractor 1 explains: ”Then you see that conflicts occasionally arise, and it turns out that circularity is often the first to be compromised.”

Involvement of Stakeholders

Within the project, the involvement of stakeholders was considered important. In this section, examples are stated when and for what duration stakeholders were involved in the project.

The Clients are active from the initial start of the project, Client 1: ”So, from the tender phase to actually getting the project off the ground. That’s the phase I’m involved in. I usually take it up to the preliminary design (VO).” This phase of the project is accompanied by the three main architect groups: ”We formed a team with OMA, FABRICations, and Lola, which became the tender group. We worked together closely and won the tender.” While they were present in the initial stage, the Contractors were introduced later on, Contractor 2: ”That is laid out in the master plan. Then we came on board, and we are quite early in the design team.” While Contractor 1 mentions: ”OMA created the design for the master plan. We were not involved in that.” and ”Certain things were already established, such as what we want, the ambitions, the direction we want to go, and what needs to be done.” The same can be said for MRC: ”Eventually, the requirement of 98% reuse was passed on to us. What we did was work with AM to examine what was all there and what could be dismantled for reuse.” Stating the ambitions were already set before technical expertise was present. This highlights the necessity for the CSF: Early and active involvement of critical project stakeholders.

Separately, in terms of the context of involvement, the way stakeholders were gathered varied per group (Client 2). Additionally, Client 2 mentions their involvement reduces over time.

4.2.2. Knowledge & Alignment

This Theme focuses on the role of knowledge in achieving alignment among project stakeholders. It analyzes the existing levels of stakeholder knowledge and the barriers to acquiring and sharing relevant information. The impact of these factors on collaboration and the alignment of project goals with execution is assessed. This analysis aims to highlight the alignment between knowledge and management of stakeholders, and the successful alignment of stakeholders towards the project’s circular economy ambitions.

Stakeholder Knowledge

To start off, all participants have shared thoughts on their individual, or company’s knowledge base. Some participants highlighted the knowledge of R-Principles, or similar methods like the Ladder of Lansink (B.V., 2024), such as the MRC: ”Based on the Ladder of Lansink, what can we do with that? Where it progressively becomes a step lower in value when higher-value options are not feasible.” Yet many participants use something similar, but not well documented, Architect 2:”so let’s say there is a, I cannot, let’s say, point out to a document that we just say these are exactly the principles. But there is a reuse by harvesting and just re-purposing of the fragments. There is a reuse by, and that’s basically concrete or other materials that basically it gets ground and then mixed in into a new form.”. Client 2 also mentions: ”We’ve done that in a bit of a makeshift way, I must say. Because there are, I think, two major approaches.” Explaining further the difference in Theoretical, and Real life knowledge on how to implement circularity. This is a new barriers that is, as of yet, unknown to literature, highlighting the difficulties of successful implementation of theory surrounding circularity in real life construction projects.

Other stakeholders consider their use of knowledge on CE at a more conceptual level: ”We do it more in a conceptual level, and then we have consultants that help us with a more technical calculation of the MPG and these kind of things we have for formality reasons. We do that, I have to say, using more common sense.” (Architect 1). Architect 3 highlighted additional information, besides the inclusion of such R Principles: ”So on one hand, you can make buildings circular by using circular materials and designing them to be dismantled later. But I believe there are also significant gains to be made from the circular use of the city itself.” Architect 3 expands by giving an example: ”For example, one of the things we proposed is to collect all organic food or organic waste separately from all the residences, [...]. At first, everyone embraced this and was very enthusiastic, but then the developers came on board and found it complicated.” He highlights a barrier that occurs, reduced internal willingness of new stakeholders entering the project team.

As an additional remark MRC also explained their vast knowledge on granulates, which are created using the remnants of the concrete within the project. Their knowledge encompasses the use of rubble

deconstruction installations and their own laboratory type setup that focuses on regulations of reused materials. Hence, they recommend keeping the decision surrounding such expertise with their company: ”[...] We see a somewhat greater involvement in this case, but even then, we still make a strong effort to keep that expertise within our own team.” This section complies with the barrier of Munaro and Tavares (2023) on Lack of knowledge about circular tools (Environmental Product Declarations, Material Passports, certifications, etc.), as only MRC specifically mentions this. Explaining the need for the CSF: Training stakeholders to increase the understanding of CE and sustainability.

Methods of gaining knowledge

Along with this previous paragraph, additional participant quotes explain their method of gaining knowledge. Both Client participants mention the inclusion of a department within their company that focuses on new research development: ”We have a department where we develop all sorts of concepts, which we call our lab. So, we have the AM Lab. Part of the lab also includes a sustainability team.” The MRC also highlights one specific colleague that focuses on constant improvement of new alternatives. Other participants highlight the lack of training on the basis of CE, an example is Architect 2: ”There is no specific training. I think this knowledge primarily comes from the history of projects and from collaborations.” This is a reoccurring theme, as Contractor 1 also mentions their method of knowledge gaining is ”Learning on the job”. This complies with literature of Munaro and Tavares (2023): Lack of guidance and tools for implementation of circular buildings. Contractor 2 does highlight they, as a company, do receive specific training to improve knowledge on CE, such as the reuse of steel.

Knowledge barriers

This last section examines knowledge barriers that are present, which can hinder the effective implementation of CE. One of which is the lack of knowledge at project start. Client 1 explains during this start there was nobody that looked into specific tools to show how circularity could be implemented within a project. This is confirmed by Client 2, highlighting nobody was interested in CE at the start of the project. This is acknowledged in literature by Munaro and Tavares (2023): Lack of information about Design for Demolition, green design, and end-of-life products.

In addition to this, initial statements made during the project are said to be given with lacking information Client 2: ”With half of the information, you have to make 100% of the decisions. The same goes for a Tender.” Which is then followed by ”You notice that over time, you learn more and more things. And that some of the ideas or actions you propose in a competition situation may not have been thoroughly researched at that moment.” This correlates to the changes in between the Master plan, and the Interim report. Additionally confirmed by Architect 1: ”So sometimes things, yeah, are difficult to fully understand in the beginning, ’how difficult is this (implementing circularity) going to be’.”

Client 2 additionally highlights many theoretical innovations are still not possible in real construction projects, which is a barrier that is, as of yet, not seen within literature:

”Nowadays, you can make everything bio-based. Supposedly, everything is possible according to the books. But I don’t know of any project in the Netherlands where it has all actually been delivered. And many of the things we are currently building, the ones that are now under construction, are projects that were conceived five to ten years ago. So you see a huge gap—and this is really a problem—especially for those in the circular field, those focused on circular material use and sustainability. We, along with them, are always working on new innovations. But these new ideas are way ahead of what is currently being implemented.” - Client 2

Added to this statement, Client 2 mentions their knowledge compared to 8 years ago has increased significantly, while stated ambitions are not considered to be ambitious anymore.

That said, other barriers to implementing knowledge also becomes clear, as Contractor 3 states: ”It’s crucial, especially in the early stages, to clearly present what the sustainable options are. However, when you look at contractors in general, they have to take a plan that’s already partially set and has a financing plan in place and turn it into a building.” Indicating their knowledge can not be implemented effectively. Highlighting necessity of CSFs: Early and active involvement of critical project stakeholders (Wuni and Shen, 2022).

Knowledge sharing

The first group of code explains findings on knowledge sharing, where various statements have been made by participants. Client 1 and Architect 1 mention the sharing of knowledge has worked well within the project as a whole, while others have not explicitly done so. Yet, contractor 2 mentions he would definitely improve on this topic in a future scenario. Client 1 further expands on their company's interest in actively improving on knowledge sharing, mentioning a platform and space within a project is necessary for fully implementing this.

Collaboration

The second group of codes highlights how collaboration between stakeholders has progressed during the project, finishing with listing found barriers and success factors that highlight what is wrong and what can be improved. Grouping the Code-groups: Collaboration of Stakeholders, Collaboration Barriers and Collaboration Success Factors.

The Collaboration Barriers, hindering CE ambitions, are caused by various groups of stakeholders. First of all, Contractor 2 mentions specific collaboration when using special concrete mixtures, such as implementing a higher amount of reused materials:

"The difficulty with concrete, so to speak, is that you have the structural engineer on one side and the construction team on the other. This creates a triangle. And yes, they just don't work well together. There's almost no collaboration, if any at all. Because everything is rooted in traditional practices, there's almost no need for collaboration. The structural engineer specifies the strength and environmental class, so the concrete technologist knows exactly what to do, and the construction team knows their role as well. But the moment I specify a mixture that falls outside the standard, things get tricky. Suddenly, they have to start collaborating, and that's something we're not used to." - Contractor 2

This importance in collaboration surrounding concrete implementation is again highlighted by the MRC: "Both what they're going to build and the old concrete we're incorporating require close collaboration each time. Not to mention the modified demolition methods." This quote shows the necessity of CSF: Clearly defined and shared goals of circular construction projects among stakeholders (Wuni, 2023).

Specifically mentioned by Architect 3 is an example on collaborating to achieve other forms of circularity, such as implementing circular design strategies like modular facades. "But all these kinds of processes require precise and stable collaboration. That collaboration is terrible for these types of tasks because just when you've finally gotten past the resistance, you get a new project manager. Then you have to start all over again because they also think they're the smartest in the room." Highlighting the Barrier: Conservative, competitive, and fragmented supply chains (Munaro and Tavares, 2023).

As an addition to this, Architect 3 mentions "It's really the builders. They need to want it and make it a priority. They'll look at the clients and say, 'Well, if we don't get that contract, we won't do it.' And the clients will say, 'But if our financiers don't support it, then we don't want it either.' So, everyone ends up pointing fingers at each other." Highlighting the Barrier: Lack of market mechanisms for recovery/reuse of materials (Munaro and Tavares, 2023).

All of the above mentioned quotes show signs of a chain of command. When focusing on Collaboration Success Factors, MRC highlights this by mentioning: "I'm getting a bit tired of the word, but the whole supply chain collaboration is really crucial for this." Which is backed up by various examples of which stakeholders should be introduced in this chain, MRC: "I strongly believe that the producers play a key role in this." Afterwards, he mentions an example of how these producers could be incorporated within the chain of collaboration. Stating: "If I don't go alone, but I go together with AM and BAM, and we tell [...], I strongly believe in that collective approach to producers and suppliers." Which corresponds to the CSF: Create links between demolition contractors and stockists to incentivize deconstruction and materials salvage (Munaro and Tavares, 2023).

He also highlights the additional collaboration between technical expertise and design function could be the a very effective measure of collaboration for overcoming Barriers:

"We create a thorough material inventory, and the Bajes is a great example of that, but then the architect has to figure out how to reuse those items. How cool would it be if you had a material

inventory done by a party that also has practical experience, and then you bring them to the table with the architect? Then, you challenge the architect to take a look at all the great materials you already have on-site and encourage them to use those."- MRC

He hereby explains the necessity of being incorporated earlier, and then have the design of the buildings. This corresponds to CSF: Early and active involvement of critical project stakeholders.

Finally, Client 1 mentions: "It's not just AM's ambition to be sustainable; it's the Bajeskwartier's ambition to be sustainable. And with that, it becomes the ambition of the entire team." Which is considered true, but varying between stakeholders; What is considered sustainable? To overcome this issue Architect 1 explains: "So it's crucial in our opinion that the client which is driving this, has to also engage new consultants or new people, even from their own team. When new people get on board it is important that everybody hears the whole story and everybody that joins the project understands those goals." Which can be possible due to the presence of a stakeholder manager in their company: "That's naturally the role of the stakeholder management department. We handle that as well." (Client 2). This corresponds to the CSF: Training stakeholders to increase the understanding of CE and sustainability. (Munaro and Tavares, 2023).

Conclusion Knowledge & Alignment

This section explored how knowledge is gained, shared, and applied, as well as the barriers of collaboration, and potential drivers or critical success factors.

Participants provided varied insights into their understanding of CE. While some, like MRC, were familiar with principles like the Ladder of Lansink, others, such as Architect 2, lacked formal guidelines and relied on practical experience. Client 2 highlighted a key issue: the gap between theoretical knowledge and real-world application. While literature, such as Munaro and Tavares (2023), notes the 'Lack of information about Design for Demolition, green design, and end-of-life products', real-world challenges reveal that even when theoretical knowledge exists, it's often difficult to implement.

Stakeholders took different approaches to CE learning. Some, like Client 1 and MRC, invested in research teams, while others, like Contractor 1, learned through past projects. Literature also identifies the 'Lack of guidance and tools for implementation of circular buildings' as a barrier which complies with lacking amounts of guidance within some companies to advance their knowledge within this context.

As explained prior, a major issue was the lack of knowledge at project start, highlighted by Clients 1 and 2. While high ambitions were set, ideas on what was to be expected were missing, linking to differences in ambitions in Master plan, and Interim report. Additionally, Client 2 noted the differences between theoretical innovations and their practical uses. This gap between theory and practice is not often emphasized in literature but remains a critical barrier to real-world implementation of CE.

Collaboration, particularly around tasks like recycled concrete within alternative mixtures, was seen as hindered by traditional practices of collaboration. Literature similarly highlights the conservative and fragmented nature of supply chains, which corresponds to this hinder within the case. Several success factors—such as early involvement of stakeholders and consistent communication—were identified as essential to overcoming barriers within collaboration, but also other areas.

Below, Table 4.1 outlines the barriers and critical success factors that relate to Knowledge and Alignment of stakeholders. Take note each barrier and CSF found within this chapter was compared to literature. Within this sub-chapter, only 1 of 9 barriers was not found in literature, while 2 out of 8 CSFs were not found in literature. Finally, some barriers were stated during interviews, while not receiving a CSF to negate them.

Table 4.1: Summary table of Knowledge & alignment

Category	Barrier	Literature Support	Critical Success Factor (CSF)	Literature Support
Methods of Gaining Knowledge	Lack of guidance and tools for implementation of circular buildings	Supported by Munaro and Tavares (2023)	Inclusion of Research Departments that provide specific Training for CE	Supported by Munaro and Tavares (2023)
General Knowledge Barriers	Lack of Knowledge at Project Start (Initial Ambitions)	Supported by Munaro and Tavares (2023)	Training stakeholders to increase the understanding of CE and sustainability	Supported by Munaro and Tavares (2023)
	Technical knowledge often incorporated in a partly finished design	Not found in literature	Incorporating other forms of knowledge (Technical) during ambition setting	Not found in literature
	Conservative, Competitive, and Fragmented Supply Chains	Supported by Munaro and Tavares (2023)	Early and active involvement of critical project stakeholders	Supported by Wuni and Shen (2022)
	Lack of Training on CE Principles	Supported by Munaro and Tavares (2023)	Not mentioned in interviews	N.a
Knowledge Sharing	Only certain stakeholder partake in Knowledge Sharing	Supported by Munaro and Tavares (2023)	Need for Platforms and Spaces for Knowledge Sharing	Not found in literature
Collaboration	Poor Collaboration Among Stakeholders	Supported by Munaro and Tavares (2023)	Importance of Supply Chain Collaboration	Supported by Wuni (2023)
	Lack of Market Mechanisms for Recovery/Reuse of Materials	Supported by Munaro and Tavares (2023)	Stable and Clear Collaboration Processes	Supported by Wuni (2023)
	Lack of Stable and Clear Collaboration Processes	Supported by Wuni (2023)	Early and active involvement of critical project stakeholders	Supported by Wuni and Shen (2022)

4.2.3. Leadership, Commitment & Ambitions

This theme examines the role of leadership and commitment in the implementation of circular economy methods. The analysis focuses on the involvement of stakeholders in leadership roles, the challenges encountered in maintaining commitment, and the factors that support sustained engagement throughout the project. The influence of knowledge-sharing mechanisms on leadership effectiveness and stakeholder commitment is also assessed. The objective is to identify how leadership and commitment contribute to the successful realization of the project's circular economy ambitions, and which stakeholders are most fitting to serve as a leader towards a circular economy.

Leadership towards Transition

Despite mentioning the intrinsic motivation of the Architects in the previous section, the Architects do highlight their inability to be the front runners towards CE goals:

> *"No, that might have been the case fifty years ago. But nowadays, you see that developers are increasingly positioning themselves as the central figures, and builders too. Contractors and developers are becoming something like the centerpiece or gravitational force in such a network. They really need to take action on this. I'm happy to help, but resistance often comes from that direction as well."* - Architect 3

Architect 3 highlights the true decisions are only made by the (Critical) stakeholder that also lay restrictions on what is possible, a 'Leader of the transition' (Jones and Samy, 2021). Examples of such are the the Contractors and Clients that surround such projects. Architect 1 does highlight they want to be leading within the transition towards a CE, while Architect 2 again explains: "It's (An Architect) not a leading role because I think the circularity touches so many aspects of the project on so many scales. Then let's say almost everybody who is on this diagram has something to say." Implying there is much more to consider.

Both Client 1 & 2 mention their importance towards this transition, Client 2: "So in that sense, it's our role to be responsible for that as well. This means we need to promote the vision of reuse. If we don't bring it up, other people won't necessarily do so on their own, so we need to inspire them." Backing up the claim on 'Leadership of the transition', Client 1 explains their power to improve on this topic, by using their private property for cultivating materials to even be used as sustainable construction materials.

Contractor 3 explains: "You can tell that it's necessary to make that step (Towards CE). The entire construction industry is like a large tanker ship; it takes a long time to change direction. But it doesn't seem to be driven by us. That's the feeling I get." Which highlights contractors should not be the main driver towards CE.

Commitment & Improvement

In this sub theme, Barriers and Success Factors surrounding the Commitment of Stakeholders are examined, to show what stakeholders are truly committed to the set goals, what could be improved and how.

This section comprises of various types of barriers, revolving around commitment, that hinder CE implementation. To start off, Architect 1 highlights lack of commitment sometimes results in working against the set goals: "if people are not fully aware or are not really committed to the same goals, then they sometimes work against the project, because then you we as architect it becomes a fight almost. 'Yeah but listen, this was your goal and we made the design based on your goals. Now are you changing the goals or is it just because you are new to the project and you don't know them and then do we have to go through the whole story again?' ." This highlights the difficulty of dealing with new people in a project were goals were already set, and can be linked to the very conceptual ambitions sketched within the Master plan. Showing necessity of CSF: Sustained collaboration, communication, and information sharing among stakeholders and project team members (Wuni, 2023).

Another group of barriers surrounding the commitment of stakeholders presents itself when being the front-runner within ambitious projects. Commitment towards improvement requires financial capabilities, yet often subsidies that get granted, do not go to the truly committed stakeholder, Contractor 2: "So, in reality, the subsidies that are available don't always reach the front-runners. That's where things

get stuck, so to speak." He combines this statement with: "Those who are currently well-intentioned and front runners invest in this, but ultimately, all the investments from these leaders are driven by intrinsic motivation and a desire to remain at the forefront." This corresponds with the CSF: Adequate financial resources and sufficient funding.

From the Client perspective, other commitment difficulties arise, an example is given my Client 2: "The downside is that you're always the pilot project. It means everyone wants to test everything in your project. Those are the biggest hurdles, I'd say." Stating the difficulty of including all new innovations in one, which is further expanded with "And the risk is that it (Innovations in the Sector) moves so quickly. If you constantly try to adapt to the latest things, nothing ever gets done." As of yet, this barrier does not reoccur in literature.

A statement later on in the interview with Client 2 explains a barrier in Commitment from the Municipality. As of yet, this barrier is unknown to literature:

"So, what we found out with the municipality, when it comes to material use, is that there are practical concerns such as the managers of public spaces. For instance, in the Netherlands, when materials are laid down in the streets, they need to be managed. If something breaks, that tile or material needs to still be available, and it has to meet regulations to prevent accidents. The managers aren't keen on new, unfamiliar materials. In Amsterdam, especially, they benefit from as much standardization as possible. The more uniform everything is, the better, because then they always have a spare tile or material somewhere to replace a broken one." - Client 2

Within the same topic, Client 1 explains: "Look, a municipality is compartmentalized. You have the aesthetics department, the mobility department, the sustainability department, and so on—there are about eight different departments. Each one optimizes within its own silo." This barrier is also unknown within literature.

Ambition of Architects

Starting off, Architect 3 mentions their presence within a construction project is considered the 'only stable factor':

"But the resistance is really quite strong, in my opinion. And every time—what's funny is that architects are often the only stable factor in such a design process. But builders, developers, and other stakeholders constantly change teams. So, every time someone new comes on board, it starts all over again. Everyone asks the same old questions, and knowledge transfer is nonexistent because everyone thinks, 'It'll be fine, just let me handle it.' " - Architect 3

Which is again confirmed by Architect 1, who mentions a lack of ambitions of new people joining the project: "[...] so many people that for example come to the project fresh and they don't know, for example, the goals from the beginning or the ambitions of the of the design. Why things were made the way they are [...]" Both Architect 1 and 3 highlight the importance of CSF: Sustained collaboration, communication, and information sharing among stakeholders and project team members (Wuni, 2023).

Within this context, the Architects highlight their own willingness to truly implement the set ambitions. Contractor 2, as a non-Architect, confirms this by mentioning "Meanwhile, the architect clings tightly to the master plan, and they had a sense from the beginning that suddenly everything would be built with concrete or something like that." Which refers to designs of wooden buildings, where others were suddenly talking about concrete as alternatives.

Finally, Architect 1 comments: "On top of that, these things (CE Goals) positively contribute to the environment. These thing are not measured in costs or return, but just that we know it is the right thing to do. As a possibility for the future." Highlighting their intrinsic motivation.

Ambition Barriers

This section considers general barriers that are present surrounding the ambitions of stakeholders. Contractor 2 mentions ambitions, set by the Client, should be set very early in the project. Additionally he mentions it is important to have a Client that truly wants to realise those ambitions: "You notice that when you want to pursue that, you really need a client who is on board with it, and you also need to set that ambition early on." Explaining further the presence of other Contractors before set ambitions hinder

setting effective CE ambitions. Furthermore, Architect 3 highlights the requirement of very ambitious people to lead this transition, this correlates with literature by Jones and Samy (2021). Architect 1, Contractor 1 and 2 all mention the importance the Client within the context of setting the ambitions. ”It all needs to start from a client having the ambition, if the client does not have an ambition to do such a thing, it is going to be very hard.” The CSF that highlights this within literature: Adequate awareness, commitment, support, and leadership of top management.

Conclusion Leadership & Commitment

Leadership is critical in advancing circular economy (CE) practices within construction projects. While architects explain they are not the primary drivers towards CE, but explain contractors and clients hold the decision-making power. Clients, particularly, agree and see their role in achieving CE goals, with Client 1 even explaining about their idea of cultivating sustainable materials for construction use. Contractors, however, feel disconnected from leading the shift, as one compares the slow progress towards CE to turning a ”large tanker ship.”

Commitment challenges often hinder CE progress. A lack of sustained engagement from stakeholders can derail CE objectives, especially when new individuals join projects without understanding prior goals, repeatedly highlighted by Architect as the ’stable factor’ within the project. This makes continuous communication and collaboration essential. Financial limitations are another obstacle specifically for commitment of stakeholders, as subsidies often bypass the most committed stakeholders. Municipalities also resist change, citing practical issues like material standardization, which complicates the adoption of CE innovations. Compartmentalized municipal departments working in isolation further delay progress.

Establishing CE ambitions early in projects is key, with clients needing to fully commit to these goals. Frequent team changes disrupt continuity, particularly for architects, who often remain the only stable presence. This inconsistency underscores the need for better knowledge transfer and collaboration. Critical success factors include sustained communication, financial resources, and leadership from top management. Ultimately, achieving CE goals requires proactive leadership and long-term commitment from all stakeholders.

Below, Table 4.2 outlines the various barriers and CSFs within the section of Leadership, Commitment and Ambitions. Take note each barrier and CSFs found within this chapter was compared to literature. Within this sub-chapter, 5 of 8 barriers were not found in literature, there were 2 CSFs not found in literature, out of 9 CSFs in total.

Table 4.2: Summary table of Leadership, Commitment and Ambitions

Category	Barriers	Literature Support	Critical Success Factors (CSFs)	Literature Support
Commitment	Wavering commitment when new stakeholders join without knowing existing CE goals	Not found in literature	Sustained collaboration, communication, and information sharing	Supported by Wuni (2023)
Commitment and Subsidies	Lack of subsidies for committed stakeholders, hindering their efforts	Similar barrier found in Munaro and Tavares (2023)	Adequate financial resources and funding	Supported by Wuni (2023)
Municipal Resistance	Resistance from municipalities due to standardization and practical concerns, e.g., unfamiliar materials	Not found in literature	Municipal engagement and standardization that accommodate innovation	Not found in literature
Innovation piloting	Clients being pilot projects for too many innovations, leading to project delays	Not found in literature	Selective and phased adoption of innovations	Not found in literature
Departmental Silos	Municipal departments working in isolation, slowing progress	Not found in literature	Cross-departmental collaboration within municipalities	Generally supported by Wuni (2023)
Ambition Setting	CE ambitions need to be set early in projects; weak ambitions hinder progress	Supported by Wuni and Shen (2022)	Early and clear ambition-setting by top management	Supported by Wuni and Shen (2022)
Team Stability	Frequent changes in project teams, especially among contractors and developers, disrupt CE progress	Not found in literature	Stable leadership or long-term involvement of key stakeholders to ensure continuity	Supported by Wuni (2023)
Architectural Stability	Architects are the only stable factor in projects, yet struggle with changing teams and priorities	Supported by Jones and Samy (2021)	Sustained collaboration, communication, and information sharing among stakeholders and project team members	Supported by Wuni (2023)

4.2.4. Barriers: A Comparison

This Theme systematically identifies other encountered barriers which have not been highlighted previously. The analysis covers a wide range of barriers, including technical, regulatory, financial, design-related, communication, and ambition-related challenges. Each barrier is examined to show its impact on the project, and the extent to which it hinders the achievement of circular economy goals. The findings provide a detailed overview of the obstacles that need to be addressed for successful project outcomes.

Technical Barriers

These barriers are related to technical situations that have hindered the process of successful implementation of CE ambitions within the case of Bajeskwartier. As explained previously, Reuse of materials started at a very high level, after various issues this level of circularity decreased.

This has occurred due to various situations, one of which is the presence of 'lightweight concrete', which was recognised by all interview participants. Architect 1 mentioned the presence of asbestos was the result of this, while Contractors 1, 2 and 3 mentioned the difficulty arose due to the presence of a type of granulate within this concrete.

All stakeholder groups concluded in their interviews that this resulted in a decrease of initial ambitions. Contractor 1 explains: "If you want to reuse something from the past, you need to know its quality, understand what it can and cannot do, and then be able to say that it will last another fifty years. And that last part is what really matters." and additionally "It's not that we don't want to reuse materials, don't get me wrong, but reusing materials also comes with, well, other risks." Also the Architects (2) acknowledge this decrease reuse opportunities: "So technically we couldn't save the buildings because of the poor quality." Which can be related to the Barrier: Lack of tools for identifying, classifying, and certification of salvaged materials (Munaro and Tavares, 2023).

This caused a decrease in ambitions, Client 2 highlights:

"The theoretical side can be explored in drawings where you can zoom in and analyze every detail. But when you go into the building, you simply see how things actually are. And then it turns out that during construction, they did things differently. For instance, on the drawing, certain things were cast together. So, in that scientific approach, you can sometimes get completely stuck in something that doesn't reflect real life." - Client 2

This Barrier, highlighting the necessity for preemptive tests, has not yet been included within literature. However Contractor 2 does mention: "In the end, technically, it is possible. You can almost fully reuse the concrete rubble. But there are also requirements attached to it. So, it does need to be clean concrete rubble."

Concluding the Technical Barriers, various quotes from Contractor 1 highlight another issue on a technical level: "In my view, it's always about looking at each project specifically—what's already there, what needs to be done, what can be reused, and what needs to be done to make it functional." This is supplemented by Contractor 2, with a project specific statement: "It has also become clear that these are very challenging buildings to redevelop due to their cell structure. The walkway structure, along with the limited height, makes it difficult. Additionally, the concrete itself is not standard; it contains a kind of aggregate that makes it lightweight." Contractor 1 additionally mentions: "The fundamental issue is that the building has to be adaptable. [...] You can't just say, 'Well, I'll combine three cells to create an apartment.' Unfortunately, it doesn't work like that."

Financial Barriers

The barriers in this section are related to financial issues that arose during the Bajeskwartier project. Starting off, the barrier that is most frequently mentioned relates to outweighing costs versus profits, this is confirmed by all participants. How this affect CE ambitions is explained by Architect 1: "And, yeah, sometimes the estimate of, okay, how much is it going to cost to reuse this was one thing, and then in reality it was a lot more expensive than we thought." Contractor 1 mentions: "Because in the end, the architecture—the visuals—are already sold, so to speak. People have seen the beauty of it, and you have to stick to that." Which relates to the initial master plan designs that have been created beforehand. This barrier has not been found in literature.

Reasoning as to who determines this financial barrier differs, Client 1 mentions: ”And when he (the Municipality) doesn’t get any additional budget, he won’t be able to easily go along with ambitions that are potentially more expensive but also more sustainable. So that’s where I often hit the biggest roadblocks.” Where Contractor 2 highlights ”The investors are putting pressure on it. Before you know it, it’s gone, and no more investment is made in it.” Finally, Architect 3 explains by giving an example on an idea surrounding experimental facades, he then proceeds by paraphrasing: ” ’Yes, but I can’t get a guarantee on that, so I’m not going to do it,’ or ’People can’t get a mortgage on an apartment where the facade isn’t part of the apartment, so yeah, I’m not going to do it.’ [...] No one really wants to make it, even though it’s actually a pretty interesting idea to build an apartment with a fully circular facade. But, well, it’s difficult.” Reasoning as to why this is the case is also explained: ”For example, we’re in a hurry, so we want to do it, but the building needs to be completed within twelve months, or even within six, so it’s not possible. Or the permit needs to be applied for, so we won’t make it. Because it requires several negotiation procedures with banks or with financing, since a circular facade essentially means that the facade itself, whoever builds it, remains the owner of it. So eventually, they would remove it from the building to reuse it somewhere else.” Within this quote, a link can be made with the Financial Barrier stated by Munaro and Tavares (2023) on financial and risk aversion for circular business models.

Regulatory Barriers
This section shortly introduces regulatory barriers that hinder ambitions for specific materials and methods for construction buildings. As Client 1 explains: ”But to be fair to the municipality, the regulations are changing. That’s also true. Eight years ago, I could still rent out office space with an energy label B without much trouble. Now, that’s a much tougher sell, I think.” Highlighting while sustainable alternatives improve other sections of the sustainable ecosystem, regulations and wishes surrounding construction materials hinder successful implementation of Circular Economy ambitions (Client 2). This is caused by norms and regulations by the municipality’s management department (Client 1).

Design Barriers
This section shows barriers that occur surrounding the context of design within a construction project. This section only covers barriers acknowledged by Contractors 1, 2 and 3. Contractor 3 explains Architects need to understand unique designs, such as floating sections of a building, hinder the implementation of reused materials, as safety factors for reused materials are stricter compared to traditional building materials.

4.2.5. Critical Success Factors: A Comparison
This Theme identifies factors that contribute to overcoming previously stated barriers and achieving circular economy ambitions within the project. The analysis focuses on technical, financial, and design-related success factors that have been critical in the effective implementation of circular practices. The section provides evidence-based insights into how these success factors have facilitated the project’s progress and helped in aligning outcomes with the initial ambitions.

Technical Success Factors
This section explains Success Factors on a Technical level. Starting off, as explained in the section of Technical Barriers, a lack of information on materials was present. This has also been explained by Contractor 1 as something of great importance. He further mentions ”Reusing steel structures that have been well-documented and taken from somewhere else is fine—you can work with that.” Which is comparable to the barrier: Lack of documentation of new and used building products (Munaro and Tavares, 2023). highlighting this barrier has been (partly) overcome.

Contractor 2 mentions the importance of discussing with the Client on technical feasibility before Architects are present. This allows Architects to further work out plans with a technical feasibility, instead of coming to a realisation later that design plans are technically not feasible: ”So that’s why sometimes it’s good to temporarily set aside the architect and let the technical people talk with the developer. That way, the developer can provide the architect with certain frameworks to guide the redevelopment.”

Architect 3 mentions the addition of non-circular materials, to implement as a circular construction method:

> *”You’re touching on a critical aspect of sustainable architecture: designing with long-term flexibility and adaptability in mind. By creating a spatial framework, like a concrete structure that remains in*

place indefinitely, and pairing it with a replaceable façade system, such as aluminum, you can significantly increase the building's sustainability. Aluminum, when used in this way, becomes highly sustainable because it maintains its quality over time and can be reused or recycled. " - Architect 3

"This approach allows buildings to adapt to changing needs and functions over decades without requiring a complete tear down, thereby conserving resources and reducing waste. The key is in designing these modular systems that can easily be updated or replaced while maintaining the integrity of the original structure. This method not only extends the building's lifespan but also provides a pathway for ongoing sustainability in urban development." - Architect 3

Highlighting the specific necessity in doing so to prevent tear downs of buildings with a different function. This corresponds to the barrier: Lack of thinking about buying a service instead of having the ownership (Munaro and Tavares, 2023). As a CSF, this solution has not explicitly been highlighted in literature.

Financial Success Factors

This section highlights financial factors that, when implemented successfully, yield a positive result. To start off, a success factor to incorporate is explained by MRC is effective implementation of material reuse, he states incorporating expertise on this topic grants a reduction in costs, as they are able to gather finances from the reused materials, instead of demolishing everything:

"What we are increasingly seeing, because we have invested a lot of time and energy into this, and continue to do so, is that reusing is becoming more financially interesting. We also see that we have a financial advantage in this compared to more traditional parties who just throw everything into the dumpster, as we like to say." - MRC

A last improvement on a financial level can be made by truly embracing alternate methods of construction, in the form of a circular business case. As Architect 3 has highlighted previously, the inclusion of 'Buying a Service' instead of 'Having the ownership' is very important, this has to be done higher up in the chain of finances:

"I think you need to be in the place where decisions are made and where the business case is put together. That business case, on one hand, involves investors and financing. A developer who tries to bring that together and a builder who manages the major part of the costs. There needs to be space considered for that. I believe that in that context, new business cases will emerge that make circularity very attractive."

"I do think that the fundamental gain is there. It's not in carefully demolishing and using a wooden frame somewhere else. That will also succeed eventually, but that's not how we will really build the city of the future." - Architect 3

This is a new CSF that is, as of yet, not found in literature specifically within construction project: Investor firms, at the highest level, are often seen separate to the decision making process, while they should be actively incorporated.

Design Success Factors

As a last section, the success factors surrounding the design process of a construction project are presented. This next quote is a combination of various sections of improvement, as Architect 1 explains:

"We always try to explain, in the best way we can, what the benefits are, both for the environment but also even commercially. Sometimes there is a benefit, for example if you keep a building and if there is a patina that people recognise, that they actually connect to it. Many times its something positive that has even some benefits commercially. If you say the bridges are going to use doors of the prison, yeah that is an investment, more expensive than buying a balustrade. But we have to make sure that we explain it properly and explain that it has a nice story and it has a lot of benefits, even on a commercial level." - Architect 1

Architect 1 explains the importance of designing to present old heritage of a building site already within the designs. Combining this with the mentioned financial barrier: "Because ultimately, the architecture, the pictures have been sold, the beauty has already been seen, and you have to stick to that." (Contractor 1) shows presenting images that incorporate design of reused materials from the start can be considered a success factor towards effective implementation of CE goals. This CSF is not found within literature.

4.2.6. Barriers & Critical Success Factors overview

This section presents an overview of the remaining barriers and critical success factors stated in Chapters 4.2.4 and 4.2.5. Stated in Table 4.3. Take note each barrier and CSF found within both chapters was compared to literature. Within these sub-chapters, 5 of 7 barriers were not found in literature, there were 3 CSFs not found in literature, out of 5. In two instances, no CSF was mentioned to overcome the stated barrier.

Table 4.3: Summary of Barriers and Critical Success Factors results

Category	Barriers	Literature Support	Critical Success Factors (CSF)	Literature Support
Technical	Lack of tools for identifying, classifying, and certification of salvaged materials	Supported by Munaro and Tavares (2023)	Reusing steel structures that have been well-documented	Supported by Munaro and Tavares (2023)
	Decrease in reuse opportunities due to material quality issues	Not found in literature	Importance of measuring technical feasibility early	Not found in literature
	Difficulty with building adaptability and unique designs	Not found in literature	Design with long-term flexibility and modular systems	Not found in literature
Financial	Standard procedure of outweighing costs versus profits	Not found in literature	Not mentioned in interviews	N.a.
	Pressure from investors maintaining budget, having financial and risk aversion towards circular business models	Supported by Munaro and Tavares (2023)	Embracing alternate construction methods and circular business cases by vertical integration of supply chain partners	Supported by Wuni (2023)
Regulations	Regulations hindering circular material usage alternatives	Not found in literature	Not found in interviews	N.a.
Design	Unique designs hinder implementation of reused materials	Not found in literature	Incorporate reused and heritage materials in initial design as incentive for implementing CE	Not found in literature

4.3. The Stakeholder Engagement Strategy

This Sub-Chapter focuses on determining a final Stakeholder Engagement Strategy along the lines of Kaipainen et al. (2023), they mention it is necessary to determine both the Alignment of stakeholders, and the Ecosystem (Management) structure). Using the information obtained through interviews, thoroughly explained in the previous Chapter, this analysis can be done.

The section on Alignment consists of separate sections on alignment of stakeholder knowledge, and alignment in Interests and Attitudes. The latter is researched using the Power-Interest method. The second part of the research of Kaipainen et al. (2023) is researched using the Salience Model. This strategy is compared and filled with additional Critical Success Factors and other relevant information to present as a Draft Stakeholder Engagement Strategy. Afterwards, this draft is validated using the information sent to the CE Experts, what is used during the validation is explained in Chapter 3.2.6: Draft Strategy & Validation. Combining the initial strategy, along with a validation serves as the end-product of this thesis.

4.3.1. Alignment

knowledge

This section compared knowledge of stakeholders in various ways. Each presented stakeholder is compared on their Level of knowledge, Methods of Knowledge gaining and the barriers present, hindering them towards effective CE.

1. Clients

- **Knowledge Level**: Initially, Clients had limited specific knowledge about implementing circular economy (CE) principles. However, they have since developed significant expertise, especially through the establishment of dedicated departments like the AM Lab.
- **Knowledge Gain**: Clients gained knowledge through internal research and development, collaboration with various stakeholders, and the creation of dedicated teams focused on sustainability.
- **Knowledge Barriers**: At the start, there was a lack of specific tools and clear understanding of how to implement CE. Theoretical innovations often exceeded practical implementation capabilities, leading to gaps in knowledge application.

2. Architects

- **Knowledge Level**: Architects have a mix of conceptual and practical knowledge about CE. Their understanding ranges to various sections, where each architect has a specific direction. Generally, they range from theoretical knowledge on new design techniques to practical barriers encountered in achieving high CE standards.
- **Knowledge Gain**: Knowledge is acquired through experience, collaboration with consultants, and adherence to theoretical principles. Here, Architect 3 has also been a lecturer which states a high knowledge base regarding the CE.
- **Knowledge Barriers**: Architects often struggle to translate theoretical knowledge into practical solutions. Practical challenges and feasibility issues can lead to discrepancies between high ambitions and actual execution.

3. Contractors

- **Knowledge Level**: Contractors possess practical knowledge related to construction and material use, with less emphasis on CE principles compared to other stakeholders. Their primary focus is on feasibility and safety rather than intrinsic CE goals.
- **Knowledge Gain**: Knowledge is primarily acquired through practical experience and on-the-job learning. Specific training on CE may vary among contractors.
- **Knowledge Barriers**: Contractors face barriers related to implementing new materials and methods that align with CE principles, often due to resistance from traditional practices and technical feasibility issues.

4. MRC (Material Reuse Company)

- **Knowledge Level**: MRC has specialized knowledge in material reuse and CE practices. Their expertise is concentrated on the technical aspects of reusing and reconstructing materials.
- **Knowledge Gain**: Knowledge is gained through hands-on experience, technical research, and laboratory work dedicated to material reuse.
- **Knowledge Barriers**: MRC's role is more niche, focusing on technical aspects rather than broader project goals. Their influence is limited to specific technical contributions rather than the overarching CE vision.

The alignment of stakeholder knowledge reveals various differences. Clients have significantly developed their understanding of circular economy (CE) principles over time through internal departments and research, although they initially lacked specific tools and practical applications. Architects possess a blend of conceptual and practical knowledge, integrating CE principles into design but facing challenges in translating these concepts into feasible, and sometimes realistic solutions. Contractors focus on practical construction and material use, with knowledge largely based on hands-on experience and limited formal training in CE principles. MRC (Material Reuse Company) has specialized expertise in material reuse, aligning closely with their technical niche but not necessarily with broader project goals. Overall, while Clients and Architects are more aligned with strategic CE goals, Contractors and MRC exhibit specialized knowledge suited to their operational roles. In that sense, this case does not show a true alignment of knowledge between each stakeholder.

Stakeholders per Phase

In this section, information surrounding the presence of stakeholders during the various project phases is sketched, within the current situation. The information that is used, is obtained through the collection of interview quotes of participants explaining their presence, and how active their presence was at various moments within the project. The information is listed within the section of Involvement. Table 4.4 shows a summarized overview of this involvement during the project. Where Figure 4.1 presents this involvement over time in the project.

Table 4.4: Stakeholder Involvement per Project Phase (Current situation)

Stakeholder	Initiation (Masterplan)	Feasibility & Planning	Design	Construction
Client	Active from start, defining scope and ambitions.	Involved, but reduces as technical aspects take over.	Overseeing key decisions, involvement decreases.	Limited involvement, overseeing progress.
Contractor	Not involved yet.	Brought in for technical feasibility and planning input.	Active in technical and practical implementation.	Fully engaged, managing the construction process.
Architect	Involved from start, forming design team for the tender.	Actively refining designs and ensuring alignment.	Leading design with CE integration.	Reduced role, supporting during construction.
Material Recycling Co.	Not involved yet.	Brought in to assess material reuse and feasibility.	Active in assessing material reuse for design.	Consulted for material-related issues if needed.

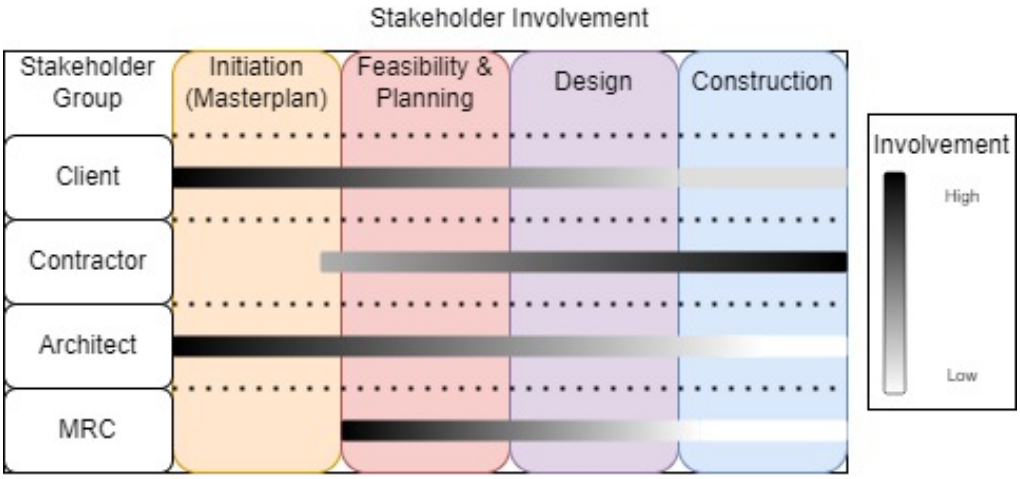


Figure 4.1: Stakeholder Involvement (Current situation)

Power-Interest-Attitude Matrix: Interest & Attitude Alignment

In this part of the results, all stakeholder groups will be divided into specific sections within the Power-Interest-Attitude scheme. This is done according to various steps. In total, only four stakeholder groups are shown, as municipality has not been incorporated this inclusion is not considered to be fit for comparison.

1. Clients: High Power / High Interest / Positive Attitude

- **Power:** Clients hold the highest form of power as they control the project's direction and financial resources. They determine decision making on a large scale.
- **Interest:** Clients are highly interested in achieving the project's sustainability and circular economy goals, as they are integral to the project's vision and outcomes. The goals/ambitions that were set were set on intrinsic motivation.
- **Attitude:** Positive, as they are intrinsically motivated by high circularity ambitions and have established departments focused on improvement of sustainability. Others also perceive them as committed and influential but admitting they face challenges in translating ambitions into practical outcomes.

2. Architects: Medium Power / Medium-High Interest / Positive Attitude

Reasoning:

- **Power:** Architects significantly influence the design and implementation of project goals. Yet they do so according so set ambitions of the Client, which results in a lower rank of power.
- **Interest:** Medium to High Interests, which varies among architects. While Architect 1 shows practical interest, Architect 2 has a specific focus on adhering to the master plan, Architect 3 is conceptually interested but faces challenges in implementation.
- **Attitude:** Very positive, as they support CE principles and contribute conceptual knowledge at initial phases and implement design strategies by using intrinsic motivation. Only stakeholder which mentioned circular business models as alternative early in the project, and recurring within previous years (Architect 3). They do struggle with practical barriers in achieving high CE standards, directing this towards other stakeholders. This indicates a potential misalignment between ambitions and knowledge on practical execution and feasibility.

3. Contractors: High Power / Medium-High Interest / Positive Attitude

Reasoning:

- **Power:** Contractors have substantial power due to their role in the actual construction and material use, determining whether CE strategies are technically feasible. They do have a lacking

power in the initial decision making as they are not present during the forming of the master plan, and within this, the initial ambitions.

- **Interest:** They show a Medium-High level of interest, primarily driven by practical considerations rather than intrinsic CE goals. Considering due to their priority of safe construction and feasibility.
- **Attitude:** Positive, yet they face significant challenges and barriers in implementing CE goals in a practical sense, such as resistance to new materials and methods. They are the stakeholder that conducts technical feasibility calculations, which is seen as a hinder by other stakeholders, such as architects, within the context for achieving the initially set ambitions.

4. MRC (Material Reuse Company): Low-Medium Power / Medium-High Interest / Positive Attitude

Reasoning:

- **Power:** MRC has less direct power compared to clients and architects, as they perform tasks based on a contractual basis, but they are most influential in the specific area of material reuse.
- **Interest:** High interest due to their expertise and conceptual business model ambitions focused on circularity.
- **Attitude:** Positive, as they are committed to advancing CE practices and providing technical expertise. Their personal opinion regards them as important due to their technical expertise on reuse and reconstructing materials to fit a new purpose. By others, MRC is seen as neutral regarding broader sustainability ambitions. Their role is essential for the technical aspects of material reuse, but their influence on overarching circular economy goals is, currently, limited. They are recognized for their expertise in materials but are not viewed as key drivers of the project's sustainability/circularity vision.

In conclusion, Table 4.5 shows an overview of alignment between power, interest and attitude. Within this context, the interest and the attitude of stakeholders towards the CE goals is used as a measurement of alignment. As can be seen, attitude of all stakeholders align, as they all personally perceive CE to be a positive implementation within the construction sector. However, other stakeholder's depictions highlight differences in attitude and Interest. An example is how architects envision contractor's attitude to be. They explain their difficult stance towards innovative CE strategies.

Table 4.5: Power-Interest-Attitude Matrix for Stakeholders

Stakeholder	Power	Interest	Attitude
Clients	High	High	Positive
Architects	Medium	Medium-High	Very Positive
Contractors	High	Medium-High	Positive
MRC	Low-Medium	Medium-High	Positive

In Figure 4.2, the matrix is presented that highlights the different types of stakeholders within this context. For each of the four sections, Attitude is stated by ++, +. - or –, within this instance, all stakeholders are considered to be +, except Architects, which are seen as ++. As can be seen, both Contractor and Client are located within the highest power & interest field. This explains them to be Saviours, due to their positive attitude. These stakeholders should be the main priority within the project (Murray-Webster and Simon, 2006). Maintaining this positive attitude towards CE ambitions is vital, as these stakeholders can also become Saboteurs towards project goals. Architects and MRC are slightly less powerful, as seen within the figure, while the Architect is highlighted to be very attitude positive. Both stakeholders are considered Friends of the project, which should be used as confidants or 'sounding boards' during the project (Murray-Webster and Simon, 2006). Additionally, knowledge that can be gained through the completion of this analysis is the further understanding of the problem at hand. It shows that the Client, being the most powerful and interested stakeholder in terms of decision-making, does not have the highest attitude, potentially allowing barriers to arise as time progresses through the project life cycle.

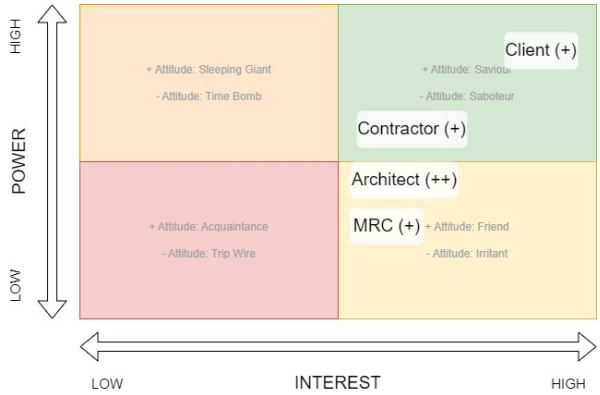


Figure 4.2: Power-Interest-Attitude Matrix (2D)

4.3.2. Ecosystem (Management) Structure

In this section, a comparison is made to determine whether a Hub-Centric Structure, or a Self-Organised Structure present within this project. This is done using the Salience Model. This model uses combined information of all interviews to get a complete overview of direction regarding the Power, Legitimacy and Urgency that stakeholders have. For more information, see Chapter 3.2.6: Stakeholder Mapping.

1. Definitive Stakeholders: Clients

Power: High

Clients hold the highest power in the project as they control its direction and financial resources. Their power is evident in the way they set and enforce sustainability goals. This is reflected in the statements of Architect 1, and Contractors 1 and 2: *"It all needs to start from a client having the ambition; if the client does not have an ambition to do such a thing, it is going to be very hard."* This clearly indicates their central role in determining the ambitions and the project's overall direction.

Legitimacy: High

Clients have strong legitimacy as they are responsible for ensuring that the project meets broader sustainability goals. Their role is further legitimized by their responsibility to inspire and promote circular economy practices. Client 2 underscores this by saying, *"We need to promote the vision of reuse. If we don't bring it up, other people won't necessarily do so on their own, so we need to inspire them."* This highlights their perceived duty to lead the project toward sustainability.

Urgency: High

Clients demonstrate a high sense of urgency, driven by their commitment to pioneering sustainability practices. However, this also comes with the challenges of being a pilot project, as mentioned by Client 2: *"The downside is that you're always the pilot project. It means everyone wants to test everything in your project. Those are the biggest hurdles, I'd say."* Their urgency to push forward despite these challenges reinforces their definitive status.

Salience Classification: Definitive Stakeholder

The Client meet all three criteria (high power, legitimacy, and urgency), making them the most critical stakeholders to address.

2. Dominant Stakeholder: Architects

Power: Medium

Architects have medium power, with their influence largely determined by the project directions, and finances set by Clients, and technical limits set by contractors. When asked whether an architect was considered 'a leader of the CE transition, Architect 3 mentioned*, "No, that might have been the case fifty years ago. But nowadays, you see that developers are increasingly positioning themselves as the central figures, and builders too. Contractors and developers are becoming something like the centerpiece or gravitational force in such a network."* This illustrates that, while architects play a crucial

role, their power has diminished over time as other stakeholders such as clients and contractors, have taken on more central roles in decision-making.

Legitimacy: High

Architects hold significant legitimacy in the project due to their central role in designing structures that align with circular economy goals. Architect 1 reflects on this by giving an example, *"We made the design based on your (The Client's) goals. Now are you changing the goals or is it just because you are new to the project?"* This quote underscores their legitimacy by highlighting their adherence to the project's original objectives, even when other stakeholders may waver or shift their priorities. Their legitimacy is rooted in their commitment to maintaining the project's integrity as initially envisioned.

Urgency: High

Architects display a high level of urgency in advocating for CE, driven by their professional commitment. However, they also recognize the challenges in achieving these ambitions due to the slower adoption by others. Architect 1's comment, *"On top of that, these things (CE goals) positively contribute to the environment. These things are not measured in costs or return, but just that we know it is the right thing to do,"* reflects their intrinsic motivation and sense of urgency to push CE forward.

Salience Classification: Dependent Stakeholders
Architects have High legitimacy and urgency yet lower power, making them dependent on other stakeholders for achieving goals.

Dominant Stakeholders: Contractors
Power: High

Contractors wield substantial power in the project because they control the practical aspects of construction and material use. Their decisions directly impact whether the project's sustainability and circular economy goals can be met. While they may not always set the initial ambitions, their role in translating these ambitions into reality gives them significant influence. The effectiveness of the project's outcomes heavily relies on the Contractors' expertise and their ability to align the practical execution with the overarching circular economy goals.

Legitimacy: Medium

Contractors are legitimate stakeholders due to their responsibility for the practical implementation of CE goals. However, they face challenges in aligning with these goals if they are not set early in the project by the Clients. Contractor 2 mentions, *"You notice that when you want to pursue that, you really need a client who is on board with it, and you also need to set that ambition early on."* Which emphasizes their reliance on the client's leadership to legitimize their role in CE implementation.

Urgency: Medium

The urgency for Contractors is at a medium level, primarily driven by project timelines and the need to meet safety standards. Their commitment to CE is seen as important but often follows the direction set by others. As mentioned by Contractor 2, the need for a committed client early on reflects their conditional urgency in pushing CE forward.

Salience Classification: Dominant Stakeholders
Contractors have medium legitimacy and urgency but high power, making them a dominant stakeholder.

4. MRC (Material Reuse Company)

Power: Low-Medium

MRC holds low to medium power, with their influence limited to the technical aspects of material reuse. Their role is essential for the technical implementation of CE, but they lack broader decision-making power. They are viewed as critical for specific tasks but not as influential in the project's overall direction.

Legitimacy: Medium

MRC's legitimacy comes from their expertise in material reuse, making them a vital technical partner. However, they are not seen as central to the broader CE vision. Their role is specialized, and while important, it does not carry the same weight as that of the Clients or Contractors.

Urgency: Medium-High

MRC shows medium to high urgency in promoting circularity within their domain of expertise. Their commitment to advancing CE practices is strong, but their influence is limited by their narrow focus. Their urgency, while present, does not have the same project-wide impact as that of other stakeholders.

Salience Classification: Latent Stakeholders
MRC has medium legitimacy and urgency but lower power, placing them in the latent category. Their role is important but does not demand as immediate attention as others.

Conclusion

Concluding this section it is possible to acknowledge the Ecosystem (Management) Structure and presence of one stakeholder that acts as a leader towards the transition for CE, this is the decision maker that has the highest power and influence to make other stakeholders comply with their demands. This correlates with the presence of a Hub-Centric Structure. Within the context of this case, the Client, is the person acting as this Leader, or in terms of the research of Kaipainen et al. (2023) the 'Hub'. Following this, Architects are also considered as relevant, although their power is lacking due being unable to influence decision making and following orders (Architect 1, 3). This is due to their high Legitimacy and sense of Urgency to transform the construction sector towards CE.

Table 4.6: Salience Classification of Stakeholders

Stakeholder	Power	Legitimacy	Urgency	Salience Classification
Clients	High	High	High	Definitive Stakeholders
Architects	Medium	High	High	Dependent Stakeholders
Contractors	Medium-High	Medium	Medium	Dominant Stakeholders
MRC (Material Reuse Company)	Low-Medium	Medium	Medium-High	Latent Stakeholders

Figure 4.3 shows an overview of all stakeholders within the salience model. As can be seen, it shows differences in power and urgency, while all stakeholder are present within the Legitimacy section.

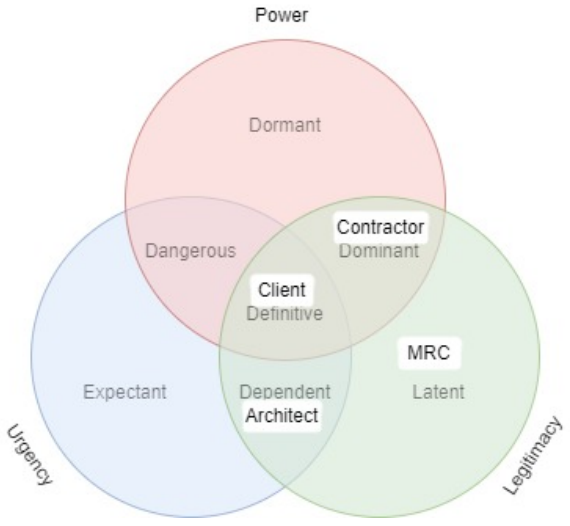


Figure 4.3: Salience depiction of Stakeholders

4.3.3. Stakeholder Engagement Strategy: A Draft

In this section, an initial draft is made by incorporating the fitting Stakeholder Engagement Strategy, while also expanding on it with relevant CSF located in literature and the case study.

Determining the Strategy

In Chapter 4.3.1: Alignment, the alignment was determined on both a knowledge level, and on the level of interest and attitude of the stakeholders towards the CE goals.

The knowledge body of all stakeholders, while similar, differed in many ways. Contractors were mainly focused on technical feasibility, talking about aspects that hindered high quality reuse of materials (Contractor 1 and 3), concrete mixes and the difficulties of improving this on a circular, and sustainable level (Contractor 2). While Clients explained their knowledge to be of high quality, using their in-house lab for new research on CE, and other Sustainable area's. Architects varied within their own stakeholder group. While one focused on the general area of the Bajeskwartier, the other focused specifically on improving reuse circularity. Due to these large gaps in knowledge on CE, their alignment can be considered as: non-aligned.

The alignment regarding attitudes towards the goals was generally considered positive, with stakeholder interest in circular economy (CE) ambitions rated as relatively high when their own interests were assessed personally by stakeholders. However, according to other participants in the study, the interests of stakeholders varied significantly and this is where alignment was lacking. Given these differing perspectives of non-aligned knowledge, and differing alignment of interests and ambitions, the alignment of stakeholders in a general perspective is considered to be non-aligned.

Secondly, Chapter 4.3.2: Ecosystem Structure shows the steps that were taken to determine the presence of a Hub, in a Hub-Centric structure. Due to overview presented in Figure 4.3: Salience Model, it is clear that the Client, as definitive stakeholder, wields the highest Power, Legitimacy and Urgency. This is also grounded by several interview participants that highlight the priority of 'Clients have to have the ambition' in order to implement and effectively pursue CE ambitions. Determining both these parts allows for the usage of one of the four strategies within Figure 4.4: The Chosen Strategy of Kaipainen et al. (2023). Within this figure, it can be seen that the Sieve complies with the two stated conclusions of a set of 'Non-Aligned' alignment level and 'Hub-Centric' ecosystem structure.

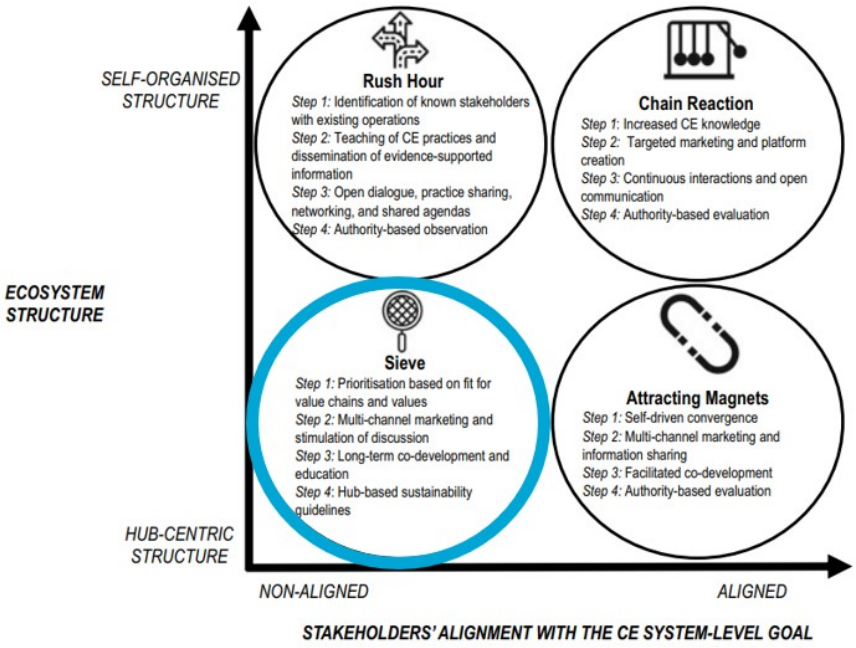


Figure 4.4: The Chosen Strategy: Sieve

A Draft Strategy

Below, a potential step by step process is sketched, combining the steps of the **Sieve Strategy**, adding Critical Success Factors linked specific barriers within literature, along with success factors and barriers from the case study to gain a most effective plan.

1. Initial Assessment and Goal Setting

The first step in the ”Sieve” strategy is to have CE goals defined and assess the current status of the project. This phase is crucial for setting a clear direction, which is necessary for developing the CE ambitions further in the project. In order to set effective goals and aligning all stakeholders with the project's circular ambitions, the barrier ”Lack of Knowledge at Project Start” needs to be overcome. This can be done by incorporating the CSF: Early and active involvement of Critical Project Stakeholders(Wuni and Shen, 2022), which are confirmed to be the Client and the Contractor (Architect 3). As additionally highlighted by Contractor 2, ”You notice that when you want to pursue that (CE Ambitions), you really need a client who is on board with it, and you also need to set that ambition early on. This step is neglected within the steps listed by Kaipainen et al. (2023), yet included as it is considered highly relevant according to interview results.

2. Stakeholder Engagement

Effective stakeholder engagement is critical for successful CE implementation. Therefore this step is envisioned through step one, and partly step two of Kaipainen et al. (2023). Here, prioritization of critical stakeholders containing important knowledge is key, while also engaging them in discussion for the steps to come.

Identifying and engaging critical stakeholders for these roles helps overcome barriers related to leadership and commitment. Architects, developers, and contractors play pivotal roles in driving CE goals. As noted by Architect 3, ”[...] nowadays, you see that developers are increasingly positioning themselves as the central figures, and builders too.” Therefore, fostering strong leadership commitment and ensuring that stakeholders who are intrinsically motivated (Architect 1, 3) to lead the transition are involved is crucial. While the Client and Contractor have already been incorporated in step 1, Architects have not. This is necessary, as they show high intrinsic motivation, and therefore high Legitimacy and Urgency towards CE goals.

Additionally, the MRC mentions the importance of their knowledge during this period, he explains ”How cool would it be if you had a material inventory done by a party that also has practical experience, and then you bring them to the table with the architect? Then, you challenge the architect to take a look at all the great materials you already have on-site and encourage them to use those.” Which is best done by experts that truly know what is possible to be deconstructed.

Along with this, it is necessary to incorporate the investor firms backing the client in such projects, as they make the final choices (Architect 3). When they are present and involved towards CE ambitions, innovative designs and business models can be implemented. This helps overcome the barrier of a lack of thinking about buying a service instead of having ownership.

3. Technical Feasibility Analysis

As a bridge between step two and three by Kaipainen et al. (2023), this step follows on the discussions among stakeholders, educating them on technical expertise and improving long-term collaboration and bonds between companies in the process.

Once all stakeholders have been brought up with initial ambitions, assessing the technical feasibility of CE ambitions, designs and materials is essential for overcoming technical barriers. Issues such as material quality and adaptation difficulties can hinder progress. To address these barriers, it is important to ensure thorough documentation of materials for reuse, as mentioned by Contractor 1: ”If you want to reuse something from the past, you need to know its quality, understand what it can and cannot do, and then be able to say that it will last another fifty years.” Additionally, discussing technical feasibility with stakeholders before finalizing design plans can help prevent issues related to technical constraints. Modular design, as emphasized by Architect 3, “By creating a spatial framework, like a concrete structure that remains in place indefinitely, and pairing it with a replaceable façade system,” is another critical success factor. This approach allows for future adaptability and reduces waste.

Finally clients have to measure the amount of piloting projects (new innovations) are added. Too much

results in hindrance in both technical feasibility and finances.

4. Financial Planning and Resource Allocation
This step is again connected to step two and three by Kaipainen et al. (2023), this step follows up on the importance of education of stakeholders, this time on a financial level, while also improving on long-term collaboration.

Financial planning is a key component in supporting CE goals. Financial barriers, such as high costs and pressure from investors, can impact the implementation of CE practices. To mitigate these barriers, leveraging financial benefits from material reuse, as observed by MRC, can reduce overall costs: “What we are increasingly seeing, because we have invested a lot of time and energy into this, and continue to do so, is that reusing is becoming more financially interesting.” Embracing circular business models, as recommended by Architect 3, is another effective strategy. This involves developing business cases that integrate circularity into financial decisions: “I think you need to be in the place where decisions are made and where the business case is put together.” For this, incorporating not only the client, but also the investors backing the client is vital, done in step 2.

5. Regulatory and Compliance Check
This step is again connected to step two and three by Kaipainen et al. (2023), this step focuses on engaging discussions of made plans and it follows up on the importance of education of stakeholders, this time on a regulatory level.

Ensuring compliance with regulatory standards is necessary for overcoming regulatory barriers. Regulations surrounding construction materials and methods can impact CE implementation. Staying updated with changing regulations and proactively addressing compliance issues can help overcome these barriers. As noted by Client 1, “But to be fair to the municipality, the regulations are changing. Eight years ago, I could still rent out office space with an energy label B without much trouble.” This adaptation to new regulations supports successful implementation of CE practices. To effectively comply with regulations, Municipal engagement needs to be of top priority, ensuring effective collaboration within the municipality (Company Internal) teams using cross-departmental collaboration. This allows for better debate between possibilities surrounding new and innovative construction materials and standardization of city materials.

6. Design and Implementation
This is the last section connected to both step two and three of Kaipainen et al. (2023). It focuses on engaging discussions of made plans while following up on the importance of education of stakeholders surrounding knowledge on design.

Effective design and implementation are crucial for incorporating CE practices into construction projects. Design barriers, such as unique design requirements that hinder material reuse, need to be addressed. Clearly communicating the benefits of reused materials and integrating them thoughtfully into designs can aid in overcoming these barriers. Architect 1’s approach to highlighting the commercial and environmental benefits of reused materials is effective: “Sometimes there is a benefit, for example if you keep a building and if there is a patina that people recognize, that they actually connect to it.” This links to the issue of finance where the images of the building have already been sold. Incorporating CE ambitions within design images allows users to link to historical context, while maintaining urgency to implement circular construction materials.

7. Monitoring and Feedback
The final step can be linked to step four of the Sieve strategy of Kaipainen et al. (2023). It involves monitoring progress and gathering feedback to refine CE strategies. Commitment barriers, such as changing project teams and lack of continuous engagement, can impact the success of CE practices. Maintaining continuous engagement with all stakeholders throughout the project ensures ongoing commitment and helps address emerging issues. Effective knowledge transfer among team members is crucial for aligning with CE goals and practices.

This step by step approach shows a clear strategy to incorporate CE ambitions within the construction sector in an effective manner. This stakeholder Engagement Strategy can be considered effective, as it encompasses various CSF obtained from both literature and case study quotations.

4.3.4. Validation

This section presents the suggestions and additions obtained by the CE experts. While suggested improvements regarding the content of steps within the Stakeholder Engagement Strategy were limited, they did highlight the necessity for reoccurring moments in time where checks with various parties could be performed. Within construction projects, this is already effective and therefore a relevant addition for this Stakeholder Engagement Strategy.

More specifically, they suggested combining the steps 3, 4, 5 and 6 of the draft strategy to perform these in a simultaneous structure, in order to be reevaluated at various moments in time.

"You know that in projects, there are often things you want to achieve or aim for at the start, but there's a good chance they won't work out or won't go exactly as planned. The question is how you deal with that." - CE Expert 1

"For example, we go through this process from the initiation phase to the detailed design phase. Each time, we go through it again. In the sustainability report, you describe it, go over everything again, and each time everyone signs off on it. It's a phase conclusion — we can call it a phase conclusion agreement — where everyone signs off again. This way, you move from the start to the final detailed design, with signatures at each stage, minimizing the risk that anything unexpected happens in between." - CE expert 2

Henceforth, the steps 3, 4, 5 and 6 will be renamed as a combination of one step, 3.1, 3.2, 3.3, 3.4. These moments are used to align stakeholders towards the goals, highlighting what has changed, or should change in the future. Alignment of Technical, Regulatory, Financial and Design steps will be included in order to improve the initial Stakeholder Engagement Strategy of Kaipainen et al. (2023). This improvement was already implemented in the initial steps 3, 4, 5 and 6. in subsequent order.

Additionally, they suggested adding the implementation of contract formulating within the first steps, along with highlighting the necessity of incorporating modular building, as this was considered to be a more effective method of circular building compared to reuse of materials. This addition was already implemented, yet further expanded within the Final Stakeholder Engagement Strategy.

4.3.5. Final Stakeholder Engagement Strategy

1. Initial Assessment and Ambition Setting

The first step in the "Sieve" strategy is to have CE goals defined and assess the current status of the project. This can be done by defining goals, or ambitions, along the lines of R-Principles, considered to be an effective and clear measurement tool. This phase is crucial for setting a clear direction, which is necessary for developing the CE ambitions further in the project. In order to set effective goals and aligning all stakeholders with the project's circular ambitions, the barrier "Lack of Knowledge at Project Start" needs to be overcome. This can be done by incorporating the CSF: Early and active involvement of Critical Project Stakeholders(Wuni and Shen, 2022), which are confirmed to be the Client and the Contractor (according to Architect 3). As additionally highlighted by Contractor 2, "You notice that when you want to pursue that (CE Ambitions), you really need a client who is on board with it, and you also need to set that ambition early on." CE Experts highlight contract formulation within this phase, in order to maintain a concise measurement of expectations for future steps. This step is neglected within the steps listed by Kaipainen et al. (2023), yet included as it is considered highly relevant according to interview results.

2. Stakeholder Engagement

Effective stakeholder engagement is critical for successful CE implementation. Therefore this step is envisioned through step one, and partly step two of Kaipainen et al. (2023). Here, prioritization of critical stakeholders containing important knowledge is key, while also engaging them in discussion for the steps to come.

Identifying and engaging critical stakeholders for these roles helps overcome barriers related to leadership and commitment. Architects, developers, and contractors play pivotal roles in driving CE goals. As noted by Architect 3, "[...] nowadays, you see that developers are increasingly positioning themselves as the central figures, and builders too." Therefore, fostering strong leadership commitment and ensuring that stakeholders who are intrinsically motivated (Architect 1, 3) to lead the transition are involved is

crucial. While the Client and Contractor have already been incorporated in step 1, Architects have not. This is necessary, as they show high intrinsic motivation, and therefore high Legitimacy and Urgency towards CE goals.

Additionally, the MRC mentions the importance of their knowledge during this period, he explains ”How cool would it be if you had a material inventory done by a party that also has practical experience, and then you bring them to the table with the architect? Then, you challenge the architect to take a look at all the great materials you already have on-site and encourage them to use those.” Which is best done by experts that truly know what is possible to be deconstructed.

Along with this, it is necessary to incorporate the investor firms backing the client in such projects, as they make the final choices (Architect 3). When they are present and involved towards CE ambitions, innovative designs and business models can be implemented. This helps overcome the barrier of a lack of thinking about buying a service instead of having ownership.

3. Discussion and Knowledge Sharing
The following steps serve as a bridge between step two and three by Kaipainen et al. (2023). It follows up on the discussions among stakeholders in the previous step, while also educating them on technical, financial, regulatory and design aspects. This is all done in order to successfully incorporate all knowledge basis in a collaborative manner and improving long-term collaboration and bonds between companies in the process.

3.1 Technical Feasibility Analysis
Once all stakeholders have been brought up with initial ambitions, assessing the technical feasibility of CE ambitions, designs and materials is essential for overcoming technical barriers. Issues such as material quality and adaptation difficulties can hinder progress. To address these barriers, it is important to ensure thorough documentation of materials for reuse, as mentioned by Contractor 1: ”If you want to reuse something from the past, you need to know its quality, understand what it can and cannot do, and then be able to say that it will last another fifty years.” Additionally, discussing technical feasibility with stakeholders before finalizing design plans can help prevent issues related to technical constraints. Modular design, as emphasized by Architect 3, “By creating a spatial framework, like a concrete structure that remains in place indefinitely, and pairing it with a replaceable façade system,” is another critical success factor. This approach allows for future adaptability and reduces waste.

Finally clients have to measure the amount of piloting projects (new innovations) are added. Too much results in hindrance in both technical feasibility and finances.

3.2 Financial Planning and Resource Allocation
Financial planning is a key component in supporting CE goals. Financial barriers, such as high costs and pressure from investors, can impact the implementation of CE practices. To mitigate these barriers, leveraging financial benefits from material reuse, as observed by MRC, can reduce overall costs: “What we are increasingly seeing, because we have invested a lot of time and energy into this, and continue to do so, is that reusing is becoming more financially interesting.” Embracing circular business models, as recommended by Architect 3, is another effective strategy. This involves developing business cases that integrate circularity into financial decisions: “I think you need to be in the place where decisions are made and where the business case is put together.” For this, incorporating not only the client, but also the investors backing the client is vital, done in step 2.

3.3 Regulatory and Compliance Check
Ensuring compliance with regulatory standards is necessary for overcoming regulatory barriers. Regulations surrounding construction materials and methods can impact CE implementation. Staying updated with changing regulations and proactively addressing compliance issues can help overcome these barriers. As noted by Client 1, “But to be fair to the municipality, the regulations are changing. Eight years ago, I could still rent out office space with an energy label B without much trouble.” This adaptation to new regulations supports successful implementation of CE practices. To effectively comply with regulations, Municipal engagement needs to be of top priority, ensuring effective collaboration within the municipality (Company Internal) teams using cross-departmental collaboration. This allows for better debate between possibilities surrounding new and innovative construction materials and standardization of city materials.

3.4 Design and Implementation
Effective design and implementation are crucial for incorporating CE practices into construction projects. Design barriers, such as unique design requirements that hinder material reuse, need to be addressed. Clearly communicating the benefits of reused materials and integrating them thoughtfully into designs can aid in overcoming these barriers. Architect 1's approach to highlighting the commercial and environmental benefits of reused materials is effective: "Sometimes there is a benefit, for example if you keep a building and if there is a patina that people recognize, that they actually connect to it." This links to the issue of finance where the images of the building have already been sold. Incorporating CE ambitions within design images allows users to link to historical context, while maintaining urgency to implement circular construction materials.

4. Monitoring and Feedback
The final step can be linked to the fourth step of Kaipainen et al. (2023). It includes monitoring progress and gathering feedback to refine CE strategies. Commitment barriers, such as changing project teams and lack of continuous engagement, can impact the success of CE practices. In this final strategy, monitoring and feedback is maintained using continuous engagement with all stakeholders throughout the project, to ensure ongoing commitment, which helps address emerging issues. Effective knowledge transfer among team members is crucial for aligning with CE goals and practices.

This step by step approach shows a clear strategy to incorporate CE ambitions within the construction sector in an effective manner. Instead of being the final step, this step will be repeated to accomplish the Phase Closing, as mentioned by CE Expert. The experts have highlighted the phases (Different naming compared to the used phases in this research) SO, VO, DO, TO, UO, REA. Which refer to Sketch Design (SO), Temporary Design (VO), Definitive Design (DO), Technical Design (TO), Implementation-Ready Design (UO) and Realisation (REA). These phases occur from Initiation Phase to the end of the Feasibility & Design Phase.

This stakeholder Engagement Strategy can be considered effective, as it encompasses various CSF obtained from both literature and case study quotations. A total, schematic overview is shown in Figure 4.5.

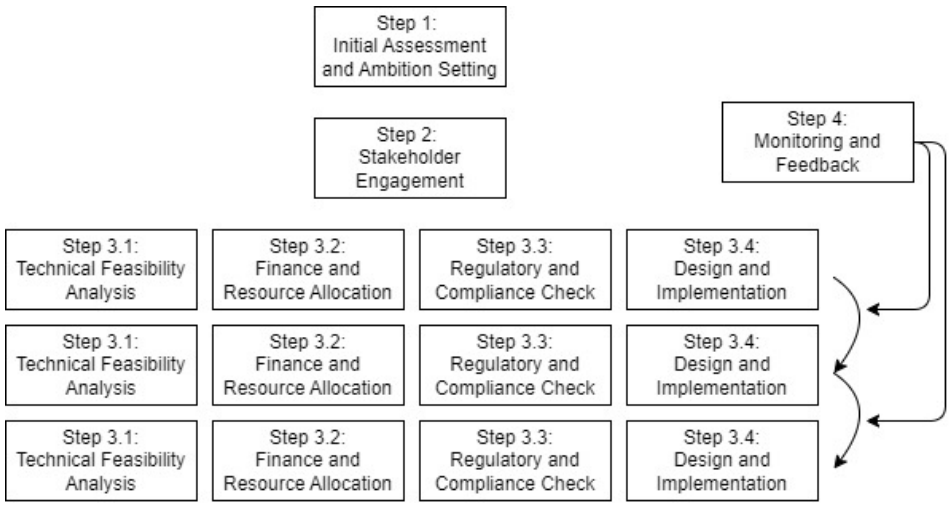


Figure 4.5: Final Stakeholder Engagement Strategy: A Schematic Representation

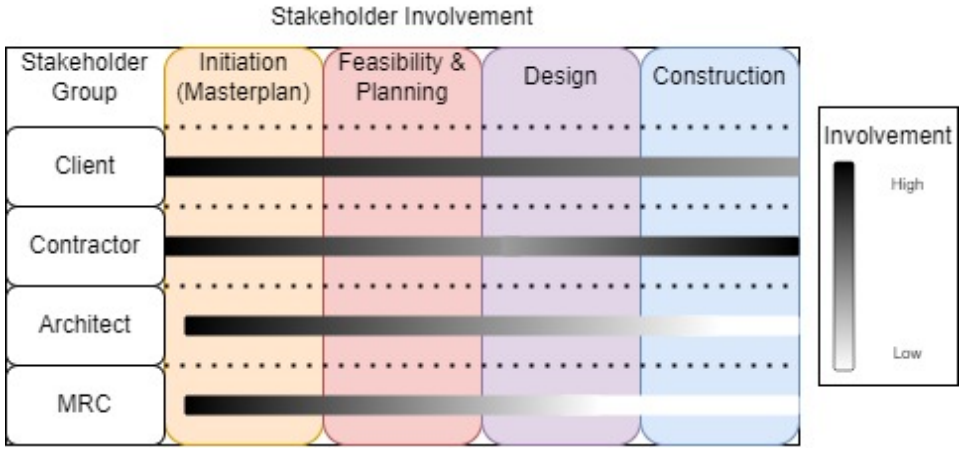


Figure 4.6: Stakeholder Involvement in the future

As additional information, Figure 4.6 is presented that shows necessary involvement of the various stakeholders over time, in doing so, comparisons are made to Figure 4.1, which shows stakeholder involvement within the present scenario. The largest difference that is made, is earlier presence of the Contractor during the Initiation Phase. This allows for technical expertise to flow into the project, determining feasibility before setting ambitions. Only afterwards, Architects aid in creating visuals, implementing CE ambitions within them to lock these ambitions in place (negating the barrier of 'Images have already been sold'). Along these lines, MRC incorporates their own knowledge to highlight methods of effective deconstruction for to-be-reused materials. Finally, the main stakeholder, or 'Hub' considered to be the client, is responsible for maintaining effective collaboration, knowledge sharing and handover of ambition, along with recurring steps 3.1, 3.2, 3.3, and 3.4 during project team alterations for the entire length of the project. While their initial involvement decreased, it should decrease less over time in a future scenario.

5

Conclusion

This research, divided into a literature section, along with a case study of the Bajeskwartier construction project. set out to explore the main research question:

”**How can effective Stakeholder Engagement Strategies overcome barriers to implementing circular economy ambitions in building projects?**”.

To systematically address this question, it was broken down into several sub-questions that examined different sections of the topic. The purpose of this conclusion is to integrate the findings from each sub-question and provide a complete answer to the main research question.

5.1. Sub Question 1

”What Circular Economy Principles are most relevant for implementation of CE Ambitions in building projects?”

A review of literature on Circular Economy (CE) Principles and ’Design For...’ strategies identified 42 different approaches to measuring circularity in construction methods (Charef, Lu, et al., 2022). To organize these, R-Principles were recognized as key. Çimen (2023) explored various R-Principle strategies (3R, 5R, 10R) and concluded that a comprehensive set of 14 R-Principles is most relevant for assessing CE ambitions in building projects.

However, in practice, stakeholders are generally aware of R-Principles but rarely apply them effectively in real-life construction. The client attributed this to a gap between theoretical and practical CE knowledge. Interviews also revealed that ”Reuse” was often used as a encompassing term for multiple R-Principles, particularly in Dutch, where ”Hergebruik” covers various circularity methods under a broad 98% reuse goal, distinguished only by ”high-quality” (”Hoogwaardig”) reuse. Architects noted that this conceptual use within CE ambitions often made it difficult to transfer goals during team changes.

This all results in reason to believe R-Principles, which are currently not used by all stakeholders in a structured manner, are necessary for a clearer and more detailed overview of goals and ambitions. Hence, the R-Principles are considered to be most relevant for improved implementation of CE ambitions within building projects.

5.2. Sub Question 2

”What are the key barriers and success factors to implementing CE ambitions in building projects?”

In response to this sub-question, several key barriers, along with critical success factors (CSFs) that are able to negate these barriers were found in literature, as stated in Table 2.7. This data, based on research by Munaro and Tavares (2023) on barriers and drivers, along with Wuni and Shen (2022) and Wuni (2023) on CSFs to improve the general implementation of CE ambitions in building projects. They offer a comprehensive overview of barriers and CSFs in implementing CE ambitions in building projects through literature. These previous findings were then compared to the case study on the Bajeskwartier.

Tables 4.1, 4.2 and 4.3 present barriers and CSFs divided per interview theme. The comparison revealed a slight contrast between theoretical literature and practical construction scenarios, confirming many barriers and CSFs while providing additional insights.

Answering the sub-question about key barriers and success factors is challenging due to differing perspectives of stakeholders within the case study and a large summation of barriers located within literature. As explained in the results, stakeholders prioritized various barriers: clients cited 'siloed' municipal departments as a major issue, architects emphasized financial constraints and lacking ambitions of others as barriers, while contractors felt that CE designs were overly ambitious at the project's outset, when looking at issues with a technical perspective. The central barrier across these perspectives is the complex and intertwined chain of command in construction projects. Architects, who often have the strongest intrinsic motivation for CE, struggle to apply their expertise because they are constrained by client directives. Clients, in turn, are limited by municipal collaboration issues and financial restrictions of investors, making it difficult for them to support ambitious CE goals. This misalignment among stakeholders severely hinders effective CE implementation.

A key success factor would be creation of greater alignment and like-mindedness among stakeholders. This reflects findings in literature, such as the need for "stable and clear collaboration processes" (Wuni, 2023) and "Early and clear ambition-setting by top management" (Wuni and Shen, 2022). Also explained by stakeholders such as Architect 1 and 3, mentioning the difficulty of maintaining consistent ambition during team changes. By prioritizing collaboration and ensuring a shared commitment to CE goals, also within their own organizations, stakeholders can better prevent the decline in ambition and improve the implementation of CE principles in construction projects.

5.3. Sub Question 3

"What are the key stakeholders involved in different phases of building projects, and what are their roles and interests related to Circular Economy implementation?"

This sub-question was investigated both through literature and the case study. According to Ma and Hao (2024) the five main stakeholders for CE ambition implementation are (Regional) Government, Client, Contractors, Architects and Material Recycling Companies. All except the (Regional) Government were interviewed, revealing distinct roles and interests. The Client leads the project, focusing on completion, stakeholder management, and sustainability goals. Contractors focus on safety of construction and feasibility, aligned with their technical responsibility within the project. Architects have intrinsic motivation for high CE ambitions and their role focuses on design of the project, while the MRC aims for optimal reuse of deconstructed materials, balancing circularity and financial considerations. This analysis of stakeholders confirms that each stakeholder has unique interests, while general alignment of attitude towards CE goals is consistent. This clarity highlights the importance of these stakeholders in CE projects.

Finally, two key stakeholders not covered in this research but crucial to consider are project investors and advisors. Investors, distinct from the client (AM), provide the primary financial backing and exert significant influence on decision-making, including pushing for alternative business models beyond traditional construction. Advisors, on the other hand, play a critical role in guiding and advising the client and architects, particularly in the early stages of the project. While not highlighted in the literature, advisors are instrumental in shaping decisions throughout the construction process.

5.4. Sub Question 4

"What Stakeholder Engagement Strategies are present, which are most effective and how can this be evaluated?"

For the final sub-question, literature revealed that the four Stakeholder Engagement Strategies (SES) outlined by Kaipainen et al. (2023) are critical for improving CE ambition. The most effective strategy can be determined by evaluating stakeholder alignment in terms of knowledge and interests, presented in Chapter 4.3.1 (The x-axis in figure 2.3) and the Ecosystem Management Structure, in Chapter 4.3.2 (The y-Axis in figure 2.3). Based on these factors, with non-aligned knowledge, aligned interests, and a hub-centric structure, the Sieve strategy was identified as the most effective.

However, further refinement of this strategy was needed. The original strategies were too generic and lacked the detail required for full implementation within a real-world construction project. This was performed within this research in order to increase effectiveness of the sieve strategy.

5.5. Main Research Question

With the insights gained from answering these sub-questions, it is now possible to answer the main research question. The analysis of CE Principles shows that the R-Principles are a crucial factor in understanding in what length am ambition can be considered effective in a circular economy. The conducted research on Barriers and CSFs support the conclusion that there are many overlaps of literature and case study, which determined which barriers can be negated. Research on Stakeholders allowed further narrowing of this to determine most important stakeholders to base the SES on. Finally, the research on SES allowed for initial steps, which were further developed using CSFs to overcome barriers, ending in a final Stakeholder Engagement Strategy.

To answer the main research question: ”**How can effective Stakeholder Engagement Strategies overcome barriers to implementing circular economy ambitions in building projects?**” the created strategy in Chapter 4.3.5: Final Stakeholder Engagement Strategy presents a clear overview of steps that demonstrate how critical involvement from all relevant parties, early alignment of ambitions, and clear communication can overcome barriers to implementing circular economy (CE) ambitions in building projects. By addressing knowledge gaps, ensuring leadership commitment, engaging technical expertise at an early phase, and incorporating financial and regulatory considerations, this strategy provides a comprehensive approach to integrating CE practices. The strategy can be completed by adding continuous monitoring and adaptation between phases, which ensures that circular ambitions can be realized effectively throughout the project life cycle.

Along these lines, it is possible for Stakeholder Engagement Strategies to overcome barriers, by using a step-by-step process of aligning goals, ensuring all stakeholders remain aware of CE goals at various moments in time, ensuring intrinsic motivation of each of the stakeholders to be fully willing to achieve these goals. This can only be done by a clear, and functional set of ambitions set at the start of a project, which ensures full cooperation of all stakeholders, even during team changes.

6

Discussion

The discussion section critically evaluates the findings of this research, linking them to the study's objectives, theoretical framework, and broader context. It assesses the validity of the research methods and the reliability of the results, including considering the accuracy of measured data and the extent to which the findings can be generalized. The interpretation of the results addresses both expected and unexpected outcomes, comparing the findings to established theories or models. Limitations encountered during the research are acknowledged, along with their potential effects on the results. Finally, the section explores the research implications and proposes future research directions based on new insights.

6.1. Validity

The validity of this research refers to how accurately it measures the variables it investigates and whether the chosen methods align with the research objectives. To ensure validity, the research employed a case study approach consisting of document analysis and semi-structured interviews, as outlined in Chapter 3: Methodology. However, the scope and methodology present certain limitations that affect the generalizability and context-specific applicability of the findings.

6.1.1. Research Method Alignment

The chosen methods, document analysis and semi-structured interviews, are generally well-suited to the research objectives of determining the level of effective collaboration and engagement. The case study approach does this by capturing context-specific nuances, which are often overlooked by other research methods (Cousin, 2005).

Document analysis compared the initial ambitions in the Masterplan to the interim results and was later cross-referenced with interview findings. This comprehensive approach ensured that planned objectives and actual outcomes were thoroughly examined. Semi-structured interviews, the primary method used in the case study, are an appropriate qualitative tool as they allow for in-depth data collection. This approach offers flexibility for personalized responses while maintaining a structured direction for the questions asked (Gillham, 2000). The method of coding interviews, open, axial and selective coding, is considered a relevant method for including all varying perspectives within the semi-structured interviews. That said, the used coding structure resulted in a total of 271 open codes, which can be considered a large number. This points out the differences in expertise and interests of the various participants, resulting in little overlap of statements.

6.1.2. Generalizability of Case Study Findings

The extent to which these findings can be generalized is limited by multiple aspects such as the participant overview and case variations.

This research focused on one specific case study, the Bajeskwartier, limiting its broader applicability. While this in-depth approach was deemed necessary to locate dynamics of collaboration between var-

ious stakeholders within the given time frame, it makes it difficult to apply the findings to other projects with different contexts, stakeholders, and objectives. The findings within this case are, in hindsight, considered highly context-specific, as the unique characteristics of this project, such as its location, size, and circularity goals, may not represent other construction projects. Different projects have varying ambitions, stakeholder compositions, and external influences, making it challenging to capture a broader range of practices.

Consequently, the stances of the specific companies towards other stakeholders and their stances to the ambitions possibly differ within other projects. In turn, this might have influenced the stakeholder mapping results. The relation between stakeholders (e.g. dominant, dependent, etc.) may change when looking into alternative projects, which hinders the successful generalization of the results within other construction projects. Furthermore, the absence of a comparative perspective limits the ability to identify trends across the sector. With only one case, it is difficult to determine whether the observed dynamics are unique or part of broader recurrence. A multi-case approach would offer clearer insights into consistent factors across projects.

6.1.3. Reliability of Literature

The reliability of the sources used in the literature and the methods employed during the case study were carefully considered, with well-established references incorporated throughout the research. Nonetheless, variations in the quality of data from external sources may have impacted the overall reliability of the findings. Additionally, gathering literature on the combined topics of Critical Success Factors (CSFs), Barriers, Stakeholders, and Stakeholder Engagement Strategies proved challenging. As limited research on the combination of these topics is present within literature. This made creation of a literary basis difficult. It does, however, highlight the relevance of the conducted research. Moreover, since the Bajeskwartier project focused primarily on the reuse of materials (98% reuse), the literature review predominantly concentrated on this aspect of circularity, with less emphasis on circular (modular) business models. However, CE experts identified circular business models as a key area warranting further investigation. Certain differences between case findings and literature do point out the unsuccessful incorporation of important literature. This will be explained in the next sub chapter.

6.2. Results Interpretation

The findings from this research largely align with initial expectations, especially regarding the importance of stakeholder dynamics and the formulation of an effective Stakeholder Engagement Strategy (SES). However, some key insights emerged that underscore the need for further research and highlight the context-specific nature of these findings.

6.2.1. Differences in Case Findings versus Literature

Barriers and CSFs

A highly relevant aspect to discuss is the comparison of barriers and CSFs across each theme in the case study to literature. The theme Knowledge & Alignment introduces one barrier, and two CSFs that were not recurrent in literature, while Leadership, Commitment and Ambitions reveal five Barriers and two CSFs that were not recurrent in literature.

This finding shows the importance of investigating Leadership, Commitment, and Ambitions in future research, while indicating that Knowledge & Alignment has been thoroughly explored in existing literature. However, since the barriers and critical success factors identified through interviews often highlight very specific issues or success examples, there is a strong likelihood that these will reflect broader, more general barriers or CSFs already considered in current literature.

Finally, the last sub-chapters on barriers and CSFs within the context of Technological, regulatory and finance and design identify five barriers and three CSFs that were not located in literature. While these findings are significant, unsuccessful inclusion of literature beyond the specific scope of this research, which targets financial, technical, or design improvements in circular economy (CE) leads to high uncertainty to determine whether these are truly not located in literature.

The previous statements have several consequences on the findings of this research. Namely, discussion on barriers and CSFs that were not found in literature and suggestions for future research looking

into these are limited due to the uncertainty of these being actual new additions. It also highlights the necessity of incorporating, or broadening the scope of the research in the future. As the presence of financial, technical and design related barriers can be considered more important than initially expected. Contrarily, the inclusion of the barriers and CSFs within the context of Financial, Technical and Design aspects does contribute as a confirmation of prior research studies on the same topic, which can be used as a comparison to other projects.

Remaining Differences

Other differences between the expectations in literature and the findings from the case study emerge. For instance, the importance of Architects (Jones and Samy, 2021). While this is mentioned in literature, architects themselves (in this case study) do not consider themselves the key towards the transition, as they do not have the financial capabilities to enforce decision-making. The findings from this case suggest that architects see their influence as limited, primarily due to their reliance on financial backers and clients for decision-making.

That said, this observation should be included with caution, as only one case has been included within this research, limiting the generalizability of the findings surrounding the role of architects in the transition to a circular economy. Nonetheless, this does warrant further exploration using multiple case studies to capture a more detailed and comprehensive understanding of architects' roles and their perceived importance in driving the transition toward circular practices.

Additionally, a significant difference has been neglected when regarding the importance of financial relationships between stakeholders. As explained by Architect 3, the investors backing the client are explained to be the biggest factor in (financial) decision-making, as they decide where the finances get prioritised. Within literature this stakeholder, the 'project investor' was also highlighted as important, unfortunately this was conceived to be the 'Client' with AM as a main stakeholder.

In hindsight, the incorporation of other companies focused specifically on the financial side of the project (Cairn, Schroders Capital or AT Capital). As this financial side was not part of the thesis' scope, these were considered less relevant at the time. Additionally highlighted by the barrier 'financial and risk aversion to circular business models', these are important stakeholders to incorporate in order to truly transform the current economy, to a true circular economy, from a financial perspective.

6.2.2. Recurrence of Theme: Knowledge & Alignment

Despite high recurrence of Knowledge & Alignment barriers in literature and reality, it is clear that well-documented barriers in literature remain unaddressed in construction projects. One possible explanation for this, as noted by Client 2, is the challenge of effectively implementing theoretical knowledge in practical contexts of a construction project.

It also highlights the saturation of literature on this specific topic, as (close to) all known barriers in real-world situations have already been uncovered, further confirmed within this research. Future research on the topic should therefore focus on the improvement of the situation, rather than the uncovering of new barriers that are present.

6.2.3. Theoretical Framework Revisited

When comparing to the theoretical framework in Chapter 2.5, the findings support the necessary application of SES by Kaipainen et al. (2023) within a construction project, rather than the construction sector as a whole. That said, the steps within their SES suggest that additional factors (CSF) are necessary to implement for true effective use of their strategies.

This research provides new insights into the importance of collaboration between stakeholders, using Stakeholder Engagement Strategies, particularly regarding the additional implementations of CSFs within context dependent situations or projects. While the literature, particularly in the European sector, is quite advanced, this study demonstrates that notable differences between literature and reality are still uncovered, which hinder the effective implementation of SES in practical construction projects.

6.3. Limitations

While the research aimed for accuracy, certain limitations affecting the reliability of data were unavoidable. The following paragraphs depict potential limitations that have affected the end result of this thesis.

6.3.1. Exclusion of Key Stakeholder

One such limitation was the exclusion of the Municipality as a stakeholder due to the unavailability or unwillingness of participants within the given time frame. This absence may have influenced the consistency of the results.

6.3.2. Importance of Advisors

CE experts, incorporated within the validation of results, highlighted the importance of 'Advisors' within the context of decision-making during projects. Particularly in technical, design, and financial matters, as these advisors are not explicitly highlighted as significant in the literature. Their importance in real-life construction projects reveals a gap between theoretical frameworks and practical applications. Inclusion of this stakeholder could have affected the creation of the final SES, and other barriers and CSFs within construction projects surrounding engagement of stakeholders.

6.3.3. Differences in Project Phases

Within this research, the project phases of Initiation, Feasibility & Planning, Design, and Construction, were used. These were considered relevant and useful through literature, yet they did not prove to be as effective as anticipated. CE experts suggested that, within construction projects in The Netherlands, more specific phases such as SO, VO, UO, TO are more commonly used. The impact of this limitations was evident in Figure 4.1 and 4.6 where the use of the original four phases hindered the depth of the analysis, therefore the additional sub division of phases would be considered a useful addition for a more specific depiction of presence during projects.

6.3.4. BAM Bias

The potential bias within the thesis due to writing within a company involved within the Bajeskwartier, Royal BAM Group, is considered as an additional limitation. Sections where this bias might have presented itself as a limitation would be the selection of participants, as the company provides internal connections with participants in an easier way. This results in obtained perspectives that can indirectly be considered lenient towards BAM's perspectives. These subconscious actions to produce results that are considered more favorable could be a limitation of this research.

6.4. Implications of the Research

The implications of this research are clear, offering valuable insights into improving stakeholder communication and improving use of knowledge at critical moments during construction projects. This leads to a more complete knowledge base at key stages in construction projects, where informed decision-making is essential in assessing the feasibility of ambitions. This not only helps determining whether the projected ambitions are technically achievable, but it also aids in communicating to top-tier investors that new circular economy (CE) initiatives, while innovative, can be financially advantageous.

The findings can contribute to the improvement of the construction sector, by reducing construction waste during demolition of old buildings and providing an initial framework for integrating alternate CE business models through Stakeholder Engagement Strategies (SES). However, if no actions or changes are made based on these results, lacking ambition implementation may continue to be a problem, meaning that the potential impact of the research would remain unrealized. This highlights the importance of further application of these findings by inspecting other cases within similar contexts.

6.5. Suggestions for Future Research

6.5.1. Suggestions for literature

Based on the findings and limitations, several directions for future research are suggested. Firstly, further investigation into the role of advisors involved in various phases of construction projects could

help clarify their influence on decision-making during the early stages . As CE experts highlight these advisors are involved during the initial decisions surrounding ambitions, their knowledge and interest surrounding CE could be vital for successful progression towards a circular construction sector. Additionally, a more specific research on the Leadership, Commitment and Ambitions of stakeholders is considered relevant, as this section included relatively more barriers and CSF not found in literature compared the other sections.

The research also highlighted new challenges, such as the incorporation of Investors, mortgage providers and other financial institutions of the sector, which would address the gaps left by this study. This would offer a more comprehensive look at rules and regulations that financially prohibit many stakeholders to prevent innovative and sustainable methods of technology. More specific investigation of these stakeholders within the context of CE decision-making would be beneficial.

6.5.2. Suggestions for BAM

The steps outlined at the end of this research are designed to address the key challenges associated with implementing circular economy (CE) ambitions in building projects, particularly the barriers that can be resolved by improving stakeholder engagement. It is recommended to use the provided strategy for incorporating early knowledge alignment, creating a sound basis for stakeholder collaboration, and continuous involvement of critical parties with recurrent steps of validation that aim to significantly reduce miscommunication, delays, and improve awareness of all stakeholders on the initially set ambitions. It also highlights the importance of determining which stakeholders are most important to include early on, as this is a key factor for aligning CE ambitions with feasible, yet innovative design methods. This should, theoretically, be performed by the Client of future projects. However, as Contractor it is vital to present technical possibilities and limitations through intrinsic motivation, as these allow for more effective use of financial resources during the initial stage of a project.

After the validation had been completed at the end of this research, an additional recommendation became present. While validated steps by CE experts have been done using knowledge from within the company, it is believed that the difference, in knowledge on possibilities and priorities surrounding CE, is rather divided within each team. When using this strategy correctly, not only the sustainable team, but other teams will also be aware of feasible, yet sustainable outcomes in the future.

References

Adams, Katherine Tebbatt et al. (2017). “Circular economy in construction: current awareness, challenges and enablers”. In: *Proceedings of the institution of civil engineers-waste and resource management*. Vol. 170. 1. Thomas Telford Ltd, pp. 15–24.

Akinade, Olugbenga et al. (2020). “Design for deconstruction using a circular economy approach: Barriers and strategies for improvement”. In: *Production Planning & Control* 31.10, pp. 829–840.

Al Hosni, Ibtisam Sulaiman, Omar Amoudi, and Nicola Callaghan (2020). “An exploratory study on challenges of circular economy in the built environment in Oman”. In: *Proceedings of the Institution of Civil Engineers-Management, Procurement and Law* 173.3, pp. 104–113.

B.V., Nijssen Recycling (July 2024). *Ladder van Lansink - Rangorde van afvalverwijdering - Recycling.nl*. URL: https://www.recycling.nl/ladder-van-lansink/.

Benachio, Gabriel Luiz Fritz, Maria do Carmo Duarte Freitas, and Sergio Fernando Tavares (July 2020). “Circular economy in the construction industry: A systematic literature review”. In: *Journal of Cleaner Production* 260, p. 121046. ISSN: 09596526. DOI: 10.1016/j.jclepro.2020.121046.

Blomberg, Annika, Johanna Kujala, and Anna Heikkinen (2023). “Multi-Stakeholder Networks in a Circular Economy Transition: A Typology of Stakeholder Relationships”. In: Springer International Publishing, pp. 133–164. DOI: 10.1007/978-3-031-31937-2_5.

BV, AM (n.d.). *Get started - Bajeskwartier*. URL: https://bajeskwartier.com/nl/planning/.

Charef, Rabia and Stephen Emmitt (2021). “Uses of building information modelling for overcoming barriers to a circular economy”. In: *Journal of cleaner production* 285, p. 124854.

Charef, Rabia, Eshmaiel Ganjian, and Stephen Emmitt (Sept. 2021). “Socio-economic and environmental barriers for a holistic asset lifecycle approach to achieve circular economy: A pattern-matching method”. In: *Technological Forecasting and Social Change* 170, p. 120798. ISSN: 00401625. DOI: 10.1016/j.techfore.2021.120798.

Charef, Rabia, Weisheng Lu, and Daniel Hall (Sept. 2022). “The transition to the circular economy of the construction industry: Insights into sustainable approaches to improve the understanding”. In: *Journal of Cleaner Production* 364, p. 132421. ISSN: 09596526. DOI: 10.1016/j.jclepro.2022.132421.

Çimen, Ömer (Mar. 2023). “Development of a Circular Building Lifecycle Framework: Inception to Circulation”. In: *Results in Engineering* 17. ISSN: 25901230. DOI: 10.1016/j.rineng.2022.100861.

Cousin, Glynis (Nov. 2005). “Case Study Research”. In: *Journal of Geography in Higher Education* 29 (3), pp. 421–427. ISSN: 0309-8265. DOI: 10.1080/03098260500290967.

Durdyev, Serdar et al. (Mar. 2023). “Barriers to circular economy implementation in the construction industry: causal assessment model”. In: *Environment, Development and Sustainability*. DOI: 10.1007/s10668-023-04061-8. URL: https://doi.org/10.1007/s10668-023-04061-8.

Ghisellini, Patrizia et al. (2018). “Evaluating the transition towards cleaner production in the construction and demolition sector of China: A review”. In: *Journal of cleaner production* 195, pp. 418–434.

Gillham, Bill (Sept. 2000). *Case study research methods*. URL: https://repository.bbg.ac.id/bitstream/582/1/Case_Study_Research_Methods_.pdf.

Guerra, Beatriz C. and Fernanda Leite (July 2021). "Circular economy in the construction industry: An overview of United States stakeholders' awareness, major challenges, and enablers". In: *Resources, Conservation and Recycling* 170, p. 105617. ISSN: 09213449. DOI: 10.1016/j.resconrec.2021.105617.

Harrin, Elizabeth (Sept. 2023). *The stakeholder salience model and how to use it*. URL: https://rebelsguidetopm.com/stakeholder-salience/.

Hossain, Md. Uzzal et al. (Mar. 2020). "Circular economy and the construction industry: Existing trends, challenges and prospective framework for sustainable construction". In: *Renewable & Sustainable Energy Reviews* 130, p. 109948. DOI: 10.1016/j.rser.2020.109948. URL: https://doi.org/10.1016/j.rser.2020.109948.

Jayasinghe, Ruchini Senarath, Raufdeen Rameezdeen, and Nicholas Chileshe (2019). *Exploring sustainable post-end-of-life of building operations: A systematic literature review*. DOI: 10.1108/ECAM-08-2017-0148.

Jones, Stephanie and Rana Samy (2021). "Future Challenges of Sustainable Leadership and Stakeholder Management in "The Circular Economy" – Examples from the Built Environment in Europe". In: *Effective Executive* 24 (1). ISSN: 09725172.

Kaipainen, Jenni et al. (Jan. 2023). *How to Engage Stakeholders in Circular Economy Ecosystems: The Process*, pp. 193–231. DOI: 10.1007/978-3-031-31937-2\{_}7. URL: https://doi.org/10.1007/978-3-031-31937-2_7.

Kirchherr, Julian, Denise Reike, and Marko P Hekkert (Mar. 2017). "Conceptualizing the Circular Economy: An analysis of 114 definitions". In: *Social Science Research Network*. DOI: 10.2139/ssrn.3037579. URL: https://doi.org/10.2139/ssrn.3037579.

Kooter, Elonie et al. (Mar. 2021). "Sustainability Transition through Dynamics of Circular Construction Projects". In: *Sustainability* 13 (21), p. 12101. DOI: 10.3390/su132112101. URL: https://doi.org/10.3390/su132112101.

Kramer, Jolien and Ellen van Bueren (2021). *Circulair ontwikkelen: even beloftevol als complex*. URL: https://www.gebiedsontwikkeling.nu/artikelen/circulair-ontwikkelen-even-beloftevol-als-complex/.

Kujala, Johanna and Sybille Sachs (Mar. 2019). *The practice of stakeholder engagement1*, pp. 227–242. DOI: 10.1017/9781108123495.014. URL: https://doi.org/10.1017/9781108123495.014.

Kujala, Johanna, Sybille Sachs, et al. (May 2022). "Stakeholder Engagement: Past, Present, and Future". In: *Business & Society* 61 (5), pp. 1136–1196. ISSN: 0007-6503. DOI: 10.1177/0007650321066595.

Leising, Eline, Jaco Quist, and Nancy Bocken (Mar. 2018). "Circular Economy in the building sector: Three cases and a collaboration tool". In: *Journal of Cleaner Production* 176, pp. 976–989. ISSN: 09596526. DOI: 10.1016/j.jclepro.2017.12.010.

Ma, Wenting and Jian Li Hao (Apr. 2024). "Enhancing a circular economy for construction and demolition waste management in China: A stakeholder engagement and key strategy approach". In: *Journal of Cleaner Production* 450, p. 141763. ISSN: 09596526. DOI: 10.1016/j.jclepro.2024.141763.

Marshall, C., G.B. Rossman, and G.L. Blanco (2022). *Designing Qualitative Research*. SAGE Publications, Incorporated. ISBN: 9781071817353. URL: https://books.google.nl/books?id=6TMyzgEACAAJ.

Mitchell, Ronald K., Bradley R. Agle, and Donna J. Wood (Oct. 1997). "Toward a Theory of Stakeholder Identification and Salience: Defining the Principle of who and What Really Counts". In: *The Academy of Management review* 22.4, pp. 853–886. DOI: 10.5465/amr.1997.9711022105. URL: https://doi.org/10.5465/amr.1997.9711022105.

Munaro, Mayara Regina and Sérgio Fernando Tavares (Mar. 2023). "A review on barriers, drivers, and stakeholders towards the circular economy: The construction sector perspective". In: *Cleaner and Responsible Consumption* 8, p. 100107. DOI: 10.1016/j.clrc.2023.100107. URL: https://doi.org/10.1016/j.clrc.2023.100107.

Murray-Webster, Ruth and Peter Simon (Nov. 2006). "Making sense of stakeholder mapping". In: *PM World Today* Vol. 8 Issue 11. URL: https://skat.ihmc.us/rid=1JGD4CJZ4-F9CF0Y-1KM6/SEMINAL%20stakeholder%20mapping%20in%203d.pdf.

Murtagh, Niamh, Lloyd Scott, and Jing-Li Fan (Mar. 2020). "Sustainable and resilient construction: Current status and future challenges". In: *Journal of Cleaner Production* 268, p. 122264. DOI: 10.1016/j.jclepro.2020.122264. URL: https://doi.org/10.1016/j.jclepro.2020.122264.

Neenu, S. K. (Sept. 2017). *Construction project life cycle; phases in life cycle of a construction project*. URL: https://theconstructor.org/construction/construction-project-life-cycle-phases/14283/.

Noktehdan, Mohammadali et al. (Mar. 2019). "Innovation management and construction phases in infrastructure projects". In: *Journal of the Construction Division and Management* 145 (2). DOI: 10.1061/(asce)co.1943-7862.0001608. URL: https://doi.org/10.1061/(asce)co.1943-7862.0001608.

Oluleye, Benjamin I. et al. (May 2023). "Modeling the principal success factors for attaining systemic circularity in the building construction industry: An international survey of circular economy experts". In: *Sustainable Production and Consumption* 37, pp. 268–283. ISSN: 23525509. DOI: 10.1016/j.spc.2023.03.008.

Selman, Ayser Dawood and Anne Nørkjær Gade (2020). "Barriers of incorporating circular economy in building design in a Danish context". In: *Association of Researchers in Construction Management (ARCOM) Annual Conference*. Vol. 2020, pp. 665–674.

Sparrevik, Magnus et al. (Mar. 2021). "Circular economy in the construction sector: advancing environmental performance through systemic and holistic thinking". In: *Environment Systems and Decisions* 41 (3), pp. 392–400. DOI: 10.1007/s10669-021-09803-5. URL: https://doi.org/10.1007/s10669-021-09803-5.

Veen, Cristel (2023). *Reducing ambition erosion to achieve strategic sustainability ambitions: A research on the realisation of strategic sustainability ambitions in the exploration phase*. URL: http://resolver.tudelft.nl/uuid:689c4858-9a80-4e46-87b8-d93811aa5c34.

Williams, Joanna (2019). "Circular cities: Challenges to implementing looping actions". In: *Sustainability* 11.2, p. 423.

Wu, Zezhou et al. (2019). "What hinders the development of green building? An investigation of China". In: *International journal of environmental research and public health* 16.17, p. 3140.

Wuni, Ibrahim Yahaya (June 2023). “A systematic review of the critical success factors for implementing circular economy in construction projects”. In: *Sustainable Development* 31 (3), pp. 1195–1213. ISSN: 0968-0802. DOI: 10.1002/sd.2449.

Wuni, Ibrahim Yahaya and Geoffrey Qiping Shen (Mar. 2022). “Developing critical success factors for integrating circular economy into modular construction projects in Hong Kong”. In: *Sustainable Production and Consumption* 29, pp. 574–587. DOI: 10.1016/j.spc.2021.11.010. URL: https://doi.org/10.1016/j.spc.2021.11.010.

Zhang, Xueqing and Rana Rabnawaz Ahmed (May 2022). “A queuing system for inert construction waste management on a reverse logistics network”. In: *Automation in Construction* 137, p. 104221. ISSN: 09265805. DOI: 10.1016/j.autcon.2022.104221.

Zhidebekkyzy, Aknur et al. (Mar. 2023). “Transition to a circular economy: Exploring stakeholder perspectives in Kazakhstan”. In: *Journal of International Studies* 16 (3), pp. 144–158. DOI: 10.14254/2071-8330.2023/16-3/8. URL: https://doi.org/10.14254/2071-8330.2023/16-3/8.

Zwikael, Ofer and Shlomo Globerson (2006). “From critical success factors to critical success processes”. In: *International journal of production research* 44.17, pp. 3433–3449.

A

Appendix A: Interview questions

Setup of Interviews

Phase 1: Introduction

- Explanation consent form
- Added value of participation
- Video & voice recording handling
- Participant visibility within thesis

Phase 2: General questions

Intro

Main Question: Can you tell me about your profession, your role within the case of Bajeskwartier, and how this involvement has progressed throughout the project?

Connected sub questions:

1. Which stakeholder am I speaking to and which phases of the construction are you mainly involved in?
2. Explain your role and which parts of the case were executed by your group?
3. I've heard that some things did not go as planned. How was this in reality?
4. What were the specific circularity requirements?
    - a. How were these assessed?
    - b. During which phase was this most relevant?
5. Detailed exploration of different phases:
    - a. What were the key issues?
    - b. What choices/changes were made?
    - c. How were these decisions made and who were involved in these discussions?

(English) Theme 1: Critical Success Factor 1: Knowledge of the Stakeholder.

<u>Main Questions:</u>

How were the choices regarding circularity made within the project, (what kind of framework did you choose to consider these requirements), and how were certain decisions weighed?

Was there room for your (companies) knowledge during the decision-making process?

How do you measure what is a circular building strategy and what is not?

General Understanding

1. Can you describe your understanding of the Circular Economy (CE)?
    - Relate to R-Principles
    - How were these used in Bajeskwartier?
    - Are you familiar with the difference between upcycling and downcycling?
    - What is meant by reuse?
2. What do you believe are the core principles of CE?

Awareness and Training

3. Have you received any training or education related to CE?
    - If so, what kind and by whom?
4. How do you stay updated on new developments and best practices in CE?
5. What is your personal level of knowledge compared to that of the company?

Practical Experience

6. Have you been involved previously in any projects that implemented CE principles? Can you describe your role?
7. What specific CE strategies have you seen applied successfully in the construction industry?

Theme 2: Critical Success Factor 2: Collaboration, Knowledge sharing

Main Questions:

How did the collaboration between different parties proceed (examples)?

Did you work on spreading knowledge about the Circular Economy (CE)? Did you learn something from this, or did you teach others?

What could have been improved (both in terms of collaboration and knowledge dissemination)?

Collaboration Attitude

- How important do you believe collaboration is for the successful implementation of CE?
- What are your experiences with collaboration on construction projects? Can you provide examples?
    - Was there a focus on Long Term Relationships?

Knowledge Sharing Practices

- How does your organization approach knowledge sharing internally and with external partners?
    - How was the contact between your company and other companies within the Bajeskwartier project?

- Are there any platforms or tools you use for knowledge sharing and collaboration?

Challenges and Solutions

- What barriers to collaboration and knowledge sharing have you encountered in your projects?
- How do you think these barriers can be overcome to improve CE implementation?

Theme 3: Critical Success Factor 3: Leadership and Ambition

Main Questions:

How do you see your role in promoting and leading CE initiatives within a project like Bajeskwartier? And how has this leadership progressed through the various phases?

(Think about guidance of/toward other stakeholders.)

(Creating a step-by-step plan, and explaining the benefits of CE.)

What is your company's vision for the future in promoting CE within the construction sector?

Leadership Role

- How do you view your role in promoting and leading CE initiatives within your organization?
- Can you describe a situation where you took a leadership role in a CE-related project?

Effectiveness and Impact

- What qualities do you think are essential for effective leadership in CE projects?
- How do you measure the success of your leadership in terms of CE implementation?

Future Vision and Ambition

- What are your long-term goals related to CE in the construction industry?
- How ambitious is your organization in pursuing CE principles compared to others in the industry?

Stakeholder-Specific Questions

Clients

- How do you prioritize CE when selecting contractors and materials for your projects?
- What expectations do you have from your contractors regarding CE practices?
- Welke strategieën worden er momenteel toegepast?

Municipalities/Government Agencies

- What policies or regulations has your agency implemented to promote CE in construction?

- How do you support local construction projects in adopting CE principles?

Contractors

- What challenges do you face in integrating CE principles into your construction processes?
- How do you collaborate with suppliers and clients to enhance CE outcomes?

Material Recycling Companies

- How do you ensure the materials you recycle meet the standards required for CE projects?
- What innovations in material recycling do you see as most impactful for CE in construction?

Architects

- What considerations do you take into account to maximize the reuse and recycling potential of materials in your designs?
- How do you balance aesthetic and functional requirements with the need for sustainable, circular materials?
- What strategies do you use to persuade clients and other stakeholders to adopt CE principles in their projects?
- How do you see your role as an architect in leading and advocating for CE within the construction industry?

Final question

- Are there any things that haven't been addressed yet that you would like to tell me?

(NL) Fase 2: Algemeen

Hoofdvraag:

Kunt u vertellen over uw beroep, functie binnen de casus en hoe deze betrokkenheid is verlopen gedurende het project?

1. Welke Stakeholder spreek ik en welke fases in de bouw vooral bezig?
2. Uitleg van functie en welke onderdelen van de casus zijn door deze groep uitgevoerd?
3. Uit verhalen gehoord dat er dingen tegen zijn gevallen, hoe was dit in de werkelijkheid?
4. Wat waren de specifieke circulariteit eisen?
    a. Hoe werden deze beoordeeld?
    b. Welke fase speelde dit vooral?
5. Diepgang verschillende fases:
    a. Wat speelde er?
    b. Welke keuzes/veranderingen?
    c. Hoe zijn deze keuzes gemaakt, met wie worden zulke dingen besproken?

Thema 1: Kritische Succes Factor 1; Intro + Kennis van de Stakeholder.

Hoofdvraag:

Hoe zijn de keuzes rondom circulariteit gemaakt binnen het project, (welk soort raamwerk hebben jullie gekozen om deze eisen te beschouwen) en hoe zijn bepaalde keuzes afgewogen?

Hoe is de kennis van verschillende stakeholders samengevoegd om zo tot een circulair ontwerp te komen?

Algemeen Begrip

- Wat is uw begrip van de Circulaire Economie (CE), kunt u dit omschrijven?
    - Relateren aan R-Principes
    - Hoe werden deze gebruikt in Bajeskwartier?
    - Bent u bekend met het verschil tussen upcycling en downcycling?
    - Wat wordt er verstaan onder hergebruik (reuse)?
- Wat zijn volgens u de kernprincipes (omschrijving) van CE?

Kennis en Training

- Heeft u enige training of opleiding gerelateerd aan CE gehad?
    - Zo ja, wat voor soort en door wie is dit aangeboden?
- Hoe blijft u op de hoogte van nieuwe ontwikkelingen in CE en best toepassingen in CE binnen de bouw?
- Hoe zou u uw persoonlijke kennis vergelijken met die van het bedrijf?

Praktische Ervaring

- Bent u eerder betrokken geweest bij projecten die CE implementeerde? Kunt u uw rol beschrijven in die projecten?
- Welke specifieke CE-strategieën heeft u met succes in de bouwsector toegepast zien worden?

Thema 2: Kritische Succes Factor 2: Samenwerking, Kennisoverdracht

Hoofdvraag:

Hoe is de samenwerking tussen verschillende partijen gegaan (voorbeelden)?

Hebben jullie gewerkt aan het verspreiden van kennis van CE, hebben jullie hier juist iets van geleerd of wat geleerd aan andere?

Wat kon er beter (zowel samenwerking als Kennis spreiding)?

Samenwerkingshouding

- Hoe belangrijk acht u samenwerking voor de succesvolle implementatie van CE?
- Wat zijn uw ervaringen met samenwerking binnen het bajeskwartier? Kunt u voorbeelden geven?

Kennisdelingspraktijken

- Hoe gaat uw organisatie om met kennisdeling intern en met externe partners?
    - Hoe is het contact gegaan tussen uw bedrijf en andere bedrijven binnen het Bajeskwartier-project?
- Zijn er platforms of tools die u (uw bedrijf) gebruikt voor kennisdeling en samenwerking?

Uitdagingen en Oplossingen

- Welke obstakels voor samenwerking en kennisdeling bent u tegengekomen bij het Bajeskwartier?
- Hoe denkt u dat deze obstakels overwonnen kunnen worden om de implementatie van CE te verbeteren?

Thema 3: Kritische Succes Factor 3: Leiderschap en Ambitie

Hoofdvraag:

Hoe ziet u uw rol in het promoten en leiden van CE-initiatieven binnen een project zoals bajeskwartier? En hoe is deze leiderschap gedurende de verschillende fases verlopen?

(Denk aan begeleiden van andere stakeholders)

(Stappenplan maken, Uitleg geven van het nut van CE)

Wat is de toekomstvisie die jullie hebben, als bedrijf, voor het bevorderen van CE binnen de bouwsector?

Leiderschapsrol

- Hoe ziet u uw rol in het promoten en leiden van CE-initiatieven binnen uw organisatie?
- Kunt u een situatie beschrijven waarin u een leidende rol had in een CE-gerelateerd project?
    - Hier aanhaken tussen verschillen met dat project en Bajeskwartier

Effectiviteit en Impact

- Welke kwaliteiten vindt u essentieel voor effectief leiderschap in CE-projecten?
- Hoe meet u het succes van uw leiderschap met betrekking tot CE-implementatie?

Toekomstvisie en Ambitie

- Wat zijn uw lange termijn doelen met betrekking tot CE in de bouwsector?
- Hoe ambitieus is uw organisatie in het nastreven van CE-principes vergeleken met andere in de industrie?

Stakeholder-Specifieke Vragen

Opdrachtgevers

- Hoe prioriteert u CE bij het selecteren van aannemers en materialen voor uw projecten?
- Welke verwachtingen heeft u van uw aannemers met betrekking tot CE-praktijken?
- Welke strategieën worden er momenteel toegepast?

Gemeenten/Overheidsinstanties

- Welke beleidsmaatregelen of regelgeving heeft uw agentschap geïmplementeerd om CE in de bouw te bevorderen?
- Hoe ondersteunt u lokale bouwprojecten bij het toepassen van CE-principes?

Aannemers

- Met welke uitdagingen wordt u geconfronteerd bij het integreren van CE-principes in uw bouwprocessen?
- Hoe werkt u samen met leveranciers en opdrachtgevers om CE-resultaten te verbeteren?

Material Recycling Companies

- Hoe zorgt u ervoor dat de materialen die u recyclet voldoen aan de normen die vereist zijn voor CE-projecten?
- Welke innovaties in materiaalrecycling ziet u als meest impactvol voor CE in de bouw?

Architecten

- Welke overwegingen neemt u in aanmerking om het hergebruik- en recyclingpotentieel van materialen in uw ontwerpen te maximaliseren?
- Hoe balanceert u esthetische en functionele vereisten met de behoefte aan duurzame, circulaire materialen? (Kennis)
- Welke strategieën gebruikt u om de opdrachtgever en andere belanghebbenden te overtuigen om CE-principes in hun projecten te adopteren? (Samenwerking)
- Hoe ziet u uw rol als architect in het leiden en pleiten voor CE binnen de bouwsector? (Leiderschap)

Eind vraag

- Zijn er nog dingen die niet aan bod zijn gekomen, die je mij nog wilt vertellen?

B

Appendix B: Consent Form

You are being invited to participate in a research study titled Stakeholder Involvement to Overcome Barriers in Circular Ambitions. This study is being done by Gijs Spruit from the TU Delft, in collaboration with Royal BAM group NV.

The purpose of this research study is to gain understanding surrounding the difficulties of implementing Circular Economy ambitions in construction projects, what the causes are of these difficulties in a context of stakeholder collaboration, and how stakeholder engagement strategies can positively affect these difficulties to better implement set ambitions in future construction projects, and will take you approximately 45 minutes to complete. The data will be used for assessing interests, ambitions and drawing conclusions. I will be asking you to answer a short series of questions on information found in the case of the Bajeskwartier, looking into knowledge of the Circular Economy, what is deemed to be 'Circular' and what could be interesting and effective strategies to improve ambition implementation in future research projects.

As with any online activity the risk of a breach is always possible. To the best of our ability your answers in this study will remain confidential. We will minimize any risks by having the interview data on an in-company OneDrive, using only job description (or reference to certain expertise) as information within the thesis. Collected personal data (name, Email, Phone number) will be kept in a notebook and not be published in any way. Participants will be numbered and listed as 'Expert', 'Architect', 'Client', etc. Information will only be published on TU Delft repository, no external publishing will be performed.

Your participation in this study is entirely voluntary and you can withdraw at any time. You are free to omit any questions. Data can be removed if necessary, when asked, up until publishing of the thesis mid-September.

PLEASE TICK THE APPROPRIATE BOXES	Yes	No
A: GENERAL AGREEMENT – RESEARCH GOALS, PARTICPANT TASKS AND VOLUNTARY PARTICIPATION		
1. I have read and understood the study information dated [*DD/MM/YYYY*], or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction.	☐	☐
2. I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions and I can withdraw from the study at any time, without having to give a reason.	☐	☐
3. I understand that taking part in the study involves: ▪ The interview will be recorded (audio) and kept secure on Royal BAM Group nv hardware. ▪ The information gathered will be transcribed using software and made anonymous. ▪ Information mentioned in this interview will be referenced solely by 'Expertise' or 'Job description' in this thesis ▪ Recordings of original audio files will be destroyed after converting to text.	☐	☐
4. I understand that I will not be compensated for my participation by	☐	☐
5. I understand that the study will end; September 2024	☐	☐
B: POTENTIAL RISKS OF PARTICIPATING (INCLUDING DATA PROTECTION)		
6. I understand that taking part in the study involves the following risks Information on choices made in Bajeskwartier project, results of Circular ambitions within this project. I understand that these will be mitigated by Focusing on the collaboration and stakeholder engagement during this study. Note: Text can be viewed after interview for additional clarification of results.	☐	☐
7. I understand that taking part in the study also involves collecting specific personally identifiable information (PII), such as Expertise, Job description, and associated personally identifiable research data (PIRD) with the potential risk of my identity being revealed.	☐	☐
• *Please list which PII and/or PIRD will be collected and summarise (if) any potential risks of re-identification (eg: public/professional reputation)*		
8. I understand that some of this PIRD is considered as sensitive data within GDPR legislation, specifically, Expert opinion on the topic.	☐	☐
9. I understand that the following steps will be taken to minimise the threat of a data breach, and protect my identity in the event of such a breach [contact information and name will be kept secure in notebook (offline). Interview recordings (audio) will be deleted after transcript, transcripts will be kept secure on company OneDrive until end of thesis, these will not be published.]	☐	☐
Provide brief summaries of the mitigating measures to be taken (eg: anonymous data collection, (pseudo-) anonymisation or aggregation, secure data storage/limited access, transcription, blurring, voice modification etc)		
10. I understand that personal information collected about me that can identify me, such as [Name, contact information], will not be shared beyond the study team.	☐	☐
11. I understand that the (identifiable) personal data I provide will be destroyed [At thesis completion, (September 2024)]	☐	☐

PLEASE TICK THE APPROPRIATE BOXES	Yes	No
C: RESEARCH PUBLICATION, DISSEMINATION AND APPLICATION		
13. I agree that my responses, views or other input can be quoted anonymously in research outputs	☐	☐
D: (LONGTERM) DATA STORAGE, ACCESS AND REUSE		
16. I give permission for the de-identified transcript that I provide to be archived in TU Delft Repository so it can be used for future research and learning.	☐	☐
17. I understand that access to this repository is *open only to students and employees of the TU Delft, and additionally others in consultation with Responsible Researcher.*	☐	☐

Signatures

_____ _____ _____

Name of participant [printed] Signature Date

I, as researcher, have accurately read out the information sheet to the potential participant and, to the best of my ability, ensured that the participant understands to what they are freely consenting.

_____ _____ _____

Researcher name [printed] Signature Date

Study contact details for further information:

C

Appendix C: Codes

Code	Code Group	Frequency
Ambition should be set very early in the project	Ambition Barriers	1
Ambitious people necessary to incorporate change	Ambition Barriers	1
Architects were invested, others had a conservative mindset	Ambition Barriers	1
Barrier: Client needs to have the ambition	Ambition Barriers	3
Barrier: New people dont know the initial ambitions	Ambition Barriers	1
AM contacted Architect 3 for help on tender	Architects & Ambitions	1
Architect highlights reuse of materials is not most important	Architects & Ambitions	1
Architect stuck to masterplan during design phase	Architects & Ambitions	1
Architects as a stable factor, other stakeholders often switch teams	Architects & Ambitions	1
Architects kept the aesthetics of the old site when reusing materials	Architects & Ambitions	1
Collaboration and knowledge sharing improves common knowledge	Architects & Ambitions	1
Each architect has a different part, also in terms of material circularity	Architects & Ambitions	1
Focus on global improvement rather than personal	Architects & Ambitions	1
Positive moral responsibility	Architects & Ambitions	1
Supervisors working towards maintaining ambition	Architects & Ambitions	1
Keeping structures as a form of heritage	Circularity from a historical perspective	1
Municipality prioritizes reuse of tower, historical purposes	Circularity from a historical perspective	1
Preservation	Circularity from a historical perspective	1
Preservation from a historical context	Circularity from a historical perspective	1
Reuse as link to history instead of circularity	Circularity from a historical perspective	1
Reusing materials provides additional historical background	Circularity from a historical perspective	1
Circular building requires a very well structured collaboration of stakeholders	Collaboration Barriers	1
Contractor not involved during design of masterplan	Collaboration Barriers	1
Contractor, building executor and concrete producer form triangle with bad collaboration	Collaboration Barriers	1
Contractor, excecutor not used to collaborating using new technologies	Collaboration Barriers	1
Everyone points towards someone giving them tasks	Collaboration Barriers	1
For reusing concrete, effective collaboration necessary	Collaboration Barriers	1
Municipality tends to get more testing after time progresses	Collaboration Barriers	1

Traditional building writes requirements, executor performs tasks based on contract	Collaboration Barriers	1
All stakeholders fully aware of sustainability	Collaboration of stakeholders	1
Close contact between AM and stakeholders	Collaboration of stakeholders	1
Collaboration	Collaboration of stakeholders	3
Collaboration with 'all' stakeholders together	Collaboration of stakeholders	1
Decisions made are mutual agreements	Collaboration of stakeholders	1
Positive collaboration process	Collaboration of stakeholders	1
'Chain collaboration' very important	Collaboration success factors	1
Client also does stakeholder management	Collaboration success factors	1
Collaboration between Architect and MRC to see what can be done with materials	Collaboration success factors	1
Collaboration with FABRICations, and DGMR	Collaboration success factors	1
Confirmation of other stakeholders to achieve ambitions (achievability)	Collaboration success factors	1
Green strategy as a collaboration between architects	Collaboration success factors	1
Incorporating reuse strategy into existing material supplychain is important	Collaboration success factors	1
Joining forces with producers and suppliers to allow for better assurance of reused material is vital	Collaboration success factors	1
Key player is the producers of materials	Collaboration success factors	1
MRC involved others when looking into reuse of concrete	Collaboration success factors	1
MRC looked into technical and financial aspects of deconstruction; Feasibility & Design phase	Collaboration success factors	1
Present time, MRC collaborate with stakeholders that guarantee high form of reuse	Collaboration success factors	1
Succes factor by Architect: Client needs to engage new people	Collaboration success factors	1
All inovation of CE from frontrunners of the sector	Commitment barriers	1
All stakeholders are advisors of their own section	Commitment barriers	1
Architect acknowledges technical/financial difficulties, besides lacking commitment	Commitment barriers	1
Architect: AM or BAM are the main cause of lack of followthrough	Commitment barriers	1
Client highlights circularity is only one of many important aspects	Commitment barriers	1
Concrete sustainability has a low priority	Commitment barriers	1

Due to leading ambitions, other parties want to test new practices in the project	Commitment barriers	1
Hindering project process	Commitment barriers	1
Modular construction results in different steps in construction process	Commitment barriers	1
Most difficult for CE is full reuse cases	Commitment barriers	1
Municipality divided in different sections	Commitment barriers	1
Municipality in favor of standard materials in public spaces	Commitment barriers	1
Negating barrier: new people understand goals & ambitions	Commitment barriers	1
Overarching insurance, warants and lease companies need to change first for implementing the transition to CE	Commitment barriers	1
Pensionfunds, (the actual investors), are very conservative	Commitment barriers	1
Reuse of materials small fraction of true circularity	Commitment barriers	1
Risk of implementing new concepts: Nothing gets realised	Commitment barriers	1
Subsidies dont always get rewarded to frontrunner investors for CE	Commitment barriers	1
Client needs to show and justify sustainability/CE	Commitment success factors	1
Intermediate testing by municipality	Commitment success factors	1
Intrinsic motivation crucial for achieving ambitions	Commitment success factors	1
Municipality had an increasing amount of ambitions for CE	Commitment success factors	1
Municipality remains sturdy in maintaining the initial ambitions	Commitment success factors	1
advisors, although important, dont have real experience in deconstructing buildings. MRC necessary for this	Communication barriers	1
Client combines all loose sections of municipality	Communication barriers	1
Different sections of municipality dont communicate	Communication barriers	1
Often necessary to explain ambitions/decisions multiple times	Communication barriers	1
Architect design choices result in difficult situations for modular construction	Design barriers	1
Difficult to change a design that has already been made	Design barriers	1
Due to design, sustainability falls to background	Design barriers	1
Each section of Bajeskwartier has a respective designmanager	Design barriers	1
Giving architect design freedom can result in difficult constructions	Design barriers	1
If CE hinders design, architects less favorable for reuse	Design barriers	1

Important for architects to realise aesthetics hinder circularity	Design barriers	1
Architect's creativity determines what will be reused	Design Success factors	1
Changing designplan to fit reused materials	Design Success factors	1
Focus on explaining how reuse results in financial benefits	Design Success factors	1
Sustainable thinking requires broader scope of a project	Design Success factors	1
A barrier for modular construction is who accepts owner rights	Financial Barriers	1
A chain of problems leading towards people spending the money	Financial Barriers	1
always a choice between costs and profits	Financial Barriers	1
Architects planned circular facade, not possible in terms of finances	Financial Barriers	1
Barrier: (Financial) Additional tests necessary for reuse of materials	Financial Barriers	1
Barrier: Costs for reuse higher than expected	Financial Barriers	3
Budget chosen in the end, CE ideas fall off	Financial Barriers	1
Business case of 'Groene toren' is bad	Financial Barriers	1
CE falls off due to financial issues	Financial Barriers	1
Client clings to basic requirements of masterplan, reducing costs	Financial Barriers	1
Client takes the risks using high ambitions	Financial Barriers	1
Client wants profit maximization	Financial Barriers	1
Commercial/financial problems hinder circularity	Financial Barriers	2
Design has to remain the same, pictures sold	Financial Barriers	1
High quality reuse of deconstructed buildings too expensive, a lower level was implemented	Financial Barriers	1
Implementing additional reuse of materials is risk of MRC	Financial Barriers	1
information of material quality was available, yet constructive changes too large	Financial Barriers	1
Initial ambitions accepted by everyone. Eventually cheaper options remove this acceptance	Financial Barriers	1
Investors pressure to improve finances of project	Financial Barriers	1
Lack of ambition always due to financial perspective	Financial Barriers	1
Technically everything is possible, yet too expensive	Financial Barriers	1
Traditional demolition makes calculating costs easy	Financial Barriers	1
Without budget, municipality chooses less sustainable option	Financial Barriers	1
Wooden constructions stay difficult due to higher expenses	Financial Barriers	1
Circular (modular) building requires many changes in businesscase and perspective	Financial Success factors	1
Financial needs necessary within a project	Financial Success factors	1

In present time, circularity becomes finacially more beneficial	Financial Success factors	1
In present time, circularity becomes finacially more beneficial pt2	Financial Success factors	1
Investors need to commit to new form of business case	Financial Success factors	1
True improvement of construction sector requires change in businesscase. "buying a service"	Financial Success factors	1
general striving for the highest amount of reuse	General desire to implement CE ambitions	1
Mutual goals for improving circularity (extention of Sustainability)	General desire to implement CE ambitions	1
Reuse of materials was considered by all stakeholders	General desire to implement CE ambitions	1
Stakeholders all willing to apply CE ambitions	General desire to implement CE ambitions	2
'bold statement' (98% reuse)	Initial Ambitions (Masterplan)	1
'Groene toren' only true reuse in terms of construction	Initial Ambitions (Masterplan)	1
1 on 1 reuse was architects choice	Initial Ambitions (Masterplan)	1
98% circular can always be achieved	Initial Ambitions (Masterplan)	1
98% of the material was concrete	Initial Ambitions (Masterplan)	1
AM Sets ambitions as very sustainable	Initial Ambitions (Masterplan)	1
Architect 2: Masterplan is clearly defined	Initial Ambitions (Masterplan)	1
Architect set initial ambitions, builders explained it to be too complicated and expensive	Initial Ambitions (Masterplan)	1
Architects made a very ambitious design	Initial Ambitions (Masterplan)	2
Choices made are among the best options (In general)	Initial Ambitions (Masterplan)	1
Circularity added through intrinsic motivation	Initial Ambitions (Masterplan)	1
Client ambitions were set from intrinsic motivation	Initial Ambitions (Masterplan)	1
FABRICations role in defining (circular) ambitions	Initial Ambitions (Masterplan)	2
First step, what is there to reuse?	Initial Ambitions (Masterplan)	1
High starting ambitions	Initial Ambitions (Masterplan)	2
If collecting unsuccessful, then grinding to rubble	Initial Ambitions (Masterplan)	1
Initial ambition was to 1 on 1 recover parts of old buildings	Initial Ambitions (Masterplan)	1

Initial ambition: Reuse as much as possible	Initial Ambitions (Masterplan)	1
Initial ambitions	Initial Ambitions (Masterplan)	3
Initial ambitions are acknowledged to be very difficult	Initial Ambitions (Masterplan)	1
Initial collaboration with contractor on circularity	Initial Ambitions (Masterplan)	1
initial reuse of 'Groene toren' not applicable anymore	Initial Ambitions (Masterplan)	1
Masterplan very high in ambitions	Initial Ambitions (Masterplan)	5
MRC joined project due to high ambitions	Initial Ambitions (Masterplan)	1
98% reuse ambition already stated, afterwards MRC joined	Initial Ambitions (Masterplan)	1
Contractor: Not involved in masterplan	Initial Ambitions (Masterplan)	1
No explicit sustainability(/circularity) demands in tender	Initial Ambitions (Masterplan)	1
People are quick to assume client sets ambitions only to win the tender	Initial Ambitions (Masterplan)	1
Set ambitions were unclear at the time	Initial Ambitions (Masterplan)	1
Sustainability aspects not described in tender	Initial Ambitions (Masterplan)	1
Unique tender addition as a succes factor	Initial Ambitions (Masterplan)	1
Unknown what was actually possible when setting ambitions	Initial Ambitions (Masterplan)	1
Very open tender for Bajeskwartier	Initial Ambitions (Masterplan)	1
3 Main architects part of tender phase	Involvement of Stakeholders	1
After tender, client involvement becomes less over time	Involvement of Stakeholders	1
Architect involved from initiation phase onwards	Involvement of Stakeholders	1
Client often involved from Tender to VO	Involvement of Stakeholders	1
Contractor 3 present in DO, UO	Involvement of Stakeholders	1
Contractors active early in the design phase	Involvement of Stakeholders	1
Decisions made were set before joining project	Involvement of Stakeholders	1
Lola, OMA, FABRICations, AM and Sweco as initial team	Involvement of Stakeholders	1
Other stakeholders asked to join the project, while some were asked by client	Involvement of Stakeholders	1
Relatively early involvement in project, short period of time	Involvement of Stakeholders	1

A tender requires 100% of the work with 50% of the information	Knowledge barriers	1
At project start, no tools for monitoring knowledge development	Knowledge barriers	1
At tender start, no one was active in implementing CE	Knowledge barriers	1
Barrier: Rapid development of both legislation and new inventions	Knowledge barriers	1
Client admits ambitions would be different if the project would start now	Knowledge barriers	1
Client explains theoretical circularity is too slow for real projects	Knowledge barriers	1
During proces new knowledge becomes available that affects ambitions	Knowledge barriers	1
Good strategy for reuse; Very open to new ways	Knowledge barriers	1
Government/municipal testing done by (project) external bodies	Knowledge barriers	1
If early, contractor can determine circular possibilities. however they join in an already made plan	Knowledge barriers	1
In practice way of thinking uses materials they see within projects	Knowledge barriers	1
Initial knowledge as difficulty for what can be reused	Knowledge barriers	2
New innovations (in theory) are way advanced compared to current construction	Knowledge barriers	1
Past ambitions are not ambitious anymore	Knowledge barriers	1
Reuse and circularity as a new concept	Knowledge barriers	1
Client needs a platform for sharing knowledge and expertise	Knowledge sharing	1
Client shares knowledge though various means	Knowledge sharing	1
knowledge is shared between stakeholders	Knowledge sharing	1
Knowledge on alternatives not shared	Knowledge sharing	1
Acknowledging issue of decreasing ambitions over time.	Lack in ambitions achievement	1
If conflicts arise, CE is the first to drop off.	Lack in ambitions achievement	1
placing concrete below pavement also seen as 'Reuse'	Lack in ambitions achievement	1
Rarely any modular construction methods	Lack in ambitions achievement	1
Reuse is in masterplan, yet some aspects are for play	Lack in ambitions achievement	1
(Landscape) Architect is not a leading role	Leading the transition	1
Architect believes selling a building as a service is much easier.	Leading the transition	1
Architects are the key, but dont have the power to enforce changes	Leading the transition	1
Architects not leading in transition to CE, friction arises from Client & Contractor	Leading the transition	1
Architects want to be leading the transition	Leading the transition	1
Barely any stimulating of CE within contractor	Leading the transition	1

Client ambition to become climate positive	Leading the transition	1
Client should inspire others to be circular	Leading the transition	1
Client using available area to produce better building material alternatives	Leading the transition	1
Stakeholder alignment gets checked by main supervisors	Leading the transition	1
Adaptability is key	Methods of Knowledge gaining	1
Architect 2: Learning in the process	Methods of Knowledge gaining	1
Contractor 2 following trainings for improving knowledge	Methods of Knowledge gaining	1
Contractor 2 invested in improving circularity	Methods of Knowledge gaining	1
Finances added for incorporating reuse	Methods of Knowledge gaining	1
Improving CE knowledge through research inhouse and with collaboration	Methods of Knowledge gaining	1
Internal knowledge gaining	Methods of Knowledge gaining	2
Knowledge on CE gained by learning on the job	Methods of Knowledge gaining	2
MRC uses circular advisor to find use for gained materials	Methods of Knowledge gaining	1
No training through company	Methods of Knowledge gaining	1
Reading research articles for new circularity knowledge	Methods of Knowledge gaining	1
Contractual barrier: underground pipes	Regulatory barriers	1
Municipal norms & checks cause hinders	Regulatory barriers	1
Requirements for materials are hindering factor for implementing circularity	Regulatory barriers	1
Rules & Regulations change	Regulatory barriers	1
Client explains to different ways of measuring circularity: Theoretical & in practise	Stakeholder knowledge	1
Knowledge CE	Stakeholder knowledge	2
Knowledge on CE more on a conceptual level	Stakeholder knowledge	1
Ladder of Lansink (like R-Principles) used by MRC	Stakeholder knowledge	1
Large section of circularity obtained from designing a city in a circular way	Stakeholder knowledge	1
MRC has a lot of knowledge of granulates & reuse of these	Stakeholder knowledge	1
MRC would like their expertise as main value for CE ambitions	Stakeholder knowledge	1
No exact principles for circularity, but there are differences in reuse	Stakeholder knowledge	1
Own (architect) knowledge deemed important	Stakeholder knowledge	1
Reuse of waste and other materials was also an important factor	Stakeholder knowledge	1
Used something similar to R-principles to measure what is possible with materials	Stakeholder knowledge	1

After noticing lightweight concrete, circularity went a step downwards.	Technical Barriers	1
Analysis results show difficulty of reusing old buildings	Technical Barriers	1
Bajeskwartier buildings got totally different function	Technical Barriers	2
Barrier: Asbestos found & very cheap concrete	Technical Barriers	2
Barrier: Dimensions of buildings	Technical Barriers	1
Barrier: Lack of insulation & force loading	Technical Barriers	1
Barrier: old calculations different compared to current models	Technical Barriers	2
Barrier: Reusing buildings not possible above parkinggarage	Technical Barriers	1
Building quality poor, could not be reused	Technical Barriers	1
Contractor suggested circular construction methods, yet in reality often nog possible	Technical Barriers	1
Contractors want to reuse, yet risks are present	Technical Barriers	1
Current buildings were not possible using old builing reuse	Technical Barriers	1
Deconstruction looked like traditional demolition	Technical Barriers	1
Formal/technical measurement for CE can be deceiving	Technical Barriers	1
Information on quality of to-be-reused item is very imporant	Technical Barriers	2
Keeping the structure (Groene toren) is practically difficult	Technical Barriers	1
lightweight concrete caused issue for circular options	Technical Barriers	2
Making a harvesting scheme was very difficult during the project	Technical Barriers	1
Many problems for reuse of materials make it impossible, the building is not designed for it	Technical Barriers	1
Material quality dissapoints after collecting	Technical Barriers	1
Old buildings are not really made for reuse	Technical Barriers	1
One on one reuse of old concrete structures is very difficult	Technical Barriers	1
Other sustainability impacts are further advanced compared to material reuse	Technical Barriers	1
Prefab concrete structures made no use of sustainable mixtures	Technical Barriers	1
Project specific what can be reused	Technical Barriers	1
Reuse difficult due to weight restrictions for transport	Technical Barriers	1
Reuse of materials is very complex.	Technical Barriers	1
Reuse of old concrete is technically possible	Technical Barriers	1
Technical barrier	Technical Barriers	1
Theoretic versus realistic: Storing deconstructed materials is difficult and not always sustainable	Technical Barriers	1
Theoretical aspects seem possible, yet in reality they often are not	Technical Barriers	1
To-be-reused building needs to be fit to do so	Technical Barriers	1

True reuse of concrete very difficult	Technical Barriers	1
Working outside of norms is difficult for more sustainable concrete options	Technical Barriers	1
CE Tools are required	Technical success factors	1
Client seeks collaboration (initially with advisors), as own knowledge doesnt cover everything	Technical success factors	1
Contractor advises client/developer	Technical success factors	1
Contractor informs Client what is possible, Client informs Architect on design choices	Technical success factors	1
Deskstudy + Fieldwork required before implementing reuse of materials	Technical success factors	1
Implementing Modular construction requires early structural calculations	Technical success factors	1
masterplan necessary, yet afterwards collaboration between technical deconstruction and architect is important	Technical success factors	1
MRC dismember entire building using material passports	Technical success factors	1
New buildings should be constructed differently to accompany other functions in the future	Technical success factors	1
Not sustainable materials can serve a sustainable purpose if used in modular construction	Technical success factors	1
Pioneering innovation requires larger scale of projects	Technical success factors	1
Reuse better to implement if core/function remains the same	Technical success factors	1
reusing concrete of other projects is a good alternative	Technical success factors	1
Reusing well documented steel can be done easily	Technical success factors	1
Total Codes: 271	**Total Quotations:**	297

D

Appendix D: Masterplan for Initial Circularity Ambitions

5.4 CIRCULAIR MATERIAALGEBRUIK

5.4.1 Gebied

Er is een ambitieuze visie op circulair bouwen en ontwerpen geformuleerd. Met enerzijds een hergebruikscore van 98% en hergebruik van beton-elementen zoals tralies en celdeuren, is de ambitie zeer hoog. Om dit te faciliteren is een oogststrategie opgesteld voor het hergebruik van bestaande gebouwdelen en materialen. Anderzijds door circulair bouwen als principe uit te leggen waarbij nieuwe materialen een zo laag mogelijke milieu impact zouden moeten hebben, en het ontwerp herbruikbaarheid van gebouwelementen in de toekomst moet faciliteren. We werken hierbij met een prioritering van hergebruik:

- Behoud van geschikte gebouwen (Het hoofdgebouw, de kerk, de Groene Toren).
- Gebouwelementen hoogwaardig hergebruiken (geveldelen, deuren, ...). Een Bajes Materialenbank App maakt beschikbare materialen inzichtelijk voor bouwers en bewoners, ook na oplevering.
- Materialen lokaal recyclen (betonpuin, glas, etc.)
- Nieuwe materialen kiezen uit een circulaire materialenlijst
- Nieuwe gebouwen krijgen een gebouwelementenpaspoort conform de methodiek van het Circulair Building Platform.

5.4.2 Gebouw

Naast hergebruik van gebouwen, gebouwdelen en bouwmaterialen wordt de circulariteit van gebouwen bepaald door haar toekomstbestendigheid. In het Bajes kwartier zijn de volgende voorzieningen opgenomen die de gebouwen flexibel maken:

Materiaalgebruik
- Naast het behoud van enkele gebouwen, wordt voor twee volumes ingezet op houtbouw. Hiermee zijn de gebouwen van hernieuwbaar materiaal gemaakt, en zijn het ineens CO2-opslagplaatsen.

Flexibiliteit
- Het mogelijk samenvoegen van appartementen om aan een eventuele veranderende vraag te voldoen in de toekomst.
- Voldoende plafondhoogte en beukmaat voor zowel wonen als bedrijvigheid aan de Amstelstroomlaan maakt wisseling van functie in de toekomst mogelijk.
- Mogelijkheid voor opbouw en aanbouw op lange termijn – zowel groot (extra vierkante meters BVO) als klein (tuinhuisjes, kasjes op groene daken, serres).

End-of-life
- Niet in het werk storten, geen verlijming en het gebruik maken van prefab delen (hout of beton) maakt demontabelheid makkelijker.
- Modulariteit is een mogelijkheid die snel aan populariteit wint en die zowel in de opbouw als in het mogelijke hergebruik van gebouwmaterialen bijdraagt aan de circulariteit.
- Het bijhouden van een materialenindex en grondstoffenbalans maakt de mogelijke CO2- en materialenbesparing bij verbouw en sloop inzichtelijk.

E

Appendix D: Interim Results as Comparison to Initial Ambitions

CIRCULAIR

3.1 INTRODUCTIE

Circulair herontwikkelen waarbij wordt geoogst, hergebruikt en goed wordt nagedacht over nieuwe materialen met een lagere milieufootprint. Op het gebied van hergebruik betekent dit leren door het te doen. Tijdens de sloop zijn kansrijke gebouwelementen geoogst en getoetst. Voor nieuwe materialen is een lijst met biobased alternatieven als startpunt ontwikkeld. Ontwerpen worden getoetst op flexibiliteit en demontabiliteit na de levensloop. Circulair bouwen begon met ambities die zijn vertaald naar prestaties waar in het VO het resultaat te zien is van studies naar de haalbaarheid van hergebruik. De definitieve materialisering vindt plaats in de ontwerpstap naar DO.

3.2 SAMENVATTING

De circulaire ambitie is geformuleerd van grootschalig hergebruik tot en met recycling. Het hoogst haalbare is om gebouwen in zijn geheel her te gebruiken Dit gebeurd met het hoofdgebouw, de groene toren, het poortgebouw en de kerk. Maar ook delen van de buitenmuur blijven overeind. De grootste innovatie zit in het hoogwaardig hergebruiken van gebouwelementen. Voor de tralies, celdeuren en betonelementen zijn studies verricht om de (on) mogelijkheden te bepalen. Recycling is het slotstuk waarbij we met name betongranulaat hergebruiken. Andere stromen worden gesorteerd en los hergebruikt. Onder aan de streep wordt 98% van alle materialen hergebruikt.

Hergebruik is maar één aspect. Ook bij nieuwe materialen kijken we naar de milieufootprint en passen we zoveel mogelijk biobased materialen toe. Om toekomstig hergebruik mogelijk te maken worden de ontwerpen getoetst aan het programma van eisen circulair en flexibel ontwerpen, ontwikkeld met C-Creators. Alle gebouwen krijgen een gebouwpaspoort.

Tijdens de sloop zijn kansrijke gebouwelementen geoogst en getoetst. Voor nieuwe materialen is een lijst met biobased alternatieven als startpunt ontwikkeld.

Prestatie overzicht : Circulair Materiaalgebruik

Indicator	Belofte	Stand v. zaken	Vervolg
Hergebruikscore	98%	Beelen heeft elementen geoogst en alle fracties gescheiden	Evaluatie na sloopwerkzaamheden
Hergebruik bestaande elementen	Hergebruik van betonelementen, stalen deuren, 'lamellen' en tralies	1.030 elementen zijn geoogst en opgenomen in VO	Verdere uitwerking in VO
Gebouw elementen paspoort	Alle gebouwen krijgen een gebouwpaspoor	In samenwerking met Madaster wordt een BIM-standaard ontwikkeld	Gebouwpaspoort opnemen in BIM-protocol en technisch ontwerp

3.3 STAND VAN ZAKEN

De aanpak omtrent hergebruik is Circular by doing! Een aantal keuzes, zoals de materialisering volgt in de volgende ontwerpstap. Toch zijn er al voldoende mijpalen om te delen

Behaalde mijlpalen

- Oogsten en haalbaarheidsstudies voor hoogwaardig hergebruik afgerond;
- In kaart brengen van hergebruik en recycling van overige materialen in samenwerking met de faculteit Techniek van de Hogeschool van Amsterdam is afgerond;
- Hergebruik van oude elementen in het nieuwe ontwerp. Ontwerpen met 1.030 geoogste elementen en goedkeuring voor het deels toepassen in openbare ruimte;
- Partnerovereenkomst met Madaster en samenwerking om een gebouwelementenpaspoort standaard voor Bajes Kwartier te maken. Deze worden toegepast als BIM-model;
- Samenwerking met verschillende circulaire makers om andere vormen van hergebruik te onderzoeken;
- Circulair Programma van Eisen voor ontwerpers opgeleverd met C-Creators;
- Het VO van Gebouw B en C worden uitgevoerd in hout;
- Voor de groene toren zijn de mogelijkheden in kaart gebracht en uitgewerkt tijdens de workshop 'Groene Toren';
- Gebouw B en C zijn flexibel en adaptief ontworpen.

Lopende werkzaamheden

Stand van zaken oogsten en hergebruik

Het oogsten en ontwerpen van gebouwelementen gaat voorspoedig. In totaal zijn er 1.030 elementen geoogst en in het VO opgenomen. In aanvulling van het ontwerpen met geoogste elementen lopen er ook initiatieven voor hergebruik door circulaire makers. T300 maakt bureautafels van isoleercelдeuren en het Hout- en meubileringscollege is gestart met designopdracht met materialen uit de Bijlmerbajes.

De sloopwerkzaamheden zijn bijna afgerond. Dat biedt gelegenheid om een tussenstand op te maken op welke wijze gebouwen en elementen en materialen worden hergebruikt. Van de bouwwerken blijven nog steeds het hoofdgebouw, de kerk en de vrouwentoren behouden. Na gesprekken met nuts-partijen is het hergebruiken van de leidingstraat niet mogelijk gebleken. Hier zijn twee zwaarwegende redenen voor: 1) de leidingstraat kruist de Amstelstroomlaan wat nutsvoorzieningen onder die straat in de weg zit. 2) nuts-partijen geven aan hun eigen leidingsystemen te hanteren in verband met aanlegkosten, onderhoud en planning. Met name de riolering gaat niet goed samen met de oude leidingstraat.

Tijdens de sloop zijn kansrijke gebouwelementen geoogst en getoetst. Voor nieuwe materialen is een lijst met biobased alternatieven als startpunt ontwikkeld.

De belangrijkste reststof, vrijgekomen betonpuin, wordt verwerkt tot betongranulaat door Beelen. Tijdens de sloop is het grove puin verwerkt door een mobiele breker die het verwerkt tot betongranulaat waarvan circa 25.000 ton in Bajes Kwartier wordt hergebruikt wat naast een hoog hergebruikpercentage ook veel vrachtvervoersbewegingen scheelt.

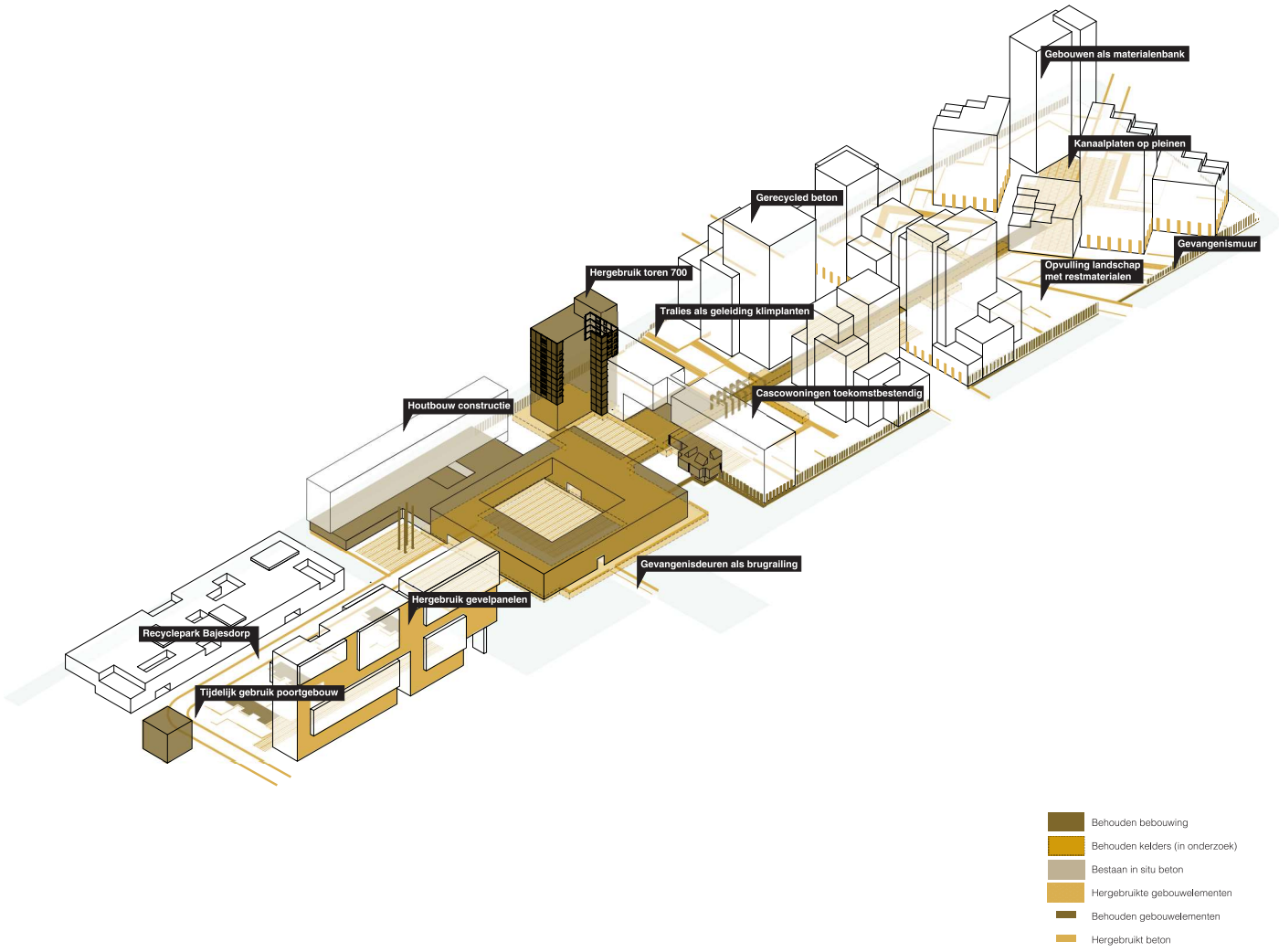
Haalbaarheidsstudies hoogwaardig hergebruik

Uit de haalbaarheidsstudies is gebleken dat het hoogwaardig hergebruiken van oude gebouwelementen in nieuwe woningbouw/hoogbouw heel beperkt mogelijk is in verband met bouwbesluit-, geluid- en brandveiligheidseisen. De vervolgstudies hebben zich daarom meer gericht op de plinten (commerciële functies) en inrichting van de openbare ruimte. De belangrijkste lessen voor hergebruik samengevat:

-	+
Bouwbesluit Wonen nieuwbouw	**Bouwbesluit niet wonen functies biedt (iets) meer mogelijkheden**
Brandveiligheidseisen hoogbouw	**Openbare ruimte biedt kansen**
(on)zekerheid op het gebied van geluid	**Circulaire makers komen met vernieuwende ideeën voor hergebruik tralies en houtwerk**
Uitdagingen voor hoogwaardig isolerend en luchtdicht bouwen	

Belangrijkste lessen hergebruik

3.4 STAND VAN ZAKEN & ONTWIKKELINGEN



Schema : Circulair Materiaalgebruik beloftes