INSTITUTIONAL DYNAMICS IN CIRCULAR CONSTRUCTION

A CASE STUDY OF PRINSENHOF - ARNHEM

ANOUK ROELOFS
MSC FINAL THESIS
WAGENINGEN UNIVERSITY AND RESEARCH

Institutional dynamics in circular construction

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Anouk Roelofs
MSc Urban Environmental Management (MUE)
1020097
200208481101

MSc Thesis Environmental Policy Group
ENP80436
Supervisor: Judith van Leeuwen
Second supervisor: Simon Bush

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Abstract

The construction sector, a major global consumer of raw materials, faces increasing pressure to adopt sustainable practices due to concerns about resource depletion. Despite the fact that policies are shifting towards circular construction, it is unclear how actors navigate this changing landscape. This study examines how actors implement circular construction strategies within the macro institutional environment, focusing on the meso level institutional capacity. By analysing the best practice case of Prinsenhof, where materials from a demolished building were reused, the research explores the interplay between macro institutions and meso capacity in shaping urban symbiosis in the Netherlands. Using an institutional capacity framework, the study assesses actors' ability to navigate existing norms and values through relational, knowledge, and mobilisation capacities. Qualitative methods including interviews and document analysis reveal that the macro institutional environment influenced meso level institutional capacities. Formal contracts facilitated relational and knowledge capacities, while the province's environmental vision enabled the experimental nature of the project and ensured knowledge creation. Selecting key actors with openness to learning and intrinsic motivation facilitated successful circular construction implementation. These macro institutional conditions fostered a favourable environment for circularity. The study highlights the importance of understanding how actors leverage institutional capacities within evolving policy contexts to advance sustainable construction practices.

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1. Introduction

With the increasing concern over the depletion of natural resources, reducing primary material use has become a critical issue in achieving sustainable development. The building and construction sector is globally the largest consumer of resources and raw materials with about 50% of the global steel production and three billion tonnes of raw material use each year (World Economic Forum, 2016). This is no different for the Netherlands where the construction sector also accounts for 50% of the raw material use (Ministerie van Infrastructuur en Waterstaat, 2022a). At the same time a substantial part of the built environment is demolished every year making the construction sector contribute for a significant part to the generation of construction and demolition waste. In the European Union (EU), construction and demolition waste even make up for 25-30% of the total waste (Huovila & Iyer-Raniga, 2021). Currently, this waste mostly goes to landfills but is partly reused as aggregates for road foundation (Di Maria et al., 2018). In the Netherlands this is also the case where 85% of the recycled demolition waste consist of crushed concrete (Schut et al., 2015). There are many opportunities for making the construction sector more circular but currently the total circularity within the construction sector is still low. In the circularity gap report by Circle Economy (2023), it was shown that 88% of construction and demolition waste is recycled, and less than 10% ends up in a landfill or incinerator. This report also showed that, due to this downcycling, only 8% of the materials used in the built environment come from reuse. This reuse is certainly useful, but it reduces the material value and may exclude opportunities for higher value reuse. In addition to this, further substitution by secondary materials is limited due to the mismatch between supply and demand in the construction sector. The number of reusable materials available in the Netherlands is not sufficient to substitute the demand for primary raw materials. In the construction sector the demand for raw materials is even 2,5 times larger than the supply of secondary material (Economisch Instituut voor de Bouw, 2022).

1.1. Dutch roadmap to circularity in construction sector

The Dutch government is aiming towards a more circular construction sector and implemented multiple circularity goals like the goals determined in the EU Circular Economy Action Plan (CEAP) (European Commission, 2015). The CEAP is based obtaining a climate neutral EU and halt biodiversity loss by 2050. They aim to go from a linear economy to a circular economy by focusing on the concepts; reuse, reduce and recycle (3R's). The Dutch government has implemented the goals of the CEAP on a national level where they aim to be completely circular by 2050 and reduce the consumption of primary raw materials with 50% (Government of the Netherlands, 2018). These national goals are linked to the international goals that this Netherlands is committed to which include the Paris Agreement on climate and the 2030 Sustainable Development Goals.

To reach these goals the 3R's are also recorded in the integrated circular economy report, which highlights the current progress towards the goals of the Dutch government (Planbureau voor de Leefomgeving, 2021, 2023). However, each R-strategy faces specific challenges. For strategies higher up the ladder, such as reuse and product sharing, more fundamental socio-institutional adjustments are often required like new business models and changes in behaviour (Potting et al., 2016). As mentioned before, 85% of the recycled demolition waste is used for road construction and its therefore downcycled which is not preferable according to the 3R strategy (Schut et al., 2015).

Therefore, the Dutch government is trying to adjust towards more circularity with the use of their own circularity road map (Ministerie van Infrastructuur en Waterstaat, 2022b), where a special transition agenda for circular construction is included. Within this agenda the reuse and upcycling of construction materials is highlighted. The use of urban mining is mentioned within this roadmap because of the storage within buildings of substantial amounts of primary resources like concrete, steel and wood. Additionally, the construction sector plays a large role in creating more circularity due to the high potential for increasing material efficiency (European Commission, 2017).

1.2. Urban mining, symbiosis and Industrial symbiosis

The concept of urban mining is used to valorise construction and demolition waste from the built environment. Urban mining is the process of recovering compounds, energy, and elements from a variety of sources, including products, buildings, and waste generated by urban activities. According to Baccini & Brunner (2012), urban mining views urban spaces as potential reservoirs (mines) of anthropogenic materials that can be recycled and reused in a circular manner (Brunner, 2011). By adopting urban mining practices, cities can reduce the demand for raw material use. The implementation of urban mining can expedite the transition to sustainable cities and give rise to new extraction and processing industries (Jones et al., 2013). Arora et al. (2017) distinguish short- and long-term mines. With regard to the construction sector, it concerns so-called long-term mines which consists of varieties of buildings, infrastructure and construction and demolition waste.

Despite the numerous benefits of urban mining, there is still a lack of collaboration between the actors in the construction sector to reuse waste streams. Therefore, fostering collaboration within and between industries and the urban environment could be a critical factor in managing the demand and supply of construction materials. This could be achieved through urban symbiosis. Van Berkel et al. (2009) propose the concept of urban symbiosis as an expansion of industrial symbiosis, with a focus on utilizing by-products or waste materials generated in urban areas as inputs for industrial processes or sources of energy. Like industrial symbiosis, urban symbiosis leverages the advantages of close proximity between urban waste sources and potential industrial users to create environmental and economic benefits by exchanging physical resources. By facilitating the transfer of waste materials, urban symbiosis aims to promote sustainable and circular economy practices.

1.3. Barriers to implement urban symbiosis

Despite urban symbiosis being recognised as a technique that can improve the circularity of urban areas, urban symbiosis has not been implemented very often in practice (Mulder, 2016). Several barriers for implementation have been indicated by literature.

The first barrier indicated is with regard to technological aspects. The study by Mulder (2016) indicates that the output streams of one company might not match the demanded input streams of another company or may not coincide. The study also notes that extra distribution, storage, and transportation systems that may be required, frequently have high costs. Likewise, transportation and storage may take up a lot of space and may degrade the quality of resources transferred (Mulder, 2016).

Secondly, the technological history of the construction sector can propose a barrier for urban symbiosis implementation. Long-term investments are used to build urban infrastructure, which results in a lock-in scenario (Mulder, 2016). Additionally, buildings are made with more labour-intensive processes and have longer lifespans than other types of products creating high investment costs (Khasreen et al., 2009). This makes individuals in the sector often hesitant to embrace new technologies or methods as they aim to minimise risk.

Third, the aim of urban symbiosis does often not comply with the conventional policy frameworks (Hemmes, 2009). Also, there is a high level of regulation and standardisation in the sector with strict building codes and safety standards (Khasreen et al., 2009). As a result, this could be considered an obstacle to the implementation of urban symbiosis on a regulatory level (Leermakers et al., 2019).

Lastly, barriers have been identified with regard to interest and profit. Since many stakeholders are involved in an urban symbiosis network, the system needs to be profitable for all actors involved in terms of economic as well as environmental aspects (Mulder, 2017). Therefore, there is a barrier to connecting the interests of all parties involved and implementing urban symbiosis because it is frequently not the primary business of the involved actors.

1.4. Capacity to implement circularity

As shown, there is a changing regulatory landscape within the construction sector that moves towards more circularity. Even though this macro institutional environment is changing, it is still unknown how actors involved in circularity projects, aiming towards urban symbiosis, work through the macro institutional environment and the barriers at play. The institutional capacity framework can help to analyse how the institutional capacity of actors has an impact on the ability of actors in the construction sector to foster symbiosis and implement circular innovations.

Institutional capacity is the ability of private or public actors to work through an existing system of rules, norms, and values to achieve a specified goal (Fuentes & Borreguero, 2018; Trang et al., 2023; Willems & Baumert, 2003). The concept of institutional capacity was created in the context of industrial symbiosis between businesses looking to innovate and/or plan initiatives that can result in increased resource efficiency and environmental performance (Abreu & Ceglia, 2018). Within the institutional capacity framework by Willems & Baumert (2003), there are three levels distinguished: the individual (micro level); the organisation (meso level); the broad institutional context (macro level). The macro level national institutions are the current system of rules, norms, and values, and influence the meso level actors in their ability to create symbiotic linkages (Trang et al., 2023; Willems & Baumert, 2003). Meso level actors are able to work through this macro institutional environment by creating strong organisational level institutional capacities (Boons & Spekkink, 2012). These meso level institutional capacities of actors consist of; acquiring resources (mobilisation capacity), accessing knowledge for enhancing exchange techniques (knowledge capacity), and developing relationships (relational capacity) (Boons & Spekkink, 2012; Healey, 1998; Willems & Baumert, 2003). The relational, knowledge and mobilisation capacity of actors to achieve more circularity support each other. When these capacities are present, there is a strong meso level institutional capacity and the actors are able to work through the macro institutional environment.

Other studies already used this framework to analyse the institutional capacity of actors to work through the existing macro institutional environment. The study by Trang et al. (2023) examines the impact of centralised states' macro-institutional environment on actors seeking to form symbiotic relationships and implement innovations at the meso-institutional level. But it is still unknown whether and how the meso institutional capacity of actors in the Netherlands who are trying to create urban symbiosis is impacted by the macro institutional environment. In addition to this, there is a lack of knowledge on the institutional conditions provided by the macro institutional environment that can support the implementation of circular construction strategies and overcome the proposed barriers to implement urban symbiosis. Following, there is also a lack of knowledge on how the meso level institutional capacities interact with each other and how they can influence the macro institutional environment.

1.5. Research aim and research questions

Despite the potential benefits that urban symbiosis can create for working towards environmental goals on EU and national level, there is a lack of knowledge regarding how the meso level institutional capacity of actors aiming to create circularity within the construction sector work through the macro institutional environment at play.

To understand the institutional conditions under which urban symbiosis can emerge in the Dutch construction sector, this study explored the interplay between macro level institutional environment and meso level institutional capacity in one case where circular construction was successfully implemented. Therefore, this study contributes to a better understanding of the institutional conditions under which urban symbiosis can emerge in the Dutch construction sector.

In order to reach this aim, this study conducted a case study with actors involved in a ‘best-practice’ circular construction project to examine their institutional capacity to obtain urban symbiosis. The chosen best-practice case is called Prinsenhof. Within this project there was chosen to one-on-one reuse elements of the to-be demolished building in new development. The actors involved were able to

successfully implement this innovative circularity strategy and create urban symbiosis. Therefore, the interplay between the macro institutional environment and the meso level institutional capacity and the interplay between the capacities of the actors involved in the Prinsenhof case is examined. This gave insights in the existing barriers and opportunities within the current Dutch circular economy policies to foster urban symbiosis and identify strategies to enhance institutional capacity for achieving greater circularity in the construction sector. The findings of this study provide policymakers and stakeholders with valuable insights that can help them create more effective circular economy policies and strategies that promote the adoption of urban symbiosis in the construction sector. The following research questions are used to research the stated aim;

How does the interplay between macro institutions and meso institutional capacity of actors in the circular construction sector shape the implementation of urban symbiosis in the case of Prinsenhof?

a. How does the macro institutional environment influence the institutional capacity of actors engaged in the case of Prinsenhof?
b. What is the institutional capacity of actors engaged in the case of Prinsenhof regarding relational capacity, knowledge capacity, mobilisation capacity and the interaction between these capacities?
c. How do the meso institutional capacities of actors engaged in the case of Prinsenhof, influence the macro institutional environment?

After the introduction, the theoretical and conceptual framework will be presented in chapter 2. Here the concepts of circular economy and urban symbiosis will be presented, and the institutional capacity framework will be introduced. In chapter 3 the methodology of this study will be explained and is followed by the case description in chapter 4. Following, an analysis of the macro institutional environment will be presented in chapter 5, including a document analysis of the rules, norms and values at play in the Dutch construction sector combined with the outcomes of the interviews. Chapter 6 will present the results found on the meso level institutional capacity, structured consistent to the four dimensions identified in chapter 2. Concluding with chapter 7 and 8. Here, the results, theories and methods are discussed followed by a conclusion.

2. Theoretical framework

The theories used to analyse the institutional capacity of participants in the circular construction sector to foster symbiosis are examined in this chapter. It starts with an explanation of the concept of urban symbiosis and the link to circular construction. After that, the chapter will outline the concept of institutional capacity, its dimensions and portray how it will be used in this study. Concluding, the conceptual framework used will be operationalised in the final section.

2.1. Circular economy and urban symbiosis

As explained in the introduction, much of the Dutch legislation towards a more sustainable construction sector involves the concept of circular economy. Circular economy can be seen as the direct opposite of a linear economy. Whereas in a linear approach, materials become waste at the end of their lifespan, within a circular approach this waste is minimised and used as "new" raw materials.

The concept of industrial and urban symbiosis emerged in the field of industrial ecology and is seen as a strategy to develop more sustainable cities (Chertow, 2004; Van Berkel et al., 2009). The concept of industrial symbiosis developed first. This concept involves creating networks of businesses and industries that can share resources, such as energy, water, and raw materials, as well as collaborate on waste management and recycling initiatives (Boons et al., 2017; Chertow, 2004). The key to a successful exchange and therefore a successful industrial symbiosis "are collaboration and the synergistic possibilities offered by geographic proximity." (Chertow, 2000). The paper by Lombardi and Laybourn (2012) adds to this that industrial symbiosis engages organisations to be in a network where mutually profitable transactions are made through creating and sharing knowledge, and therefore value-added destinations for non-product outputs can be created.

The idea of industrial symbiosis has been further extended to urban waste streams and energy exchange, known as urban symbiosis (Van Berkel et al., 2009). Urban symbiosis is seen as an extension of industrial symbiosis and is defined as; "the use of by-products (wastes) from cities (or urban areas) as alternative raw materials or energy sources in industrial operations" (Ohnishi et al., 2017). The concept of urban symbiosis was found in Japan during the realisation of an eco-town (Lenhart et al., 2015; Mulder, 2016). A variety of actors establish links with one another in an urban symbiosis to facilitate resource exchange, which closes resource cycles at the city level and reduces the number of raw materials used in urban areas. According to a study by Geng et al. (2010), applying urban symbiosis can lower CO_2 emissions, which is one way that symbioses contribute to greener cities.

Nevertheless, due to several barriers, no clear strategies on how to create urban symbiosis innovations exist (Mulder, 2017). Identified barriers are of technological, historical, regulatory and interest-based nature and are stated in the introduction of this research. The barriers are linked to the conservative nature of the construction chain and therefore their inability to create urban symbiosis.

The concepts of urban symbiosis and industrial symbiosis are intricately linked (Joensuu et al., 2020), and can therefore be studied through the institutional capacity framework, which is mostly used to examine the institutional capacity of industrial symbiosis (Van Berkel et al., 2009). By studying the institutional capacity of actors in the circular construction network to create linkages, the opportunities and hurdles for creating greater circularity in the construction sector can be identified. As stated above there are various hurdles that are identified in urban symbiosis literature, therefore this study will use a "best-practice" case where actors were able to overcome stated barriers.

2.2. The concept of institutional capacity

Multiple studies utilised the concept of institutional capacity, to give insight in how organisations collectively address an environmental issue (Abreu & Ceglia, 2018; Boons et al., 2011; Spekkink, 2013). The term "institutional capacity" was introduced by Healey (1998), and refers to the capacity of administrative organisations and agencies to address and resolve collective issues. It is derived from the literature on deliberative planning. Overtime the concept has evolved and applied in several disciplines making it applicable to a wide array of projects (Willems & Baumert, 2003).

Boons et al. (2011) brought the concept of institutional capacity building into the industrial symbiosis literature because positive examples of industrial symbiosis implementation align with planning literature scenarios. The ability of relevant organisations to collectively address an issue can be characterised as the extent to which they have built the three capacities (relation, knowledge and mobilisation) (Boons et al., 2011). Abreu & Ceglia, (2018), also define it in the context of symbiotic industrial relationships between businesses looking to innovate and/or plan actions that can improve environmental performance, including resource efficiency. Healey et al. (2003), claim that urban governance initiatives, in order to reach their full potential, need the support of capacities that were created from knowledge and relational resources and that they must be purposefully activated.

2.3. Dimensions of institutional capacity

The preceding paragraph indicated that institutional capacity is a suitable concept to employ in the case of looking at symbiotic relationships and implementing innovations in the circular construction sector. The dominant framework used in this study is developed by Boons & Spekkink (2012), and Healey et al (2003). This framework identifies knowledge, relational, and mobilisation capacities that are required for symbiosis with and between actors. Knowledge capacity relates to the range of knowledge an organisation has, the sources of knowledge they utilise, how this knowledge is integrated and how open an organisation is within the learning process. Relational capacity relates to the range of actors within the network, the morphology and integration of these relations and, their power to act. Finally, mobilisation capacity relates to the ability of actors to mobilise other actors as well as the underlying structures to create mobilisation. It is also argued that all capacities interact with each other, and need to exist together to influence the opportunity set and ultimately create symbiosis (Boons & Spekkink, 2012).

Boons & Spekkink (2012) and Healey et al (2003) mainly focus on the institutional capacity of actors even though multiple studies have acknowledged the importance of looking at the wider macro institutional environment when assessing the actions of organisations and networks of organisations (Boons et al., 2017; Willems & Baumert, 2003). Boons & Spekkink (2012) state that the existence of an enabling context, which may be defined in terms of policies, regulations, and other institutions, but also in much broader terms such as cultural, structural, spatial, and temporal embeddedness (Boons & Howard-Grenville, 2009), is a proposed factor for successful symbiotic linkages.

Willems and Baumert (2003) distinguish three levels within institutional capacity; a micro level (the individual), a meso level (the organisation) and, a macro level (the broad institutional context). They describe in their holistic view of institutional capacity that actions of organisations, as well as individuals, are embedded in a broader context: the institutional environment. They show the importance of analysing the regulatory framework, public sector setting and overall norms and values, as illustrated in figure 1, when investigating institutional capacity. The regulatory framework is defined as the overall effectiveness of the public sector in fulfilling its main functions. The social norms values and practices point to a broader environment where a governments actions are not sufficient to achieve result towards climate change mitigation. They put emphasis on improving the public participation to improve this level of capacity.

This view has much overlap with the institutional capacity framework of Boons & Spekkink (2012), and Healey et al. (2003), because the three dimensions of the institutional capacity framework are embedded in the network of organisations in the broader context. Therefore, this study chooses to label the institutional capacity of actors as meso level (the organisation) and the macro institutional environment as the macro level (broader context). Therefore, institutional capacity building within this study is defined as the capacity of private or public actors to cooperate within a framework of rules, norms, and values to accomplish a predetermined collective goal (Fuentes & Borreguero, 2018; Wadström et al., 2021; Willems & Baumert, 2003), because it also considers the interplay between the macro level institutional environment and meso level institutional capacity.

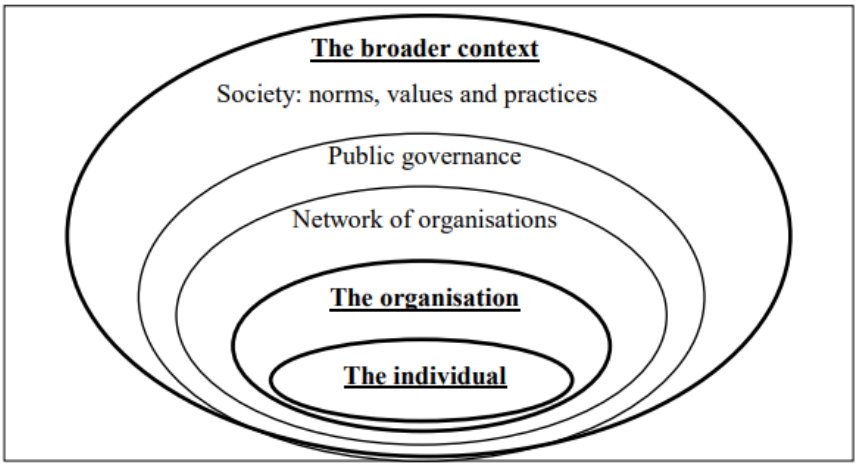

Figure 1. A comprehensive view of institutional capacity (Willems & Baumert, 2003)

2.4. The conceptual framework

The previous section explained the importance of the different dimensions of institutional capacity. This section will provide the framework used, illustrated in figure 2, to examine the institutional capacity of actors aiming to create circularity in the Dutch construction sector. The framework is an adaptation of the institutional capacity framework used by Trang et al. (2023).In the following paragraphs, the concepts used will be explained and operationalised.

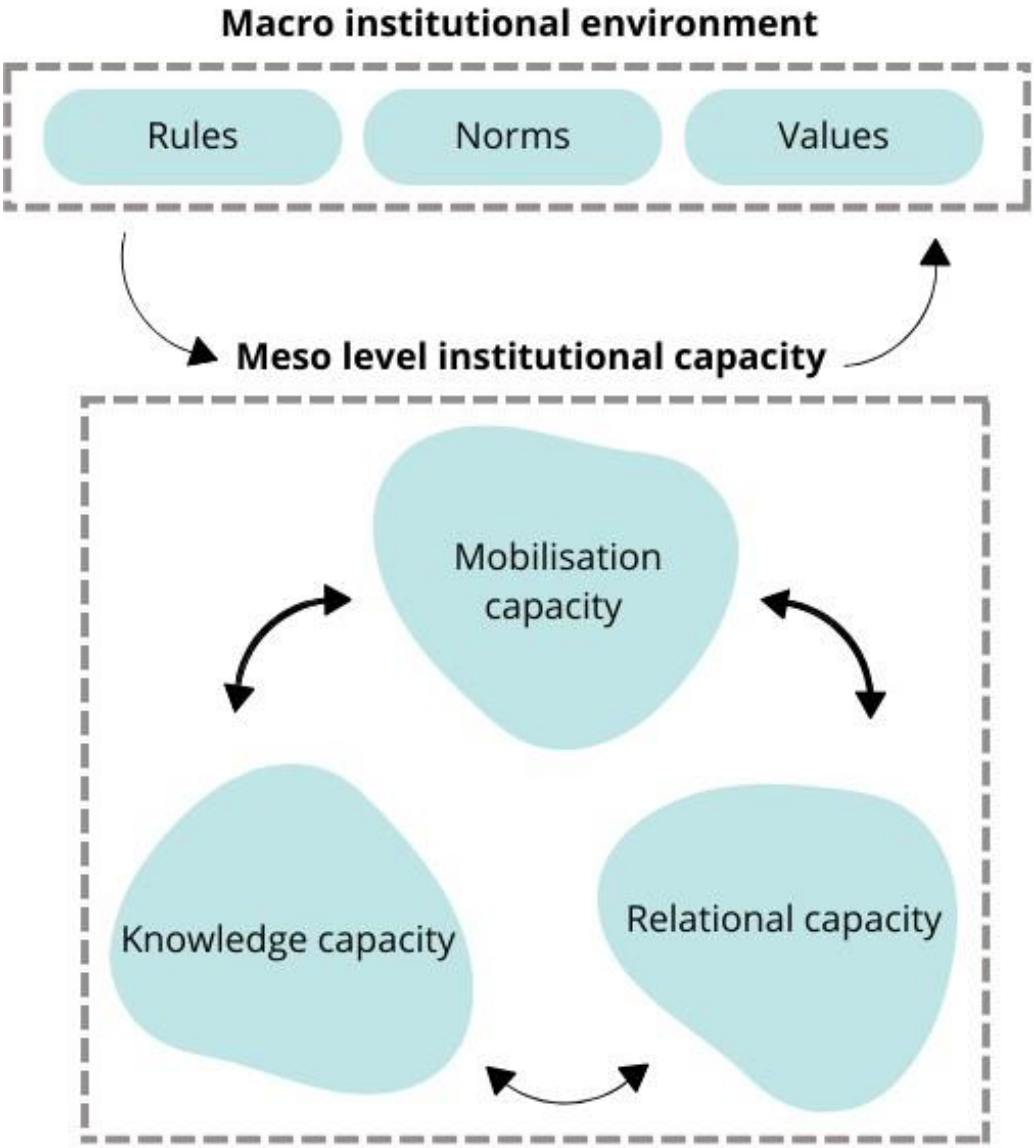

Figure 2. Institutional capacity framework (Adapted from Trang et al., 2023)

2.4.1. Macro institutional environment

Following the described relevance of taking the macro institutional environment into account and a description of the concept, the concept will be operationalised. Because Willems & Baumert (2003) mainly look at the institutional capacity of the macro environment and this study aims to look at the institutional capacity of actors aiming to create a circular economy. According to Korhonen et al. (2018), policymakers and businesses have essential roles to play in transforming the linear economy to a circular one by implementing innovation, entrepreneurship and technological development.

Therefore, this research will follow the conceptualisation of macro institutional environment given by Trang et al. (2023). They state that meso level actors have the ability to work through this macro institutional environment by; (1) participating in decision-making and implementation (Abreu & Ceglia, 2018); (2) complying with governmental policies and regulations (Willems & Baumert, 2003), and/or (3) actively engaging in individual or collaborative problem solving and innovation (Boons & Spekkink, 2012). The elements are further explained below.

First of all, the (1) participation in decision-making and implementation of actors is explored. This is a force driving leading companies in the direction of a circular economy (Abreu & Ceglia, 2018). When actors are involved in the participation of decision-making and implementation they can influence the macro institutional environment of rules, norms and values surrounding the implementation of circularity in the construction sector.

Second the (2) compliance of governmental policies and regulations is accessed to provide the institutional capacity of actors to assess the broader institutional environment as conceptualised by Willems and Baumert (2003). This compliance shows the overall effectiveness of the public sector in fulfilling its main functions. Most of the capacity that is needed to implement environmental policies is likely to draw upon this "enabling environment" that exists to some extent before the policy is set up.

Finally, the (3) engagement in overcoming individual or collective problems is explored. The importance of this is shown by Boons & Spekkink (2012), and relates to the amount of engagement to assess the potential of projects. Innes & Booher (1999), even state that the participating actors may start to influence policy processes outside of the process of institutional capacity building by developing a willingness to cooperate, which they were unable to do when acting independently. This is regarded as social learning, and it may be one of the most profound outcomes of institutional capacity building (Boons and Spekkink, 2012). The involved parties might come up with novel solutions to recurring issues. It is also possible for the stakeholders to reevaluate their objectives and purposes and realise how interconnected their interests and issues are. This could result in a shared strategic vision for how these issues and interests should be handled.

2.4.2. Meso level institutional capacity

The meso level institutional capacity of the actors involved in the case are identified through the relational, knowledge, and mobilisation capacities (Boons & Spekkink, 2012; Healey et al., 2003).The following chapters will describe and conceptualise these capacities.

Relational capacity

Relational capacity refers to the network of connections between the participants in a symbiosis and how the relevant actors are incorporated into them. This capacity consists of the (1) range of stakeholders, (2) morphology, (3) integration and (4) the power to act (Healey et al., 2003).

The (1) range of stakeholders involved identifies the actors involved in the project and who they are connected with (Healey et al., 2003). Exploring this is essential because symbiotic relationships showed that local partnerships, collaborations, and local governments are key for involved actors or social networks (Boons et al., 2011; Trang et al., 2023).

The (2) morphology of their social networks explains the density of network interconnections and their route structure (Healey et al., 2003). This is also defined as the number of relations, their spatial or temporal reach, and the type of relation. It is emphasised that relationships grow over time, and that informal relationships are seen as stronger than formal institutions (Boons & Spekkink, 2012). According to Korhonen et al. (2018), individuals can establish recurring relationships by getting to know one another, cooperating at various levels and sectors, and subsequently becoming more cognizant of the relationships and interdependencies between various professional spheres of accountability and expertise. Stability can be ensured for all parties involved in symbiotic linkage when businesses are open

with one another, and the plans are clearly defined. Additionally, this supports the notion that stability in relationships takes time to develop (Gibbs, 2003). For symbiotic relationships to be successful, there must be close proximity in terms of institutional, social, organisational, and cognitive proximity (Velenturf & Jensen, 2016). This demonstrates that businesses must overcome some of their self-interest as well as a lack of trust in order to facilitate communication and create the foundational elements required for successful relational capacity (Södergren & Palm, 2021). The importance of interactions and transparency can overcome this self-interest on the part of businesses and will enhance the sharing of waste streams and knowledge (Abreu & Ceglia, 2018).

The degree of (3) integration of the various networks is described as the degree of exchange between the actors within the network (Healey et al., 2003). This gives us insight into how these relationships affect collaborative learning and innovations between actors in the network. Boons & Spekkink (2012), add to this that there should be presence of a formal statement of intent signed by the pertinent actors because it could otherwise lead to vague designation of responsibilities. They state that the presence of a formal document stating that the actors are committed to the collaboration, and the presence of a plan created by the actors stating their plans for the transaction, is essential. Moreover, in institutional theory, on which institutional capacity is based, both formal and informal institutions are significant. Posch' (2010) research found that 91% of intercompany recycling activities originated from direct bilateral contact with the recycling company that used the waste as a raw material. Furthermore, this shows the relevance of informal institutions within creating symbiotic relationships by demonstrating how businesses can view their relationship with the recycling partner similarly to regular customer relations. According to Isaksson and Hagbert (2020), a barrier in interpersonal relationships, and therefore their integration, can be a difference in how they view collaboration, whether it be formal or informal limiting the degree of the exchange of knowledge.

Finally, the (4) power to act helps to identify the exact centre of power (Healey et al., 2003). This ability to act, where it is located, how actors relate to one another, and how they interact with larger authoritative, allocative, and ideological structuring forces all shed light on the opportunities and obstacles that actors face when trying to create circularity. The research by Abreu and Ceglia (2018), showed that a set of rules and guidelines established by the government empowered greater circularity showing that, when the centre of power implement certain guidelines, the actors may be more able to implement them on a lower level.

Knowledge capacity

Overall knowledge capacity focusses on knowledge present and developed within the organisation and describes the construction industry's ability to gather knowledge necessary for the adoption of circularity (Boons & Spekkink, 2012; Healey et al., 2003; Trang et al., 2023). Boons & Spekkink (2012), apply knowledge capacity to industrial symbiosis and define it as the ability to obtain and use information that allows firms to shape their exchanges in a way that reduces their ecological impact. This makes sure that actors can learn about potential symbiotic relationships between one another and expands their opportunity set when previously unimaginable options become feasible, but it also means that their opportunity set will shrink if the information is used to temper overly pessimistic expectations. Malone & Yohe (2002), state that a knowledge-based strategy, regarding creating a connection between actors, can lead to a more sustainable and economically productive cooperation. This is supported by Lombardi & Laybourn (2012), who state that sharing knowledge through the network can create mutually profitable transactions that are not merely based on resource exchange. Healey et al. (2003), define knowledge capacity as "the capacity for collective action based on the quality of the knowledge and experience of the members of a community, as well as the existence of a common alignment between problems and solutions". They differentiate four elements related to knowledge capacity: (1) the range of knowledge; (2) frames of reference; (3) integrating different spheres of policy development; and (4) openness within the learning process.

The (1) range of knowledge resources is described as the range of, explicit, tacit, systematised and experiential knowledge, to which actors have access (Healey et al., 2003). Explicit knowledge consists of facts, rules, relationships and policies that can be dependently codified and is information that can be

easily shared without the need for discussion (Wyatt, 2001). This knowledge is often expressed in words, numbers or illustrations. In this research, it can be deduced by asking to which extent knowledge on circular building exists. Tacit knowledge is opposing to explicit knowledge and consists of personal skills and experience (Frost, 2017). To transfer this kind of knowledge it can be indirectly communicated through tutoring or discourse. This will be explored in this research by asking about one's perspective on the topic of circular building. Systematised knowledge is also called embedded knowledge. This type of knowledge consists of processes, products culture routines or structures (Wyatt, 2001). By exploring this type of knowledge, the perspectives on which the knowledge is build can be revealed. This will be done by asking the interviewees on how knowledge on circularity is embedded in their organisation. Finally, experiential knowledge. This type of knowledge is similar to tacit knowledge because it also builds on intuition and skills. Experiential focuses more on memory and recognition and is therefore harder to identify and difficult to transfer to other parties (Fazey et al., 2006). In this research, experiential knowledge is identified by reviewing how made mistakes are solved and obstacles were overcome.

The (2) frames of reference shape ideas of the issues, problems, opportunities and interventions, at play (Healey et al., 2003). In this research this is explored by looking at the sources of knowledge an organisation uses and how these sources are obtained.

The extent to which the range and frames are shared among stakeholders, is seen as (3) integrating different spheres of policy development and action around place qualities (Healey et al., 2003). An organisation can learn more from its knowledge the more it is shared within the organisation. This component can be examined through events that encourage knowledge exchange and the ways in which they aided in the integration of knowledge within the organisation.

(4) Openness and learning is described as the capacity to absorb new ideas and how we learn from them (Healey et al., 2003). This is also acknowledged by Boons & Spekkink (2012), when they state that one of the conditions needed for circularity to arise is the need for a learning process. Social learning can be identified as one of the most important elements of institutional capacity building because stakeholders might find new ways to solve common problems and reassess their purpose and goals (Innes & Booher, 1999). This may lead to the stakeholders seeing interest and issues as interconnected, possibly leading to a shared strategic vision on how these interests and issues should be addressed (Boons and Spekkink, 2012). This can be assessed through how and if circularity is implemented, the organisation gained more knowledge from this and directly asking what their perception towards learning was.

Mobilisation capacity

Finally, mobilisation capacity describes the capacity of the construction sector to recognise and involve a variety of stakeholders to support shared objectives like increased circularity (Boons & Spekkink, 2012; Healey et al., 2003). They can thereby influence policies, regulations and attract external resources that are needed to realise exchanges (Boons & Spekkink, 2012). This includes the capacity of those involved in the construction industry to draw in funding and subsequently use opportunity structures for technological, infrastructural, or organisational innovation and, as a result, be able to react to the incentives imposed on them by economic instruments. The purpose of mobilisation capacity is to demonstrate that changes occur in deeper layers in addition to the surface-level ones. Healey et al. (2003), state that mobilisation capacity comprises of; (1) the opportunity structure, (2) the institutional arena, (3) the repertoire of mobilisation techniques and (4) change agents.

The (1) opportunity structure is the physically and institutionally shaped set of options for action that are seen as feasible by stakeholders (Elster, 2007). These opportunity structures, consisting of rules, norms and values, are examined to see how they enable private and public actors to support and design innovative circularity projects (Boons & Spekkink, 2012). Additionally, the degree to which the actors take advantage of these opportunity structures can be examined, as well as the possibility that they will create new opportunity structures that will encourage other actors to pursue similar circularity goals (Healey et al., 2003). This research will examine this concept by identifying the regulations in place and

to what extent actors in the circular construction sector are willing to encourage more circularity in construction projects in the future.

The (2) institutional arenas are a social space in which relations between stakeholders are governed by accepted rules of interaction. This concept explores how these arenas are used and developed by stakeholders and how they take advantage of opportunities created in these arenas (Healey et al., 2003). Lombardi and Laybourn (2007), see workshops and technical advisers as capable of facilitating information-sharing about waste, thus creating an arena in which common interests should be seen as converging

The (3) repertoire of mobilisation techniques are used to develop and sustain momentum in implementing new initiatives (Healey et al., 2003). The repertoire is identified through asking what exact techniques are used to mobilise other actors. This can consist of, for example, local strategies or financial incentives.

Finally, the presence or absence of critical (4) change agents is identified (Healey et al., 2003). These change agents have a key role in initiating and managing governance innovations. External actors can act as a change agent and overcome certain obstacles by facilitating and directing the network's various actors' cooperative processes and fostering greater trust among them (Mortensen & Kørnøv, 2019). It has been established that the involvement of a change-agent like, an outside knowledge institute or consulting firm (change-agent) is key in guiding the various actors involved in circularity initiatives (Abreu & Ceglia, 2018; Spekkink, 2013; Farel et al., 2016).

Interplay between the capacities

Figure 3 illustrates the dimensions and correlating elements of institutional capacity. Further data collection for this research will be based on the elements. Essentially, the dimensions and elements serve as indicators. By examining the components, one can better analyse the dimensions and, from there, look into the actors' overall institutional capacity to create circular construction. It should be noted that because each dimension and element is discussed independently, institutional capacity is primarily concerned with how these dimensions interact (Boons and Spekkink 2012). They describe how, for example, knowledge and interpersonal relationships help to unite actors in order to achieve a common goal. Based on their research, they concluded that improving or altering institutional capacity begins with altering relational capacity, which is followed by knowledge capacity and mobilisation capacity. Furthermore, mobilisation capacity is the most important capacity, according to Boons and Spekkink (2012), since it requires the active participation of relevant actors in order for the exchange of materials or resources to occur.

Spekkink (2015) identifies a strong link between institutional capacity and the opportunities that individual actors see for engaging in collective action. First, the amount and variety of actors can shape the opportunities that actors see for engaging in interactions that require coordinated efforts of the actors involved. This links to the relational capacities of the actors at hand because the amount of trust reduces the perceived risk of actors in cooperative relationships. Additionally, it supports the possibility of selecting the actors needed in the framework to mobilise others.

Secondly, actors that have a high level of relational capacity, have a higher probability of sharing knowledge and experiences, and negotiating confliction views on problems and solutions (Innes and Booher, 1999). Actors' conceptions of what actions are feasible and impractical are shaped by the knowledge and experience they acquire from interactions. This allows actors to perceive opportunities for different courses of action. Furthermore, if actors can align their interpretations of the issues and potential solutions, the opportunities they perceive for collaboration will grow. It is possible for the actors to achieve knowledge inclusion (Buuren, 2009), which entails that they mutually understand and recognise each other's perspectives on problems and solutions as well as their views on which knowledge is valid and significant. This does not necessarily imply that the actors converge on a specific set of problem and solution definitions.

Third, since shared strategic visions provide long-term, unifying frameworks around which actors can mobilise, they affect the opportunities that actors perceive for collective action (Healey et al., 2003). If one or more actors are willing to take the lead or facilitate the interactions, actors will also perceive greater opportunities to participate in collective action (Elliott, 1999). Therefore, a strong relational and knowledge capacity can support the mobilisation capacity. Following, a committed actor might be needed who has made the commitment to see the vision through is necessary for the implementation of shared visions (Spekkink, 2015).

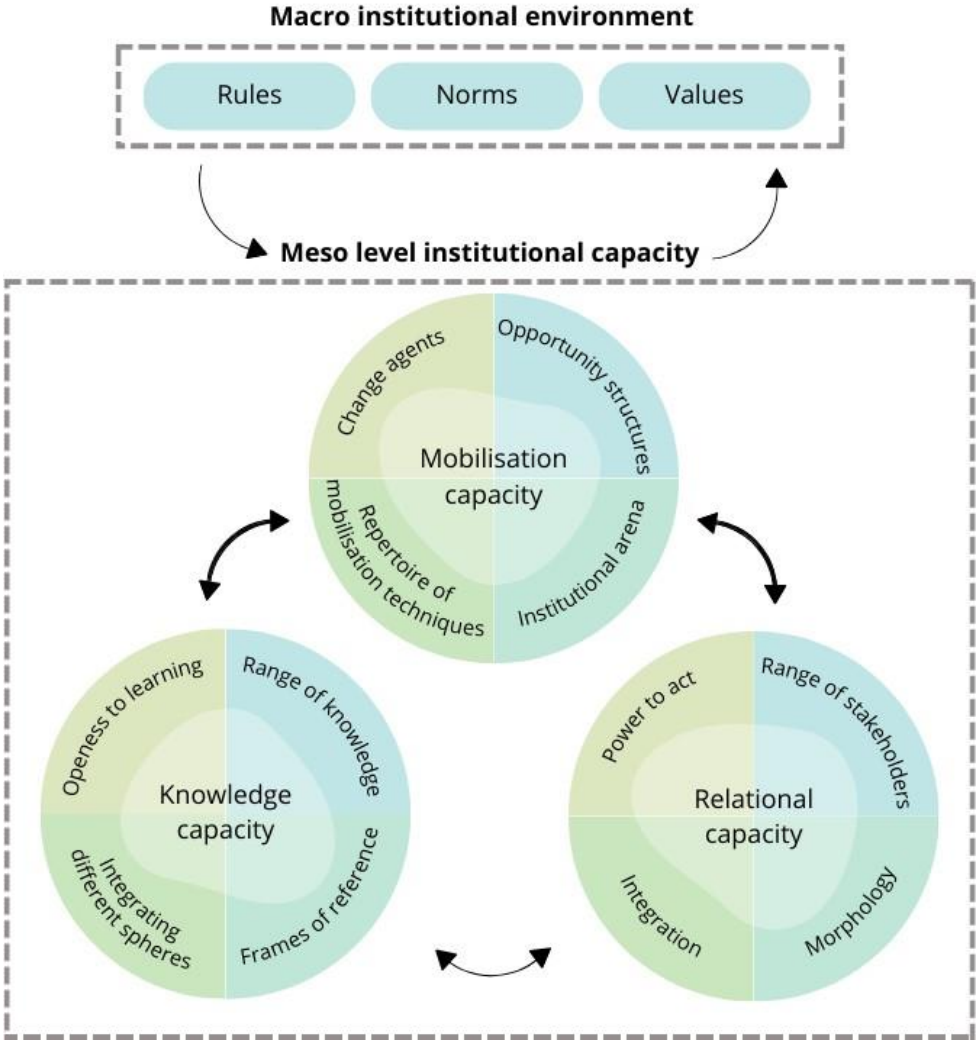

Figure 3. The institutional capacity framework with the correlating elements

3. Methodology

To answer the research question, *How does the interplay between macro institutions and meso institutional capacity of actors in the circular construction sector shape the implementation of urban symbiosis in the case of Prinsenhof?* the research design, multiple data collection methods and how the data is analysed are elaborated on and the validity and reliability of the study is discussed.

3.1. Research design

In this section the research methodology is elaborated on. In this section the nature of the case, the selection of the case and the research strategy is discussed.

In this study, one case was chosen to create an explanatory case study. A case study is an empirical investigation that looks at a phenomenon in its real-life setting (Yin, 2009). According to Krusenvik (2016), an advantage of doing a case study is to show real-life and in-depth data. Case studies can thereby create new theories and provide strength to previous research. As it involves an in-depth examination of a phenomenon, case study research employs a variety of data collection techniques. By conducting an explanatory research, the primary focus is to explain how and why certain conditions arise and why certain events do or do not occur (Yin, 2014). The purpose of this is to test the theoretical framework created in the previous chapter.

The selection of the case is important in case study research especially in this case where the intention is to support an existing theory from the case. According to Gray (2021) it is preferable to choose those that are polar of extreme types. This helps to ensure that the participants in the case are transparently observable. Only a single case is examined, at a holistic level because the case plays a significant role in testing the theory displayed in the previous chapter. The chosen case displays a “best practice”. In the context of this study this means that the case was a successful and novel case of circular reuse in the construction sector. This case was chosen after consultation with an expert at Cirkelstad which is knowledge platform that works together with the private and public sector to create collaboration between parties that want to create circularity in the construction sector. The expert suggested the case of the municipal office building Prinsenhof in Arnhem. This case was suitable because it is a novel case where many parties worked together, and new circular construction strategies were implemented. In addition to this, all of the parties involved were open to interviews. Because this study aims to gain in-depth insights, it is important to choose a recent case so that the parties involved still had all the information on top of mind with regard to the collaboration and how this formed their institutional capacity to create circularity. The case of Prinsenhof was conducted in 2022, therefore this case is deemed suitable. The units of analysis in this case are the organisations that were involved in the project.

3.2. Data collection methods

This study was able to use two data collection methods; interviews, and a document analysis. These methods were complemented with literature research to substantiate any background information.

3.2.1. Qualitative interviews

Interviews is the main source to obtain data in this study. Within this study semi-structured interviews were used because they are widely used in qualitative research. They utilise a predetermined question framework that directs the interview process, while allowing the researcher flexibility to request clarifications when necessary (Wheeler et al., 2010). The application of this method carries certain advantages and disadvantages, as highlighted by Adams (2015). A notable disadvantage of semi-

structured interviews is their extensive time requirement and labour-intensive nature, particularly with a large sample size. Conversely, the benefits of employing this approach encompass the ability to pose open-ended questions to gain before unknown information. In this study, the interrelationships between the actors and how this interplays with the macro institutional environment were not previously researched, therefore a semi-structured interview approach was conducted.

Because of the connection with the expert at Cirkelstad the initial actors involved in the Prinsenhof case were identified. For actors outside of this initial network, a snowballing technique was used. This refers to a technique used in data collection, particularly qualitative research. This technique, explained by Wohlin (2014), involves initially identifying a few participants of sources who are relevant actors in the sector of circular construction. After conducting interviews with them or gathering data from them, the researcher then requests recommendations or referrals to additional people or sources who may have information or characteristics like those found in these initial participants. As the process continues iteratively, each new participant or source suggests additional potential participants or sources. Snowball sampling may introduce biases, though, as participants are frequently linked together through social networks or other commonalities, which may leave the sample lacking in diversity. This disadvantage is not the case within this case study because all participants involved in the case gave a more well-rounded overview of the barriers and possibilities urban symbiosis in the Dutch construction sector

The first interview was conducted with Lagemaat, because this was one of the most important parties in the case because they were the contractor of the circular construction project. Following, the researcher asked for contact information of other parties that were involved. This resulted in interviews with the following actors; IDDS Construction and Demolition Management, Cepezed Architecture and Dycore. The final interview was with the project initiator of the province of Gelderland. The interviewees were asked to answer questions about their institutional capacity and about the influence on and of the macro institutional environment from their point of view. These questions and the interviewees can be found as Appendix 1 and 2.

The time scheduled for the interviews was 45-60 minutes depending on the time the interviewee was available. Within this timeframe the pre-determined questions were asked, but it also created time to dive deeper into subjects and ask additional questions. Several factors were taken into consideration in order to reduce the likelihood that ethical concerns would interfere with data collection. The interviewees were fully informed of the interview's precise objectives, its subject matter, its intended audience, and the confidentiality of the information they provided. This was discussed with the interviewees in the emails that they received before the interview. Before the interview itself the participants were asked if they approve to the interview being recorded.

3.2.2. Document analysis

During the interviews, multiple documents were brought up that influenced the institutional capacity of the actors involved. These documents were analysed as well as documents related to the current legislation surrounding circular building in the Netherlands to show the possibilities of urban symbiosis. This document analysis gave more insight in how the rules, norms and values influence the meso level organisations within the Dutch circular building sector. Because the researchers first language is Dutch there was no language barrier when reviewing these documents. It should be noted that the contractual documents are confidential.

3.3. Data analysis

During the data analysis phase, the interviews were further processed. The interviews were recorded in Dutch and transcribed in Dutch. The method by Gray (2021), was followed when coding these transcripts in order to facilitate additional analysis. Because the researcher transcribed and coded the data by hand in excel, they got familiarised with the data and gained a general idea of what is happening in the case. Following, the results were structured in four main themes'; macro institutional environment, relational capacity, knowledge capacity and, mobilisation capacity. These are again split up in the different elements of the capacities shown in chapter 2. It should be noted that the interview questions about the macro institutional environment are based on the concepts, used by Trang et al. (2023). Their case study is based on Vietnam where there is a hierarchal government structure. This differs from the Dutch governmental structure. Therefore, the analysis of the macro institutional level is not based exactly on the interviews questions but a thematic analysis will be executed to group the main constraining and enabling factors of the macro institutional environment. To limit the amount of possible interpretations of data, which can create a bias, the interviewees' answers were examined if they corresponded with each other.

4. Case description

Due to the arrival of the new Provincial House in Arnhem, the provincial office building Prinsenhof A became redundant. The building was difficult to renovate and remained vacant. Therefore, the municipality of Gelderland opted for a sustainable approach to demolition and construction: circular excavation. The tender requested a target building, where the dismantled elements could be reused. Lagemaat won the tender because they wanted to build their own knowledge centre with these secondary materials. Their focus was to reuse all the concrete of the old building; hollow-core slab floors and the prefabricated façade elements. The province already purchased 1,050 m2 of hollow-core slab flooring for a sports centre in Arnhem, but the remaining 6,400 m2 was reused by Lagemaat for their knowledge centre. Therefore, the province is the contractor and the client for their own building. Figure 4 shows a representation of the reused materials. It is important to note that this case is focussed on the reuse of the hollow-core slab floors from Prinsenhof to the circular knowledge centre. The activities of the sports centre in Arnhem will not be taken into account in this research.

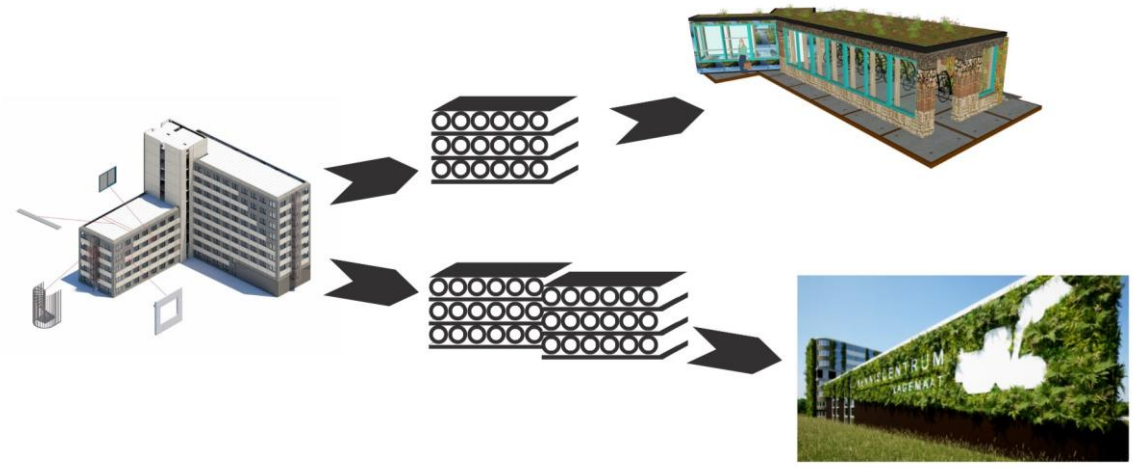

Figure 4. Value flow model of the reused materials

In 2022 the old office building was carefully dismantled to make sure there is high-value reuse of the resources. In the end, the 9-story building, 40 meters high, and 8,400 square meters in size, has been completely dismantled and is being repurposed for 92.1% into three purpose-built structures, resulting in a saving of approximately 2,400 tons of CO_2 emissions. The municipality initiated the project and stated that the project was "An exemplary project at the regional, national, and even international levels." (Provincie Gelderland, 2023). The province provided space for engaged and willing parties to pioneer. According to the province, this exemplary project has given a significant boost to the circular economy. They have proven that a closed loop is a realistic alternative to the traditional linear construction system. As a result, this project serves as a stepping stone towards circular excavation and construction becoming the new standard and a new circular mindset and approach. Together with the market, they are looking ahead how to further scale up circular excavation based on these lessons

In the project, all concrete elements, channel plates, facade elements, and core walls, serve the same purpose in a sports hall, bicycle storage facility, and circular centre, although the concrete elements were never designed for these purposes in 1984. In this case the entire chain collaborated and managed the entire process, including the insurance of the new buildings with building permits and guaranteed reuse. This results in an efficient and financially viable process. By high-quality reusing nearly all construction products from Prinsenhof, there is hardly any need for new production. This significantly saves on the use of primary resources and reduces CO_2 emissions from production.

Other engaged parties in the Prinsenhof case where Cepezed, IDDS and Dycore. Cepezed was involved in the reconstruction of all the materials that were extracted from the building. They were the architect of the new circular knowledge centre of Lagemaat. With all the materials that came from Prinsenhof, they were able to create a new design for the knowledge centre. IDDS is a nationally operating multidisciplinary engineering and consultancy firm. In this case they took care of the technical management of the building and collaborate with the Province of Gelderland on the contract that was in place between the stakeholders. They took on an advisory role and overseeing role during the project. Dycore is a traditional producing firm of hollow-core slab floors. They were the original supplier of the hollow-core slab floors and joined in as an adviser in the project. They made technical calculations on the strength of the floors and were able to provide a warranty on the floors after the reuse.

Within this case there was a different process that deviates from a traditional linear construction process. First the tender was made by the province of Gelderland with an open-ended programme of requirements. This was done because the project initiator believed that the market was able to come up with a solution to reuse the building materials to be in line with the environmental vision of the province of Gelderland. Different contractors were able to participate and present their ideas. From these sessions the province was able to choose the organisation that resonated with their own ideas for circular demolition. Lagemaat, together with Cepezed, were able to create one-on-one reuse because they had a target building to reuse most of the hollow-core slab floors and were therefore chosen as contractor. Lagemaat had done projects before with Cepezed on circular construction and have a strong relationship. Because of the circular nature of the project there were a lot of revisions and changes throughout the planning, design and development phases of construction. New materials came about, and new technical calculations were made that created new opportunities. Because of their involvement in earlier circularity projects together they were able to work in this changing environment. IDDS joined the project as technical advisor and created the contractual documents in collaboration with the province. The established UAV-GC contract gave a lot of freedom to the stakeholders involved to create a circular construction strategy.

This case is suitable for this research because the actors were open to the interviews and willing to share their experiences. Additionally, it is a “best-practice” case that was able to implement a new circular initiative in the construction sector. Their institutional capacity can be analysed in-depth to see how they created a symbiotic relationship and were able to work through the macro institutional environment, creating new insights in opportunities within the overall construction sector.

5. Analysis of the macro institutional environment

Within this chapter the rules, norms and values of the macro institutional environment will be analysed. First, the overarching norms and values of the conservative construction chain will be evaluated. Following, a document analysis will be executed on the rules and legislation that are relevant for the case. These documents are summarised in figure 5. Additionally, the interview data will be linked to the analysis and show how the actors were able to work through the macro institutional environment at play. To conclude, the results on the constraining and enabling factors will be summarised, in figure 6.

5.1. Analysis of the conservative Dutch construction chain

To understand the norms and values in the conservative construction chain and the macro institutional environment it creates, a general overview of the Dutch construction chain will be presented. In general, the construction sector has several characteristics making it conservative. Conservative in this case means the lack of implementing new technologies and ideas that could lead to more circularity in the construction sector.

First, the Dutch construction sector has a relative traditional character according to Herk et al. (2007), meaning they have been using the same methods and techniques for decades. There is a strong tendency to stick to what is familiar and proven effective rather than experimenting with new approaches. This is also because of the wide range of stakeholders involved in the process and the trust present between the various stakeholders. The conventional construction process involves nine main stakeholders, as identified by (Clough et al., 2015) and summarised by Leermakers et al. (2019). (1) The project manager leads the construction team and acts as the primary contact for the client. (2) Owners initiate and finance the project, whether they are public or private entities. They might delegate work to architects or contractors. (3) Architects design the project either independently or in collaboration with construction contractors. (4) Engineering consultants provide specialised knowledge for building design, often contracted by the designer or the owner. (5) Construction managers represent the owner's interests, offering advice, coordination, and overseeing the construction process. (6) Prime contractors manage resources, supervise construction, and frequently subcontract specific tasks. (7) Subcontractors, engaged by the prime contractor, specialise in particular tasks without direct contracts with the owner. (8) Sub-subcontractors work under subcontractors, executing designated tasks as outlined in contracts. Concluding with, (9) vendors, they supply materials/products without installation services, engaging in sales contracts with different project entities. This shows the intricate web of actors involved in the overall construction process and the conventional range of stakeholders involved.

Second, according to Khasreen et al. (2009), buildings are made with more labour-intensive processes and have longer lifespans than other types of products creating high investment costs. This makes individuals in the sector often hesitant to embrace new technologies or methods as they aim to minimise risk.

Third, there is a high level of regulation and standardisation in the sector with strict building codes and safety standards (Khasreen et al., 2009). New ideas must first meet these stringent regulations before they can be widely implemented hindering change and innovation. One of these regulations is the Dutch Building Decree which will be analysed further in chapter 5.2.2.

And finally, according to Leermakers et al. (2019), the majority of construction processes are currently linear in nature. Tijhuis (1996), describes the four phases; planning, design, development, and realisation. In the planning phase, the building initiative is assessed for feasibility and a clear project definition is established. The design phase involves creating internal and external structures, developing cost estimates, and finalizing detailed designs and specifications. The development phase focuses on contracting, budget adjustments, and choosing a contractor through various procurement processes. The realisation phase entails thorough preparation by the contractor, technical elaboration of plans,

construction, adherence to agreements, formal client handover, and subsequent building use and management. Finally, at the end of its life cycle, the building may undergo renovation, reconstruction, or demolition.

In contrast to these conservative characteristics, no materials are disposed of in a circular construction cycle. Materials that are extracted during building demolition can be utilised as inputs to create new (half-)fabricates, which can then be applied in a new building (Leermakers et al., 2019). According to the Transition Agenda; The Circular Construction Economy (2018), circular building can be defined as "the development, use and reuse of buildings, areas and infrastructure, without depleting natural resources, polluting the living environment and affecting ecosystems" (p. 10). There is a need to create more circularity in the construction chain because of the high environmental impacts of the construction chain.

Within the Prinsenhof case, the actors were able to work through the norms and values related to the conservative construction chain. As stated in the literature, the involved organisations might be able to reevaluate their objectives (Boons & Spekkink, 2012). This was the case for Dycore. They were the only interviewed organisation involved in the case who did not have any prior experience in circular construction. The knowledge gained by participating in this case, gave them insight in new possibilities to create a business case in the circular economy by constructing demountable couplings for hollow-core slab floors (Dycore, Interview, 2023). This can increase their re-use and detachability. When researching their options, they found some constraining factors. "For making those demountable couplings, architects and structural engineers are needed. That's the tricky part in this case because you need more parties to be involved in the process. There is no party that is really decisive in this" (Dycore, interview, 2023). Additionally, Dycore (interview, 2023), stated that there has to be demand for such options, if no one asks for it, it is a high investment to make something circular, further confirming the indecisiveness of other parties involved. According to Dycore (interview, 2023) "So that requires a whole cultural change and people who think differently and as long as you involve the province and government, they will see people who want that. There is might also money available to do that". This indicates a constraining environment related to the conservative nature of the construction chain and a need for a top-down change through the whole chain for producing companies, like Dycore, to be more involved in creating circularity in the construction industry.

Within the case there was one instance where there was an enabling environment created to change this conservative chain. Due to the circular, experimental nature of the project and all the pre-determined aims to create as much circularity as possible, major changes were made during the demolition process of the building. In the demand specification added to the UAV-GC, there was the option of reuse for the concrete core of the building which was also the stairwell (Provincie Gelderland, Vraagspecificatie, 2021). Due to the trust given by the client to the contractor the workers from Lagemaat wanted to try to deconstruct it during the demolition process (Province of Gelderland, Interview, 2023). In the end they succeeded to do so. Their enabling environment was created because of the circular and experimental nature of the project instead of the conventional linear one.

Additionally, there were some actors that already directly participate in changing the traditional norms and rules surrounding construction on a macro institutional level. The interviewed actor of Cepezed is part of the transition team circular buildings, which gives him the opportunity to directly advise the government (Cepezed, Interview, 2023). The interviewed actor of IDDS stated to be a part of chain that created a new SMI-tool (IDDS, Interview, 2023). This tool provides insight into the possible (re)use of materials released during the demolition or renovation work of a building for municipalities. Furthermore, Lagemaat (Interview, 2023), stated that they like to share the outcomes of the project with national knowledge institutions like the Dutch Green Building Council (DGBC) and have connections with governmental ministries. During the interviews it was not directly indicated if the outcomes of the one-on-one reuse could also influence the macro institutional environment but their connections with macro-level authorities could indicate there was some kind of knowledge sharing.

5.2. Regulatory analysis

The documents on the European and National level analysed in this section provide an explanatory background on how the momentum for green policies within the construction sector are created. From this background the documents that arose during the interviews will be analysed in-depth to understand the macro institutional environment at play in the case. The European level and National level legislative documents are not as relevant for the case but are important to keep in mind when observing the overall circular construction chain. The document analysis will consist of the identified documents shown in figure 5.

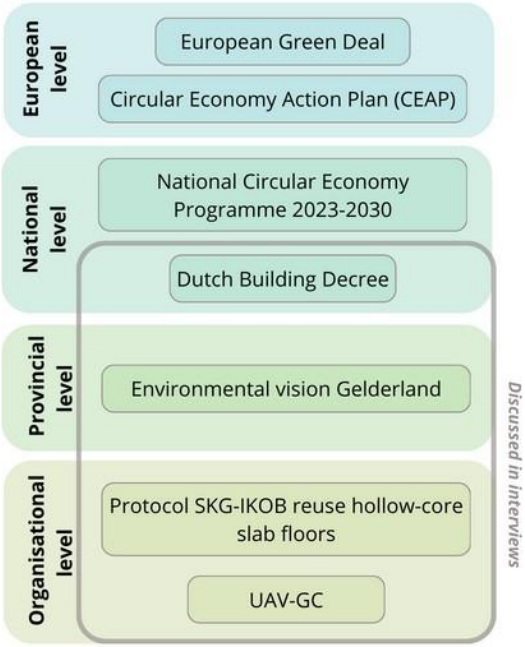

Figure 5. identified documents for the document analysis

5.2.1. Circularity economy ambitions

As described in the introduction, many developments towards a more circular construction sector were already present. The first one touched upon is the European Green Deal which aims towards the 2050 goal of climate-neutrality in EU legislation. The Green Deal provides a roadmap of actions to boost resource efficiency by moving to a clean, circular economy, restoring biodiversity, and reducing pollution.

In order to reach this ultimate goal of being climate neutral by 2050, the EU set an intermediate target for 2030 of reducing greenhouse gas (GHG) emissions by at least 55% compared to 1990. The Green Deal, as a whole, results in relevant policies for the Dutch construction sector. The policies and documents that are relevant to the case and are aligned with The Green Deal are the National Circular Economy Programme 2023-2050 on the national Dutch level and the environmental vision of Gelderland on a provincial level. These documents also aim for climate neutrality by 2050.

Before the Green Deal was presented, the Netherlands already employed a government-wide programme in 2019 called; “Netherlands Circular in 2050”. Within this programme there is a focus on developing a circular economy before 2050. The government’s intermediate target is to decrease primary raw material use with 50% by 2030. The PBL (Planbureau voor de Leefomgeving - Netherlands Environmental Assessment Agency) monitors this programme by using the R-ladder. This method indicates the degree of circularity with six steps (R1 to R6) that represent different strategies (Rijksdienst voor Ondernemend Nederland, 2020). The highest strategy, R1 is Refuse and Rethink. Here the main aim is to only use products that are essential or intensify the use of the product by sharing. R2 focuses on Reduce, where less resources can be used more efficiently to create the same output. R1 and R2 are therefore mainly about decreasing the consumption and production of materials and resources. Following, R3, Re-use. By reusing products, the lifespan can be extended and less virgin materials are needed. R4 encompasses Repair, Refurbish, Remanufacture and Repurpose. R3 and R4 both focus on expanding the lifespan of the materials used. R5, Recycling, focusses on processing materials into new raw materials with the same (high-quality) or lesser (low-quality) quality than the original raw material. Finally, R6, Recover is about incineration of materials to recover the energy. R5 and R6 are the bottom of the chain and are seen as the least circular option. These focus on useful recovery of materials that would otherwise be landfilled. The R-ladder is a method that is not only employed by the government but also by companies that want to employ circularity strategies. The R-ladder is also used in the UAV-GC contact to choose the most circular demolition strategy (Provincie Gelderland, Vraagspecificatie, 2021).

The Environmental Vision of the Province of Gelderland is named “Gaaf Gelderland” (Provinciale Staten, 2018). Within this vision document, the province states their ambitions for the upcoming years. The themes highlighted in the document are; energy transition, climate adaptation, circular economy, biodiversity, accessibility, business climate and living and work environment. Their ambition on circular economy states that the province aims to lower their use of primary materials with 50% by 2030 which relates to the ambitions on European and national level. They aim to do so by making sure the partners they work with are already circular and by searching for room in legislation that may obstruct circularity. The remainder of the document does not have any further focus on the construction sector in relation to the case.

5.2.2. The Dutch Building Decree

The Dutch Building Decree, often referred to as "Bouwbesluit" in Dutch, is a set of regulations and standards that govern the construction and use of buildings in the Netherlands (Bouwbesluit 2012, 2023). It outlines various requirements concerning safety, health, usability, energy efficiency, and environmental aspects within the built environment. It aims to ensure that buildings in the Netherlands meet minimum standards for safety, health, and sustainability, and it applies to both new constructions and renovations.

This decree has strict technical requirements to ensure safety and additional requirements on the environmental performance of a building especially compared to the Dutch Building Decree that was in place when the building was constructed. The main issues the interviewees brought up were with regard to the usage of concrete and technical requirements. A high percentage of concrete can lower the score on environmental performance. This is determined with the Dutch Environmental Performance of Buildings (MPG) method that takes a lifecycle approach to prioritising sustainability. In an MPG, the environmental impact of the materials used are brought into scope. It also addresses trade-offs where buildings with solar panels might have a higher energy-efficiency but also a higher carbon footprint in terms of materials. Also, the requirements for the sizing of the hollow-core slab floors that were reused in the case, currently has different requirements than when the building was first constructed. The actors indicated that because of the changing technical specifications and environmental requirements like the MPG, reuse of materials is difficult. As indicated by Lagemaat (Interview, 2023);

> “But suppose you don't move a building for another 20 years, such as Prinsenhof, you notice that the insulation value of the façade panels no longer meets the requirements set by the current building decree. While, if you just left it in Arnhem then it would have been allowed.”

By changing the location of the building or reusing the building materials, the project is seen as new development. Therefore, the requirements set by the latest building decree are in place. As indicated before, this Decree has strict technical requirements and additional requirements on environmental performance of a building. Consequently, additional Building Decree proof calculations and building insurances are needed. The province of Gelderland (Interview, 2023) pointed out that some parties participating in the pre-selection, also brought up these issues; “If we want to insure our new construction and to get building insurance there are a number of complex things were you have to agree on specials for anyway” or “An insurance company says, you can reuse materials, but no more than two years old.” and “Your project has to be building decree proof and there must and preferably also guarantees guaranteed.”

This creates a barrier for reuse because all the properties of the reused materials have to be recalculated for their new purpose and there are no standardised rules for this reuse. This also had to be done for the environmental standard and technical calculations. As indicated by the province (Interview, 2023), the building decree proof calculations were from 1984. During this time, the floors were constructed heavier to meet the requirements of the building decree. In the environmental standards, more use of concrete leads to a lower score which could lead to not meeting the requirements. Additionally, slimmer floors

are now the environmental standard in new developments, again the old, reused floors do not meet these standardised requirements. Because of the one-on-one reuse, the penalty of using more concrete is lower because it does not use virgin materials and the thickness of the floor makes it even more durable. Therefore, it depends on how you make the calculation and the knowledge on these materials to make a Building Decree proof calculation.

5.2.3. UAV-GC

The UAV-GC (Uniforme Administratieve Voorwaarden voor Geïntegreerde Contractvormen 2005; Uniform Administrative Conditions for Integrated Forms of Contract) is a commonly used contract form in the construction industry (Comaen, 2022). The UAV-GC differs from contracts normally used for new development. This is because in the UAV-GC the contractor carries out both the design and execution of the project. In conventional project these responsibilities are separated the contractor is therefore also given more responsibility in a UAV-GC and the content of the contract differs. Within these contracts it is set out who bears the responsibilities and what the associated consequences are. The advantage of a UAV-GC contract is that the contractor is only limited by the requirements of the client in the demand specification. This gives the contractor more freedom to use innovative solutions. Additionally, it is more suitable for an integrated collaboration process. The involvement of the client is also recorded in the UAV-GC. In this case the client checks if the contractor complies with the obligations stated in the contract.

In this case there are nine documents that will be analysed. First, the basic agreement which is based on the traditional UAV-GC as explained above. Additionally, there are three attachments that discuss the definition of the concepts used in the contract, a list of binding and informative documents and, a document on the Social Return. Secondly, four documents on the demand specification where the case is explained and the responsibilities for the contractor are laid out are analysed. These documents also specify how the client chose the winning contractor for the tender. And finally, the annex that discusses any further specifications on the basic agreement.

In the basic agreement one paragraph specifies the intellectual ownership of the project. Here it states that the involved parties are known with the fact that the aim of this project is to work towards a more circular economy where knowledge and educational experiences are acquired in collaboration and will be shared with external parties in the same interest;

> "The parties are aware that the aim of this work is to jointly acquire knowledge and learning experiences in the public interest and specifically in the interest of the growth towards a circular economy, and that these will be shared with third parties (e.g. knowledge institutions, sector organisations, governments, market parties) in the same interest." (Provincie Gelderland, Basisovereenkomst, 2021).

In the list of binding and informative documents is also the protocol on reuse of hollow-core slab floors. This protocol is stated as binding in the contract with an addition that the working method will be tested on the project location but should be evaluated with the involved parties afterwards.

The demand specification contains multiple documents. The first is a registration guideline. This guideline gives the contractor information about the ambitions, description and background of the project. This document gives also insight why the UAV-GC was chosen as the leading contract. “This type of contract was chosen to offer the contractor more freedom and flexibility to give its own interpretation to the execution work and to align it with high-quality Reuse.” (Provincie Gelderland, Vraagspecificatie, 2021). As this contract type is relatively unfamiliar for circular mining tasks and requires specific considerations from the contracting authority, a tendering approach has been adopted to allow flexibility, enabling discussions and modifications. The contracting authority states to aim

towards maintaining an ongoing dialogue with the contractor throughout the agreement. By employing system-oriented contract management, the client will oversee the contractor's quality assurance and methods through various tests. This innovative contract format is anticipated to contribute to the shift towards a circular economy, and the contracting authority states to be open towards the joint challenge of evaluating and shaping its vision.

Additionally, it showed there was a selection phase followed by an extensive registration phase consisting of multiple dialogues concluded by an award phase where the contractors had to deliver the tender documents. In these documents is also stated that the client wishes to play a role as a catalyst and quartermaster in the transition to a circular economy. They aim to do so by challenging the market and offering space for innovations in the field of circularity; stimulating high-quality reuse of released products, materials and (raw) materials during the demolition by means of circular mining of the objects and surrounding terrain. By sharing their experiences gained during and after the project and linking them to a 'community of practice' of circular mining and high-quality reuse, they can further stimulate the transition towards a circular economy. They added that this also includes "stimulating chain cooperation, transparent business models, uniform measurement methods for circularity, incorporating circularity into building standards and improving laws and regulations." (Provincie Gelderland, Vraagspecificatie, 2021).

The aim of the overall project is also described in detail; "The objective is to deconstruct by circular mining. An optimal (costs, benefits and revenues) ratio is sought between the period that these objects are available and the possibilities of high-quality reuse of released products and (raw) materials." In the aim there is also a specific mention that the acquired knowledge will be bundled and shared with other public authorities, market parties, knowledge institutions and interested parties. Additionally, the overall aim states;

> "The contractor is required to be able to demonstrate, at all times, that the activities it performs in order to comply with the obligations under the agreement, contribute to the above-mentioned ambitions and objectives and in all cases the contractor's actions are not in conflict with this." (Provincie Gelderland, Vraagspecificatie, 2021).

Even though the contractor has to validate its actions, there is a lot of room within the contract to give input and create a high-quality reuse. According to the contract; "The development of innovations is an important part of bringing about this transition. The Contracting Authority assumes that innovations that are made available under the right circumstances can develop into standard practice and thus bring about a system-wide transition" (Provincie Gelderland, Vraagspecificatie, 2021). To ensure this system wide transition there is a lot of room for dialogue and changes within the project.

During the selection process, the contractor is selected on multiple criteria. One of the relevant criteria is the R-ladder. When the contractor presents an idea that scores high on the R-ladder, there is a stronger connection to the ambition of the project, where re-use is the highest applicable strategy in this case. R1 and R2 (Refuse and Reduce), are not applicable because the materials are already used. Therefore, R3 Reuse is the highest possible circularity strategy to extent the lifespan of the materials.

Another paragraph lays out how the collaboration should look like. In this paragraph an open and proactive collaboration is described; "Short lines of communication, transparency and clear communication are necessary for good cooperation. Parties hold frequent consultations to discuss the progress, opportunities and risks to the project objectives. In order to get to know each other better, informal team sessions are organised by the Contractor." (Provincie Gelderland, Vraagspecificatie, 2021). There was also the mention that the contractor will convene a progress meeting with the client at least once every two weeks.

Finally, the annex of the basic agreement is analysed to see what the differences are between the basic agreement and the specific agreement used for the Prinsenhof project. In this annex, further specifications about the project planning are given but these are irrelevant for the objective of this study. The main information from the annex acquired is the change in responsibilities. The first specification is on the design work. In the basic agreement, the design work has to be described in general terms but because the contract is based on circular mining of materials, the design (e.g. elaboration on paper, specifics on goal achievement), cannot be translated into specific measures. Therefore, the contract uses a reference to the demand specification documents. Following, two changes have been made with regard to the responsibilities. These changes give the contractor more risk because they are the ones responsible for the demolition process.

The use of this contract enabled the actors, and especially the contractor, had space to change their plans along the way, because the project has an experimental aim. Within the UAV-GC contract, it was stated that the contractor had the most responsibilities to ensure the aim of the project, high-quality reuse. Furthermore; "The Contracting Authority assumes that innovations that are made available under the right circumstances can develop into standard practice and thus bring about a system-wide transition" (Provincie Gelderland, Vraagspecificatie, 2021), creating a lot of room for changes and dialogue during the project instead of working with a set contract as tendering method. An example of this was the plan to crush the core of the Prinsenhof building but during the demolition they decided to reuse it. This would not be possible when a traditional construction contract was used.

Governmental institutions showed interest in this contract and wanted to reuse it to make sure they had the same outcome but when they asked the province of Gelderland for the contract, they responded with; "You don't live through what our vision is, what our way of thinking is. (...) So you're not going to get there by copying the contract if that's your philosophy, well, then you don't have to copy this project." (Province of Gelderland, Interview, 2023). In the end, this contract was not used during the demolition nor the construction phases according to the interviewees because of this common philosophy.

5.2.4. Hollow-core slab floor reuse protocol

In the context of circular construction and the reuse of raw materials, the Central Government Real Estate Agency has commissioned SKG-IKOB certification to draw up a protocol for the reuse of hollow-core slab floor sections from the demolition of existing buildings. The purpose of this dossier is to verify the suitability of the hollow core slab floor sections in the future application or group of applications. This flowchart can be found as Appendix 3.

The aim of this protocol is to arrive at a standard for assessing the reuse of hollow core slabs by means of a standard assessment report. The following aspects must be taken into account in the assessment report: the original design principles of the hollow-core slab floors, the current condition of the reused hollow-core slab floors and the design starting points for the new application. Therefore, Dycore and Lagemaat created an additional protocol. Dycore stated that this is important because other parties are involved in the mechanical subtraction of the floorboards and may become damaged (Dycore, Interview, 2023). They monitored all the subtracted floors and inspected them for damages.

When asking the interviewees about the protocol they mainly referred to the fact that they got stuck on the step-by-step plan. During the case, they used the guidelines but soon enough found out that when following these, they were unable to reuse the hollow-core slab floors;

> "Well, if we now test that protocol that was devised at the time, we end up with red 5 or 6 times while the reuse has succeeded (Lagemaat, Interview, 2023)" "(…) I now see clients coming to me who want the same thing and they are already stuck on the protocol at step 2 or 3. It is actually hindering the reuse, so everywhere I give the presentation, I also tell - you get stuck on that protocol (Province of Gelderland, Interview, 2023)."

As shown, the interviewees indicated to get stuck on the protocol. The first requirement they were unable to meet was the stated requirement for equal span. Span is the length between the supports of the hollow-core slab floors. The requirement states that when reusing the hollow-core slab floors, the span must be equal between the original building and the new building. This was not the case because the span was smaller in the new building compared to the original building. Another point that obstructed the reuse was the compliance of the environmental requirements for new development.

In this case they were able to reuse the hollow-slab floors by not using the protocol. This is also because Dycore, the initial supplier of the hollow-core slab floors, was able to give a new warranty on the materials and make new technical calculations. Some of the interviewees stated to be working on changing the reuse of hallow-core slab floors protocol to guarantee reuse. During the document analysis, a new version of the protocol was not yet available.

5.3. Concluding remarks on the macro institutional environment

The environmental vision by the province, based on the European and national environmental legislation, provided the possibility to start the innovative circularity project that lead to the implementation of the UAV-GC contract. This contract created an experimental project and created space for changes during the project and overcomes the linear nature of the conventional construction chain. Additionally, the contract made sure that the actors involved had knowledge on circularity creating enabling them to overcome the additional requirements created by the Dutch Building Decree and overcome the issues that arose when implementing the hollow-core slab floor reuse protocol. Within the UAV-GC contract, the dialogue sessions were highlighted and the experimental nature of the project which were enabling factors for the actors to successfully move through the macro institutional environment.

Constraining factors that were identified are the conservative construction chain, the Dutch Building Decree and the SKG-IKOB protocol. As identified, the conservative construction chain proposes constraints because of the individuals in the sector who are often hesitant to embrace new methods as they aim to minimise risk. Following, the Building Decree does not yet comply with the aim of urban symbiosis creating a constraint because more knowledge is needed to make the required Building Decree proof calculations. Finally, the hollow-core slab floor protocol did not create the intended outcome of one-on-one reuse when applied in practice. The enabling factors, their relation and the constraining factors identified is shown below in figure 6.

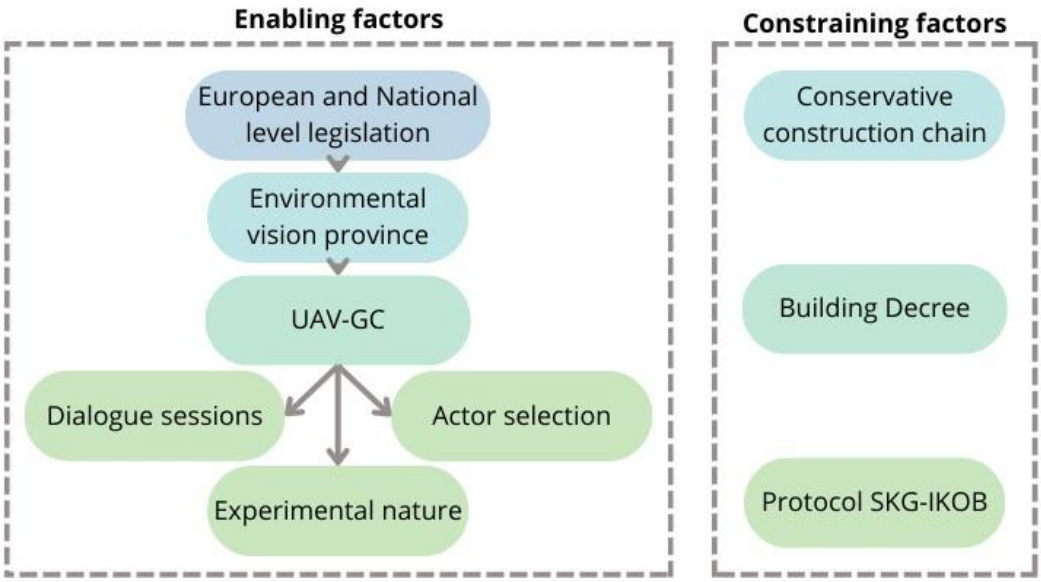

Figure 6 Enabling and constraining factors of the macro institutional environment

6. Meso level institutional capacity

In this section the three dimensions (relational, knowledge and mobilisation) of institutional capacity of the actors involved in the circular demolition and construction project; Prinsenhof will be analysed. The last section of this chapter elaborates on the interplay of these dimensions and shows how the three dimensions relate to one another. Finally, a conclusion is drawn regarding the actors involved in the "Prinsenhof case" and their overall ability to support the adoption of circular construction strategies.

6.1. Relational capacity

In this chapter, the relationship between the actors identified in the case description will be elaborated on. It includes the (1) range of stakeholders, (2) morphology, (3) integration and (4) the power to act as described by (Healey et al., 2003). The findings on the range of stakeholders and their morphology are summarised in figure 7.

6.1.1. Range of stakeholders

All the actors involved show engagement with state and non-state actors. Cepezed mentioned to have good connections with Ministry of the Interior due to his personal connection to the transition team Circular Construction Economy (Cepezed, Interview, 2023). The ambition of the Province of Gelderland was drawn up together with the Central Government Real Estate Agency and the municipality of Arnhem (Province of Gelderland, Interview, 2023; IDDS, Interview, 2023). The Central Government Real Estate Agency dropped as an actor later in the process due to policy constraints (Province of Gelderland, Interview, 2023). The province started the tender and had dialogues with various market parties to see what their motivations were to join the project. The province had an elaborative selection process which is discussed in the documents on the demand specification (Provincie Gelderland, Vraagspecificatie, 2021). From these documents it became clear that the province wanted to look for a partner who had a target building in mind where the materials directly could be reused since this would generate the highest value according to the R-ladder. The actor who was able to demolish the building and had a new destination for the hollow-core slab floors and additional materials, was Lagemaat. They joined the tender together with Cepezed as their architect (Lagemaat, Interview, 2023; Cepezed, Interview, 2023). During this process, IDDS was already involved because they had made the UAV-GC contract together with the province (Province of Gelderland, Interview, 2023; IDDS, Interview, 2023). Later on, IDDS was involved as technical consultant in the project. From here other market actors that were already involved or wanted to be involved joined the project. As stated by Boons et al. (2011) and. Trang et al. (2023), exploring the involved actors in the case and specifically the local partnerships, and collaborations are key for creating symbiosis.

6.1.2. Morphology

The morphology of the actors in this case shows the density of the network interconnections. As can be seen in figure 7, the actors are closely related. One aspect that strongly influenced the success of this project is the narrow network between the actors involved. All the interviewees also stated some of the names of the other involved actors, indicating that they worked together in some way creating a web-like morphology.

Regarding their relationships, some of the organisations had formerly worked together. The literature support that this shows a strong morphology because informal relationships grow over time and are deemed stronger than formal relationships (Boons & Spekkink, 2012). Lagemaat and the province had worked on circularity projects together before (Province of Gelderland, Interview, 2023; Lagemaat, Interview, 2023). Lagemaat and IDDS did not work together before, but IDDS did state that they enjoyed their collaboration (IDDS, Interview, 2023). Cepezed stated that Lagemaat and them did other projects before Prinsenhof (Cepezed, Interview, 2023). In this case they stated that Lagemaat was in the lead but

in the other projects their relation also shifted to one where Cepezed was more in the lead. Showing they have a strong equal relationship. Sloopcheck even mentioned that they almost seem to operate as one organisation in this case because they enrolled in the tender together (Sloopcheck, Interview, 2023). Dycore was asked by the province to join the project to see how they could gain more knowledge on the reuse of the hollow-core slab floors. After, they worked together with Lagemaat to advise on the practical implications of the demolition and rebuilding, they stated that they enjoyed this collaboration (Dycore, Interview, 2023).

Stability within these relationships is also an important aspect to consider when measuring the morphology. Stability can be ensured when businesses are open to one another and have a close proximity in terms of institutional, social, organisational, and cognitive proximity (Korhonen et al., 2018; Velenturf & Jensen, 2016). During the first dialogues between the parties Lagemaat (Interview, 2023) emphasised that; “We have to try to keep it light and airy, but that means you have to work with an open mind towards each other.”. This open-minded mentality is a pattern that reoccurs multiple times during the interviews but was also stated in the demand specification which is a part of the UAV-GC documents; "Short lines of communication, transparency and clear communication are necessary for good cooperation. Parties will have frequent consultations to discuss the progress, opportunities, and risks to the project objectives. In order to get to know each other better, informal team sessions are organised by the contractor." (Provincie Gelderland, Vraagspecificatie, 2021).

As an additional example, IDDS (Interview, 2023) added that collaboration through the whole chain is an important factor to ensure a circular economy and the Province of Gelderland (Interview, 2023) stated; “it’s more about connecting the whole chain”. This shows a close cognitive proximity and common goal of working together to create circularity. The importance of interactions and transparency can overcome this self-interest on the part of businesses and will enhance the sharing of waste streams and knowledge (Abreu & Ceglia, 2018). An example is mentioned by Cepezed (Interview, 2023) of overcoming this self-interest; “we are now also working more and more with other companies, so that everyone is not reinventing the wheel."

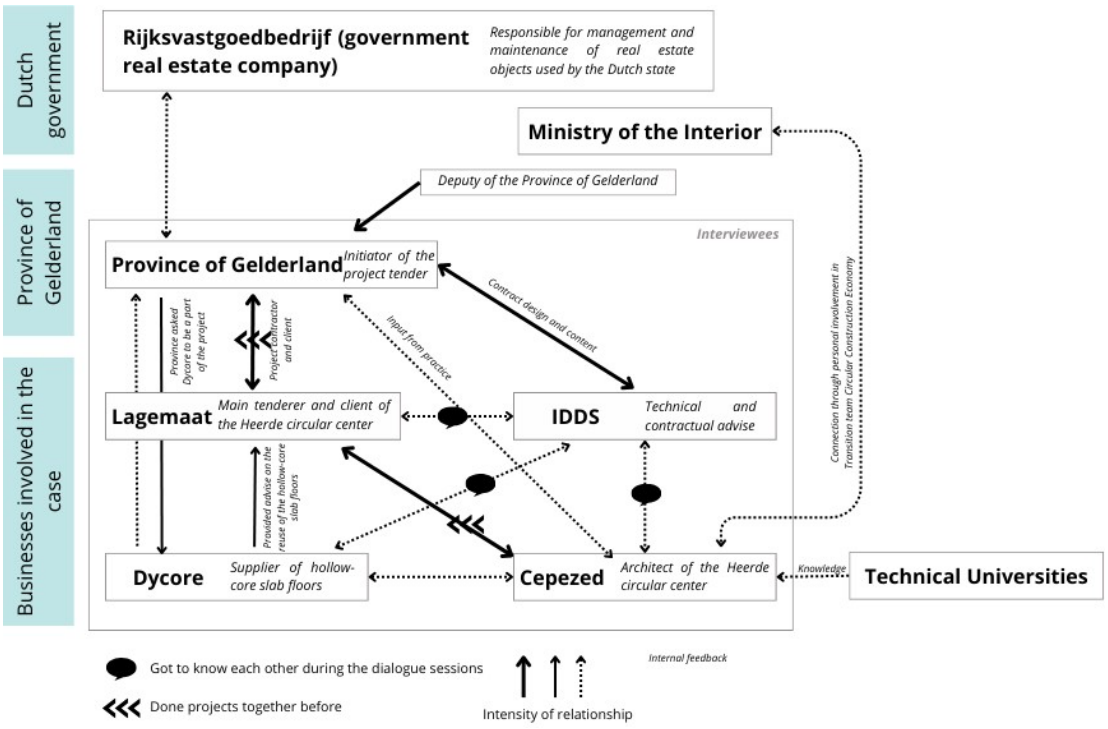

Figure 7. Range of stakeholders and their morphology

6.1.3. Integration

There is a high degree of exchange between the actors in the network because they had to come up with the solution that created the lowest environmental impact. There was a formal statement in the form of an UAV-GC contract;

> “This contract essentially means that you do not prescribe the initiative, so you do not prescribe what should be done in a circular manner, but you actually say to the market, tell us; what you can do? That was also a gamble for them (the province), because the disadvantage of a UAV-GC is that as a client you naturally give the contractor a lot of freedom.” (Lagemaat, Interview, 2023)

This could lead to a lot of time spend monitoring when there is not a strong relationship or close cognitive proximity between the parties. Lagemaat (Interview, 2023) did state that all the parties that joined the project were aware of the common goal “circularity”. This is also mentioned in the UAV-GC itself because one of the selection criteria for winning the tender stated that the organisation is already involved in circularity practices (Provincie Gelderland, Vraagspecificatie, 2021). Additionally in this project, the parties monitored each other through audits. Meaning that they checked whether the contractor put in practice whatever they designed, based on the requirements were formulated and the preconditions under which the project had to take place. At the start of the project there were open dialogues on what should be changed in the contract to make sure every party was aware of their responsibility (Provincie Gelderland, Vraagspecificatie, 2021). On top of that, they discussed if every party interpreted the contract in the same manner ensuring again that everyone was aware of their responsibilities. “In the end we did not change much, confirming we set up a good contract.” (IDDS, Interview, 2023)

According to the literature, such a formal contract is needed because it could otherwise lead to vague designation of responsibilities (Boons & Spekkink, 2012). This case is relatively unique in this case because, even though there was a contract in place, this contract was not revised during the project (Province of Gelderland, Interview, 2023). This could be because of the strong integration between the parties and a clear, common goal, there was a lot of trust and support within the network of actors. The province of Gelderland, as a contract manager, said he prefers to work from trust instead of relying on contractual agreements. Additionally, he stated that his commissioner gave him a lot of trust that the project would work out which caused the other parties tot to have more trust in the process as well (Province of Gelderland, Interview, 2023). This is crucial because even though there is a contract in place, parties could pull out of the project as stated in this example; "And, we solved the issues together, didn't we? At the time Dycore was in danger of dropping out. Well, then a contract is of no use; if we don't want it, then they won't do it." (Province of Gelderland, Interview, 2023)

Through the whole process there was a high degree of integration with multiple moments where the parties sat together and looked at the best viable solutions for the issues that arose. But, as stated before in the chapter on morphology, it could be discussed that because there was a contract in place, there were planned dialogue sessions, and the communication was not as natural as stated during the interviews. According to the UAV-GC; “At least once every two weeks, the Contractor will convene a progress meeting”. There were no barriers regarding their interpersonal relationships indicated during the interviews displaying similarities in their view on collaboration. This again could be linked to the extensive demand specification that aimed towards a contractor and collaborating parties with a common goal; "(..) Researching and experiencing how circular mining, circular development and the combinations between mining and development can be made" (Provincie Gelderland, Vraagspecificatie, 2021).

6.1.4. Power to act

The power to act reflects a wider authoritative, allocative and ideological structuring force (Abreu & Ceglia, 2018). This suggests that the ability or authority to take action does not just signify the capability to do something but represents a broader influence that shapes and structures various aspects within a system. This closely links to the macro institutional environment of the actors because ideology relates to the norms and values at play and the authority to the rules.

One of the structuring forces was the UAV-GC contract. The actors that established the contract were IDDS and the province of Gelderland (Province of Gelderland, Interview, 2023; IDDS, Interview 2023). Within this contract they made the ambition of creating high-quality reuse of the objects that came from the demolished building. This created a common ideology and ambition between the partners involved. Additionally, by indicating that; “The client wishes to play a role as a catalyst and quartermaster in the transition to a circular economy.” (Provincie Gelderland, Vraagspecificatie, 2021), they place themselves in a position to be the authoritative force within the project. The contract also aimed to selected participating actors that had previous knowledge on circular building. The contract also created more responsibilities for the contractor and created space for revisions on the building design to optimise the level of circularity. Therefore, it gained interest from the Dutch government who wanted to create similar projects. Other parties that wanted to join, like Central Government Real Estate Agency, were unable to stay involved in the case due to the rules in place with regard to tendering and contracting rules;

> "Look, we were actually able to do this project from the niche of the organisation, because I fell under facility services. I didn't fall under execution works. And execution of works had difficulty with the procurement law way that I wanted; innovative dialogue with the market (don't throw a contract over the fence, but set up dialogue conversations in a convenient way, so that it is not too big an investment for the market parties). They had trouble with that; the Central Government Real Estate Agency as a large institution. At that time, they were still participating in the project. And on the one hand, they were very to have as a participant in the project, but on the other hand, they were also obstructive. Why? Because they were even more bound and all kinds of policy rules on how they had to tender and contract." (Province of Gelderland, Interview, 2023)

The contract shaped the system in such a way that the Central Government Real Estate Agency was not involved in the project anymore limiting the macro institutional influence on the project. As can be seen in figure 7, some parties involved had external relationships with knowledge institutes with the aim to advise on circular building. These external involvements indicate that the parties within the project have a circular ideology shaping their decisions and actions.

6.1.5. Concluding remarks on relational capacity

The chapter shows that there is a strong horizontal structure throughout the whole project. All the parties worked together, and even though that the project initiator and executor have relatively high levels of power over the other parties, the input from the other parties was highly valuable and embraced. Communication between all parties is shown to be informal, transparent, and based on mutual understanding and trust. This is also stated in the UAV-GC contract, so it is difficult to distinguish whether the parties were preselected on the criteria to be open and transparent or if this arose because of other factors. The parties did incentivise and persuade each other to overcome barriers that arose during the project to, in the end, create a one-on-one reuse of the building materials. Most of the parties involved still have a strong relationship with each other. The power to act is closely related to the rules and legislation that is in place and therefore relates to the macro institutional environment.

6.2. Knowledge capacity

Following the relational capacity, the knowledge capacity of the identified actors will be elaborated on in this section. Knowledge capacity contains four elements: (1) the range of knowledge; (2) frames of reference; (3) integrating different spheres of policy development; and (4) openness within the learning process (Healey et al., 2003).

6.2.1. Range of knowledge

The knowledge resources will be divided in the range of, explicit, tacit, systemised, and experiential knowledge. Per interviewed actor the range of knowledge resources of the organisation will be determined and summarised in table 1.

Lagemaat made calculations for the demolition and reuse of the materials (Lagemaat, Interview, 2023). During the interview they gave precise amounts of waste saved by reuse, and during the project they were able to provide the province with verified numbers on reuse which later could be used for external communication (Province of Gelderland, Interview, 2023). This indicates that there is a high level of explicit knowledge. With regard to tacit knowledge, Lagemaat was involved in earlier circularity projects where they gained knowledge on circular building. On their website they state that; “Circular entrepreneurship has been the core idea in our business operations for years. We show that it is possible to give materials a second life.” (Lagemaat Heerde, 2019). Additionally in the interview Lagemaat stated; “It's very nice how the different sectors, say within construction, are now driving each other in the field of circularity, so I do see a logarithmic acceleration there. Yes, very interesting, yes" (Interview, 2023). This shows a lot of positivity towards the present circular building sector, but also in the future. Because of their involvement in earlier circularity projects Lagemaat sees that there is a routine and learning process in circular demolition and building, creating systemised knowledge (Lagemaat, Interview, 2023). They also did some projects out of a learning position to gain more knowledge on circular demolition and building. Their experiential knowledge shows from the engagement in these learning experiences. The experiences and knowledge they gained is also shared with other parties in the construction industry like Dutch Green Building Council and Insert (Lagemaat, Interview, 2023). In the interview Lagemaat (Interview, 2023), also stated that, what they learned from the case was that everything they “fantasised” about was possible in practice.

IDDS is a broad consultancy firm that focusses on multiple knowledge areas. Within this project they had a similar role as the technical management (IDDS, Interview, 2023). They made some of the technical calculations needed to secure the safety of the reuse of the materials. Additionally, they have the knowledge how much, and what materials are inside a certain building. They even recently collaborated on the Sustainable Material Inventory (SMI). This tool provides insight into the possible (re)use of materials released during the demolition or renovation work of a building. This shows a high level of explicit knowledge available in their business. They also have a high level of tacit knowledge due to their involvement in various circularity projects and a positive outlook on more reuse in the future (IDDS, Interview, 2023). Because of this knowledge they were asked to join the project in the first place. They did multiple large complex projects regarding circular demolition and even claims to be the frontrunner in this area (IDDS, Interview, 2023). From these previous projects they gained a lot of experience which leads towards structured processes and routines. It is important to note that they stated that every project in different in the circular demolition industry and therefore a real routine is difficult to detect (IDDS, Interview, 2023). Their experiential knowledge can be identified as the capacity of the firm to convince others to stay involved in the project by delivering them calculations. Also, they stated that “there are rules and procedures in place that have to be followed but by not always following those, the project can create greater circularity” (IDDS, Interview, 2023). This shows a high level of recognition and skill.

Cepezed works with a large team of architects, construction technologists and engineers. As they made the design for the new circularity centre of Lagemaat located in Heerde, they provided the drawings which is a form of explicit knowledge. Also, due to their earlier experiences within circular building and particularly building in an industrial, flexible, and demountable way, they have a high degree of tacit knowledge. Regarding systemised knowledge, they stated that such a project is only feasible is there is a donor-building in the picture where all the materials can be reused (Cepezed, Interview, 2023). This shows that they have knowledge on circular building and see what works and what does not in their business. With regard to experiential knowledge, they stated that they have a lot of collaborations where they overcome barriers that were made in earlier projects by creating calculations and databases that can be used by other actors (Cepezed, Interview, 2023).

Dycore was not yet before involved in circularity projects because they are producer of the hollow-core sla floors and have no initial gain from circularity. With regard of tacit knowledge, they did not have any regarding circularity but did have significant knowledge on what was inside the hollow-core slab floors and how to reuse them (Dycore, Interview, 2023). They made calculations and provided a warranty for the reuse of the floors. As they were not earlier involved in circularity projects and predominantly filled in an advisory role during the project, their tacit knowledge was low. Resulting from their participation in the case, they did start an internal project on how to make demountable connections between hollow-core slab floors (Dycore, Interview, 2023). They do so because they stated that they see a future with more reuse of their products which leads to new issues like the warranty (Dycore, Interview, 2023). Due to their minimal involvement in earlier circular projects, they have a low degree of systemised and experiential knowledge on the subject.

Finally, the Province of Gelderland, and particularly the frontrunner in within the Province are analysed to identify their range of knowledge. As the province wrote up an environmental vision for a more sustainable future, they believed that the building should be reused or be demolished in a circular manner (Provinciale Staten, 2018). This environmental vision could be seen as a form of explicit knowledge, but also systematised knowledge on circularity. The main actor at the province of Gelderland did have some prior knowledge on sustainability and circularity but his main form of knowledge regarding tacit knowledge was knowing who had to be involved in the project to create a successful outcome (Province of Gelderland, Interview, 2023). This led to asking the firms who had more practical knowledge instead of only asking universities, who would create a learning goal instead of creating a project goal. This also links to experiential knowledge, as many of the issues were solved through asking the right parties to come and have a dialogue on the barrier and come up with solutions on how to overcome them (Province of Gelderland, Interview, 2023).

Table 1. Range of knowledge identified

Range of knowledge	Explicit	Tacit	Systematised	Experiential
Lagemaat	+	+	+	+
IDDS	+	+	+	+
Cepezed	+	+	+	+
Dycore	+	-	-	-
Province of Gelderland	+/-	+/-	+	+

6.2.2. Frames of reference

Frames of reference are the sources of knowledge that define the conceptions on, in this case, circular building. In the UAV-GC demand specification there is a section included on what is deemed to be the most circular option in this case (Provincie Gelderland, Vraagspecificatie, 2021). Re-use of materials is deemed to be the most circular because refuse, rethink, and reduce are not viable options in circular mining projects. Therefore, reuse and specifically, one-on-one reuse is the frame of reference with the highest possible level of circularity.

As shown in the previous chapter, the organisations gained most of their knowledge about circular building and demolition from this or previous projects. Because none of the organisations were familiar with a total one-on-one use, they also learned throughout the process. When asking the organisations about their view on future circular reuse, most of them answered that there had to be a doner building where the materials would go because storage would be too expensive. This would be the most reasonable answer because that is what worked in this case. Additionally, the collaboration between the actors within circularity projects is also emphasised. Therefore, their conception on how to overcome issues and problems is to collaborate and have a dialogue on possible solutions. These dialogues are conceived as something positive because it created solutions during the project. Another point that is mentioned multiple times is the persuasion to just do it instead of only seeing obstacles on the road.

6.2.3. Integrating different spheres of knowledge

When the project started there was one main goal for all the participants of the tender; "create circularity by reuse of the building" (Provincie Gelderland, Vraagspecificatie, 2021). What this would look like was unknown, but this created a common frame among the stakeholders who participated in the tender process. To start with the sharing of knowledge internally. The organisations that participated stated that, what they learned from this process is shared internally with other involved project managers. One interesting mention on internal knowledge sharing was of Lagemaat (Interview, 2023), who stated that;

> "If you consider on the one hand the traditional demolition contractor who dismantles circularly and on the other a builder who wants to build circularly with second-hand materials - if you put them in a box and let them go through the plans, how are we going to do this? They would find within 15 minutes that there are 5000 obstacles on the roads and the projects will never happen. So that's why we're having this conversation internally."

Because Lagemaat already has knowledge on circular demolition and is the contractor one can assume that the process to overcome certain issues works more efficient internally, without any outside influence on the project. But this does show that the rest of the market is not ready to create such a novel project and does not have the knowledge to execute it efficiently making it easier to exclude parties who are not willing to integrate knowledge. Looking at external knowledge sharing, Lagemaat, IDDS, and the Province of Gelderland stated to give presentations about the case to share their findings with external stakeholders (IDDS, Interview, 2023; Lagemaat, Interview, 2023; Province of Gelderland, Interview, 2023). They did so through soft institutions like; magazines, newspapers, and other online sources. Subsequently they see that they can be an international example of one-on-one reuse because it was never done before at this scale.

This piqued the interest of a governmental institution, and they sought contact with the Province of Gelderland, because they wanted to copy the UAV-GC contract that was in place between the stakeholders. But, the province consequently said "Yes, but we should talk about the whole process" (Interview, 2023). Even though all the parties engaged in the case where very close knit and had a common knowledge sphere, the contract was not used during the project. This contract would therefore, according to the Province of Gelderland (Interview, 2023), not determine the integration of the different spheres.

A barrier that arose, which they had to overcome, was the influence of the knowledge spheres of other circular construction industries. Especially the lobby from the concrete crushing industry was brought up as an example (Province of Gelderland, Interview, 2023). During presentations about the project, circular concrete crushing organisations were against the one-on-one reuse of the building. They wanted to make the public doubt the project and stated that crushing the concrete would create more circularity than reusing the materials one-on-one. The actors involved in the case overcame this by making calculations on the footprint and CO_2 reduction created by the one-on-one reuse of the building (Province of Gelderland, Interview, 2023). These calculations deemed as a defence mechanism to make sure the public was not doubting the outcome of the overall project.

6.2.4. Openness to learning

How open an organisation is towards learning is identified as one of the most important elements to institutional capacity building, especially social learning (Innes & Booher, 1999). This is something that is also discussed in the previous chapters on knowledge capacity, there were many dialogues to overcome issues together. Within the UAV-GC it was stated that;

> "The parties are aware that the aim of this Work is to jointly acquire knowledge and learning experiences in the public interest and specifically in the interest of the growth towards a circular economy, and that these will be shared with third parties (e.g. knowledge institutions, sector organisations, governments, market parties) in the same interest." (Provincie Gelderland, Vraagspecificatie, 2021)

This indicated that the parties involved had the prior knowledge that the project would have an experimental nature and had to possess a certain degree of openness to learning to be willing to participate in the first place. One thing that was observed during the interviews, when the question was asked on what the organisation learned from this specific case is that they were all very enthusiastic about telling what they learned and how they will implement it in future projects. For Lagemaat their main takeaway was "-everything we imagined in our wild fantasies - can actually be done that way." (Interview, 2023). For IDDS, their main takeaway was based in combination with other projects because they stated that every circularity project requires different solutions, which calls for an openness to learning in future projects (IDDS, Interview, 2023). Cepezed also mentioned that it is important to learn something new everyday and "you have to recognise with each other that things can be more efficient. This can subsequently be implemented in following projects." (Cepezed, Interview, 2023). As for Dycore, they had an interesting position. This was the first time they were asked to join a circularity project. Because they stayed engaged in the process, it opened their opportunities to search what place their, concrete-producing, organisation would have in the future. They learned, and are currently researching, how to make demountable connections between hollow-core slab floors. They stated that they did not financially gain form collaborating in the project, but they saw it as a learning opportunity which shows a progression in openness to learning throughout the project (Dycore, Interview, 2023).

6.2.5. Concluding remarks on knowledge capacity

All forms of knowledge were prevalent in most interviewed actors. This is mainly because the organisations were chosen to join the project because they had prior knowledge on circular construction and demolition. Therefore, they had similar frames of reference where their conceptions on problems and opportunities were similar and integrated spheres of knowledge indicated by knowledge sharing. Knowledge is mostly obtained by earlier projects and dialogue with the other organisations involved in the project. The project had an experimental, knowledge-based nature meaning the parties involved wanted to learn as much as possible about the one-on-one reuse of materials, creating a high level of openness to learning.

6.3. Mobilisation capacity

In this chapter the mobilisation capacity of the organisations will be analysed. This will be divided into (1) the opportunity structure, (2) the institutional arena, (3) the repertoire of mobilisation techniques and (4) change agents (Healey et al., 2003).

6.3.1. Opportunity structures

The opportunity structures created for circular construction differs per stakeholder because it is based on their physical and institutional shaped set of actions that are seen as feasible by them (Elster, 2007). Additionally, these opportunity structures, consisting of rules, norms, and values, are examined to see

how they enable private and public actors to support and design innovative circularity projects (Boons & Spekkink, 2012). By using the opportunity structures created, the actors are able to mobilise themselves to work through the macro institutional environment.

With regard to the case, the province of Gelderland had an environmental vision for the upcoming years where they wanted to engage more in circular economy. According to the province's circular economy ambition, they want to reduce their use of primary materials by 50% by 2030. They try to achieve this by ensuring that the partners they work with are already circular and by looking for legislative barriers that could prevent circularity (Provinciale Staten, 2018). This created the opportunity structure for the main actor at the Province of Gelderland to initiate the project. This together with trust and freedom he was given by the province caused the idea for one-on-one reuse of the Prinsenhof building. Additionally, the environmental vision created opportunities for circular projects by stating that they aimed to make sure partners that they worked with are already circular and by looking for room in legislation that may obstruct circularity.

The contract in place created two main opportunity structures for the actors to create more circularity. The first one is the opportunity for alterations during the project. Within the contract and the additional annexes is the mention of; “This is done by challenging the market and offering space for innovations in the field of circularity; stimulating chain cooperation, transparent business models, uniform measurement methods for circularity, incorporating circularity into building standards and improving laws and regulations.” (Provincie Gelderland, Annex, 2021). This notion on room for deviating from the initial contract gave the actors, and specifically the contractor, the chance to create higher levels of circularity. Moreover, they were able to utilise opportunities that arose during the process instead of following the predetermined conditions in a conservative construction contract.

Because of the experimental nature of the case, the opportunity was created for the actors involved to create and share new innovations and ideas within this project to stimulate higher levels of circularity in the construction sector. The experimental nature of this case is extensively elaborated on in the demand specification. Therefore, the predetermined actors involved in this project, had to have a similar view towards creating high-quality reuse to be considered as a viable organisation to execute the project. Additionally, intrinsic motivation is needed to create circularity. Therefore, it did create an opportunity structure but the emergence of this might not be natural. On the other hand, it could be debated that, because of their prior relations and their matching knowledge and vision on circular construction, they created the opportunity structure to engage in an experimental project. An example of this experimental nature and how they used their knowledge capacity to create an opportunity structure is told by the Province of Gelderland (Interview, 2023);

> "Which was also cool, because the Building Decree is also a hoop you have to go through, isn't it? Or an institution that you have to go through. Well, there were no building code proof calculations, were there? Because we had calculations from 1984. Until an engineer said, but wait a minute. In 1984 the floors were constructed tougher, because the requirements more strict, therefore we made heavier floors back then. But now we're making slimmer floors, so those floors from the old building are actually better than new floors, aren't they? But you don't have a building decree-proof account of that yet. Following, one of those guys from Dycore said; ‘can I leave the meeting for a while?’ After half an hour, he had entered everything into their models and said; Here you go: a Building Decree proof calculation."

This shows that even though the rules were an obstruction for innovative reuse of the materials, they created an enabling environment through enough knowledge and mobilisation capacity. They did have to comply with the building decree because these are important rules made for the safety of buildings. But as shown above by having enough practical knowledge and creating an enabling environment by trying, they were able to overcome this constraint.

6.3.2. Institutional arena

The institutional arena explores how, social spaces in which relations between stakeholders are governed by accepted rules of interaction, are used, and developed by stakeholders. This also relates to how they take advantage of opportunities created in these arenas (Healey et al., 2003).

One of the social spaces originated from the room within the UAV-GC contract and environmental vision of the Province to deviate from the earlier set guidelines. This opportunity was utilised when demolishing the concrete core of the building; “so that (the concrete core) would first be just granulate with which we would make new concrete, but in the end that has been reused one on one. So that's kind of the deviation in contact that you can play with as well.” (IDDS, Interview, 2023)

Lombardi and Laybourn (2007) see workshops and technical advisers as capable of facilitating information-sharing about waste, thus creating an arena in which common interests should be seen as converging. The dialogue sessions between the actors, as stated in the UAV-GC, created a temporal and specified, institutional arena for the actors involved to create this common converging interest. Multiple interviewees also indicated that they found these dialogue sessions helpful and enabled them to create a stronger relation capacity. Moreover, there were dialogue sessions on the composition of the contract to make sure all the involved parties had the same interests and were aware of their responsibilities.

6.3.3. Repertoire of mobilisation techniques

By identifying the exact techniques used in mobilising other organisations, the momentum in the innovative case can be shown.

The main mobilisation techniques identified relate to the high levels of relational and knowledge capacity, as shown in the previous sections. The relational capacity of the involved actors is high due to previous collaborations, multiple dialogue sessions and a common, open view on collaboration. As identified by Spekkink (2015), the amount of trust reduces the perceived risk in cooperative relationships. This follows into more likeliness to share knowledge and experiences and can help actors to negotiate conflicting views on problems and solutions (Innes and Booher, 1999). This is also the case with the actors involved in the project. For the parties involved that were doubting the process, other techniques were used like; persuasion in dialogue and using data to support their claims;

> “So, then you look at, how can I trigger something in my customer? Because if I make sure that a client chooses to construct a building with secondary material, then we are going to generate embodied CO_2 numbers” (Lagemaat, Interview, 2023) “But especially convincing those people because they actually find the process scary - That’s really a part of it” (IDDS, Interview, 2023) “Well, also to have a real impact on that transition. So, what is needed in that transition?" (Province of Gelderland, Interview, 2023).

By creating open dialogue other actors can be mobilised to create more circularity. The trust can then go through the whole chain. There were no financial incentives in place for this project to join, most of the actors joined because of intrinsic motivation and to learn something from the experiment. Therefore, the actors that decided to partake in the tender, were aware of the knowledge-based nature of the project. Because most of the organisations, as identified before in the chapter on relational capacity, were already involved in circularity, it was not difficult to mobilise them to create circularity within the construction project. Therefore, they have a greater gain in encouraging others to pursue similar circularity goals, as shown by Healey et al. (2003).

Additionally, due to their high relational capacity, there was an easier transmission of knowledge and experience and even knowledge inclusion where there is a mutual recognition of each other’s problems and solutions. An example of this is the involvement and relations with actors that had less knowledge on circular construction like Dycore. They would not gain from more circularity because they are a

producing organisation. But, as mentioned earlier, this project was a learning process for them, that lead to wanting to engage more in circularity projects in the future. Currently, they are working on demountable connections between the hollow-core slab floors which shows they do take advantage of the opportunity structure provided by the knowledge gained by participating in this case and the persuasion of other actors to stay involved in the case (Dycore, Interview, 2023).

One interesting notion is that the financial structure behind the whole project was not brought up during the interviews. According to Chertow (2007), the desire for economic benefits is the main reason for development of circular practices. Additionally, financial incentives can be seen as the core driver in resource exchange (Gibbs & Deutz, 2007). It was stated that money should not be the guiding principle in creating circularity in the construction sector contradicting the literature. This viewpoint can be supported by assuming that the involvement in learning projects, like this case, is only to gain knowledge on how to make more profit in the circular construction chain. Following, it can be debated if this is a good or a bad thing. When organisations can make a business case from circular construction, it could be implemented more and change the overall construction chain but on the other hand it can be debated if this is the right reason to join such a project. As stressed in the research of Abreu & Ceglia (2018), the circular economy requires the adopting of new business models. Overall, it is unknown what the exact financial structure of the project looked like.

6.3.4. Change agents

Change agents have a key role in initiating and managing governance innovations and overcoming obstacles by facilitating and directing the networks' various actors' cooperative processes.

Within this case the main change agent identified for implementation circular construction is the Province of Gelderland. This is also because it is stated in the UAV-GC that; "The client wishes to play a role as a catalyst and quartermaster in the transition to a circular economy". The province aims to do so "by challenging the market and offering a space for innovations in the field of circularity" (Provincie Gelderland, Vraagspecificatie, 2021). Furthermore, multiple organisations stated that the main actor of the province of Gelderland really took the lead in the whole project. He was the pioneer that did it from an intrinsic viewpoint and was able to foster cooperation within the network of the project (Dycore, Interview, 2023; Lagemaat, Interview, 2023). As seen in literature, local governments do have the power to move past mobilisation obstacles according to Södergren & Palm (2021). They were the ones to start the project creating an enabling environment for the parties involved to let the market create a feasible circular construction project. Additionally, Spekkink (2015), found that a committed actor is a necessary condition for implementing shared vision.

IDDS took a lead in delivering and checking the technical input as technical consulting firm, making them also a change agent (IDDS, Interview, 2023). By delivering valuable technical input, obstacles could be overcome. Also, IDDS indicated to work together with a club of partners in the chain to create a new tool called the Sustainable Material Inventory (SMI). They saw that in the case of Prinsenhof this analysis was not sufficient, so they decide to collaborate with other parties to overcome this issue and create a tool for the whole chain to overcome this issue in other circularity building projects (IDDS, Interview, 2023).

6.3.5. Concluding remarks on mobilisation capacity

Overall, there is a strong mobilisation capacity of and between the actors involved in the project to motivate each other to create more circularity. There are predetermined opportunity structures in place like the environmental vision of the province and the overall UAV-GC contract that made sure all the visions of the participants were aligned. The experimental vision that arose from these documents also created opportunities to create a niche project. The dialogue sessions provided are seen as the most important institutional arenas. These dialogue sessions strengthen the relational and knowledge capacities which created the main mobilisation techniques at play. The main change agent identified is the main actor who initiated the project at the Province of Gelderland.

6.4. Interplay of the dimensions

The results show an overall high level of institutional capacity of actors to create circular construction. As stated by Boons & Spekkink (2012), the focus lies on the interaction between the capacities to analyse overall institutional capacity of actors to create circularity.

The relational capacity of the actors related to the project is high due to their earlier relationships and high levels of trust as confirmed by the study of Boons & Spekkink (2012). Communication between all parties is shown to be informal, transparent, and based on mutual understanding and trust revealing their ability to overcome self-interest which is a fundamental element required for successful relational capacity (Södergren & Palm, 2021). The openness and transparency are elements that also stated in the UAV-GC contract, so it is difficult to distinguish whether the parties were preselected on the criteria to be open and transparent or if this arose because of other factors. Despite this, Boons & Spekkink (2012), found that the presence of a formal document is essential because the absence of this could lead to vague responsibilities.

High levels of knowledge capacity can lead to profitable transactions that are not merely based on resource exchange and expand their opportunities (Boons & Spekkink, 2012). In the contract, there was the mention of openness to learning and creating knowledge from the experiences during the execution of the project creating a prerequisite for knowledge on circular construction to be engaged in the project. Such a knowledge-based strategy can create a connection between actors and lead to a more sustainable and productive cooperation (Malone & Yohe, 2002), further improving the relational capacity as well. Overall, the organisations engaged had a high level of knowledge capacity and all of them had openness to learning which is the condition needed for implementing circular innovations (Boons & Spekkink, 2012; Innes & Booher, 1999).

High levels of relational and knowledge capacity can lead to strong mobilisation capacity (Boons & Spekkink, 2012). Mobilisation capacity requires active participation of relevant actors to work through the macro institutional environment of rules norms and values (Trang et al., 2023). As shown in the results on mobilisation capacity, there were three main opportunity structures in place that helped the actors to overcome barriers placed by the macro institutional environment. The actors were able to work through this environment because of their high levels of relational and knowledge capacity. Additionally, the main change agents in this case, created a main vision throughout the whole project that made it possible to implement shared visions leading to successful implementation of circularity (Spekkink, 2015). The direct influence of the macro institutional environment on the implementation of circular innovation was limited because of the high overall level of institutional capacity. The actors were able to mobilise each other, due to high levels of relational and knowledge capacity, and use opportunity structures to overcome the barriers created by the macro institutional environment.

6.5. Influence of the institutional capacity on the institutional environment

One of the research questions was aimed at analysing the influence of the meso level institutional capacity on the macro institutional environment. According to Boons & Spekkink (2012), high levels of mobilisation capacity could lead to influences on polies, regulations and attract external resources needed to realise exchanges. The interviewees were asked questions about their influence on the macro institutional level, but their responses were less focused on what they did during the project and more about the overall changes the construction sector had to go through. Therefore, the analysis on the influence of the institutional capacity of actors to create circularity on the level of the macro institutional environment was limited. The only identified influence was with regard to the sharing of knowledge with external governmental bodies during and after the project, indicated with the dotted arrow in figure 8.

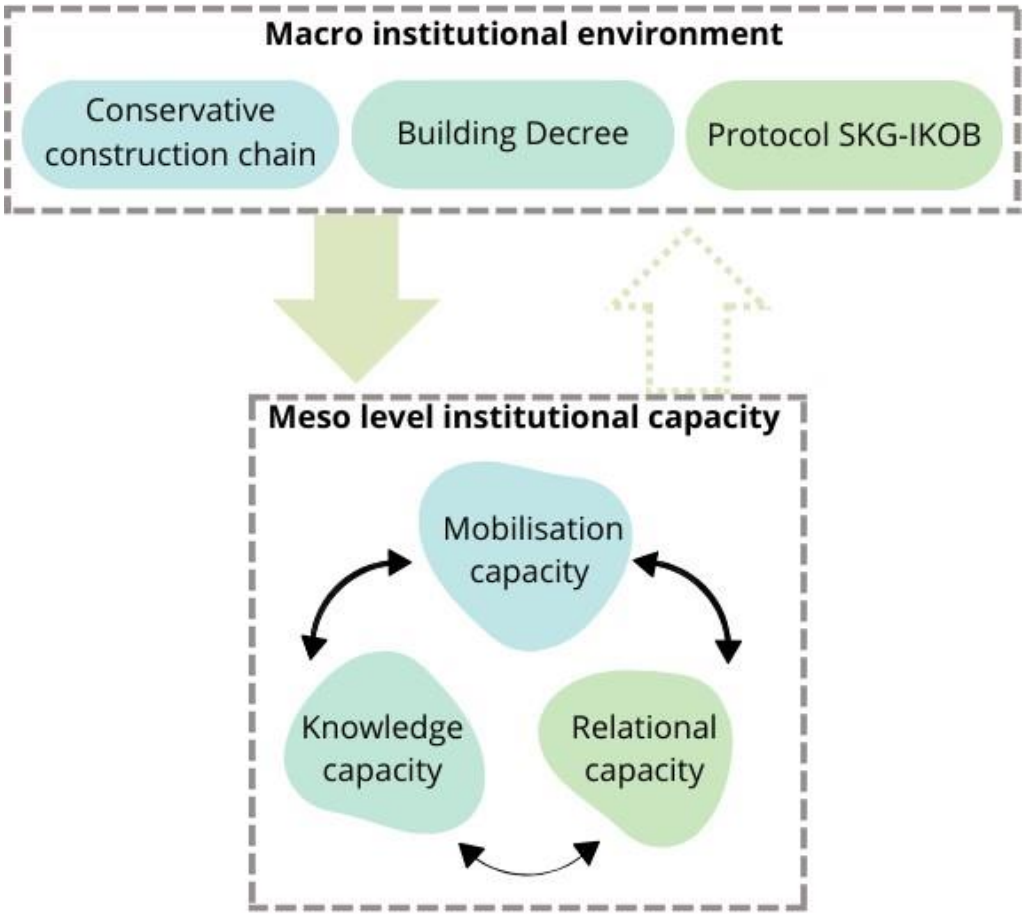

Figure 8. Results on the interplay between the macro institutional environment and the meso institutional capacities

7. Discussion

The aim of this research was to explore the influence of the macro institutional environment on the institutional capacity of the actors involved in the innovative 'Prinsenhof' case regarding the encouragement of circular building strategies. Semi-structured interviews and an analysis of the macro institutional environment at play provided insights in how the actors were able to work through the environment and implement a circular building strategy successfully. This chapter outlines the study's theoretical implications, research limitations, and recommendations for further research.

7.1. Overall findings

This study has shown that rules, norms and values that the macro institutional environment consist of had an influence on the meso level institutional capacity. The actors were able to work through the macro institutional environment because of their level of institutional capacity. In this case three main macro institutional conditions were identified that enabled the actors to work through the macro level institutional environment; the UAV-GC contract, the involvement of key actors, and the experimental nature of the project.

7.1.1. The UAV-GC contract

The most important macro institution that enabled the project to have a successful outcome was the presence of the UAV-GC contract. The meso institutional capacity analysis showed a high power to act because of the structuring forces the UAV-GC contract created. As suggested by Haas et al. (2015), the development of the circular economy could be greatly advanced because the formal existence of a structure for the recycling, remanufacturing and reusing of products. Because this is a novel case, there were no formal structures in place on one-on-one reuse before this project besides the hollow-core slab floor protocol which was deemed unusable. This could indicate a mismatch between the current macro institutional environment and the meso level actors who want to implement circular innovations. This mismatch was also found in literature on urban symbiosis where the aim of urban symbiosis does often not comply with the conventional policy framework (Hemmes, 2009) and that regulations can be seen as a complicating factor in the process (Mirata, 2004). The actors in this case were able to overcome these complicating factors because they created their own structure in the UAV-GC contract.

Within this contract, predetermined characteristics about communication were stated that actors had to posses that showed to be of great significance to ensure the successful outcome of the project. This study found that the communication between all parties was informal, transparent, and based on mutual understanding and trust. These characteristics ensured the integration between the actors and build a strong relational capacity. In the study of Boons & Spekkink (2012), the availability of a master plan stating their ambitions is one of the indicators of relational capacity. Further literature shows that formal contracts on the one hand can create clarity on the designation of responsibilities (Boons & Spekkink, 2012), but on the other hand informal relationships are deemed stronger than formal ones (Södergren & Palm, 2021). This study showed that because of the contract in place, the actors involved could overcome both issues. Because the UAV-GC contract stated guidelines on communication, it created a certain openness between the actors. This, in addition to the pre-planned dialogue sessions and former collaborations with each other, strengthened their informal relationships during the execution of the project. It should be noted that the actors stated that the contract was not used again during the execution of the project. It could be argued that, because of the extensive pre-selection of the actors involved, a relationship based on knowledge inclusion has emerged. This inclusion overcomes a barrier, found by Isaksson & Hagbert (2020), who emphasise that difficulties within interpersonal relationships can arise because of differences in how they view collaboration, whether it be formal or informal. The strong integration created a close-knit network within the broad morphology, of the actors directly involved in the case. Abreu & Ceglia (2018), discuss that a broad morphology can promote further circularity because it creates stronger integration, thus broadening the exchange of information and materials.

The actors within the project showed that their integration indeed increased the exchange of information and helped to build their overall knowledge capacity. The UAV-GC may have influenced this because the aim of the project was also to create and share new knowledge as it was an innovative project. Even though the contract was in place, the actors involved showed to have a wide range of knowledge towards circular construction strategies. The range of knowledge is also quantified in the study by Boons & Spekkink (2012), as the number of feasibility studies performed. These relate the required calculations that made sure the new development was Building Decree proof. Following, the frames of references are the sources of knowledge that define the conceptions on, in this case, circular construction. In the UAV-GC demand specification there is a section included on what is most circular outcome which is the one-on-one re-use of materials. This is the case because refuse, rethink, and reduce are not viable options in circular mining projects. Because this was pre-determined in the contract it could be argued that there was a common frame of reference for the involved parties to aim towards one-on-one reuse. The integration of the different spheres of knowledge was done by many dialogue sessions that were included in the UAV-GC. This confirms former studies like the one by Lombardi & Layborn (2012), who see workshops and dialogue sessions as a vital arena for engaging companies. Additionally, Wang et al. (2017), found that periodical, project related events also helped to establish their common goal.

To establish common goals and realise change, actors have to build mobilisation capacity. Within this capacity the environmental vision of the province created a strong opportunity structure to mobilise the actors to implement a circular construction strategy. Because this environmental vision was already in place, it created more room for the actors to implement the strategy independently from existing institutional structures. These opportunity structures are defined as an infrastructure where formal structures can provide opportunities for interaction (Valentine, 2016), like in this case the UAV-GC that created the dialogue sessions. This is in line with the study of Lombardi and Laybourn (2007), who see workshops and technical advisers as capable of facilitating information-sharing about waste, thus creating an arena in which common interests should be seen as converging. Following, this study found that the main institutional arena were these dialogue sessions between the actors. These dialogue sessions, that created openness between the actors, also showed to be a mobilisation technique that was used to develop and sustain momentum. This follows Velenturf & Jensen (2016) who found that a pro-active attitude, flexibility and openness are critical factors to organising and establishing relationships and ensure mobilisation of the actors. One interesting find in this study is the absence of any information on financial incentives. Even though many other studies stress the importance of financial instruments (Spekkink, 2013; Valentine, 2016; Mortensen & Kørnøv, 2019), during the interviews the financial structure of the project was not mentioned. When such a financial structure is in place, it can increase the possibility in forming symbiotic relationships in early awareness phases but also in later organising phases (Mortensen & Kørnøv, 2019).

Concluding, the guidelines and policies at play created the main enabling environment. By creating an experimental case with learning opportunities for the actors involved, with the UAV-GC as a foundation, the tender attracted parties involved in circular construction. The UAV-GC created a new structure that was able to overcome the mismatch with the conventional guidelines and policies within the construction sector. Within this structure the main elements that were important were the pre-planned dialogue sessions and the predetermined characteristic as they created strong relational, knowledge and mobilisation capacities. The implementation of the contract ensured that the constraining influences of institutions are less apparent and there is more room for innovation within the project. Following, the constraining factors of legislation and policy were overcome by high degree of relational and knowledge capacity which even led to some degree of knowledge inclusion.

7.1.2. Involvement of key actors

The following condition that was found was the involvement of key actors that made the project successful. One find was the overall low involvement of macro institutional organisations on an national level. National governmental bodies had to step out of the project because they have to adhere to stricter policies and guidelines. Therefore, it could be argued that, if they would have been involved, this could have obstructed the successful outcome of the project. No literature could be found that substantiated these possible barriers that the involvement of governmental bodies could have had. It can be debated if the province of Gelderland can be seen as a macro institutional organisation because it was also the client who executed the project. The literature review by Mortensen & Kørnøv (2019), showed that public bodies is one of the most cited actor categories that is important for the emergence of symbiotic linkages. The role that the province had in this project follows the outcomes of Valentine (2016), who states that public bodies can be seen as those who seed the innovation process by providing support, access to knowledge and promote symbiotic thinking among other actors. This emphasises the importance of the province in the relational and knowledge capacity building.

Further evaluating the relational resources, this study shows a network that involved connections with external actors like governmental and knowledge institutes. As found by (Wang et al., 2017), relational links across organisational divisions and levels of governance can increase the institutional capacity of actors. Additionally, the involvement of local governments is key to create a symbiotic relationship between involved actors (Boons et al., 2011; Trang et al., 2023). But it should be noted that the main relational link across levels of governance was because of the involvement of the province as the client, while other literature focusses on the local government being a facilitator (Södergren & Palm, 2021). Therefore, it could be discussed that the involvement of the local government, as a client and facilitator, is one of the key aspects which made it possible to implement the one-on-one reuse successfully. One find in the range of actors involved was the lack of research and education institutions included. According to the study of Mortensen & Kørnøv (2019), consultancy companies can overtake this researching role and be important with regard to modelling and calculations. The importance of consulting companies is in line with the findings of this study where the consulting companies had an important role creating the required technical calculations needed for renewing warranty of the reused materials. Because the involved actors were chosen partly on their prior knowledge on circular building, they had the knowledge capacity to create these needed calculations. Furthermore, due to their prior external relations with macro institutional bodies and knowledge on circular construction they were able to share the acquired knowledge from the project externally.

The importance of involving companies is also discussed by Farel et al. (2016). They argue that businesses can become a leading and influential actor for the symbiosis by engaging themselves in coordination activities and therefore become so-called “champions” as described by Hewes & Lyons (2008). Within this study IDDS can be seen as an external consulting firm who engaged themselves in the coordination activities of the project. But, the main change-agent found is this study was the province of Gelderland. Within this study, the province of Gelderland is seen as an institution but it should be noted that there was one main enabler that created the project. He could be seen as the key change-agent in this project because he possessed many characteristics that are deemed important like a high degree of personal enthusiasm and expertise in coordinating business networks as identified by Wang et al. (2017). This also emphasises the importance of taking the micro institutional environment into account when analysing the overall institutional environment as done by Willems & Baumert (2003). It could be argued that because of the high intrinsic, micro level motivation to create a circular construction strategy, the project was able to have a successful outcome. This is also argued by Spekkink (2015) who stated that a committed actor is needed to see the vision through and implement a shared vision amongst the involved actors.

Overall, by not collaborating with macro institutional bodies (except the Province of Gelderland), they were able to avoid legislative issues that national governmental bodies are bound to create an innovative niche. The lack of educational actors involved was overcome by the key role the consulting companies had in creating the required calculations. These companies also engaged in coordination activities making them facilitators as well as executioners of the project. The main change-agent identified was the so-called 'frontrunner' at the province of Gelderland who was able to create the project and mobilise the actors to implement the circular construction strategy successfully.

7.1.3. The experimental nature of the project

As stated before, the presence of the contract in combination with the key actors involved or absent in the project, made the actors able to execute the project from a niche of the sector. Because of this, the project was experimental in nature and required the actors to be involved to have a high level of knowledge capacity to successfully execute the project. This niche in combination with the UAV-GC contract created some internalisation of the macro institutional environment in the meso level actors. It could be argued that the niche served as a parallel space next to the conservative construction chain explaining the ability to work through the macro institutional environment. Therefore, the experimental nature of the project is found to be an important institutional condition that made the implementation of the circular construction strategy successful.

One found barrier in the construction chain is the high investment costs to embrace new technologies like circular construction. The study by Leermakers et al. (2019), showed that reuse is in many circumstances not cost efficiently and proposes that the government should focus more on pricing reused materials competitively compared to raw materials to encourage circularity. The experimental case analysed in this study showed that the reuse is possible and they were able to create circularity. This was also because the actors involved build a strong relational capacity and possessed important characteristics like are a pro-active attitude, flexibility, motivation and willingness to open up for new relations (Mortensen & Kørnøv, 2019). This is opposite to the elements found in the conservative construction chain like a fixed tender, one contractor delegating tasks and a focus on making profit.

The project had an experimental, knowledge-based nature meaning the parties involved wanted to learn as much as possible about the one-on-one reuse of materials, showing a high level of openness to learning. As found by Abreu & Ceglia (2018), circular economy is an exercise in knowledge creation and application involving a joint effort in social learning, rather than being just a venue in which to facilitate deliberation and negotiation. This study shows that there is a high level of knowledge creation resulting from their openness to learning and there was social learning through all the dialogue sessions. Following, the actors involved had a broad range of knowledge because not only actors with a broad range of knowledge on circular construction were involved but also a conventional production business. A broad range of knowledge can ensure development and change through the entire supply chain (Moreno et al., 2014). Following Ceglia et al. (2017), a high level of trust, combined with a broad cognitive domain regarding circularity, is allowing firms to come to agreements regarding waste exchange initiatives.

The experimental nature of the project is, next to the contract and involvement of key actors also seen as an opportunity structure. The experimental niche, and not following protocols and rules in place, enabled the market to create an innovative solution to the problem on how to demolish in a circular way. The need for a more experimental nature in the interactions between involved actors is stressed by Mortensen & Kørnøv (2019), to ensure a successful symbiotic outcome.

Concluding, this case shows divergence from the conventional construction sector because of its experimental nature. The main elements are; many adjustments during the process instead of a fixed tender, lots of advice and open dialogue about the processes instead of one contractor delegating tasks and a common circularity goal with a learning objective instead of creating as much profit as possible. Also, this study showed that the norms and values of the construction sector work obstructive and even though the actors involved were able to portray the needed characteristics, they were unable to change this conservative nature of the construction chain.

7.1.4. Interplay of the capacities

The importance of interplay between the capacities is also supported by the outcome of this case. Multiple authors stress the importance of mobilisation capacity to be present in the network to ensure change or implementation of innovations (Boons & Spekkink, 2012; Trang, 2024). The possibility of mobilisation capacity to arise depends on the presence of the other capacities, relational and knowledge and it is argued there is a constant interaction between these capacities (Trang, 2024).

First, the presence of relational capacity can improve the selection of key actors that can enhance the mobilisation capacity. This is in line with Boons & Spekkink (2012), who stress that there is a need for mobilisation of relationships for symbiotic linkages to occur and Trang (2024), who shows that a characteristic of dynamic interplay is the tendency for relational capacity to catalyse knowledge and mobilisation capacity which can create relations needed for industrial symbiosis. Furthermore, in this case the relational capacity was high due to a high level of trust and open communication, there were actors that stepped up during the process and showed initiative to overcome issues. Also, new actors were brought in by the network to overcome issues, like Dycore. Therefore, relational capacity is an important factor in the implementation of circular building initiatives.

Second, the mobilisation capacity is also dependent on the knowledge capacity of the actors. However, it can be argued if increased knowledge leads to action. This case has shown that when new information became available and knowledge was shared, new possibilities opened up. One example of this is the demolition and reuse of the concrete core of the building. On the other hand, this could be because of the strong mobilisation capacity that was already present and therefore led to increased knowledge capacity.

Third, mobilisation capacity was stressed by the interviewees to be very important. They explained that they were able to execute the project because they had the opportunity to do so. They showed a high level of initiative and did not need support by higher governmental bodies to ensure successful implementation. The study by Valentine (2016), follows this by stating that actors' agency in the form of willingness to invest in new knowledge and relationships is necessary for institutional capacity to arise. Additionally, a committed actor was present who was able to implement shared visions (Spekkink, 2015). To conclude, the knowledge and relational capacity supported the mobilisation capacity in this case and mobilisation capacity is therefore important to consider when analysing institutional capacity.

7.1.5. Influence on the macro institutional environment

The final research question was aimed at researching the influence of the meso institutional capacities on the macro institutional environment. The only found influence was with regard to the knowledge sharing. Multiple actors had connections as advisor with governmental bodies and were able to share their knowledge with the broader institutional environment.

The lack of influence on the macro institutional environment might be due to the niche the project originated from. This niche resulted in a project that operated parallel to the overall construction chain where the indicated barriers to implement urban symbiosis were not present. For instance, the technological barrier of matching supply and demand was overcome by creating a tender before the start of the project. The niche and experimental nature of the project lowered the investment costs for actors to be involved and embrace this new technology. And, the actors were preselected on having similar business models aiming towards new circular strategies creating an integration beforehand. These aspects created a successful implementation of the circular construction strategy but limited the influence of the project on the wider macro institutional environment.

According to Trang (2024), influence on the macro environmental institutions could emerge through dynamic pathways where institutional capacity at the meso level can influence the institutions at macro level. The proposed dynamic institutional capacity model shows how institutional capacities and institutions continuously interact in multiple directions across macro, meso and micro levels. They imply that these interactions can lead to new relations, opportunity sets and positive or negative reinforcement. In the proposition of what a positively reinforcing pathway might look like, Trang touched upon the influence of the micro and meso levels on the macro level. There they implied that, for instance, improved knowledge and collaborations with key actors provide opportunities for accessing knowledge support needed to implement innovations. Additionally, enhanced institutional capacities cannot only enable more effective implementation but also enable actors to shape the rules and norms at a higher level. If these feedbacks are made possible, higher-level institutions can focus more on providing support to develop institutional capacity and reinforce systemic change. Although this study provided a successful case with high levels of institutional capacity, there was no influence on the macro institutional environment like described by Trang (2024). This could be because of the niche and experimental characteristic of this case and therefore the lack of reinforcing rules and macro level actors involved in the project. Contrary, research by Geels (2002), focusses on how these niche innovations can influence the wider socio-technical landscape. Recommendations for further research are therefore to look into how the meso institutional capacity can influence the wider macro institutional environment through niche innovations and projects in the construction sector.

8. Conclusion

In this final chapter, the overall conclusions are presented. First, the conclusions of the interplay between macro institutional environment and the meso institutional capacity of the analysed case "Prinsenhof" are presented. This is followed by the current barriers for implementing urban symbiosis and how the conclusions of this study are linked to these barriers. After this, the limitations and ideas for future research are presented. This chapter will conclude with some reflections on the conservative construction chain and recommendations.

8.1. Summary of the main findings

This research addressed the question: *How does the interplay between macro institutional environment and meso institutional capacity of actors in the circular construction sector shape the implementation of urban symbiosis in the case of Prinsenhof?* This was theoretically relevant because there is an increasing need for more circularity within the construction sector because of the negative environmental impacts this sector has. More and more legislation and policies aim to work towards a more circular construction sector but how actors work together to work through the influence of this wider macro institutional environment is still unknown. Therefore, in order to answer this question, the conceptual framework of institutional capacity was used consisting of the macro institutional environment, relational, knowledge, and mobilisation capacity. These dimensions included a number of components that served as indicators to investigate the actors' institutional capacity to apply circular construction practices in the Prinsenhof case. With this conceptual framework the interaction of the macro institutional environment and the meso level institutional capacity has been analysed. Findings on this interaction with regard to the chosen best practice provides insights into the wider implementation of urban symbiosis in the Netherlands. With regard to the chosen case, one can conclude that the project was a unique, best practice case where innovative circular construction was successfully implemented. Because the project originated from a niche in the organisation, they were successful in their implementation. After the interviews, multiple documents arose that are important to consider when analysing the macro institutional environment.

The results of the institutional capacity analysis have shown that the macro institutional environment had influence on the meso level capacity of the actors. Because they acquired high levels of relational, knowledge and mobilisation capacity they were able to work through the barriers that resulted from this macro environment. These high levels of the capacities arose partly because of the presence of a formal document that encompassed the relational and knowledge capacities expected of the actors before executing the project. Even though it is debated whether their capacities arose because of this document, the analysis also showed other factors at play that enforced their capacities. Some of the actors had previous relationships with each other and their communication was shown to be informal, transparent and based on mutual understanding and trust which fosters relational capacity. All forms of knowledge were prevalent in the interviews. They showed to have similar frames of reference and integrated spheres of knowledge with regard to circular construction strategies. There was a strong facilitator, or change-agent, present which fostered the mobilisation capacity of the actors. This resulted in motivation to overcome barriers and be engaged in the process of the project. Additionally, the opportunity structures in place provided a strong foundation for the project and made the implementation successful. These opportunity structures arose from the EU and national environmental policies on lowering the CO_2 emissions. These led to the environmental vision of the province which created the possibility to execute the project. Following, the contract created an experimental project where the actors were able to create the highest possible form of circularity, reuse. The initial aim was also to research if through strong meso level institutional capacity there could be an influence on the macro level institutional environment. The research was not able to find any results on this despite the successful implementation of the circular construction.

8.2. Barriers to implement urban symbiosis

The findings showed that there are possibilities to implement urban symbiosis in the Dutch construction sector. Within this study the influence of the macro institutional environment was limited because of the niche the project was executed from and the high levels of meso institutional capacity of the actors to create a circular construction strategy. This niche created the opportunity to work through the conventional policy frameworks which often mismatch with circular initiatives. This mismatch can be seen as a barrier to implement urban symbiosis on a regulatory level.

Another proposed barrier for urban symbiosis is connecting the interests of all parties involved because circularity is frequently not the primary business of the involved actors. But, by choosing key actors that show a high degree of openness to learning, have previous knowledge on circular construction and have the ability to motivate and persuade other actors to implement circular construction strategies, more successful circularity projects can be executed in the Netherlands.

Also, the environmental vision of provinces can create room for niche projects executed by local actors. The presence of the contract made sure the actors involved where preselected on the criteria that they had previous knowledge on circular contraction and were aware of the experimental nature of the project. Normally, the individuals in the construction chain are often hesitant to embrace new technologies and aim to minimise risks because of the high investment costs. But, this study has shown that because of the presence of the contract and the preselection of the involved actors, individuals or organisations were chosen who wanted to embrace this experiment. This led to more knowledge sharing, dialogue sessions and openness to learning in comparison to conservative construction projects.

8.3. Limitations and future research

Because of time limitations, this study was not able to further look in-depth into the influence of the meso level institutional capacity on the macro institutional environment. The research by Trang (2024), proposes there might be an influence on the macro institutional environment through a dynamic institutional capacity framework. As also proposed in their research, the exact influence and positive reinforcing pathways could be explored further to identify the opportunities and barriers leading towards circular innovations and systemic change.

The methodological limitations arise within the conducted interviews. The interview questions used were based on earlier research where there was more emphasis on the regulatory framework at play. Therefore, one aspect that was overlooked during the interviews was the focus on the financial aspect of the project and therefore no data was available. In further research more emphasis on the financial aspect could be taken into account.

During the interviewing process, many of the interviewees focussed on the successful implementation of the one-on-one reuse. When asking about learning possibilities some of the barriers were brought to light but overall, all the actors were extremely positive about the project. The researcher tried to triangulate the outcomes with some of the acquired documents and literature to overcome biases. To ensure internal validity the answers of the interviewees were matched to see if they showed any discrepancies.

The external validity can be debated because conclusions will be made on one “best-practice” case. Therefore, it might be difficult to generate conclusions that are fit for the overall Dutch construction sector. But the outcomes can be theoretically generalised to give conclusions on what would be possible for the Dutch construction sector. More best-practice cases, cases that originated from a niche or cases that show an experimental nature, should be analysed in future research to see if these cases can influence the conservative construction sector.

8.4. Reflections on the construction sector and recommendations

This research provided answers on the interplay between meso level institutional capacity and the macro level institutional environment. With the increasing need for more circularity within the construction sector because of the negative environmental impacts this sector has, this study gives some recommendations based on the results to further implement circularity in the construction sector.

The main barrier proposed for the implementation of urban symbiosis is the gap between the supply and demand of demolition projects that can supply the material needs of new development. The supply of to-be demolished buildings are still insufficiently facilitated by good demolition agreements. Therefore, there should be more projects that are facilitated through demolition contracts like in the case of this study. A contract in place creates more flexibility and room to achieve higher levels of circularity. Additionally, when more projects are executed with predetermined contracts, there are better agreements available in the circular construction sector further enhancing the circular construction possibilities. With regard to the demand side, there is a lack of new development projects that ask for circular construction strategies. These can be stimulated through various strategies.

First, the local governments have the possibility to implement EU and national level legislation on a more local level, which increases the successful implementation of circularity projects. Therefore, provinces should be more open towards creating experimental projects to increase knowledge on circular construction in the overall sector. From a top-down perspective, governments can put more emphasis on stricter MPG requirements, CO_2 pricing and mandatory percentages of reuse when creating new development. This will stimulate local governments but also market parties to implement more circularity.

Second, there should be more focus on involving market participants in the implementation instead of solely focussing on theoretical ideas. Market participants have more practical knowledge how to overcome certain barriers in comparison to institutions that steer more towards efficiency and risk mitigation. Therefore it is important to chose the right actors that aim towards a common goal of circularity. Additionally, it is important that these actors are able to attract and motivate conventional construction actors to enhance their knowledge on the implementation of circular construction practices. From a bottom-up perspective, this can lead to more clients willing to become frontrunners in the construction sector with regard to circularity strategies.

Third, the power to mobilise other actors a local government has, can be transferred to market parties making them a mobilising actor. This can connect more parties within the overall construction chain and create more openness to learning and knowledge sharing. It should be taken into account that there are risks associated with transferring this power to market parties because they are mostly focussed on efficiency and profit maximisation. Therefore, the local governments should monitor these projects. But, with more mobilising actors, a circularity project has a higher chance to create a successful implementation. This goes hand in hand with an overall mindset change in the conservative construction chain. There should be more emphasis on; creating room for adjustments during the process instead of a fixed tender, lots openness to learning and open dialogue about the processes instead of one contractor delegating tasks and a common circularity goal with a learning objective instead of creating as much profit as possible.

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10. Appendices

Appendix 1. Interview guide

Theme	*Question*
Introduction	
• Can I record this interview? • Introduce myself + topic • Can you introduce yourself? So which organisation and function in organisation plus background • How are you related to the case? What was your role?	
Macro institutional environment	
(1) participating in decision-making and implementation (2) complying with governmental policies (3) actively engaging in individual or collaborative problem solving and innovation	What triggered the participation in this circular construction project? (1) To what extent were you involved in the decision-making process of the project? (1) Did you follow the policies that are in place surrounding circular construction? (2) In what ways did the policies in place surrounding circular construction, influence the project? (2) What were problems you came across? – How did you solve them? Were you actively engaged in the problem solving or were there other parties involved? (3)
Knowledge capacity	
(1) the range of knowledge (2) frames of reference (3) integrating different spheres of policy development (4) openness within the learning process.	Were you/your organisation involved in previous circular projects? If so, what did you/your organisation learn from them? (experimental) (1) Does your organisation have further knowledge about circular construction? Or other technological innovations that promote efficient material reuse? (1) Do you think your organisation's knowledge is sufficient? (explicit) (1) What knowledge is missing regarding these technologies? (1) How is this knowledge integrated into what your organisation does? Do you have guidelines for these technologies/developments? (systematic) (1) What is your opinion on circular construction? (1) What do you personally think of these kinds of developments/technological innovations? (implicit) (1) How is knowledge acquired on the subject of technological innovations that promote circular construction? (2) Where do you obtain this knowledge? (2) How is knowledge exchanged within your organisation? (3) To what extent does your organisation organise workshops or training to promote knowledge on this subject? (3) How does your organisation remain open to new ideas? (4) How does your organisation learn from its mistakes? (4) How is new knowledge integrated/exchanged within your organisation? (4)

Relational capacity	
(1) range of stakeholders (2) morphology (3) integration (4) the power to act	Which organisations/companies/institutions are involved? (1) Are there any parties missing in the network? (1) Can you describe the relationship between your organisation and (to be specified) other involved parties? (2) *For each relationship: (3)* How often do you communicate? To what extent is there mutual trust in this relationship? To what extent are stakeholders in these relationships considered equals? Which organisations dominate in this relationship? To what extent is this relationship integrated into legislation? Which organisations have the power to act? And how do they act? (4)
Mobilisation capacity	
(1) the opportunity structure (2) the institutional arena (3) the repertoire of mobilisation techniques (4) change agents.	What is the role of your organisation in promoting circular construction? Do they want to promote circularity? (1) To what extent can the organisation currently take action to promote/initiate circular construction? How? (2) If not: to what extent can the organisation take action on its own? To what extent is the organisation currently mobilising other stakeholders or organisations to promote circular construction? How? Regulatory framework/communication? (3) To what extent can the organisation mobilise others? (3) Regarding circular construction, who are the key stakeholders/organisations for mobilising other stakeholders/organisations? How do they do this/should they do this? (4)
Conclusion	
• Do you feel any information is missing, or would you like to add something? • Thank you very much for your time, I really appreciated it. • Can we use your name in our theses? Can we use the name of your organisation in our theses? • Would you be interested in receiving the theses when we are finished? • Would you know any people that we could interview that are involved in the project? (give overview of the already interviewed actors)	

Appendix 2. Interviewees related to the case

#	Company	Position	Date
1	Lagemaat	Circularity Program Manager	18-9-2023
2	IDDS	Director/Owner IDDS Construction and Demolition Management	26-9-2023
3	Cepezed	Director/Owner Cepezed projects b.v.	6-10-2023
4	Dycore	Account manager	6-10-2023
5	Dycore	Sustainability manager	6-10-2023
6	Provincie Gelderland	Manager transition projects	13-10-2023
7	Sloopcheck	Founder	6-10-2023

Appendix 3. Flowchart hollow-core slab floor reuse protocol SKG-IKOB