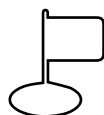
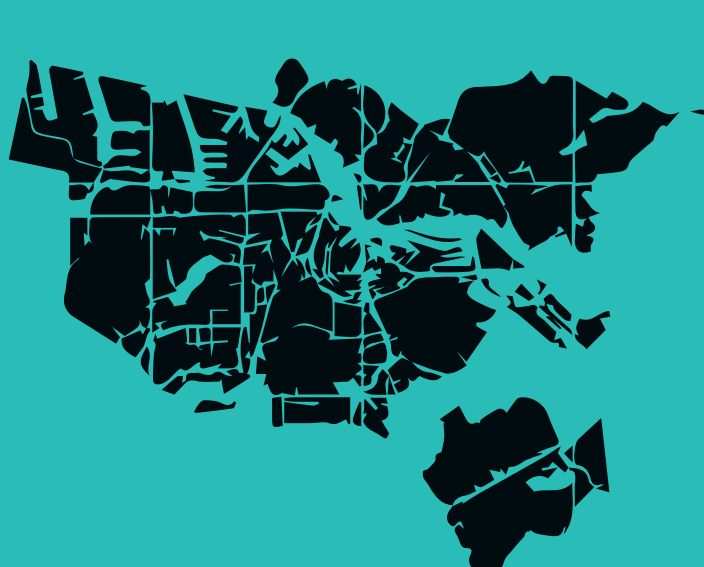
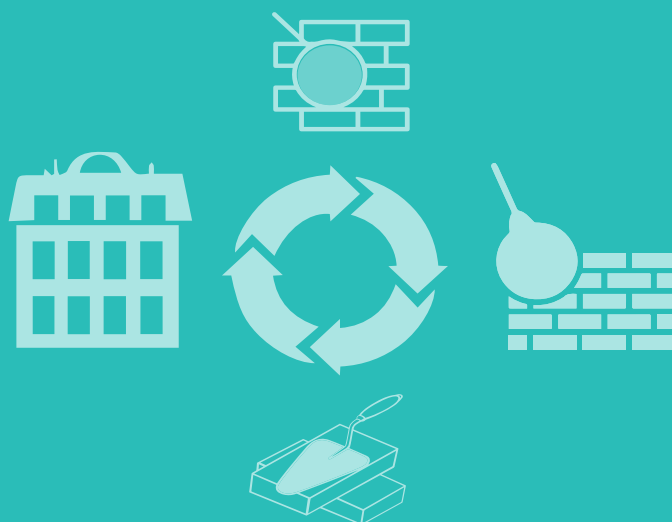


An analysis of the institutional barriers of circular construction in Amsterdam and Stockholm



02-07-2019

Preface

Dear reader,

Before you lies my master thesis, a research on barriers and opportunities of circular construction within Amsterdam and Stockholm. It was performed as a part of the master Spatial Planning. During the process of performing the required research and data collection for this masterthesis, I worked as an intern at the sustainability and spatial planning department of the municipality of Amsterdam. During this internship, which lasted from September 2018 to February 2019, I did not only focus on the subject of this thesis, but I also experienced being part of the Team New Assignments of this department. The internship granted the opportunity to elaborately discuss the subject of this thesis with people that are currently active in this field within the municipality. These conversations were of indispensable value in reshaping specific aspects of the research and contributed greatly in improving the quality of the thesis. For this reason, I would like to thank the people that shared their knowledge and in particular I would like to thank my internship-supervisor Karlijn Kokhuis.

In addition, I would like to thank my thesis supervisor Sander Meijerink for his guidance during the process and for his contributions to the research in the form of discussions, reviews and critical reflections. His knowledge of academic studies within among others institutional analysis allowed for thorough discussions on the contents of the thesis.

A final word of thanks is addressed to the different respondents, in both Amsterdam and Stockholm, who were interviewed for the thesis. The respondents, who are among others employed by the municipality, project developers and consultant companies, each provided new and invaluable information which contributed to my thesis in an unique fashion.

Sarah Vodovar,

July 2, 2019

Abstract

The circular economy (CE) concept is a currently popular concept that guides many cities towards a more sustainable future. The popularity of the concept can be explained by the view that the CE is in line with sustainable and economic development (Korhonen et al., 2017). In this thesis is focused on the institutional barriers that limit the successful implementation of the CE concept in Amsterdam and Stockholm and therefore the following main question is posed: Which institutional barriers can be identified, explained and overcome in order to successfully implement CE-related policy in construction projects within cities? Amsterdam and Stockholm had been selected because of their frontrunner position on circular construction. In order to explain the existence of institutional barriers and institutional change, elements of historical institutionalism, which focusses on the constraints of institutional change, and elements of rational institutionalism, which offers a perspective on institutions as a way of creating institutional change, are used.

In order to analyze the institutions that influence the application of the circular economy concept in the construction sector, the IAD framework of Ostrom (2005) was used. It facilitates the analysis of these institutional barriers by placing the different barriers into seven different categories.

After answering the different subquestion it appeared to be impossible to give one uniform and concluding answer on the main question because of the diversity of the identified barriers and the several ways to overcome these barriers. Also, the institutional context between countries might differ widely, which might lead to the identification of other barriers in other institutional contexts. However, it appeared that most institutional barriers are related to laws and regulations and requirements set by the municipality during the tendering procedure. Because of the different institutional contexts in different countries and sometimes even cities, it is important to find the best fitting solution that is in line with this institutional context. Different solutions have been suggested within this research in order to leave room to find the best fitted solutions in the given context. Next to this was found that although some identified barriers might be hard to change, there are other, creative, ways to work around these sticky barriers.

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Chapter 1 Project framework

1.1 Introduction

Challenges like urbanization, climate change and the future scarcity of resources are forcing cities to plan novel and innovative paths towards sustainable futures. Several cities are turning to the 'circular economy' (CE) concept to guide them within this redirection (Prendeville, Cherim and Bocken, 2018). The challenges of balancing industrial development, environmental and human health and economic growth in different countries in the world form another driver for the creation of resource use and low-carbon development strategies that include the application of the circular economy concept (Prendeville, Cherim and Bocken, 2018). Different international organizations encourage countries and cities to use the concept. Circle-Economy is an example of such an organization, which created a global platform through which cities, regions and local businesses can exchange knowledge about their transition towards a circular economy (Circle Cities, N.D.). Next to this, during the run-up to the United Nations Conference on Sustainable Development in Rio in June 2012, there has been created a revived focus on significant action to reduce resource and environmental pressures (Preston, 2012). Next to the UN, also the EU has worked on this topic as the EU has agreed on a strategy for 'a resource-efficient Europe' under its 'Europe 2020 Strategy' (Preston, 2012). In 2015 the European Commission (EC) set up a circular economy action plan for cities, regions and nations while also subsidies and new laws, like a waste law, were developed.

An important aspect and a possible reason for the attractiveness and current popularity of the concept is that the circular economy is considered to be an approach to economic growth that is in line with sustainable environmental and economic development (Korhonen, Honksalo and Seppala, 2017). The European Commission recently even stated that a circular economy type of transition might generate 6000 billion euros on cost savings a year (McKinsey Company for Business and Environment, 2016).

The circular economy provides a new economic system with an alternative flow model, namely one that is cyclical (Zink and Geyer, 2017). Unlike the traditional practical policy that only enhances recycling, the business oriented CE emphasizes product, component and material reuse as well as remanufacturing, refurbishment, repair, cascading and upgrading (Zink and Geyer, 2017).

Homrich et al. (2017) did an elaborated literature review on scientific literature related to the CE theme. In their research they distinct a wide range of theoretical influences from different epistemological fields varying from economy, biology and sustainability. This wide range of influences might explain why it is hard to achieve a consensus about what circular economy really is (Homrich et al., 2017). Homrich et al. (2017, p. 19), after their extended literature review of 387 articles, present the following inclusive, but also broad definition:

CE is a strategy that emerges to oppose the traditional open-ended system, aiming to face the challenge of resource scarcity and waste disposal in a win-win approach with economic and value perspective'.

In addition to this definition Homrich et al. (2017) state that the circular aspect of this concept is core, which incorporates lifecycle extension, sharing, reuse, recycling, remanufacturing and refurbishing.

Despite the popularity and the recently frequent use of the concept, there are critiques from different angles. For example Korhonen, Honksalo and Seppala (2017) posed the question whether the circular economy really displaces primary products and thus if the concept would not lead to even more material use. The CE is next to this critiqued for being an incomplete picture based upon idealism and is sometimes seen as a 'partial' approach that has 'unrealistic' and 'narrow' goals (Korhonen, Honksalo and Seppala, 2017). Also a number of contrasting and in some cases contradictory perspectives on the core principles of the CE can be identified within the literature. One of these perspectives is that from the origin in industrial ecology it is expected that CE should be a primarily macro-level activity (Korhonen, Honksalo and Seppala, 2017), while the contemporary CE literature has predominantly focused on micro-level interventions (Korhonen, Honksalo and Seppala, 2017).

However, the attention for macro-level activities is currently rising as since the past years cities are starting to apply the concept within area development projects (Circle Cities, N.D.). CE is interesting at the city-level for a number of reasons. For example 75% of global natural resources and 80% of the global energy supply are consumed within cities. The contribution to and the threats of climate change are significant and future protection for cities is therefore needed (Prendeville, Cherim and Bocken, 2018). Next to this, it is said that the pragmatism and physical proximity in cities makes it easier to implement policy changes than at a state or national level, where bureaucratic structures and legislative timelines can block the institutionalizing novel circular concepts (World Economic Forum, 2018). Therefore, cities can be more adaptive when implementing pilot initiatives than national governments, allowing them to stimulate change faster (World Economic Forum, 2018).

One of the biggest contributors to the energy consumption (40%) and consumption of natural resources consumption (33%) within cities all over the world is the construction sector (Radhi and Sharples, 2013). These high percentages form the motivation for focusing on the implementation of the circular economy concept within this sector. Within construction there is often distinguished between infrastructure and utility and civil construction (houses and offices). Reason for this is the difference in structure: utility and civil construction is often financed through private financing and consists of a big and divers playing field with a great amount of different stakeholders (Rijksoverheid, 2016). When realizing infrastructure there is often public commissioning and the amount of stakeholders is smaller and more homogeneous (Rijksoverheid, 2016). Although many of the same principles and approaches apply to buildings and infrastructure will be focused on utility and civil construction. Reason for this is that although 95% of the utility and civil construction in the Netherlands is recycled, only 3% of these materials flow back into buildings as most of these materials are recycled as foundation material for infrastructure (Rijksoverheid, 2016). This while the construction and demolition waste of infrastructure is often recycled within new infrastructure.

Despite the efforts of different governmental organizations and companies,

the circular economy concept remains difficult to implement on the entire construction sector as a part of the stakeholders within the construction sector don't dare, want or are able to engage in circular construction (Berchum, 2015; Boros 2017). A real and large scale transition remains missing, although more and more initiatives appear (Berchum, 2015).

Some authors paid attention towards the creation of new policies that stimulate the CE, but only limited research has been done on the implementation of these policies. Reason for this might be that cities only just started the implementation process and only little evaluation has been done by city governments (Circle cities, N.D.). Boros (2017) is one of the researchers that discussed the application of the circular economy concept within cities, although not within the construction sector. During his research he found that different barriers might constrain the implementation of the concept within cities, varying from the level of motivation of people implementing to the limited financial resources to invest in innovation (Boros, 2017). Winans, Kendall and Heng (2017) found that the implementation of the concept was constrained by a lack of regulation, interventions, or incentives that are needed and a lack of help to identify commercial opportunities. These barriers show the need for an unconventional way of implementing policies that involve innovative concepts like the CE, which might differ from the conventional way of implementing policies and lead to several questions, like: What is the difference between the implementation of innovative policies compared to conventional policies? Are there more barriers that can be identified when implementing CE policy? Do we also find these barriers when implementing the concept within the construction sector? If so, how can we overcome these barriers?

1.2 Scientific relevance

As earlier stated many literature has been written about the circular economy, while the implementation perspective is often underexposed (Homrich et al., 2017). Especially the application of the circular economy within the construction sector has not been a main topic. On top of this, the literature written related to the circular economy mainly focusses on China (Homrich et al, 2017). In the previous paragraph a little attention has been paid to the available literature on application of the circular economy concept within cities. In this part more insight will be gained into the current scientific literature about the implementation of the circular economy concept within cities and the ambiguities and gaps within this available literature.

Prendeville, Cherim and Bocken (2018), in their work about how cities are using the CE as a strategy, identified political leadership of the agenda, consideration of the city's context as well as engagement with all of the city's urban stakeholders as important aspects of the implementation of circular economy initiatives. They also identified weak governance structures within cities, where the success of CE initiatives was beholden to individual actions and therefore exposed to short-termism and political motivations. Prendeville, Cherim and Bocken (2018) state that a possible explanation for this existence of weak governance structures, which also gives more insight in what they understand as 'weak governance structures' is that city policymakers are seen to be keen to include the CE within their agendas. However, in reality, policymakers are unclear on what a circular city constitutes and express the challenge of untangling a clear

and evident picture of what a circular city means in practice (Prendeville, Cherim and Bocken (2018). To overcome the weak government structures Circle Cities (N.D.) states that the government should act as a market player or launching customer to stimulate the development of the circular economy in cities. However, there must be noted that this role is proposed by TNO for especially the national government. Mosannenzadeha et al. (2017) identified the lack of long-term support and an absence of political motivations as a barrier of the implementation of the circular economy concept within cities.

Campbell-Johnston et al. (2019) state that crucial barriers include suitable technologies to be deployed for practitioners, upscaling of pilot projects, the engineering of a 'mindshift' in companies and space and logistics. The barriers that the earlier mentioned Boros (2017) identified within his research are also varying from behavioral barriers towards technical barriers. However, next to the barriers he identified, he also found some success factors to the implementation of the circular economy concept, which are flexibility in policymaking and learning and adapting the CE policy to new situations. However, his research does not provide further explanations or recommendations on why or how this should happen. Linder, Mooij and Rogers (2017) present in their research the following recommendations to municipalities implementing the circular economy concept, as they should be: *'recognizing the leveraging of their areas of influence, adapting to their cultural context, considering the system-level barriers and opportunities and providing internal education to embed the concept within the municipality.'* (Linder, Mooij and Rogers, 2017, p. x).

To conclude, it appears that, as expected, only a little research has been done on the implementation of the circular economy concept within cities and especially within the construction sector, although the amount of literature on this topic is currently rising. Different barriers and important aspects of the implementation of CE policy have been identified, but these are mainly based on explorative research in which no explanations or solutions to overcome these barriers are researched. Also there appears to be a difference in identified barriers, which might be explained by the assumption that policy implementation is not value-free due to social-cultural, political and economic variations in the country's context (Paudel, 2009). Another conclusion from this literature review is that most of the literature, as is often the case with explorative research, is exploring a big range of barriers, varying from technical to financial barriers (Boros, 2017; Linder, Mooij and Rogers; 2017). This leads to a superficial view on the different barriers of policy implementation related to the CE; A thorough in-depth analysis of one or a few range of barriers seems to be absent. Only in one article the authors purposefully focused on barriers related to governance structures (Prendeville, Cherim and Bocken, 2018). In order to prevent another superficial perspective on the barriers of implementing CE and to provide a detailed and thorough analysis of these barriers, there will only be looked into the institutional barriers of the implementation of the circular economy concept. This choice is based upon the fact that in the analysis of Boros (2017), Prendeville, Cherim and Bocken (2018) and Winans, Kendall and Heng (2017) institutional barriers, barriers related to among others financing and laws and regulations, are considered to be one of the most important challenges in policy implementation of CE policies within cities.

1.3 Societal relevance

Several pioneering cities are currently working on a circular economy strategy in order to develop a circular city by setting up different pilot projects related to circular construction. An important part of this pioneering is the development and evaluation of a new and fitting policy that is successfully implemented (Cramer, 2013). Within this research will be focused on the implementation of the circular economy concept in two particular cities, namely Stockholm and Amsterdam, which are considered to be two frontrunners on the circular economy within the construction sector based upon the available policy documents.

By analyzing one of the most important types of barriers that are encountered when applying the circular economy concept, the institutional barrier, this research aims at supporting different governmental levels to create a better understanding of the issues encountered when applying the circular economy concept within cities and especially within the construction sector. Practically, this research wants to:

- help municipalities, in particular Stockholm and Amsterdam, to improve their objectives on the CE, especially within the construction sector
- support different governmental stakeholders to gain more insight into what a circular construction sector constitutes
- provide more insight into the barriers that currently exist within the construction sector and which constrain the application of the circular economy concept
- form recommendations on which actions municipalities, regional authorities and the national government should undertake in order to stimulate CE within the construction sector

1.4 Problem statement

In this thesis the institutional barriers of CE policy implementation within the construction sector will be thoroughly analyzed. Currently, there is an existing knowledge gap within the scientific debate about the barriers that make it difficult to apply the circular economy concept within cities as only explorative research has been done on the barriers of policy implementation within this field and only a few cases are discussed within scientific literature (Homrich et al., 2017). Within this research, in order to provide a more thorough analysis of the barriers encountered when applying the circular economy concept to construction projects, will be focused on institutional barriers and how these institutional barriers can be explained and overcome. Different cities have already embraced the circular economy concept in their construction projects, especially within new housing development projects. This thesis might support city, regional, and national governments and businesses with identifying and overcoming these institutional barriers in order to improve the application of the circular economy concept on a city-level and especially within construction projects. Summarized, this leads to the following aim of this research is: Explaining and analyzing the institutional barriers that arise during the implementation of CE policies within construction projects in cities and find concrete enablers to overcome these barriers.

1.5 Research questions

In this research will be tried to find an answer on the following question:

Which institutional barriers can be identified, explained and overcome in order to successfully implement CE-related policy in construction projects within cities?

To answer the main question, the following sub questions are posed:

Subquestion 1: What are the main differences between traditional and circular construction?

Subquestion 2: Which institutional barriers of the implementation of the circular economy concept in circular construction projects in Stockholm and Amsterdam can be identified and how can these barriers be explained?

Subquestion 3: What are possible ways (enablers) to overcome the identified institutional barriers of circular economy implementation within construction projects in Stockholm and Amsterdam?

Chapter 2 Theoretical framework

2.1 Institutionalism

Both in institutional-economic literature and in political literature there exists a considerable agreement that institutions are by humans created rules that structure the interaction between humans/their behaviour (Buitelaar et al., 2013). This structuration ensures certain securities, through which routines or habits are created. In this way the transaction costs of the interaction between people, but also organizations, can be reduced (Buitelaar et al., 2013). When defining the term 'institution', a distinction can be made between formal and informal institutions. Formal institutions are for example laws, policy rules or contracts; all institutions with some sort of legal effect (Buitelaar et al., 2013). These institutions are most tangible and therefore most discussed within scientific literature. Next to this we know the remarkably less researched informal institutions (Buitelaar et al., 2013). Examples of informal institutions are conventions, habits or working practices. These institutions, although not tested by a judge, are considered as important for societal behavior as the formal institutions (Buitelaar et al., 2013).

Next to these general definitions, different scholar have tried to define institutions more detailed. There are several different ways to define institutions, which depend on the discipline and focus of research (Sorensen, 2015). In this research we are in particular interested in planning institutions, since this research takes place within the urban planning context. Sorensen (2015), operating in the field of urban planning, defines planning institutions as: *'collectively enforced expectations with respect to the creation, management, and use of urban space'* (Sorensen, 2015, p. 33). He adds in his definition that *'collective enforcement refers primarily to the use of coercion by the state to enforce laws and bylaws, and recourse of private actors to the courts to enforce contracts. In particular the formal legal-political institutions that structure the urban space, such as such as plans, laws, and regulations'*.

Because of the limited timespan of this research and focus on planning institutions, there is chosen to only look at the formal institutional barriers, since these appear to be more dominant than the informal barriers regarding the application of the circular economy concept in the construction sector (Bosor, 2017). The definition of Sorensen (2015) is focused on the formal planning institutions, which is why this definition will be used in this research.

Since Hall and Taylor (1996) first introduced their classification of institutional analysis at least three types of institutional analysis are acknowledged within social sciences: the rational choice institutionalism, sociological institutionalism and historical institutionalism. It has nowadays become more or less commonplace to make this distinction (Lockwood et al., 2016). The different types that are distinguished differ in particular on their understanding of the nature of the beings whose actions are structured by institutions (Hall and Taylor, 1996). For example, the rational choice school argues that human beings are rational individualist who calculate the costs and benefits in the choices they face (Hall and Taylor, 1996). The rationalist believes that people follow rules because humans act strategic and want to maximize their individual gain. In contrast,

sociological institutionalists consider human beings as fundamentally social beings (Hall and Taylor, 1996). This thus means that humans are neither self-interested, nor rational. Sociological institutionalist consider humans 'satisfiers', who act habitually.

In the following paragraphs each type of institutional analysis will be further explained, which will eventually lead towards a concluding paragraph in which will be decided which of the three types of institutional analysis will be most fitted to use as a framework in this thesis.

2.1.1 Historical institutionalism (HI)

Historical institutionalism starts with the assumption that institutions are adopted or created in a world already imbedded within institutions. It focuses on how these institutions develop over time (Hall and Taylor, 1996).

At its broadest, historical institutionalism is said to represent an attempt to illuminate how political struggles are mediated by the institutional setting in which they occur (Lockwood, et al. 2016). It might thus be considered as a theory of action within institutional constraints. Several historical institutionalist state however that institutions are important not only because they constrain individual strategies or choices, but also in how they might affect the articulation of the collective interest (Lockwood et al., 2016).

Historical institutionalism emphasizes path dependency and the unintended consequences of the institutional design and policies. This path dependency is considered to be the most important characteristic for this school of thought (Nichols, 1998). The different pathways are marked by critical turning points that represent new paths of opportunities of change. These turning points are, however, often only reached by major societal changes. When taking planning institutions as a specific example, there is no doubt that many urban institutions show signs of path dependency (Sorensen, 2015). Planning history can be considered as history of institution-building as the development of a multifaceted system of decision rules, shared understandings and codes (Sorensen, 2015). These institutional choices from the past then become 'locked-in' shaping and constraining actors and creating long term effects. The urban institutions often generate powerful political and economic incentives to oppose change and some even state that urban planning institutions are often intentionally designed to be hard to change, although this is dismissed by others (Sorensen, 2015). However, change does still occur, for example through the establishment of new arrangements. It must however be noted that some institutions are harder to change than others due to differences in openness to and patterns of change.

To more or less summarise the prior, the core assumption of HI can be described as followed:

'Historical developments are path dependent; once certain choices are made, they constrain future possibilities. The range of options available to policymakers at any given point in time is function of institutional capabilities that were put in place at some earlier period, possible in response to very different environmental pressures' (Nichols, 1998, p. 17).

Also the function of preferences plays a big role in creating institutional change. Unlike the other two types of institutional analysis, HI does not aim at proving the primacy of either institutions or preferences. Within HI the conversion of preferences only takes place when the benefits of an alternative outweigh the losses that are associated with giving up an approach to past designs. This in contrast to for example rational institutionalism, where the rise of better options influences preferences (Hall and Taylor, 1996).

HI focusses on the interactions between institutions and preferences, which allows a researcher to study the evolution of policy over time. Often a comparison of institutions across countries is included (Friel, 2017). This while sociological and rational institutionalism both only concentrate on snap shots and therefore might establish causal relations that are not reflecting the reality (Lungu, 2017).

Considered fundamentally as a theory of action within institutional constraints (Campbell, 2007), historical institutionalism through its concepts of among others path dependency, gradual change and unintended consequences pays a significant deal of attention on how processes unfolds over time. This provides a complete image on the evolution of the policy, especially in terms of scope of the policy, policy practice and policy content (Lungu, 2017).

2.1.2 Sociological institutionalism

An alternative vision on the dynamics of institutions is based upon a more sociological conception of rules, resources and social skill. This more sociological version states that actors are collective and embedded in social relationships. These relations determine the available cultural scripts; actors have no alternative but to follow these scripts, which could reflect their interests, values, roles or norms (Hall and Taylor, 1996). These scripts form also a critique on this approach, since some state it focusses too heavily on scripts and a structural determination of action and therefore only provides a little insight into how actors exactly 'get' action (Amenta and Ramsey, 2009).

Sociological institutionalism knows a broad definition of institutions as they are rules as well as 'moral templates', symbol systems and cognitive scripts (Zhang, 2016). Institutions are created through individuals' choices and they lay down the bases of interests, goals and future choices. Sociological institutionalism emphasizes cultural factors in the creation or alteration of institutions (Nichols, 1998). In the study of policy, sociological institutionalism tends to focus on processes of policy imitation and diffusion (Amenta and Ramsey, 2009.).

Currently, the most striking element of the sociological institutionalism perspective is the consideration that interests and identities are endogenous to the process of interaction that institutions represent (Hall and Taylor, 1996).

2.1.3 Rational choice institutionalism

RCI explains the creation of institutions as a way to reduce transaction costs of collective activity. These 'transaction costs' would be significantly higher without these institutions. The reason that institutions persist after their creation, is that

they reduce uncertainty (Hall and Taylor, 1996). The institutional environment provides information and enforcement mechanisms that reduce uncertainty for each actor about the corresponding behavior of other actors. This so called 'calculus approach' explains how the institutional setting influences individual behavior and stresses how strategic interaction determines policy outcomes (Hall and Taylor, 1996).

When considered as a game, this last type of institutionalism sees institutions as an exogenously given 'game form' (Fligstein, 1997). They might be considered as 'the rules of the game' in a society. Following this approach an institution is a script that names the participating actors, their behavioral strategies, the information that the actors possess and when they make their selections and the outcome resulting from the combination of actor choices. Once actor preferences are added in the game, the game form is transformed into a game (Fligstein, 1997). These preferences are thus fixed and actors behave instrumentally to maximize their goals. To maximize those preferences actors behave highly strategic through systematic foresight and strategic cost-benefit calculation.

The rational choice approach is in particular useful to study which incentives are adopted and if or how these change people's behaviour. Another question that is often asked within the rationalist approach is why bad or inefficient institutions exist (Hall and Taylor, 1996).

2.1.4 Evaluation of the three types of institutionalism

All three types of institutional analysis might give an interesting perspective on the institutional barriers that restrict the policy implementation of circular economy principles. However, another aspect that is important in considering the different types of institutional analysis, is the form of the research. Sorensen (2015) states that an HI approach to the comparison or investigation of particular urban institutions that examines the critical junctures of institutional development, patterns or path dependency is valuable. Whereas the sociological perspective mainly looks into more informal institutions and also looks into the diffusion of policy, this might be less fitting this research. The rational and historical institutionalism, on the other hand, both have interesting perspectives to offer on this research. Historical institutionalism makes it possible to explain policy changes or – better said – why policy change does not happen. This might offer explanations for the barriers of implementing circular economy concepts and help answering the second sub question. The rational institutionalism offers the possibility to find opportunities to create change, by offering ways to analyze or find incentives and produce change and helps to answer the third sub question. With using elements of HI, which focusses on the constraints of institutions to change, and elements of rational institutionalism, which offers a perspective on institutions as a way of creating change, a complete perspective is offered.

2.2 Analyzing the different institutions

2.2.1 The IAD framework of Ostrom

To analyze (formal) institutions, sometimes referred to as institutional arrangements, that exist around the implementation of circular economy policy

the Institutional Analysis and Development framework (IAD framework) of Ostrom (2005) will be used. This framework has been described as “one of the most developed and sophisticated attempts to use institutional and stakeholder assessment in order to link theory and practice, analysis and policy”. As any other framework advantages and disadvantages are described within the scientific literature. One of the characteristics in favor of the framework is the careful consideration of contextual factors. Another advantage is variety of criteria to assess institutional performance (Cole, 2014). However, at the same time, it is said that the framework fails to explore complex relations between different institutions (Cole, 2014). One of the unique attributes of the IAD framework is its utility across a wide range of social settings, which includes for example markets, courtrooms and clubs. It can also be applied at different levels of social choice, including constitutional-level choice, with constitutional rules that function as outputs establishing the meta-rules of the game or with regulations and laws as output that establishes rules and patterns of interaction among individuals in their ordinary activities in society (operational-level), which is in accordance (or is not) with various constitutional and legal rules (Ostrom, Gardner and Walker, 1994; Cole, 2014).

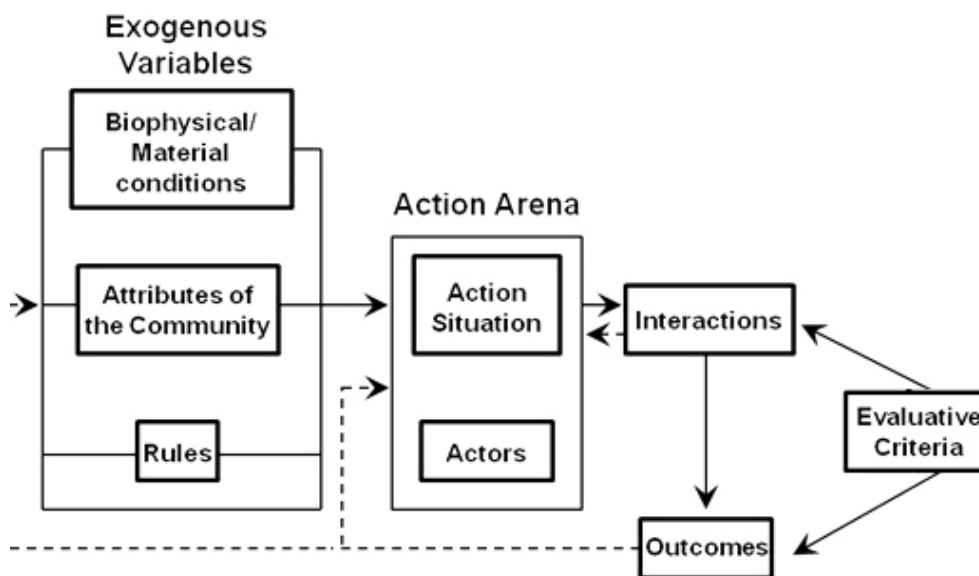


Figure 1 Basic components of the IAD framework (Ostrom, 2005, p. 189).

The basic components of the IAD framework are exogenous variables and the action arena (figure 1). The latter forms the main focus of the institutional analysis. Many researches are undertaken without the attempt to address the underlying factors of an action arena and how they are affecting the arena. Theorist working on institutional questions have to understand how rules combine with a physical and cultural world in order to generate particular types of situations (Ostrom, Gardner and Walker, 1994), since the implicit or explicit assumptions about rules, physical variables and the nature of a community influence the way that the elements of the action situation and action arena are conceptualized (Ostrom, Gardner and Walker, 1994). This means that an institutional analysis might begin with an analysis of these factors first.

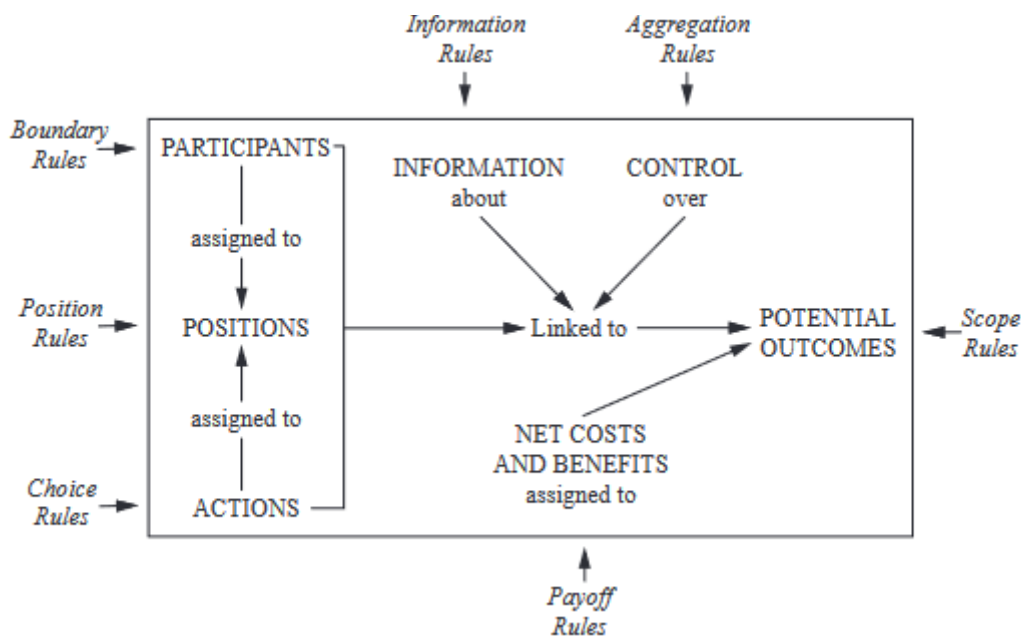


Figure 2 Action arena of the IAD framework (Ostrom, 2005, p.189)

A next step is the identification of a conceptual unit, the action arena (Ostrom, Gardner and Walker 1994). This action arena is the focus of analysis. Action arenas include both an action and actor component.

'Action situations refer to the social space where individuals interact, exchange goods and services, engage in appropriation and provision activities, solve problems, or fight (among the many things that individuals do in action situations)' (Ostrom, Gardner and Walker, 1994, p. 28).

It can be hard to tell where a situation ends and the other begins. It is the task of the researcher to separate one action situation from another for the purpose of analysis. What is distinctive about the IAD framework is that all situations are viewed as composed out of the same set of elements (Ostrom, Gardner and Walker, 1994). Markets as well as common pool resources and legislatures are all considered to be constituted by a similar set of elemental parts. These elemental parts can be found in figure 2. Concerning the actor(s) operating in the action situation and in order to explain its behavior one has to make assumptions about the information-processing skills, selection criteria and resources of the actors that are participating in the action situation. As Ostrom, Gardner and Walker (1994) state, the actor is the animating force that allows a researcher to generate predictions about possible outcomes with regard to the action situation. There is an underlying assumption that the participants in the action situation act fully rational. This means that players assign complete preferences over outcomes, they conduct complete analyses and possess the resources that are required for action. The main question related to the action arena is: 'how does this situation work to produce outcomes?' In order to discover how the action arena is set up and which elements can be distinguished within the arena, one might ask themselves the following questions (Witting, 2018):

- *Who is concerned with/affected by the particular problem?*
- *What are their positions?*
- *What actions can they take to tackle the problem, what actions are they aware of?*
- *What costs & benefits do the actors assign to these actions?*
- *What information do they use and who provided it?*
- *What geographic region and what events in that region would these actions affect?*
- *To what extent can actors exercise control over the action-outcome linkage?*
- *What outcomes are feasible given the external factors?*

So, the elements of a variety of analytical models of for example markets and corporations know several elements; participants, positions, actions, outcomes, information, control, and costs/benefits. Following Ostrom (2005) these elements are related together in the following manner: Participants, individuals or organized entities and actions are assigned to specific positions. Outcomes are linked to actions, information is available about action-outcome linkages and control is exercised over these linkages (Ostrom, 2005). Costs and benefits are assigned to action-outcome linkages. The earlier called participants, in their positions, choose among actions in the light of the information they possess, the control they have over action-outcome linkages and the benefits and costs assigned to actions and outcomes.

As the earlier description of the framework might suggest, the framework is mainly based upon rational institutionalism as cost-benefits and the way people make choices are central within this framework as well as the way rules directly influence people's behaviour, which can be considered as a means to create a desired situation. This makes the framework very useful within this thesis, since this fits with the way that rational institutionalism explains why the different institutional arrangements in this thesis stimulate 'participants' to circular principles.

2.2.2 A close look to the rule types of Ostrom

Before the institutional barriers can be classified according to the rules Ostrom, Gardner and Walker (1994) described, it first has to be clear what is understood under 'rule type' or 'rule'. Cole (2014) states that Ostrom defined, in earlier work, rules as "generally agreed-upon and enforced prescriptions that require, forbid, or permit specific actions for more than a single individual." A rule forms an operationalization of different institutional arrangements. A spectrum exists between complete nonenforcement and 100 percent enforcement of a rule. Ostrom, Gardner and Walker (1994) state that no one would require perfect enforcement as a defining condition for a rule. However, at some point along the enforcement continuum, the actual enforcement rate could become so low

that a rule is no longer considered to be a rule (Ostrom, Gardner and Walker, 1994). However, where that point lies seems indeterminate. Rules are contextual in the sense that they apply to general set of action arenas, but do not apply everywhere. Ostrom, Gardner and Walker (1994) gives the example of chess, where the rules of chess only apply to the situations in which participants wish to play chess and they apply to every such situation. The game of chess provides the context for the application of its rules (Ostrom, Gardner and Walker, 1994). Next to this, rules are prescriptive in a way that the people who are knowledgeable of a rule also know that they can be held accountable if they break it. Within this research, rules refer to the institutions or institutional arrangements that affect the implementation of CE policy.

A next step, is the operationalization of the rules. Operationalization is the process of defining the measurement of a phenomenon that is not directly measurable in order to make it clearly distinguishable, measurable, and understandable by empirical observation. As described, rule types itself form an operationalization of an institutional arrangement (Cole, 2014) and therefore the scientific literature does not provide any further operationalization of the rule types itself. However, there are several ways to identify or recognize the different rule types in order to distinguish these. Rules are classified by the element of the action situation that is most directly affected by the rule, focusing on the direct link between the aim of a rule and the affected component of the action situation (Ostrom, 2005). Many rules also indirectly affect other components of the action situation. Eventually, a classification of these rules leads to the specification of seven broad types of rules: position, boundary, choice, aggregation, information, payoff, and scope. The direct relationships among rules and the components of an action situation are shown in figure 2 as the set of arrows connecting rules to specific parts of a specific action situation. Ostrom (2005) also proposed general verbs that link the aim of the rules directly to different parts of the action situation. These verbs help to sort out the various types of rules. A first assessment in sorting the rules that affect an action situation can be to determine the general verb, as described by Ostrom (2005), that most closely resembles the specific verb. An overview of these verbs is given in figure 3. In figure 4 a description of the different rule types is provided.

<i>Type of rule</i>	<i>Basic AIM verb</i>	<i>Regulated component of the action situation</i>
Position	Be	Positions
Boundary	Enter or leave	Participants
Choice	Do	Actions
Aggregation	Jointly affect	Control
Information	Send or receive	Information
Payoff	Pay or receive	Costs/Benefits
Scope	Occur	Outcomes

Figure 3 An overview of the AIM components of the IAD framework (Ostrom, 2005)

Rule type	Function of rule
Position rule	Creates positions that actors may hold
Boundary rule	Define (1) who is eligible to hold a certain position, (2) the process by which positions are assigned to actors (including rules of succession), and (3) how positions may be exited
Choice rules	Prescribe actions actors in positions must, must not, or may take in various circumstances
Aggregation rules	Determine how many, and which, players must participate in a given collective- or operational-choice decision
Information rules	Authorize channels of information flows available to participants, including assignments of obligations, permissions or prohibitions on communication
Payoff rules	Assign rewards or sanctions to particular actions that have been taken or based on outcome
Scope rules	Delimit the range of possible outcomes. In the absence of scope rule, actors can affect any physically possible outcomes

Figure 4 AIM component of each rule as defined by Ostrom (2005).

In this research the different institutions found that affect the implementation of circular economy concept will be categorised as a specific rule type of Ostrom in order to create a clear overview of the institutions that influence the implementation of CE policy.

2.3 The implementation barriers of implementing innovative policy

2.3.1. Policy implementation

First, before looking into the institutions that affect the implementation of CE policy, it is useful to shortly pay attention to the policy implementation process itself. Different often-conflicting uses of the concept of implementation are found within the currently available literature. Meter and Horn (1975) provide a quite explicit definition: policy implementation encompasses those actions by public and private individuals (or groups) that are directed at the achievement of objectives created in prior policy decisions. In their work they emphasize that the implementation phase does not start until goals and objectives have been identified with the use of prior policy decisions. This means that it takes place only after legislation has been passed and funds are committed (Meter and Horn, 1975). A clear distinction has been made between the exact policy implementation, performance and what generally has been referred to as the policy impact (Meter and Horn, 1975). The study of the impact searches the consequences of a particular policy decision. The study of policy implementation researches and highlights the one or multiple forces that determine the policy impact. Within this study it is important to realize that it is risky to assume that putting good policies in place will guarantee an automatic flow into successful implementation, since the policy itself is depending on several other external factors (Meter and Horn, 1975). This forms an important difference between barriers within policy formulation and policy implementation.

2.3.2 The implementation barrier

An implementation barrier is an obstacle that prevents a given policy instrument of being implemented or limits the way in which the instrument might be implemented. In the most extreme cases these barriers may lead to certain policy instruments being overlooked, which results into strategies being much less effective (Konsult, N.D.).

A distinction that can be made between short-term and long-term barriers. It is said that different policy instruments might overcome short-term barriers. Especially financial, political or cultural barriers might be overcome as, for example, a policy instrument might start to generate revenue after a while (Konsult, N.D.). It is therefore important to not reject a particular policy simply because there are barriers at its introduction. It is however often harder to overcome legal, institutional and technological barriers in the short term (Konsult, N.D.). There is also a danger that these barriers might be getting worse over time, although it has to be noted that strategies are ideally developed to be implemented for another fifteen or twenty years (Konsult, N.D.).

Within this research is mainly focused on the implementation barriers that arise because of a change in policy towards a more innovative path. From a historical institutionalism perspective this means that because policy innovation implies new policy practices, it requires the choice for a new institutional path (Meijerink

and Van de Brink, 2005). However, this is not often achieved when implementing innovative policies. Within historical institutionalism continuity and persistence of institutional paths are emphasized (Hall and Taylor, 2016). A radical change or transformation would only be possible in exceptional cases of fundamental performance crises or external shocks (Hall and Taylor, 1996). The ignorance of necessary changes within the institutional path might evolve as a barrier in implementing innovative policies. In the following section the institutional barriers of innovative policy will be discussed.

2.3.3 Barriers of implementing innovative policies

During the past two decades policy-makers have increasingly become concerned about the role innovation plays in economic performance and the solution of challenges that arise. The view that policy is from importance in innovation has become widespread and the term innovation policy has become more commonly used (Edler and Fagelberg, 2017). Policy-makers are from nature concerned about the extent to which innovation policy instruments have the expected impact and, since the late 1980s onwards, there have been several attempts to evaluate the effects of innovation policy interventions. The study of Edler and Fagelberg (2017) identified a large number of variables influencing the impact of innovation policy instruments among others interaction with other interventions, conditions for implementation, local and national capabilities, economic structure, the profile and performance of the national science base and risk taking. However, as Edler and Fagelberg (2017) state, only an identification of the barriers alone is not enough for selecting appropriate policy interventions to compensate or mitigate identified barriers. In order to make decision for future compensation policies the analysis and prioritization of barriers is crucial (Edler and Fagelberg, 2017).

From different other innovative policies, varying from smart city concepts to sustainable mobility, we can learn about the challenges of implementing innovative policies, since innovative concepts, for example the pursuit of sustainable mobility, require a process of innovations for spatial planning policies (European Commission, N.D.). For example from smart city implementation we learn that the main implementation barriers were related to financing; the financial costs and the risks that are associated with innovative technologies were dis-incentivizing different project developers (Edler and Fagelberg, 2014).

Next to this, the application of SEC technologies, another innovative concept, is constrained by market and financial barriers. The main barriers are the relatively high costs of the design, installation and construction and a higher risk and uncertainty (European Commission, N.D.). General costs are typically higher for new technologies. The high investment costs are highlighted in comparison to conventional costs and therefore these costs are operating as cost disincentives (European Commission, N.D.). So, insecure or insufficient financial incentives for new technologies make these less attractive.

Another identified barrier when implementing innovative policy are local regulations. Local restrictions related to building aesthetic or structure may hind project implementations of innovative concepts (European Commission, N.D.). In particular regulations for historical preservation of buildings appeared to be hard to match with the application of new technologies. Legal and regulatory

barriers occurred because of the novelty of the concept, reflected in more long and complex procedures for non-updated as well as inadequate regulations for relatively new technologies (European Commission, N.D.). In some projects these barriers are accompanied by complicated procurement. These barriers discourage investments and also complicate the implementation process (European Commission, N.D.). Innovative concepts like smart city or sustainable mobility require a process of innovations for spatial planning policies. A project in Jakarta that implemented new mobility technologies to stimulate sustainable mobility was mainly hampered by technological barriers, but also the fuel subsidy was an important limiting factor (European Commission, N.D.).

From the HI perspective, we see that decisions made in the past are constraining technological and social innovation, like the local building regulations or the use of fuel subsidy. However, also financial risk seems to constrain innovative policy implementation. When looking from a rational-economic perspective, there is a possibility to overcome the different barriers by using several incentives, like minimizing the risk with economic incentives.

2.4. Institutional barriers and in CE policy implementation within area developments

In the former paragraph attention has already been paid to the barriers of innovative policy implementation in general. In this paragraph the little available research that specifically looks at barriers of CE-related policy implementation will be discussed. Eventually, a scheme with institutional barriers to CE-related policy will be discussed.

Dimension	Barriers
Economic	Existing business models; Financial support and subsidies for existing systems; Market price of resources; Limited financial resources to invest in innovation
Environmental	Availability of natural resources; Carrying capacity of the environment
Technological	Available techniques; Existing technology; Available infrastructure.

Societal	Education level of citizens, shortage of educated personnel; Lack of professional knowledge; Awareness of people; Lack of good understanding of complex systems; Knowledge gap between professionals and larger public; Unknown potentials and uncertainty.
Governmental	Established interests and existing system configurations; Institutions at place, governmental officials; Existing rules and regulation, law system (permits); Complexity and interconnectedness of systems; Uncertainty and other risk factors.
Behavioral	Level of involvement and motivation of people; Mindset of people, personnel and civil servants; Focus on primary business activities; Willingness to invest in innovation and to work together; Social practices and attitude of people; Sense of urgency of stakeholders

Figure 5 Implementation dimensions of CE on macro (city) level (Bosor, 2017)

Bosor (2017) states that the identified dimensions (figure 5) should be proportionately considered in order to successfully implement CE-related policies. He identified per dimension different implementation barriers that are in the way of successful policy implementation. In his research the governmental barrier also incorporates institutional barriers, like existing rules and regulation and the law system, which appears to be a very general description. Bosor (2017) adds that existing policy, rules, regulations and laws form a barrier because of their support to the current linear system. Van Eijk (2015) has a specific addition to the identified barrier of existing regulation, stating that what appeared to be a larger barrier than regulations in place was the 'lack of regulations'. Since a linear economy is already regulated, a circular would also need to be (Van Eijk, 2015). However, van Eijk (2015) does no suggestions for the possible content of these regulations.

Next to Bosor (2017), Torstensson (2016) identified several institutional barriers that exist when implementing circular economy related policy. While Bosor (2017) does not categorize institutional barriers on itself, Torstensson (2016) proposes a broader interpretation of the term institutional and identifies the following institutional barriers (figure 6):

Institutional barriers following Torstensson (2016).	Unleveled playing field created by current institutions
	Financial governmental incentives support the linear economy
	Circularity is not effectively integrated in innovation policies
	Competition legislation inhibits collaboration between companies
	Recycling policies are ineffective to obtain high quality recycling
	Governance issues concerning responsibilities, liabilities and ownership

Figure 6 Institutional barriers following Torstensson (2016)

Remarkable is that Torstensson (2016) incorporates a financial dimension into his analysis of the institutional barriers, while Bosor (2017) makes a distinction between financial (economic) and institutional or governmental barriers. Since the financial system in different researches is described as a sticky system of rules that appears challenging to change and because of the importance of the aspect for the implementation of CE-related policy it will also be incorporated as a dimension of the institutional barriers within this thesis. Besides this distinction, the barriers Bosor (2017) and Torstensson (2016) identified are both partly corresponding to the earlier described barriers that were found during the implementation of similar innovative policy implementation.

In order to create a concrete and complete overview of the institutional barriers of CE-related policy, the researches of, among others, Bosor (2017) and Torstensson (2016) are compared and then combined into one scheme. Then, the institutional barriers are classified as a specific rule type (Ostrom, Gardner and Walker, 1994), which results into the following overview of identified barriers within scientific literature that constrain the implementation of CE policy (see figure 7).

Description	Type of rule	Explanation of rule type
Financial governmental incentives support the linear economy	Pay-off rule	Incentives influence the costs and benefits in the action arena, since they allocate financial benefits. 'Pay-off rules' assign external rewards or sanctions to specific actors relative to distinct actions (Ostrom, 2005).'
Circularity is not effectively integrated in innovation policies	Scope rule	It is the task of a municipality to specify the goals they want to achieve in innovation policies. 'Scope rules' are illustrated by government regulations that specify the goal to be achieved, but allow regulated entities discretion in how best to achieve that goal.
Competition legislation inhibits collaboration between companies	Choice rule	Competition legislation prescribes what companies may or may not do related to competition, which then influences the behavior of companies.
Governance issues concerning responsibilities, liabilities and ownership	Position rule	Governance issues determine the position actors have within a given situation.
Existing business models	Pay-off rule	Traditional business models are used for many decades and assign rewards or costs to input and output of a company.
Financial support and subsidies for the existing systems;	Pay-off rule	Statements that allocate/ influence benefits or costs. 'Pay-off rules' assign external rewards or sanctions to specific actors relative to distinct actions (Ostrom, 2005).'

Market price of resources	Pay-off rule	Statements that allocate/influence benefits or costs.
Limited financial resources to invest in innovation, especially in relation towards the high prices of installation and construction	Pay-off rule	Assign external rewards or sanctions to specific actors relative to distinct actions (Ostrom, 2005).
Legal issues related to the novelty of the concept	Choice rule	Some actors cannot implement their innovative solutions, since law prescribes certain activities that they are not allowed to execute, which constrain the implementation.
Uncertainty and risks that come with innovation	Information rules	Uncertainty is closely linked towards information that is shared about the innovation. The more information a party has, the less uncertainty there exist and the more control a party has.

Figure 7 Institutional barriers that will be used in this thesis based upon (Bosor, 2017), Torensstön (2016), (European Commission, N.D.) and (Edler and Fagelberg, 2014)

As earlier mentioned, an explanation for the existence of the implementation barriers is provided by the rational perspective on institutionalism. People will not change their behaviour since incentives guide them towards the direction of current institutions. For example, subsidies that support the linear business models make it less appealing to create a circular economy business model. However, these incentives might also offer a way to overcome the institutional barriers, since changing incentives, might be a possibility to stimulate or trigger institutional change. When subsidies for circular business models are provided, it suddenly becomes more interesting to develop this kind of business models.

2.4.1 Instruments to overcome the barriers

Bosor (2017), next to an identification of barriers, also proposes several ways to overcome these identified institutional barriers. To challenge the financial problems that occur when implementing CE policy, Bosor (2017) states that new business models should be developed. These business models should primarily be focussed on the Total Cost of Ownership (TCO). Ensuring new and fair business

models is needed in order to get the real value of products and to create a better functioning economy that takes the real value of resources into consideration (Bosor, 2017). Next to this, financial resources and financial stimulus are mentioned as a way to overcome financial barriers. Bosor (2017) considers these 'financial resources' as all investments from private sector to citizens into the circular economy. However, he does not elaborate on how or why people are going to invest and which incentive there is for parties or people to invest, which makes this argument rather weak. A financial stimulus however, is by different authors considered to be a way that the government is able to help the private sector to transition to a circular economy and therefore as a way to make it easier for these parties to adapt to the innovative policy that has been implemented (Bosor, 2017; Prendeville, Cherim and Bocken, 2018).

To overcome the barriers related to current policy, Bosor (2017) states that three things must be changed within the policy: openness, flexibility and cooperation. Where Bosor (2017) does not further elaborate on how to create flexibility in policy, he does specify the cooperation aspect a little as he writes that the role of local policymakers as a facilitator of cooperation is considered to be important. Prendeville, Cherim and Bocken (2018) also call strong cooperation of stakeholders on different levels as one of the requirements of successful implementation of CE-related policy. However, how these can be incorporated or transformed into specific instruments and which cooperative contracts these might be remains unspecified.

2.5 Conceptual framework

Based upon the IAD framework, the barriers identified within scientific literature and the ways that these barriers might be overcome, the following conceptual framework can be created (figure 7).

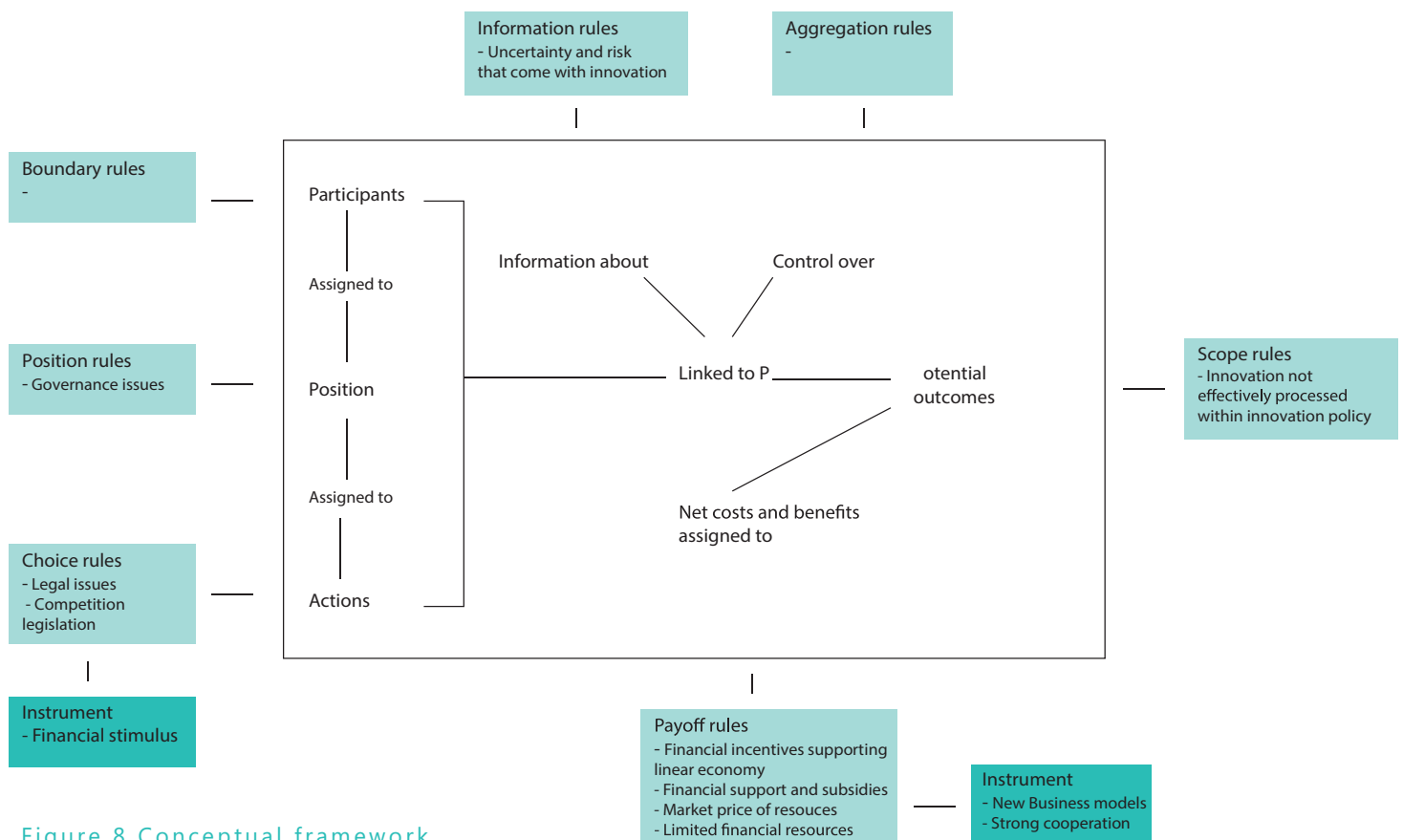


Figure 8 Conceptual framework

2.6 Circular economy: the concept

This paragraph gives an overview of relevant literature on the circular economy in order to come to a clear understanding of the concept. First, the circular economy concept will be related to other concepts, which share common elements, in order to put the concept into perspective.

2.6.1 Relation with other concepts

The circular economy concept has a lot in common – and is often confused – with several other concepts that are currently popular within recent scientific literature (Homrich et al., 2015). One of these is the concept of urban metabolism, which considers

“the sum total of the technical and socioeconomic processes that occur in cities, resulting in growth, production of energy, and elimination of waste.” (Kennedy et al., 2007, p. 44).

Urban metabolism is a framework for modelling complex urban systems flows, varying from energy to water flows (Delft University of Technology, 2018). Another CE-related concept is the eco-city, which is motivated by the need for knowledge resources of, among others, nearing exhaustion. This led towards different waste-reduction or zero-waste programs (Ghisellini et al., 2015). Although the two different concepts has seen some successes, they rely heavily on subsidies and remain too focused on industrial parks and not necessarily on cities as a whole (Prendeville, Cherim and Bocken, 2018). A last concept related to the CE is the concept of smart city. This concept has gained more popularity the past years and is seen as a way to achieve urban sustainability. It also is considered to be an enabler of CE initiatives (Prendeville, Cherim and Bocken, 2018). Other authors (Ghisellini et al., 2015) describe how new digital capabilities can benefit through smart management of natural resources with the use of participatory governance. The concept of smart city is related to the gathering of data to monitor and optimize resource use with the help of technology, which is also important within a circular economy. Still some critiques exist on the smart city concept, since some state that it ‘blindly’ embraces technologies and does not take into account the socio-environmental impacts (Ghisellini et al., 2015).

2.6.2 Defining the Circular Economy (CE)

Because of the close relations with other concepts as well as the earlier mentioned several different epistemological perspectives on the circular economy concept it is important to find an inclusive and clear definition of the circular economy. The concept of circular economy knows different definitions, but most of the definitions agree that circular economy is related to cyclical thinking and is an idea or ideal for facing the increasing limitations of the earth’s natural resources (Homrich et al., 2015; Prendeville, Cherim and Bocken, 2018). This

cyclical thinking differs from the linear thinking of the current economic system. To clarify the difference between a circular and linear system, both systems are visualized:

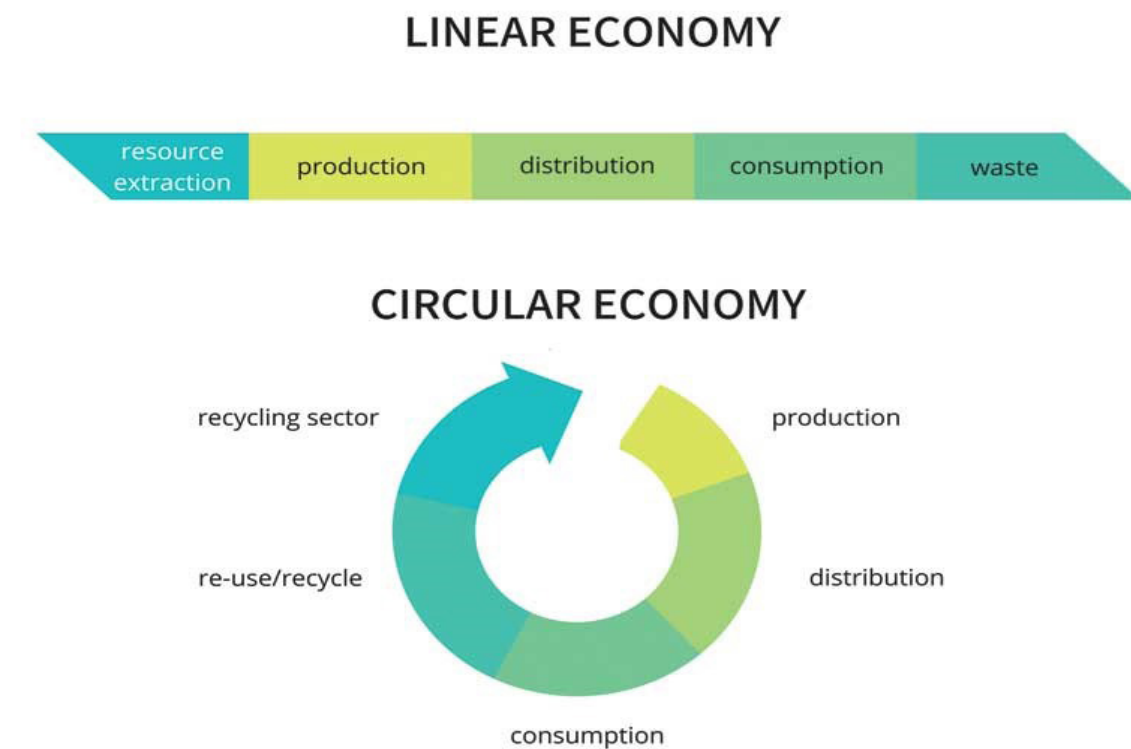


Figure 9 Difference between a circular and linear economy, The Construction Specificier (2018)

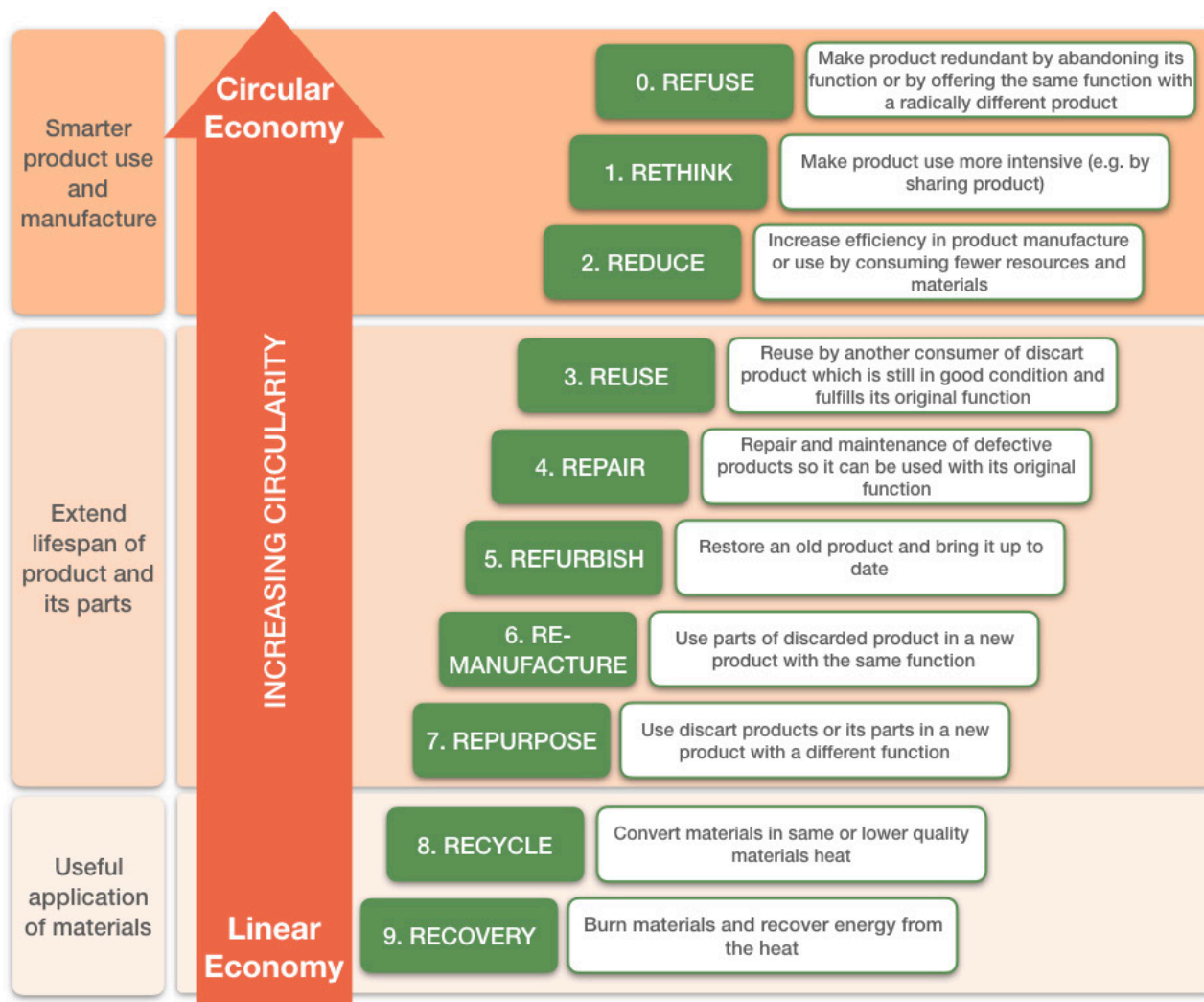


Figure 10 9R model from Arthur (2017)

Kirchherr, Reike & Hekkert (2017) compared different definitions that are used in literature and found that most scholars describe circular economy by referring to the 3Rs: Reducing material need and waste, Reusing products and product parts and Recycling materials. Many definitions also consider a system change as a fundamental part of reaching a circular economy.

The 9R model (figure 9) adds another 6Rs that are included within a circular economy and further specifies the concept. The distinction between different ambition levels that Arthur (2018) provided, helps to distinguish the importance of the large amount of measures in circular construction (figure 11). The highest ambitions level is refuse and the lowest level is recovery and describes the linear economy. Here, waste is burned and energy and heat is recovered from it (Arthur, 2018).

Although the amount of publications on circular economy is growing, there is no real definition of circular economy yet (Circle Cities, N.D.). The Ellen MacArthur Foundation (2016, p. 18) which is working on this topic for a couple of years, states that the CE concept *'is characterised, more than defined, as an economy that is restorative and regenerative by design and which aims to keep products, components and materials at their highest utility and value at all times'*.

This lack of a general definition that is agreed upon also means that there are no official standards on how to measure circularity yet. This is related to the fact that in different sectors different indicators are important (Circle Cities, N.D.). Although the principles of the circular economy are more or less the same for different sectors, the definition and operationalization of the concept might differ. This is also the reason why it is important to provide a definition and operationalization of the concept when applied to the construction sector instead of trying to provide a clear and official definition of the concept in general.

Before gaining more insight into circular economy applied to the construction sector, there will be looked at some critiques on the circular economy concept. There exist critique from different angles on the CE concept. The most well-known critiques are the Rebound Effect, Jevon's paradox and the Boomerang effect, which all refer to the limits posed by physical economic growth (Korhonen et al., 2017). Zink and Geyer (2017) argue in their article that circular economy activities might increase overall production, which might fully or partly offset their benefits. The circular economy rebound effect focusses on secondary goods that are created with reuse and recycling. There are at least two mechanisms that can lead to a circular economy rebound. The first has to do with the substitutability of secondary goods (Zink and Geyer, 2017). Different recycled materials, like for example metal, are contaminated with materials that reduce their utility and value. This leads to a situation where some metals are likely to be produced in addition to, rather than instead of, primary metals and with this the benefits of CE decrease (Zink and Geyer, 2017). The same applies to many goods where technology changes too rapidly to support a secondhand market.

The second mechanism has to do with the effect of secondary goods on market prices, when secondary production activity impacts prices (Zink and Greyer, 2017). To see how this happens, one has to consider again that some circular economy goods are lower quality than their primary production counterparts. In order to stimulate buyers to buy downgraded materials, sellers offer them the products at a discount relative to primary materials. Downstream producers that choose to

substitute with secondary material are now comparatively wealthier (this is the income effect) and can purchase more material and use it to make more products than they could before (Zink and Greyer, 2017). It is likely that these products will also be of lower quality and will need to be sold to end users at a discount, which leads to a multiply of the income effect.

2.6.2 Circular construction

There has been done relatively limited research on the application of circular economy principles in the built environment, since the focus of the research related to circular economy has focussed on short- and medium lived consumer products (Adams et al., 2017). Across Europe, most research and activity in the field of circular economy has focused on end-of-pipe solutions that should manage waste generation (Adams et al., 2017). Although regarding institutional barriers of the application circular economy within the construction sector there is almost no scientific literature available, there are different documents that try to define and operationalize the circular economy within the built environment and construction sector. When investigating the difference between traditional and circular construction, one can find that both consists of almost the same steps from concept towards realization. However, based on literature, there are two important differences. Firstly, circular construction takes into account use, maintenance and eventual disassembly, restructuring or reuse. Thinking about these dimensions might influences the type of partners which is cooperated with and the form of contract that is used (Circulair Friesland, 2018; Boros, 2017). Second, circularity asks for innovative development and acting. The creation of fitting conditions for innovation is essential for its success (Circulair Friesland, 2018; Boros, 2017). To create these conditions for innovation one could think about actions like attracting certain parties within an early phase of the area development or using certain forms of tendering, since some forms of tendering might provoke innovation sooner than others. However, when one takes a closer look into the different phases of the realization of circular constructions, one can find that within these phases there are a lot of different CE-related principles that can be applied or taken into account that do not specifically change the process, but still have an impact on the kind of topics and subjects that are taken into account.

When we take a step back and try to come to a definition for circular construction, we find that often circular building/circular construction and circular area (re-)development are confused, while also overlapping. The biggest difference is that circular area development focuses on, next to the construction of buildings and offices, water reuse, renewable energy and sometimes even mobility issues (Ter Heijden, 2018). Compared to circular construction, circular area development is more integral incorporating several other aspects next to construction.

Although there is no clear definition of circular construction within scientific literature, The Dutch 'Bouwagenda' (Nelissen et al., 2018, p. 10) recently created a comprehensive definition for circular construction, which is the following:

'developing, use and reuse of buildings, areas and infrastructure without using natural resources unnecessarily, the environment and ecosystems to affect. Build

in a way that is economically justified and contributes to the welfare of humans and animals. Here and there, now and later.'

From this definition, among others, it becomes clear that also resource-efficiency is an important element of circular construction, which is confirmed by different definitions of the concept (MVO Nederland, 2015; Prendeville, Cherim and Bocken, 2018). The definition provided by the Dutch Bouwagenda has been set up by different parties from governmental organisations, market parties and the scientific community. Because of the diversity of parties that acknowledge this definition and the compensability of it, this definition will be used in this research.

Still, a general definition of circular construction offers too little support when trying to identify institutional arrangements that affect the implementation of CE policy within the construction sector. Adams et al. (2015) provided an overview of the circular economy concept applied to a building's life cycle, which creates a more detailed perspective on what an application of the CE concept on the construction sector incorporates. These principles will be used to identify circular construction during the data collection. However, it is impossible to identify and analyse all these different principles, because of the limited resources available for this research. This is why the principles that are most frequently mentioned and/or considered to be most important during data collection will mainly be discussed within this research. The importance is also depending on the level of ambition that the barriers and opportunities apply to as discussed by Arthur (2018): barriers and opportunities that constrain reuse are considered to be more important than barriers constraining recycling.

Life cycle stage Circular economy aspect	
Design	DfD Design for adaptability and flexibility Design for standardisation Design out waste Design in modularity Specify reclaimed materials Specify recycled materials
Manufacture and supply	Eco-design principles Use less materials/optmise material use Use less hazardous materials Increase the lifespan Design for product disassembly Design for product standardisation Use secondary materials Take-back schemes Reverse logistics
Construction	Minimise waste Procure reused materials Procure recycled materials Off-site construction
In use and refurbishment	Minimise waste Minimal maintenance Easy repair and upgrade Adaptability Flexibility
End of life	Deconstruction Selective demolition Reuse of products and components Closed-loop recycling Open-loop recycling
All stages: management of information including metrics and datasets	

Figure 11 Circular economy across a building's life cycle (Adams et al., 2017)

Chapter 3 Methodology

3.1. Research strategy

Different research strategies are known within social sciences, which each differ in their way of collecting and analyzing empirical evidence (Yin, 2014). Each strategy also has its own advantages and disadvantages. Yin (2014) states that it is necessary to formulate an answer on two questions before deciding which strategy will be used. Firstly, one has to consider whether control over behavioral events is required. The second question is if the research focusses on contemporary events. Also the form of the research question is determining in the choice for a certain strategy. The characteristics that are determining the research strategy following Yin (2014) are presented in the following overview:

Strategy	Form of research	Require control over behavioral events?	Focus on temporary events?
Experiment	How, why	Yes	No
Survey	Who, what, where, how many, how much	No	Yes/no
Archival analysis	Who, what, where, how many, how much	No	Yes/no
History	How, why	No	No
Case study	How, why	No	Yes

Figure 12 Overview of different research strategies by Yin (2014)

Firstly, within this research no control is required over the behavioral events. Second, given cities undertaking CE activities is a relatively novel and emerging phenomenon, this research is strongly related to contemporary institutional environments. Thirdly, the research question consists of both a what-question and which-question. Based upon this, the survey, case study and archival analysis are likely to be the most fitting research methods for this research. Yin (2014) states that survey research is more likely to be advantageous when the goal of the research is to describe the prevalence of a certain phenomenon or if the aim is to be predictive of a certain outcome. The same applies for archival analysis (Yin, 2014). This however, is not the case within this research. Case study research, as Eisenhardt (1989) describes, is often used in new topics and when a research is attempting to explore and understand, rather than to quantify and confirm. This research is from exploratory nature, which forms an argument to consider the case study as an appropriate way to investigate this phenomenon. Next to this, often when the impetus of the research lies in broad, familiarizing questions about a

particular social process, it might be fitting to do a case-study (Yin, 2014). This broad question often is caused by a lack of knowledge, since otherwise one could have formulated a more specific hypothesis (Yin, 2014). As earlier argumentized in this research there is a significant knowledge gap, which indeed is able to explain the broad main question within this thesis. That the case study might be a fitting approach is also confirmed by the literature review of Homrich et al. (2017), which shows that the case study is most often used within CE research. Based upon the past paragraph, there is chosen to use the case study as a research strategy.

Although there are many advantages to execute case study research, like the ability to provide an in-depth understanding of complex phenomenon's, there exist different critiques. One particular critique is the question whether one is able to generalize from only one case; some scientist state that the case study provides only a little basis for scientific generalization (Yin, 2014). To address this it might be possible to do a multiple case study, which is one specific variant of the research strategy. Another frequent critique is that case studies take too much time and result into lots of unreadable documents. However, there are different innovative ways available to execute a case study with which a long narrative can be avoided (Yin, 2014).

An important danger when doing a case study is that the reliability and validity come into question (Kelliher, 2005). Two forms of validity are known: the external and internal validity. The internal validity refers to the establishment of a causal relationship, whereby certain conditions are shown to lead to other conditions. A way to ensure this is to use source tremor, which means that multiple data collection methods will be used side by side. Important related to the internal validity is that the reader is able to easily follow the formulated conclusions (Kelliher, 2005). The conclusions should therefore be derived logically and comprehensibly from the data collected. The external validity refers to the establishment of the domain to which a study's findings can be generalized (Kelliher, 2005). This has been described earlier and in this paragraph and as told by executing multiple case studies instead of a single case study this might be tackled.

At last, a research is reliable when the operations of a study, for example the data collection procedures, can be repeated with the same outcome. Since case study research is very depended on its context a clear description of methodology is from high importance to ensure the reliability of the research. Also, it is highly important to follow systematically procedures.

3.1.1 Multiple case study

When a researcher has decided on a certain research strategy, there still remain several considerations and choices related to the chosen strategy that should be taken into account. When executing a case study, an important consideration exists between a single and multiple case study. An earlier mentioned advantage of using multiple cases is that the evidence is often considered more compelling and the research is regarded as more robust. However, a multiple case study often takes more extensive resources and time that lay beyond the means of a student or researcher. Also, Yin (2014) emphasizes that the decision to do a multiple case study cannot be taken lightly, since every case should serve a specific purpose within the whole research (Yin, 2014).

When decided to execute a multiple case study, a decision has to be made related to the amount of cases that will be analyzed. The number of cases included is usually limited since a deep understanding of each case is needed and this requires intensive data collection and analysis. Also in this research there is a limited time span. Yin (2014) states that when the researcher is unsure whether the external conditions will produce different case study results it might be helpful to select a larger number of cases. Since this research will be from an exploratory nature there is no high certainty needed or possible. However, in order to provide more compelling evidence for the barriers and opportunities for circular area development, a multiple case study will still be executed. But, because of the limited time span and limited resources available, only two cases are selected. Important to highlight regarding this decision is that the goal of the multiple case study is not to execute a comparative analysis. The motivation behind executing a multiple case study is to provide a more extensive description and understanding on the barriers and opportunities behind circular construction and not to explain differences within the policy implementation of the concept (Yin, 2014). However, if there is an additional value of making a comparison between the different cases, this will not be ignored. Important to highlight however is that opportunities and barriers are depending on the institutional context of the case, which means that these might differ per country or city and therefore also identified opportunities cannot be copied or transferred without adapting these to the context of a specific city or country.

3.1.2 Cross-national case study

Now we arrive at the last feature of the research strategy; the case itself. In this thesis a cross-national multiple case study will be executed. We currently live in an increasingly "globalized" world, in which the local, national and international dimensions are more and more interwoven. It is therefore almost inevitable for a significant amount of countries and cities to feel the need to look at each other's experiences when making important political and administrative decisions. This context of increasing interdependence between nations makes it quite easy to understand the reason for the growing interest in, especially international, case study research (Belfiore, N.D.). During cross-national research, one might encounter different barriers. The two most frequent mentioned barriers are a language barrier and cultural differences. The level of English is considered high in the Netherlands as well as Sweden, as both countries are in the top 5 of countries with the highest English proficiency (EF, 2018). If there are any issues related to language these might be solved with Google Translate or a dictionary. Next to this, the Netherlands as well as Sweden are both developed European countries and therefore the cultural differences are small (Grol, N.D.). What is important especially for this research is a thorough understanding of the planning systems of both countries in order to better understand the nature of the barriers or opportunities within circular construction. A lack of understanding of the different contexts might lead to wrong explanations. This is why a comprehensive analysis of the Swedish and Dutch planning system will be included in the case study.

3.1.3 Case selection

When a case study intends to generalize the findings of his/her research it is done by audiences through 'naturalistic generalization'. The researcher focusses on understanding the case. Sometimes the case is chosen on intrinsic base, however most are purposefully or analytically selected. A case may be purposefully selected in virtue of being, for instance, information-rich, revelatory, unique, or extreme (Swanborn, 2010). If a case is purposefully selected, then there is an interest in generalizing the findings. In this thesis two cases will be purposefully selected. The cases are selected because they are considered 'information rich'. Since the circular economy concept within the construction sector is relatively new, there are only a few cases of CE policy implementation known.

Within a case-study can be chosen for different levels of detail: a micro level (persons or interpersonal relations), meso level (organization/institutional) or macro level (large communities/nation-states) (Swanborn, 2010). It also matters whether one actor or more actors are involved. These characteristics are important because every meso or macro-level case study has its own tradition and specific character (Swanborn, 2010). Within this research is chosen for a meso-level case study, since CE is especially interesting on a city-level for a number of already mentioned reasons.

Different cities are currently working on circular economy. Circle Cities (N.D.) provides an overview of cities and regions that are considered frontrunners on the circular economy. The cities that are mentioned within this list are Amsterdam, Rotterdam, Haarlemmermeer and Venlo. The city of Amsterdam developed several policy documents on circular economy and, what is interesting from the perspective of this research, the municipality of Amsterdam focuses among others on circular economy within area development and the construction sector. Because of this focus, the quantity of policy documents available and their frontrunner position, the city of Amsterdam will be the first case study.

Circle Cities (N.D.) provides an overview of international frontrunner regions on its website, but these frontrunners are mainly focusing on circular economy in the consumption or food chain and not especially within the construction sector. In order to find a suitable second case study in which the CE concept circular is applied within the construction sector, different high profiled sustainability area developments are investigated on their goals related to circular economy. Examples of high profiled sustainability area projects are HafenCity in Hamburg, Royal Seaport in Stockholm and Clichy-Batignolles in Paris. Only the Royal Seaport project explicitly mentions several sustainability goals related to resource-efficiency and circular economy within construction (Stockholms Stadt, 2015). When further investigating, one finds that the Swedish Environmental Protection Agency (Naturvårdsverket) carried out a waste management plan that focuses on how to improve the management, reduction and reuse of construction and demolition waste (CDW) (Naturvårdsverket, 2014). On top of this, also Stockholm created a waste management plan in which the reuse and reduction of waste in the construction sector plays an important role (Stockholm Vatten och Afvall, 2017). Based upon the different policy documents within Stockholm and Sweden that discuss the circular economy concept within the construction sector, Stockholm will be selected as the second case study.

3.1.4 Research methods

Now that the research strategy has been determined, the next step is to define the research method. Data can be derived with the use of a qualitative, quantitative or mixed research method (Verschuren en Doorewaard, 2000). A quantitative approach studies a phenomenon in a way that only some factors or variables remain; this method thus simplifies the context (Everaert & Peet, 2006). Quantitative research is often considered as a less detailed form of research, because it ignores underlying motivations by giving answers.

Swanborn (2010) partly based the distinction of qualitative and quantitative research upon the difference between extensive and intensive research. In extensive research one uses a large set of events, people or organizations to ground the conclusion about a certain phenomenon. With extensive research the methods do not look at the development of one person. Instead, the answers collected are aggregated over all respondents to create information about for example the relationships between variables. In contrast, within intensive research the method used focusses on one or a handful instances of the phenomenon. Each of the instances is studied within their own context and in greater detail than with the extensive research.

Another key difference between quantitative and qualitative methods is their flexibility. Generally, quantitative methods are considered inflexible. With quantitative methods such as surveys or questionnaires, researchers ask the participants identical questions in the same order. The response categories are often closed-ended or fixed. The advantage of this inflexibility is that it allows for a meaningful comparison of responses across all participants. However, it requires a thorough understanding of especially the important questions to ask and the range of possible responses. An advantage that has been offered by the flexibility of the qualitative method, which is important in more explorative research, is that it offers the possibility to change paths during the data collection (Swanborn, 2010). Also the changes are little that the outcomes have no meaning. This is mainly caused by the fact that within interview one can discuss and talk with the research objects

Earlier in this chapter was decided on a research strategy, which in this thesis will be the case study. Swanborn (2010) states the following related to the case study and the choice between qualitative and quantitative research: 'In identifying 'case studies' with 'intensive research' and focusing on the perceptions, interactions and decisions of people, we attach a substantive meaning to the label 'case study'. This contrasts with a purely formal approach, in which a case study would relate simply to the study of one case versus other approaches that involve a number of cases (Swanborn, 2010, p. 14). Swanborn (2010) thus acknowledges that quantitative (extensive) as well as qualitative (intensive) methods can be used within a case study. However, since a clear and deep understanding of the context of the barriers and opportunities is from a high importance in this research a choice for a qualitative research method is obvious. Next to providing a deep understanding of a phenomenon, a qualitative research method makes it possible to ask further questions and to change paths. Since this research is exploratory of nature, the latter is very important.

The three most common qualitative methods are participant observation, in-depth interviews and focus groups (Yin, 2014). Each of these methods are particularly suited for obtaining a specific type of data. In-depth interviews are optimal for collecting data on personal perspectives or experiences. Participant observations are appropriate for collecting data on naturally occurring behavior in a usual context. At last, focus groups are effective in eliciting data of a group and in generating broad overviews of issues of concern to the different groups or subgroups represented (Swanborn, 2010). In this research will be worked with in-depth interviews in order to create a perspective from different parties on the barriers and opportunities of circular construction.

3.1.5 Semi-structured interview

Within research it is important to choose the right technique to ensure that the data is collected in a scientific and standardized way (RAND, 2009). RAND institution (2009) states that interviews are the best way to provide a complete response with the depth of information that might be useful. When interested in determining a certain emphasis on a particular issue, interviews permit the researcher to ask for an emphasis. The researcher might ask someone to prioritize issues or assign weights to the different topics. Also, data is more likely to be generalizable if they are well sampled and collected by a large number of interviews than with for example focus groups (RAND, 2009).

Interviews can be used for a variety of purposes. They can be used as primary data collecting method in order to collect information from individuals about their own practices or beliefs, but also information on past or present experiences can be collected. Interviews also might be used to gather background information or to make use of the expert knowledge of an individual (RAND, 2009). In this thesis interviews will be used as primary data collecting method.

Interviews can be structured, semi-structured and completely unstructured. Semi-structured interviews are often used in policy research. With semi-structured interviewing, a guide with questions and topics that must be covered, is used (RAND, 2009). The interviewer has some discretion about the order in which the different questions are posed, but the questions are standardized and probes are often provided in order to cover all the correct and needed material. These semi-structured interviews are used when the researcher wants to deeply delve into an issue and wants to create a thorough understanding of the answers provided. Structured interviews are mainly used when a researcher is looking for data that can be generalized to a large population (RAND, 2009). A structured interview has fixed questions and also the questions are posed in a fixed order. With unstructured interviews the researcher has a plan, but minimal control over the way the respondents answers. Therefore, the conversations can head into different directions (RAND, 2009). Within this thesis will be worked with semi-structured interviews. These provide the structure and systematic approach that is necessary to guarantee the reliability of this research, while also offering the possibility to discuss upcoming topics, which is from importance when discussing a relatively new concept.

3.1.6 Document analysis

Like other analytical methods in qualitative research, document analysis requires that data can be examined and interpreted in order to elicit meaning, gain understanding, and develop empirical knowledge. The data might include different documents, like agendas, event programs, books or minutes of meetings.

As a research method, document analysis is particularly applicable to qualitative case studies—intensive studies producing rich descriptions of a single phenomenon, event, organisation or program (Bowen, 2009). Documents can serve a variety of purposes as part of a research undertaking. Bowen (2009) considers five specific functions of documentary material:

- documents can provide data on the context within which research participants operate
- information contained in documents can suggest some questions that need to be asked and situations that need to be observed as part of the research
- documents provide supplementary research data. Information and insights derived from documents can be valuable additions to a knowledge base.
- documents provide a means of tracking change and development. Where various drafts of a particular document are accessible, the researcher can compare them to identify the changes.
- documents can be analysed as a way to verify findings or corroborate evidence from other sources.

Document analysis in this research will mainly serve for the first three purposes as an additional data collection method, next to in-depth interviews, in order to achieve source tremor.

3.1.7 Subject selection

Subject selection in qualitative research happens purposefully, in contrast with selection in quantitative research. The participants are selected on their ability of informing the research questions and their understanding of the phenomenon. Therefore, one of the most important steps within the research design is to identify appropriate participants. Choices regarding selections are mainly based upon the theoretical perspectives and questions. Another choice related to this selection is the sample size. The sample size is within qualitative research not predetermined (Sargeant, 2012). The number of participants depend on the number required to fully inform all important elements of the phenomenon that is being studied. This is the case when additional interviews or focus groups do not result in the identification of new concepts and an end point called data saturation is reached (Sargeant, 2012). In order to determine when data saturation occurs, the analysis ideally occurs concurrently with the data collection in an iterative cycle. This makes it possible to document the emergence of new themes and to identify perspectives that may otherwise be overlooked (Sargeant, 2012).

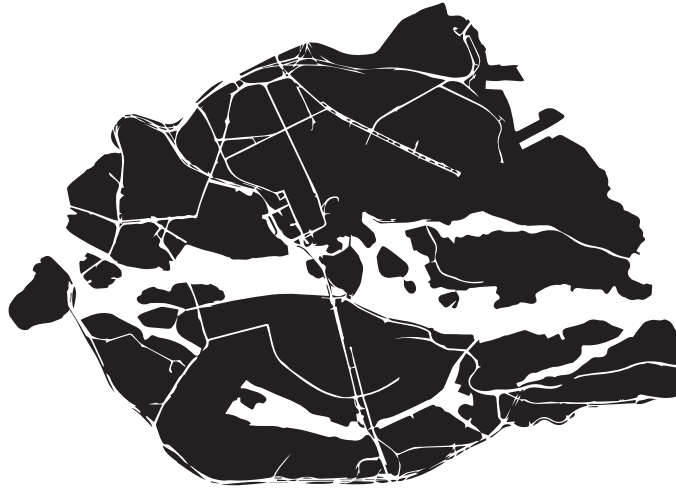
As said are the choices regarding selections mainly based upon the research questions and the theoretical framework. Since the subjects or respondents sampled must be able to inform important facets and perspectives related to the phenomenon being studied, they have to or had to be involved with circular construction in the present or past. Next to this, the respondents are selected on the organization they are working in. Preferably, in order to analyse multiple perspectives on the implementation of CE related policy in construction projects, respondents from the private as well as public sector are selected, which is why the respondents consists of project developers, an advisory company, the municipality, contractors, and an architect and lecturer. During an internship at the municipality of Amsterdam has been spoken to different colleagues from different departments on the topic of circular construction. Reports of these conversations and meetings are included in the data analysis.

Regarding the document analysis, the documents that will be analysed are policy documents from different levels (national, regional, municipal), documents from organizations working on circular area development and data derived during an internship at the municipality of Amsterdam. The data from the latter consists among others of reports of several meetings.

3.1.8 Data analysis

To make sure that the data collection occurs in an iterative cycle as the interviews and documents will be gathered and analysed with the use of Atlas.ti and form input for future interviews in order to validate the information gained. With Atlas.ti the data will be systematically analysed, by firstly open coding and then axial coding the data. Systematically analysing the data is very important, as earlier explained, to secure the internal validity and reliability of the research. With open coding labels are assigned to pieces of text in order to indicate what the text is about. Each fragment can have multiple labels, so you can analyse per theme or keyword. Within this thesis the labels used are relatively general, namely 'barriers' and 'opportunities'. After coding one or two transcripts, it makes sense to perform a brief evaluation, possibly revising the label structure before continuing with the next transcripts (Tubbing, 2019). After open coding of several interviews the label 'organization' has been added to the themes. It may also be useful to start axial coding between interviews, so relevant questions can be identified for subsequent interviews. This has also been done during this research. In the second step, axial coding, the fragments identified with open coding are usually compared with each other. This is a technique whereby codes are operationalized and validated by comparing them. In addition, different groups can be identified based on this coding. The codes within this research will be divided into preselected groups, namely the rule types of Ostrom. Although the codes will be arranged in these preselected 'themes', barriers or opportunities that will not fit within this framework, will be arranged into new code themes. For example the group 'aesthetic barriers' has been added.

Chapter 4 Case study Stockholm



The city of Stockholm has around 962.154 inhabitants and a surface of 215,9 square kilometre (Jelly, 2019). As the largest city of Sweden, Stockholm is also the capital. The city is currently expanding and the 1,3 million inhabitants that are predicted to live in the city by 2040 foster the need for a larger housing stock. The city council states that advanced sustainability efforts are required in order to create an effective urban environment for the city's inhabitants in this rapidly growing region (Stockholms Stadt, N.D.). This, among others, might be why the Municipal Council in 2009 designated the Royal Seaport, which is with 12,000 houses the largest area development in the city, as Stockholm's new environmentally profiled area (Stockholms Stadt, 2015). This designation provided the foundation for this area to become a national as well as international example for sustainable urban development. The Royal Seaport project contributes to the 140,000 houses that will be built in Stockholm between 2010 and 2030 (Clark and Moonen, 2015). Before diving into circular construction in Stockholm, an overview of the Swedish planning system will be provided in order to fully understand the influence of circular economy and the possibilities for circular constructions for the construction sector and area development in Stockholm.

A first step in the IAD framework is to address the underlying factors of an action arena and how they are affecting the arena. These underlying factors consist of attributes of the community and the influences of the (bio)physical world. One of the influences of the physical world that is important for the application of the CE concept in the construction sector are the limitations on materials, as some materials currently cannot be recycled or reused, because of the chemical content of the materials (Swedish Environmental Protection Agency, 2014). Next to this, some buildings know a high rate of pollution, especially in within the Royal Seaport area in Stockholm (Lennartsson, personal communication, 2019). Since materials or soils are highly polluted within the area, these cannot serve a new purpose within the construction of new housing. Next to this, the extreme weather constrains the prevention of wrapping materials, as materials otherwise become damaged. One of the main restrictions of the biophysical world within this case is that Sweden is not that densely built and therefore a lot of buildings are built on onbuilt plots, which makes it harder to harvest any materials

(Jakobsson, personal communication, 2019). An attribute of the community that has a significant influence on the action arena is the attitude of the construction industry towards innovation and circular construction as the construction industry within Sweden is very conservative (Lennartsson, personal communication, 2019).

As described in the theoretical framework a second step in institutional analysis is to describe the identification of a conceptual unit, the action arena (Ostrom, Gardner and Walker, 1994). This action arena is the focus of the analysis. When answering several questions mentioned within the theoretical framework that help to identify the action arena, the following arena can be constructed:

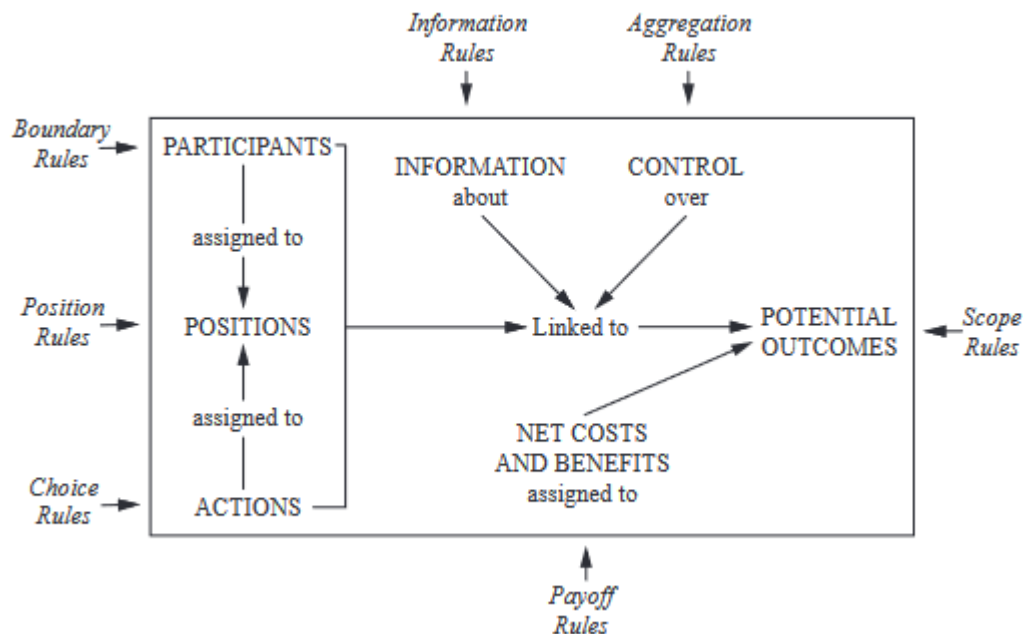


Figure 13 Action arena of the IAD framework (Ostrom, 2005, p.189)

Participants: municipality of Stockholm, market parties, inhabitants of Stockholm

Positions: contractor, contracted project developer, municipality, inhabitants, future inhabitants, investors of the project developer, suppliers, architect

Actions: putting incentives in place that stimulate the circular economy, the implementation of the CE principles within a building's life cycle (figure 11)

Costs and benefits: additional costs for constructing a circular building, profit from selling the building, costs for municipality to prepare the land and planning documents

Information: consultancy reports, policy documents, contracts, meeting reports, information sessions, training programs

Control: the municipality of Stockholm can steer market parties in the right direction during the tendering process, investors often have control over the budget of the project developer, project developers assign contractors, architects and suppliers

Potential outcome: the exact potential outcome is not clear yet, since only a little amount of circular constructed buildings exist

There has to be noted that this is a general action arena and the situation might differ per project.

4.1 Sweden's planning system

In the following paragraph, different relevant elements of the planning system in Sweden will be discussed on a national, regional and municipal level in order to understand the responsibilities per governmental level as well as the coherency between and content of these different layers of the Swedish planning system.

4.1.1 National

The Parliament is the supreme political decision-making body in Sweden, which appoints the Prime Minister who forms the Government (Boverket, 2018). The national government of Sweden has no planning competence. However, despite the planning monopoly of municipalities, the State can interfere in municipal planning in order to protect the national interests, national resources and to handle inter-municipal issues.

National interest in Sweden is regulated through different laws, the two most relevant for this research are the Planning and Building act and the Environmental Code. The Planning and Building Act regulates the planning of land and water resources as well as buildings and is therefore the main legal framework that defines the planning system in Sweden. This law also arranges the distribution of responsibilities between municipalities and the national government. Boverket, the National Board of Housing, Building and Planning is the governmental authority that is mainly responsible for spatial planning policy and supervision on town and country planning from a legislative, procedural and architectural perspective (Boverket, 2018).

The Planning and Building law refers several times to the Environmental Code, for example concerning resource management, environmental quality standards and soil contamination (Ministry of the Environment, N.D.). The Environmental Code, which contains the fundamental environmental rules, aims at supporting sustainable development that builds upon the principle that the human right to change and use nature is strongly associated with a responsibility to manage nature in a good way (Ministry of the Environment, N.D.). The Swedish Environmental Protection Agency (SEPA) carries out assignments on the topic of environmental issues on behalf of the Swedish Government.

4.1.2 Regional

There are 21 counties in Sweden that have two organisations with different obligations, the County Administrative Board and the County Council. Like the national planning level, the regional planning level in Sweden is relatively limited (Boverket, 2018). The County Administrative Board is considered to be the link between the local and the national/state level, since it represents national government locally and local interests nationally (Boverket, 2018). This board might be considered as the extended arm of the state in the different regions as its main responsibility is to coordinate the development of the county in line with goals in national politics. The county administration has no planning competence,

but gives advice and provides background materials to the municipalities as well as ensures that the planning is suitable with regard to national interest (Boverket, 2018). Next to this, the Administrative Board handles and coordinates cross-municipal issues, such as infrastructure, climate and regional housing supply, since these issues often require resources and abilities that individual municipalities have difficulties mobilising (Boverket, 2018).

The County Councils are a policy-making assembly elected by the residents of the county. The Stockholm County Council has planning competence and produces a regional plan (Boverket, 2018). This planning document does not have any legal status, but serves as guides for the municipalities' own planning. Regional planning is, however, only undertaken in two regions, one of which is the Stockholm area.

4.1.3 Municipal

There are 290 municipalities in Sweden of varying size with regard to surface area and number of inhabitants. The decentralized municipal monopoly on spatial planning is a distinctive feature of the Swedish planning system and gives the municipality an ultimate authority to decide on its plans (Boverket, 2018). The Planning and Building Committee at the municipality is responsible for planning and approval of plans. In larger municipalities this committee closely works with the Property Management Committee and the Transport Committee. The former is responsible for housing policy and development of municipal land, as well as assessment of land demands for among others housing and industry (Boverket, 2018).

Following the Planning and Building Act, the Swedish planning system consists of a regional plan, a comprehensive plan, area regulations and a detailed development plan (figure 12) (MILT, 2014). Only the area regulations and the detailed development plan are legally binding documents. However, the regional plan and the comprehensive plan might be considered as indicating the overall direction of the municipality over a significant time period. The plan is considered to be a guidance in the development of the detailed development plan and the permit granting process.

The municipalities are obligated to have a current comprehensive plan that covers the entire area of the municipality. In the comprehensive plan, the municipality has to present some basic characteristics of its intended use of land and water areas (Boverket, 2018):

- how the built environment is going to be used, developed and preserved
- what consideration is to be given to public interests
- what the intention is regarding how national interests and environmental quality standards are to be served.
- the plan must also indicate how the municipality intends to take into account national and regional goals, plans, and programmes of significance for sustainable development within the municipality.

Area regulations enable the municipality to regulate these basic characteristics to safeguard the purposes of the comprehensive plan or to satisfy the national interest (Boverket, 2018). They can also regulate the degree to which building permits are required for certain measures.

A detailed development plan enables the municipality to regulate the use of land and water areas and what the built environment is to look like in a particular area. Detailed development plans are generally prepared when new construction is to be carried out in a dense area and often incorporate one or several city blocks (Boverket, 2018). The detailed development plan regulates what are public spaces, development districts and water areas and how these are to be used and designed. The perquisites in the detailed development plan are binding for building permit applications. Individuals are accorded a utilisation right in the detailed development plan that may not be changed during the period of its implementation, which is usually 15 years (Boverket, 2018). The development of both the comprehensive and the detailed plan includes several series of consultations of the municipality with the County Administration Board, neighbouring municipalities, the public and other stakeholders.

After discussing the most important aspects of the Swedish planning system, the following figure summarizes these: (figure 14):

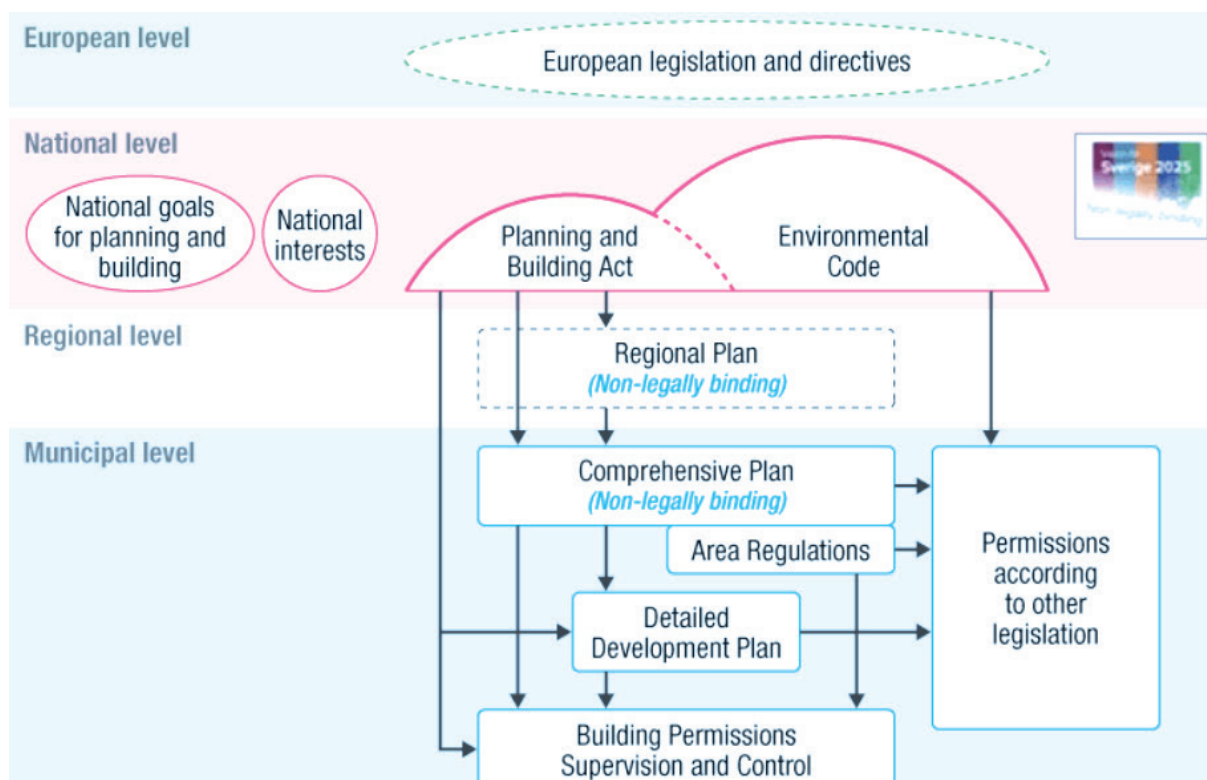


Figure 14 Overview of the Swedish planning system (MILT, 2014).

4.2 Policy framework

Now a light has been shed on the Swedish planning system will be continued with an introduction into circular construction in Sweden and especially in Stockholm by discussing the current most relevant policy documents that incorporate the principles of circular construction as described within the theoretical framework.

These policy documents will also, later on in this thesis, be used to identify barriers and opportunities of circular construction in Stockholm. The policy documents will be distinguished on the level that they have been set up; the national level and municipal level.

4.2.1 National policy

Following the Directive, all EU member states must draw a waste plan and develop special programmes for waste prevention. The Swedish Environmental Protection Agency (SEPA) is responsible for the establishment of this plan and program in Sweden. Within a waste management report in 2018 Afvall Sverige described that the construction waste is in Sweden the highest contributor to overall waste with almost 10 millions of tonnes of construction waste produced per year. This means that almost one-third of all waste in Sweden is produced by the construction sector (Afvall Sverige,, 2018) and therefore, as they state; *'Construction and demolition waste is (..) prioritised in the national waste plan and in the waste prevention programme (Afvall Sverige, 2018, p. 38).*

Within the national waste plan 2012-2017 an objective concerning building and demolition waste was created, which prescribes that by 2020 preparation for reuse, recycling and other material utilisation of non-hazardous building and demolition waste must be at least 70 percent by weight (Swedish Environmental Protection Agency, 2017). However, further in the document is stated that reuse and recycling might be difficult to achieve regarding building and demolition waste (Swedish Environmental Protection Agency, 2017). Still, following the waste management report in 2018 re-use of construction material is increasing.

In order to achieve the objectives set in the waste plan, better sorting of waste for both reuse and recycling is required, particularly in connection with demolition. In the case of demolition, the plan also described that the inventory of buildings needs to improve and materials that can be reused and recycled must be identified (Swedish Environmental Protection Agency, 2017). The waste plan also gives concrete examples of tasks that different actors need to execute, for example the SEPA advises the County Administrative board to impose requirements on the reporting of materials management in environmental impact assessments for roads and railway plans (Swedish Environmental Protection Agency, 2017).

Next to the waste plan and according the EU guidelines, the SEPA set up a waste prevention program, which is meant to supplement the waste plan. It is designed to guide among others municipalities, authorities and the business sector by illustrating the necessity to improve waste management and by identifying targets and measures that will help accomplish this (Swedish Environmental and Protection Agency, 2014). Construction waste is also within this program one of the priority areas. Within the document SEPA presents different strategies to achieve the objective of the program. This objective incorporates the generation of less waste per square meter of construction compared to 2014 and the phasing out of particularly dangerous substances (Swedish Environmental and Protection Agency, 2014). Examples of strategies that the SEPA wants to use to achieve this is to increase the reuse of construction products (such as bricks) and to design building products that can be disassembled in a way that enables easy reuse (Swedish Environmental and Protection Agency, 2014).

The last relevant policy document on the national level has been created by Boverket, the National Board of Housing, Building and Planning. They describe the following vision for Sweden in 2025:

New buildings for both housing and offices are built using demountable components. This means they can simply be adapted to changes in the housing requirement, household size and altered needs such as rapid changes in business conditions. The buildings are designed so that wall surfaces and fixed furnishings and fittings are flexible and can easily be modernised and re-used. The environmental classification system has been developed into a few international systems which are regionally adapted and environmentally certified buildings are in general demand. (Boverket, 2014, p. 22)

To realise this vision the National board of Housing, Building and Planning ensures, among others, that building and management is eco-sensitive through the efficient use of resources and the phasing out of hazardous substances and that the dialogue between public authorities and the construction and real estate sectors has reached consensus concerning (Boverket, 2014):

- co-ordination between different interested parties in the building process*
- the prevention of waste arising from building-related activities*
- the phasing-out of building materials hazardous to the environment and human health*
- renewal of older series-produced housing areas that have reached the end of their useful lives*
- flexible design of buildings with possibility of development, alteration, dismantling and subsequent rebuilding.’ (Boverket, 2014, p. 23)*

4.2.2 Municipal policy document

Although, in contrast to household waste, the municipality is not responsible for collecting or handling such waste (Afvall Sverige, 2017) the SEPA suggested several actions that municipalities can take to improve waste management in the construction sector, like the carrying out of inspections concerning the management of construction and demolition waste.

The city of Stockholm created a vision towards 2040 (Stockholms Stadt, 2012) and the Stockholm City Plan (Stockholms Stadt, N.D.). Sustainability as well as urban development play an important part in both these documents. Although the circular economy concept is mentioned within this document, the main focus lays on circular economy as a way of innovation within businesses rather than resource efficiency in the construction sector or area developments. Within the documents a few sentences are paid towards the reduction of construction and demolition waste and resource efficiency:

'The city is also looking into the options for resource-efficient management of the large quantities of waste that arise from construction and infrastructure projects.' (Stockholms Stadt, 2012)' and *'Waste considerations generally need to be better integrated into the planning and development of the city's physical environment and into work to reduce the consumption of resources. An eco-cycle for materials, products and services needs to be made possible. In a circular economy, materials and products have a longer service life, less waste is generated and raw material extraction is lower.'* (Stockholms Stadt, N.D.). However, within the policy document it is not specified how these objectives will be achieved and who will be responsible for them.

Next to these two policy documents, Stockholm Vatten och Avfall, which is a municipal-owned group company that is responsible for the waste and water management within Stockholm, set up a waste management plan for Stockholm 2017-2020 (Stockholm Vatten och Avfall, 2017). One of the subsidiary objectives for the period of the plan is that the prevention, reuse and recycling of construction and demolition waste is to increase. The plan also describes what the municipality and other actors can do to achieve this, like imposing requirements on construction and demolition contractors to recover material to the greatest possible extent or reviewing the potential to reuse materials from demolition and renovation (Stockholm Vatten och Avfall, 2017). The plan does however not describe how these requirements can best be imposed.

The plan describes another objective related to construction and demolition waste, namely that waste issues are to be taken into account at the initial planning of new construction and refurbishment. An example of what the municipality or Stockholm Vatten och Avfall can do regarding this objective is to develop partnership arrangements between public administrative bodies and companies in order to set good examples of first-rate waste management (Stockholm Vatten och Avfall, 2017).

A last relevant document for this research is the Stockholm is the Royal Seaport Strategy, as it incorporates objectives regarding resource-efficiency and is the largest area development in Stockholm. Although lacking in the initial vision for this area, the sustainability plan of the project describes in one paragraph their goals on circular economy and resource efficiency. Circular economy is explicitly called as a target with sub-targets under resource efficiency and climate responsibility (Stockholms Stadt, 2017):

Main target: Promote a circular construction and management process. Sub targets: Prevent and minimize construction waste, treat and recycle collected garden and park waste with optimized energy and resource efficiency, build knowledge about sustainable and circular construction and management processes (Stockholms Stadt, 2015). Also, when in the area a building is demolished to be replaced by new construction, this investment can be counted as a debit in the analysis of the project's life cycle cost, which makes it more attractive to re-use existing buildings or parts of these buildings. More implicitly, attention is paid to the circular economy principles as robust constructions are promoted and buildings and facilities should be designed with high architectural, functional and material quality (Stockholms Stadt, 2015).

4.3. Applying the rule types of Ostrom

In the following paragraphs the collected data will be discussed per rule type of Ostrom. Each rule type will have the same setup: firstly a short description of the rule type will be given, followed by a recap of the barriers identified during the document analysis and eventually the identified barriers, combined with opportunities, will be discussed. An overview of all identified barriers and opportunities can be found in appendix 1 and 2.

4.3.1 Scope rules

A scope rule has been described as a rule that delimits the range of possible outcomes. In the absence of scope rule, actors can affect any physically possible outcomes (Ostrom, 2005). One of the most important characteristics of these scope rules is that it should guide stakeholders towards circular construction. Scope rules most directly influence the outcome of the action arena (Ostrom, 2005). The identified barriers are mainly related to policy and certification and labeling methods. Based upon the analysis of the different policy documents, the following barrier can be added to the list of scope rules: *'the inspection authorities have no guidance as to how issues concerning recycling and resource efficiency should be managed within the inspections'* (Swedish Environmental Protection Agency, 2012, p. 58). Next to the barrier, also an opportunity has been identified: *'an increase in the reuse of materials requires that authorities design appropriate and clear regulations, provide guidance, inspect and enforce, and collaborate with each other and with all actors subject to such regulation'* (Swedish Environmental Protection Agency, 2012, p. 55). In the Waste Plan of Stockholm is added that the putting in place of clear requirements on waste management should occur in building permits and supervision of the waste management of construction (Stockholm Vatten och Avfall, 2017).

Remarkable is that the opportunities and barriers mentioned in policy documents mainly concentrate on later phases within area development, while in several initial plans that were discussed during data collection the reduction of waste and especially the re-use of materials were not mentioned as one of the ambitions. However, there must be noted that most of the plans that were discussed were created within the 00's. In most of the plans a sustainability component related to waste management of construction and demolition waste was added after a few years.

Shaping the appropriate requirements for the desired result has proved to be one of the biggest challenges based upon policy documents as well as interviews (Lennartsson, personal communication, 2019 and Swedish Environmental Protection Agency, 2012). In the project of Royal Seaport the municipality of Stockholm, Stockholms Stadt, incorporated requirements regarding waste management in the tendering document, but none of the project developers achieved this requirement (Lennartsson, personal communication, 2019; Stockholms Stadt, 2017). The requirement was a limit of 20 kilogram of waste per square meter and was based upon a survey the municipality executed (Stockholms Stadt, 2017; Lennartsson, personal communication, 2019). There

were no consequences attached to the requirement. A possible explanation for not meeting the requirements might be that this topic is not prioritized and not considered to be very important compared to, for example, energy performance (Lennartsson, personal communication, 2019). In order to make the project developers and the construction companies live up to the requirement Stockholms Stadt added a requirement to the tendering document within a later phase of the project with which they obligated project developers to set up a plan on how they are going to lower their construction and demolition waste. The municipality chose to leave the form blank in order to stimulate the project developers to think actively about this topic from the beginning of the area development (Lennartsson, personal communication, 2019). An official from the municipality of Stockholm said the following about this process: *'...We learnt from the first phase that they didn't pay attention to it. Then we said; well what do we need to do to let them pay attention? Then we decided to add that into the requirements that they should start to think about it earlier. It is a constant learning process. What we have learned in one phase, we try to draw conclusions and either change our requirements or make them even more strict, so it is a constant learning process in the setting of the requirements'* (Lennartsson, personal communication, 2019). This also applies to other requirements, like the use of climate calculations on the structure of the building in order to encourage different use of materials, like wood instead of concrete. The municipality tried to define the requirements within the tendering document in such a way that developers would be encouraged to build with wood, but they have not succeeded in this yet (Lennartsson, personal communication, 2019).

What the barriers related to setting requirements implicitly also show, is the importance of a good monitoring system in order to identify a lack of disfunction of requirements. This applies especially to projects with a longer time span and several phases. The Royal Seaport project knows a very strict monitoring system, since project developers have to provide verifications of what they do and provide an explanation of how they came to the conclusion of what they reported (Lennartsson, personal communication, 2019). The publication of the results of the performance of the project developer were also a way of stimulating the project developers.

Within several projects that were discussed the certification methods contributed to the application of some of the principles of circular construction as some of the criteria of the certification methods are related to resource-efficiency (Jakobsson, personal communication, 2019; Isaksson, personal communication, 2019). The certification methods mentioned within the interviews were mainly LEED and the Swan Ecolabel. The Swan Ecolabel says to promote circular economy and states to be 'an obvious tool for promoting the CE' (Nordic Ecolabelling, 2018). This promoting is primarily achieved with the help of six parameters: strict chemical requirements, quality requirements and lifetime, requirements for optimum waste handling, reduced use of resources and energy, requirements for product design, dismantling, and repairability and requirements for renewable, recycled and sustainable raw materials (Nordic Ecolabelling, 2018). Regarding some construction materials the Swan ecolabel sets requirements for a percentage of recycled material within the products, like flooring. Next to this, there are chemical requirements so that the choice of raw materials ensures clean materials that can be reused within the construction sector in the future (Nordic Ecolabelling, 2018). However, the question remains whether this does not make

it even harder to re-use materials that are currently present within old building, since these materials often do not meet the very strict criteria of clean materials.

The LEED certification incorporates an important criteria, namely that the purchase contains 50% of the materials harvested or extracted within 800 kilometres of the project site, so for example, materials with a high recycling percentage from China are avoided (US Green Building Council, N.D.). Another requirement of the LEED (and Swan Ecolabel) certification is the logging in of materials. Still however, with these certification systems a big part of the points earned comes from energy performance and a certificate can also be obtained without paying attention to resources (US Green Building Council, N.D.). However, an example of how the right requirements might lead to a reduction of waste forms the project of NYA Karolinska, a hospital, where project developer Skanska was able to merge the objectives of the county council and LEED certification (Jakobsson, personal communication, 2019). To obtain the LEED certificate Skanska worked with different ways to reduce the waste, like prefabricated solutions, ordering the right amount and right measurements of materials, careful sorting of waste and the creation of a concrete factory on site (Jakobsson, personal communication, 2019). This concrete factory made it possible to produce the right amounts of concrete. Also rocks that were blasted away on the site were used for the concrete. In order to lower the CO2 footprint of the buildings, Skanska chose to look for measures within the design phase instead of production phase, like the choice of insulation, choice of superstructure and a reduction of the amounts of concrete needed: *'The most sustainable material is the material that you don't use. (...) I mean, what I said about the design measures taken: if you can reduce the superstructure and basically slim it down as you go up the building, for example, or reduce the amount of concrete that you pour on the HDF, you can reduce material use, especially for climate heavy materials'* (Jakobsson, personal communication, 2019).

Barriers	Rule type of Ostrom
The inspection authorities have no guidance as to how issues concerning recycling and resource efficiency should be managed within the inspections	Scope rule
Municipalities are having trouble with shaping the appropriate requirements for the desired result (circular construction)	Scope rule
The construction industry is not recognizing and acknowledging the importance and need for circular construction	Scope rule

Opportunity
An increase in the reuse of materials requires that authorities design appropriate and clear regulations, provide guidance, inspect and enforce, and collaborate with each other and with all actors subject to such regulation
The putting in place of clear requirements by the municipality on waste management should occur in building permits and supervision of the waste management of construction.
The revision of requirements during different phases of a project
A strict monitoring system in order to measure the performance of project developers and identify (a lack of) requirements
The alignment of requirements and ambitions with certification systems

Figure 15 Overview of barriers and opportunities related to scope rules

4.3.2 Choice rules

Choice rules are rules that prescribe actions actors in positions must, must not, or may take in various circumstances. Choice rules most directly influence the actions of the action arena and mainly consists of barriers related to law. Barriers identified within policy documents are the lower price of materials compared to labour (Swedish Environmental Protection Agency, 2012; Matz, 2019) and the hazardous substances that are found in products that are currently being demolished, which may have been manufactured a long time ago and may contain substances that are now banned from use in new products (Swedish Environmental Protection Agency, 2012). Also, when building materials contain hazardous substances, their long life span is problematic (Swedish Environmental Protection Agency, 2012). In the same way, we might be using materials today in new productions that are later found to have hazardous properties. The Swedish Waste Prevention Program states that the first barrier is the primary reason why we don't already build with the most resource efficient methods and why we generate such an excess of waste (Swedish Environmental Protection Agency, 2014). The document also describes that in many situations extra volumes of materials are ordered to prevent construction delays that cause workers to wait for delivery of materials, which has almost become a habit within the sector (Swedish Environmental Protection Agency, 2014). This is also confirmed in different interviews. A last barrier identified within the policy documents is the requirement to notify the municipal environmental boards of the use of not entirely uncontaminated waste, which often involves a delay (Swedish Environmental Protection Agency, 2012). A notification must be given at least six weeks in advance. This notification makes it difficult to rapidly use slightly contaminated soil that might have been generated by one project in another project (Swedish Environmental Protection Agency, 2012). Difficulties in handling the materials

during this period through for example finding facilities for temporary storage mean that in many cases it is easier to dispose of the materials, even though it may be suitable for recycling or reuse (Swedish Environmental Protection Agency, 2012). An opportunity to tackle these problems forms the chemical treatment of soil on the site with the use of bacteria's that eat the pollution within the soil (Bramfalk, personal communication, 2019).

Regarding most legal issues, the municipality is depending on law that has been set up on a supra-municipal level. Even though the municipality might, in general, impose requirements through a detailed development plan within the planning process, it is, at least in the case of circular construction, depending on supra-municipal legislation. This supra-municipal legislation is derived from the national government as well as the European Union. It is however possible to include stricter, further requirements on resource-efficiency or the principles of circular construction within civil contracts (Lennartsson, personal communication, 2019). There are however often no consequences if these requirements are not achieved. This emphasizes the importance of information rules, which will be discussed later in this chapter. The Environmental Code describes the following: *'re-use and recycling, as well as other management of materials, raw materials and energy are encouraged so that natural cycles are established and maintained'* (Swedish Environmental Protection Agency, 2018). With the support of the efficiency principle in the Environmental Code in connection with the permit assessment, the permit authority might be able to impose requirements to promote reductions both in the quantities of waste that are generated and in the quantities of hazardous substances that are present within waste. This could for example apply to the imposition of requirements concerning the choice of technology to reduce the quantities of waste generated and the use of waste or recycled material instead of virgin materials (Swedish Environmental Protection Agency, 2017). The latter is only possible if the risk of pollution does not make it unsuitable and the requirements only can be imposed if they are not considered too unreasonable (too expensive relative to the benefits) (Swedish Environmental Protection Agency, 2017). In connection with inspections, the inspection authority may carry out checks to ensure that the operator is following this efficiency principle (Swedish Environmental Protection Agency, 2017). It is however debatable whether this really stimulates reuse of materials and the use of more sustainable materials.

The Planning and Building Act, Environmental Code and the Boverket building regulations consists of different restrictions and requirements regarding (fire) safety and material quality (Swedish Environmental Protection Agency, 2017; Matz, personal communication, 2019; Jakobsson, personal communication, 2019). Because of the quality control on materials that these laws obligate, old materials can often not be re-used, since they do not fulfil all requirements that are put on materials that are used for new-constructed houses. This has often to do with the hazardous properties within materials as has also been mentioned within policy documents. A way to deal with these requirements is to focus on material re-use on the interior, like kitchen cabinets, flooring or plasterboards, instead of the exterior, because the requirements are less strict within the building than outside of the building (Matz, personal communication, 2019). For efficient resource-use within the exterior, like the concrete construction, an option is to use concrete with a high percentage of recycled materials (Matz, personal communication, 2019).

Barriers	Rule type of Ostrom
The lower price on materials compared to labour	Choice rule
Extra volumes of materials are ordered to prevent construction delays that cause workers to wait for delivery of materials	Choice rule
The hazardous substances that are found in products that are currently being demolished and, which are now banned from use in new products	Choice rule
The requirement to notify the municipal environmental boards of the use of not entirely uncontaminated waste	Choice rule
Older materials do not comply with the current Planning, Law and Building Act, Environmental Code and building regulations.	Choice rule
Absence of law stimulating re-use of materials or the use of recycled or sustainable materials with a low carbon footprint	Choice rule

Opportunity
Chemical treatment of soil on site with the use of bacteria's
The permit authority might be able to impose requirements to promote reductions both in the quantities of waste that are generated and in the quantities of hazardous substances that are present in the waste
Focus on material reuse in the interior instead of exterior
Use materials for the superstructure (exterior) with a high recycled percentage

Figure 16 Overview of barriers and opportunities related to choice rules

4.3.3 Pay-off rules

A pay-off rule assigns rewards or sanctions to particular actions that have been taken or based on outcomes (Ostrom, 2005). Pay-off rules most directly influence the actions of the action arena. During the document analysis the following barriers were identified. The waste from an activity is often only sufficient for a small part of a construction project, which causes added costs to be incurred when not all the materials can be sourced from one single location (Swedish Environmental Protection Agency, 2012). A solution for this might be the coordination between activities that generate waste or surplus materials that is suitable for construction purposes and suppliers of conventional ballast (Swedish Environmental Protection Agency, 2012). This probably would take place at a regional level and in urban areas where a high proportion of construction project are carried out. Currently, the strongest force behind the use of waste is the avoidance of transport and landfill costs (Swedish Environmental Protection Agency, 2012). Especially the landfill tax represents an important opportunity for identifying alternatives to landfill.

The importance of the pay-off rule appeared during the data collection as several times has been stated that the reduction of waste is not only considered a CO2 initiative, but also a way of saving costs and time. The SEPA also states that the primary driving force for increasing the sorting and recycling of construction waste is the costs associated with the waste management (Swedish Environmental Protection Agency, 2012). However, this cost advantage does not apply to the re-use of materials or the use of sustainable materials with a smaller CO2 footprint, which is often more expensive (Matz, personal communication, 2019; Swedish Environmental Protection Agency, 2012). That the re-use of materials is more expensive is caused by several reasons. The main reason for this difference in price is the earlier mentioned tax on labour instead of materials (Matz, personal communication, 2019). Since second hand materials need to be renovated, more labour hours are going into re-used materials compared to new materials, which leads to this higher price for these materials (Matz, personal communication, 2019).. Even when the materials are in a good state it has to be renovated, because it might not have the desired shape (Matz, personal communication, 2019). There are different ways of dealing with this higher pricing of re-used materials.

- At first, the longer a project takes, the higher the costs and the risk will be for the project developer or investor. The longer a project takes, the longer your resources are locked up (Jakobsson, personal communication, 2019). Therefore, it might be better to re-use materials in projects that have a shorter time span.
- Another solution might be in the hands of the architect. If the architect creates, in their design, a system in which different materials and different sizes can fit, the different shapes might be less of a problem. Ideally, there are no requirements on the exact shape, dimensions or colour of the materials. For example, if you need a wooden wall, this wood can be of all different sorts of wood from all different sizes and colours (Matz, personal communication, 2019). The architect is also, however, often depending on the requirements of the project developer.

- Another way to deal with this is to use less material within your construction, which leaves space to use more expensive materials (Jakobsson, personal communication). It is therefore important to see what is possible regarding sustainable materials, re-used materials or materials with a high recycled percentage within the project budget. A helpful instrument is the Eco2 instrument of project developer Skanska (Jakobsson, personal communication, 2019), which they use for climate calculations. It makes it possible to import data from project budget calculations. In this way it is possible to see which construction parts have a big climate impact and it makes it possible to see whether it is possible to use less of a material more expensive and more sustainable material (Jakobsson, personal communication, 2019). So, for example if you have an alternative product that has a lower CO2 footprint, you can see whether it is possible to use hundred ton less and you can see what this means to the budget and what this means to the carbon footprint. There is a possibility that it is cheaper and that is why it is important to monitor and compare this; it is a way of analyzing what can be changed and what can be improved.

Although there are ways to deal with higher prices of materials, there is still often the conviction that it is much more cheap to tear down a whole building and start from zero, because of the time to invest looking into how you would do it.

Barriers	Rule type of Ostrom
The coordination between activities that generate waste or surplus materials that is suitable for construction purposes and suppliers of conventional ballast	Pay-off rule
The waste from an activity is often only sufficient for a small part of a construction project, which causes added costs to be incurred when not all the materials can be sourced from one single location.	Pay-off rule
Taxes on labour instead of materials	Pay-off rule
It takes more time (and thus money) to look into how you need to re-use materials	Pay-off rule

Opportunity

The strongest force behind the use of waste is the avoidance of transport and landfill costs

Comparing climate calculations and project budget and taking time to look into the possibilities

Starting with smaller or shorter projects

(Be open minded for) Creating a design which is flexible and a design in which there are no strict material requirements on shape or form

Overview of barriers and opportunities related to pay-off rules

4.3.4 Information rules

Information rules are said to authorize channels of information flows available to participants, including assignments of obligations, permissions or prohibitions on communication. With new practices or concepts there always are a lot of question and uncertainties, whether it is about the costs, the risks or the method of construction. It is important to deal with questions regarding these issues, especially as a client. Information channels are a way of motivating, but also facilitating the executer of your ambitions. There are different ways to achieve this.

A first step is making clear why your ambitions are important. For example, as described, one of the barriers in the Royal Seaport Project was that some of the project developers did not pay attention to the reduction of construction waste and therefore achieved a bad result on this topic. So, first it is important to make the project developers believe that waste reduction is an important topic and explain why this is the case. The same applies for reusing materials and other aspects of circular construction. For the Royal Seaport project the municipality developed a capacity development program for the project developers, after receiving several comments as 'we are not able to do this or we cannot do this' during the first developments with strengthened requirements (Lennartsson, personal communication, 2019). During the capacity development program a changing attitude was found: *'since they were pushed and given a reason why they should do it and also examples of how they could do it, all of a sudden it became easier to work with'* (Lennartson, 2019). Another approach to remind the project developer of the importance and presence of the several ambitions of the municipality has been used within this project as a sustainability strategic consultant from Stockholms Stadt is constantly reminding the project manager of the project developers about the reports that they have to submit and which sustainability requirements are set for their development phase.

Next to this, the municipality is supporting the project developers within this project by bringing them in for different thematic seminars that are related to their requirements. In those seminars they are trying to motivate and explain why the requirements are important and they give them examples of how this has been done in the past in other projects. Examples of issues discussed in the thematic seminars are green roofs or energy.

There are however also ways that a project developer or construction company might set up information flows for themselves in order to reduce the uncertainty and risk around the reuse of materials. A way to reduce this uncertainty might be to test different materials to see what is possible on a sustainability perspective: *'If you do your big project, I guess you could do one part which would be tested and everyone would look at it, with a whole group of consultants, and say what the issues could be and what the problem could be and then maybe everyone could agree that this is not actually a big risk.'* (Matz, personal communication, 2019).

It also appeared that a strong leadership that sees the importance of the requirements and ambitions is very important. For example, project developer JM has the ambition to reduce their waste to 20 kilogram per square meter in each project (Isaksson, personal communication, 2019). Within the company all projects have this same ambitions and they also build the same superstructure in every project, so in fact all waste numbers should be the same. However, a project management that has achieved good waste reduction numbers also achieves good rates in other projects, when a project management that achieved bad numbers also often achieves bad numbers in the following projects (Isaksson, personal communication, 2019). Therefore, training project management teams on how to achieve waste reduction, or circular construction in general, might be important.

Barriers	Rule type of Ostrom
No acknowledgement of the problem or necessity to reduce waste of project developer	Information rule
Project management does not acknowledge the necessity of waste reduction	Information rule
Too little knowledge on how to achieve the requirements regarding circular construction	Information rule

Opportunity
Set up several training programs to teach necessity of the requirements by the municipality
Organize training programs as a municipality to learn the project developers how to achieve the strict requirements within the area
As a municipality, provide examples of earlier projects where they build successful, bringing in specialists for education
Create training programs as a project developer on circular construction for your project management teams
Testing different materials in order to see what is possible from a sustainability perspective

Figure 17 Overview of barriers and opportunities related to information rules

4.3.5 Position rules

Position rules create positions that actors may hold. Position rules most directly influence the element 'position' of the action arena. No additional barriers were found in policy documents. Whether circular construction forms an opportunity for a project developer is also determined by the organizational structure of the company, which varies strongly per project developer or construction company. The project developer JM, as earlier stated, has a strategy where they work and build in the same way in each project; with the same strategy, same goals and same (concrete) superstructure. On the one hand does this make the impact of certain sustainability measures much bigger, but on the other hand it is much more complicated to implement these measures in each project (Isaksson, personal communication, 2019). This is partly caused by the long time that the implementation process takes with this particular organizational structure.

Another organizational aspect focuses on a larger image. Within the circular construction chain there are a few functions or responsibilities identified that are important to take into account. These extra 'steps' or 'tasks' within a project are the renovation of older materials and a check of the reclaimed materials on current legislation for new constructed buildings and quality (Matz, personal communication, 2019). Within a traditional construction process, the supplier is mainly responsible for this quality control. However, within a circular construction chain this responsibility has not been assigned to anyone yet. The question is also whether someone wants to be responsible for the quality of the materials. One of the respondents said the following: *'So a lot of the apartments here are sold and there is a number of years that they are responsible for the costs, so they don't want to take any risks. Everyone always wants everything to be signed by someone else that takes the responsibility for everything, right? Then there would have to be someone who would have gone in and given it a like a stamp or something'* (Matz, personal communication, 2019).

Barriers	Rule type of Ostrom
Organizational structures of project developers	Position rule
New tasks or steps within the circular construction chain that no one feels responsible for (yet)	Position rule

Figure 18 Overview of barriers related to position rules

4.3.6 Boundary rules

Boundary rules define (1) who is eligible to hold a certain position, (2) the process by which positions are assigned to actors (including rules of succession), and (3) how positions may be exited. Boundary rules most directly influence the participants of the action arena. Next to different roles and responsibilities that exist within a circular construction chain, the moment when different stakeholders are involved within a project might be changing. During the different interviews there were several examples of this, like when building an energy efficient house you have to start with thinking about this element when you start designing the house together with the architect. It is important to have an energy person involved during the design phase, so that you are not designing the house in such a way that it constrains the ambitions on energy efficiency. The same applies when implementing green roofs or reuse materials. When reusing materials or using materials with a high recycled percentage it would be even better to involve experts on a product level, like for example concrete, as well as experts on reuse of materials or people who have knowledge on building regulations for materials like fire safety or material quality (Matz, personal communication, 2019).

Opportunity
Involving (sustainability) experts within the design phase of a construction project

Figure 19 Overview of barriers related to boundary rules

4.3.7 Aggregation rules

Aggregation rules determine how many, and which, players must participate in a given collective- or operational-choice decision. No barriers were identified within the document analysis or during data collection.

4.3.8 Aesthetic performance

This category of aesthetic performance is added to the framework, since it is considered to be an important barrier as it was discussed during different interviews. This refers to identified barriers related to the appearance and

aesthetic value of a building. A significant problem regarding resource-efficiency within the Swedish Construction sector is the already touched upon problem of overbuying (Bramfalk, personal communication, 2019; Swedish Environmental Protection Agency, 2012). Materials that are not used within the project are often thrown away. It would make sense that these materials are more easy to use than materials from older buildings, since their quality is guaranteed by the supplier and comply with current law. However, these materials are still often not re-used (Jakobsson, personal communication, 2019; Bramfalk, personal communication, 2019). One of the reasons for this is that the volumes are too low. The same applies to materials that are mined out of existing buildings as volumes are often also very low. This when while purchasing new materials, you purchase them in one bulk, so all materials in one building look the same. There are however different ways to make sure that the leftover or reclaimed materials are not thrown away. For example, the Swedish company Compagnonen takes leftover materials from construction projects and sells them online. They do have pretty strict requirements on the materials they take, so they are not able to pick up all materials from the construction site (Isaksson, personal communication, 2019). Another example is from Skanska, who tries to sell the superfluous materials to other projects within their company (Jakobsson, personal communication, 2019). An last and earlier mentioned solution for this would be the coordination between activities that generate waste or surplus materials, which would take place at a regional level or urban areas where a high proportion of construction project are carried out.

Barriers	Rule type of Ostrom
The volumes of reclaimed and leftover materials within construction projects are too low	Aesthetic performance

Opportunity	
Contact a company that is able to take leftover from construction projects	
Organize a system within the organization to transfer leftovers from project to project	
Coordinate activities that generate waste or surplus materials	
Testing different materials in order to see what is possible from a sustainability perspective	

Figure 20 Overview of barriers and opportunities related to the aesthetic performance

4.4 Conclusion

After discussing the Swedish planning system and relevant policy documents related to circular construction in Sweden and Stockholm, the results of the data collection and document analysis were presented according to the rule types of Ostrom (2005) in order to answer the following question: Which institutional

barriers of policy implementation in construction projects can be identified in Stockholm and how can these barriers be explained and overcome? As earlier explained these barriers were analysed with the help of the IAD framework of Ostrom (2005) and classified according to the seven different rule types of Ostrom (2005) and arranged by the way that they influence the different elements of the action arena.

Barriers related to the scope rules identified within this research were focussed on steering different participants within the action arena towards the desired outcome. One of the barriers identified was the search of the municipality to formulate the appropriate requirements to achieve the desired result, namely the reduction of construction and demolition waste (Lennartsson, personal communication, 2019). What makes appropriate requirements even more important and necessary, which is the second barrier, is that there is a lack of acknowledgement of the importance of circular construction within the construction sector (Lennartsson, personal communication, 2019). Next to this, the requirements should be dynamic as the possibility must exist to revise and change requirements during an area development. This is mainly relevant within large projects with different project phases. What might support finding the appropriate requirements is to have a strict monitoring system in order to constantly follow the status, influence and result of currently set requirements. Combining certification methods with requirements of the municipality also might help to formulate requirements that project developers will live up to. Within scientific literature was identified that not effectively integrating circularity in innovation policies was considered to be a barrier. However, this has not been found within this research as circularity was integrated within policy documents on both a national and municipal level. It is the translation of these policies into the right requirements that forms a problem.

It appeared that most barriers are directly influencing the actions of the participants within the action arena. Within the theoretical framework was found that these barriers, which are mainly related to law and regulation, are often most difficult to change (Sorensen, 2015). The laws, differing from strict requirements on materials to a tax on labour instead of materials, are arranged on both an European and national level and often put in place to support a linear economy. Within scientific literature is found that a barrier were the legal issues around the novelty of the circular economy concept. However, the biggest challenge forms the change of law that has been adapted to support a linear economy. In order to changes paths, from a linear to circular economy, a large transition has to take place, which will probably cost a large amount of time. Although changing these laws might need a system change, it might be possible to work around these laws and regulations, for example by reusing materials in the interior instead of exterior material and the use of materials with a high recycling percentage within the superstructure of a building (Matz, personal communication, 2019).

The reduction of construction and demolition waste is considered to be a way to save costs and time. However, this is cost advantage does not apply to the re-use of materials or the use of sustainable materials with a smaller CO₂ footprint, which is often considered to be more expensive. The main reason for this forms the earlier mentioned the tax on labour instead of materials (Swedish Environmental Protection Agency, 2012). Next to this, because of the novelty of reusing materials, often has to be figured out how to work with these materials,

which requires more resources (both time and money). A way of dealing with the higher investments is to start with relatively small and short projects (Jakobsson, personal communication, 2019). In this way the financial resources are not locked in for several years. Another way to deal with the costs is to compare climate calculations and project budget during a project to explore the possibilities (Jakobsson, personal communication, 2019). It might for example be possible to use more expensive and sustainable materials, but using less of it. Two other barriers, namely existing business models and financial support and subsidies for the existing system were not confirmed during data collection or document analysis.

With new practices or concepts there always are a lot of question and uncertainties, whether it is about the costs, the risks or the method of construction. This risk and uncertainty has also been identified within scientific literature. In Sweden, where the construction sector is very conservative, education and informing play a big role in the transition towards circular construction. A part of the project developers within the Royal Seaport project did not reduce their construction and demolition waste, because they simply did not pay attention to it. Next to this, when stricter requirements were put in place different project developers did not know how to deal with these stricter requirements. Different training programs and thematic seminars of the municipality that were put in place to support and inform project developers about the possibilities, helped change the attitude of the project developers and provided them with knowledge and support on how to live up to the requirements. The importance of acknowledging the necessity of waste reduction also appeared within organizations as project management that wanted to work on this topic achieved better waste numbers, which also implicitly appoints a positive and negative influence of leadership.

Positions rules influence the different positions within the action arena. In this case study was also found that whether circular construction might form an opportunity or barrier is also determined by the organizational structure of a company, which varies strongly per project developer or construction company. Regarding these organizational structures, the organization of a circular construction chain differs from a linear construction chain, as additional steps and tasks are added for which no one feels responsible for. An example of an additional step forms the involvement of sustainability experts and experts on a product level during the creation of the design (Matz, personal communication, 2019).

A last important barrier, which has added a category to the framework of Ostrom (2005), is that the volumes of the reclaimed materials are often too low (Isaksson, personal communication, 2019; Matz, personal communication, 2019; Swedish Environmental Protection Agency, 2012). This means that the materials within the building might be different from color or shape. This while it is easier to purchase new materials in one bulk, so all materials in one building look the same. This makes it less attractive to use reclaimed materials. A solution for this might be the coordination between activities that generate waste or surplus materials that is suitable for construction purposes and suppliers of conventional ballast (Swedish Environmental Protection Agency, 2012)

Chapter 5 Case study Amsterdam



The city of Amsterdam has about 821.752 inhabitants and a surface of 219,3 square kilometre (World population review, 2019). As the biggest city of the Netherlands, Amsterdam is also the capital. Amsterdam is expanding as a city and the aim is to grow the housing stock by an average of 7,500 homes per year (City of Amsterdam, N.D.). A growing housing stock offers challenges as well as opportunities. The municipality of Amsterdam considers circular construction as one of the biggest opportunities for new constructions and defines itself as one of the frontrunners on circular economy in the world, which also appears from the elaborated policy documents on circular economy that the city developed over the last few years (Circle Economy, .Fabric and TNO, 2015; Circle Economy and Copper8, 2018).

A first step in the IAD framework is to address the underlying factors of an action arena and how they are affecting the arena. These underlying factors consist of attributes of the community and the influences of the (bio)physical world. One of the influences of the physical world that is important for the application of the CE concept in the construction sector are the limitations on materials, as some materials currently cannot be recycled or reused, because of the chemical content of the materials. An attribute of the community that has a significant influence on the action arena is the attitude of the construction industry towards innovation and circular construction. Another attribute is that the municipality of Amsterdam does not own different landplots within the city, which makes it in some cases harder for the municipality to set requirements and successfully implement their ambitions on circular construction.

As described in the theoretical framework a second step in institutional analysis is to describe the identification of a conceptual unit, the action arena (Ostrom, 2005). This action arena is the focus of the analysis. When answering several questions that help to identify the action arena, the following arena can be constructed:

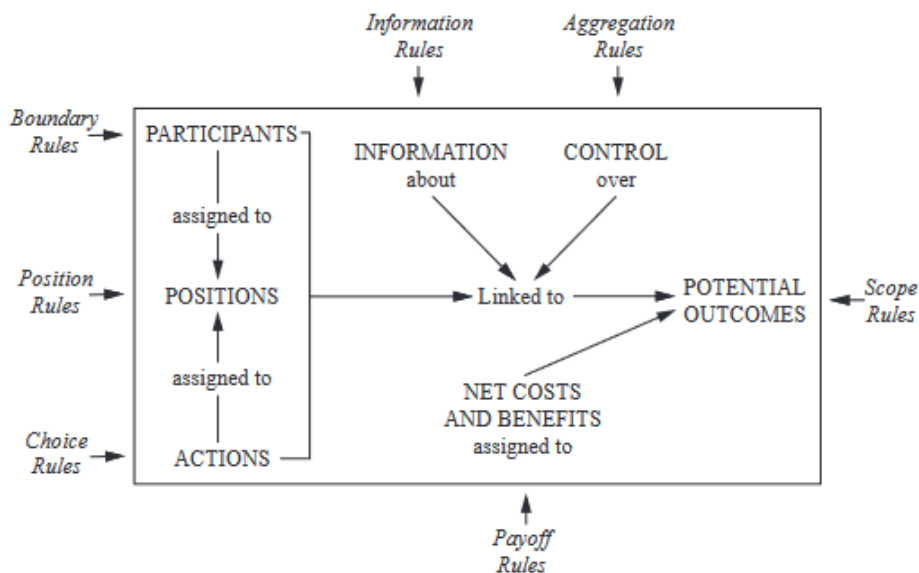


Figure 21 Action arena of the IAD framework (Ostrom, 2005, p.189)

Participants: Municipality of Stockholm, market parties, inhabitants of Stockholm

Positions: contractor, contracted project developer, municipality, inhabitants, future inhabitants, investors of the project developer, suppliers, architect

Actions: putting incentives in place that stimulate the circular economy, the implementation of the CE principles within a building's life cycle (figure 11)

Costs and benefits: additional costs for constructing a circular building, profit from selling the building and costs for municipality to prepare the land and planning documents

Information: consultancy reports, policy documents, contracts, meeting reports and information sessions.

Control: the municipality of Amsterdam can steer market parties in the right direction during the tendering process. However, the municipality does not own all land within the municipality, which reduces their control. Investors often have control over the budget of the project developer and project developers assign contractors, architects and suppliers

Potential outcome: the exact potential outcome is not clear yet, since only a little amount of circular constructed buildings exist.

There has to be noted that this is a general action arena and the situation might differ per project.

5.1 The Dutch planning system

The planning system in The Netherlands will be discussed on a national, regional and municipal level in order to understand the responsibilities per governmental

level as well as the coherency between these different layers of the planning system.

5.1.1 National

In the Netherlands, legislation is made by the central government and approved in the Senat (Eerste Kamer). After 2010, Spatial planning became the responsibility of the Ministry of Infrastructure and the Environment (MinIE) while housing was assigned to Internal Affairs. The first Spatial Planning Act of the Netherlands dates from 1965: the 'wet ruimtelijke ordening'. Within the coming years this law will be replaced by the Environmental Law in order to fasten and simplify the decision making process (Rijksoverheid, N.D.a).

The overarching environmental legislation is provided in the Environmental Protection Act that first came into effect in 1993 (Rijkswaterstaat, N.D.c). This law provides a broadly overview of what legal instruments are available to protect the environment and what principles apply to this. For example, this law requires companies to have an environmental permit and sets general regulations for water, air, soil and waste (Rijkswaterstaat, N.D.).

5.1.2 Regional

In the Netherlands the role of the twelve provinces is strong in spatial management but they are mainly advisory in development planning. Regions form special planning agencies to create, among others, inter-municipal Structure Plans or Structural Visions.

The province determines where roads, rail and shipping connections, residential and industrial areas, agricultural and nature areas and recreational facilities will be located (Rijksoverheid, N.D.a). To this end, the province creates a so-called structural vision. Municipalities have to take this into account when making their zoning plans. In this way the plans of the municipalities are aligned with each other. The structure plans of the province are not legally binding, but are setting large scale conditions that are usually incorporated into regional plans (Rijksoverheid, N.D.). The province supervises compliance with environmental laws in the field of air, soil and water. Among other things, regulations and licensing systems are used for this. In addition, the province is responsible for combating pollution, for example through soil remediation and the use of treatment plants. In addition, the province encourages the use of sustainable energy by, for example, designating places where wind turbines may be installed (Pro Demos, N.D.). A provincial Structural Vision only binds the province itself. To get effect on municipalities, the province must include the subjects of provincial interest in a provincial regulation (Rijkswaterstaat, N.D.).

5.1.3 Municipal

The Netherlands counted 390 municipalities in 2016. Municipalities are responsible for housing, business parks and the construction of new places for

companies. The municipality creates two important documents: a Structural Vision and zoning plans. Municipalities are required to have up-to-date zoning plans and a Structural Vision for their entire territory.

A municipal Structural Vision is a strategic policy document on spatial and functional developments within a municipality (Rijksoverheid, N.D.c). The document indicates which functions are desirable within a certain area. This vision is therefore primarily concerned with the broad outline of the intended spatial developments and spatial policy and not legally binding (Rijksoverheid, N.D.c). Policy that is included in the structural vision must first be processed within a zoning plan by the municipality before they provide any legal binding. The zoning plan is a legally binding document for both the government, citizens and businesses. The use (such as living, working, green or traffic) and construction options for an area are laid down in a zoning plan, like for example building height, distance to the neighbours and whether outbuildings are allowed. If an initiator (that may be the municipality itself, but also a citizen or a commercial project developer) wants to develop something somewhere, then this must first be made possible in a zoning plan (SAB, 2010). A procedure must be followed to revise a zoning plan.

The zoning plan is a municipal instrument, but the national government and the provinces are also able to create a zoning plan, which are called integration plans or 'inpassingsplannen', when national interests are at stake. These municipal zoning plans are rather dominant within spatial planning in the Netherlands, since the zoning of an urban district is the base for the building codes that are connected to these zones; the regulations are also quite strict, which are for example preventing mixed use of areas (SAB, 2010).

Under the new Environmental Law, the zoning plan will be replaced by the 'omgevingsplan' or environmental plan. The starting point of the Environmental Law is that all existing zoning plans are merged into one environmental plan per municipality. This means a transition from 50.000 zoning plans towards 400 environmental plans (Liebregts, 2018). The environmental plan will contain rules on the physical environment, which is a broader framework than the spatial planning that the zoning plan currently relates to. Within the Environmental Act is stated that the physical environment in any case comprises buildings, infrastructure, water systems, water, soil, air, landscapes, nature and cultural heritage (Liebregts, 2018).

After discussing the most important aspects of the Dutch planning system, the following figure summarizes these (figure 16, next page).



Figure 22 Overview of the Dutch planning system (MILT, 2014).

5.2 Policy framework

5.2.1 National policy

The national government, Rijksoverheid, created a vision on circular economy in the Netherlands in 2050 (Rijksoverheid, 2016). Within this vision the national government firstly describes the high resource-intensity of the construction sector within the Netherlands, which takes an estimated 50% of raw material consumption, 40% of the total energy consumption and 30% of the total water consumption in the Netherlands (Rijksoverheid, 2016). In addition, a large share of all waste in the Netherlands, around 40%, is construction and demolition waste and, at last, the sector is responsible for around 35% of CO2 emissions. Regarding circular construction, the following vision is created: *'By 2050, construction will include design, development, use, management and disassembly of structures so that these objects sustainably built, (re) used, maintained and dismantled. Sustainable construction is used for building materials and is aligned with the dynamic wishes of the users.'* (Rijksoverheid, 2016, p. 61).

Within the Netherlands 95% of the construction and demolition waste is recycled, however only 3% is recycled within buildings and 92% within infrastructure as foundation material (Rijksoverheid, 2016). Within the infrastructure there is expected to be a decrease in need for foundation material. The Dutch government considers this as a driving force behind the development of new circular applications within the civil and utility construction.

In order to realize their vision, the Dutch government designed a set of strategic objectives (Rijksoverheid, 2016):

- The construction sector uses (mainly) renewable raw materials;
- Material use is over the entire life of it construction optimized (value retention, less costs, more reuse and less environmental impact);

- The construction sector reduces CO2 emissions as much as possible, both in the construction and use phase;
- The construction sector is an innovative sector that proactively responds on changes in society and the demand of market and consumer.

Five interventions are defined to reach these objectives, which will have to be elaborated in transition pathways for different sectors (Rijksoverheid, 2016):

- Stimulating legislation – Legislation must accommodate circular initiatives by:
 - Providing (more) room for experimentation
 - Adaptation of European rules on nutrient recycling and reuse
 - Encouraging circular revenue models and recycling and reuse
 - Stimulating an integral chain approach.
- Smart market incentives. The existing instruments of taxation, duties and subsidies could be better aligned with the transition to a circular economy. In addition, the government wants to achieve 10% of circular purchases in 2020.
- Financing. Investment in sustainable developments in the Netherlands should be further encouraged.
- Knowledge and Innovation. The government will strengthen the joint focus on innovation and knowledge development in order to reach a circular economy by developing transition routes for different key sectors.
- International cooperation. The Netherlands will be positioned as an international Circular Hotspot.
- Behavior. To make this transition land in society, policy needs to be formulated about how to influence and change the behaviour of organisations and individuals in a more sustainable direction.

Within this document the government describes their support for different deals between different stakeholders within the construction sector (Rijksoverheid, 2016). Important deals are the Concrete agreement and the green deals. The purpose of the first agreement is to realize annual substantial reductions of the CO2 emissions from the production and use of concrete and the creation of a circular chain.

The Dutch government, next to this, created several green deals in order to stimulate the circular economy in the construction sector (Rijksoverheid, 2016). Green Deals are agreements between the central government and other parties. The other parties are companies, social organizations and other governments. The Green Deal helps to implement sustainable plans. For example for energy, raw materials, mobility, biobased economy, construction and food. Relevant green deals are the deal for circular building and biobased building.

Another action of the national government within the strategy document for 2050 was to write transition agendas. These agendas outline the change strategy for the next five years. The government has identified five priority sectors. These are

the sectors where the most progress can be made through the adoption of circular economy principles. The five sectors are: consumer goods, construction, plastics, biomass and food and manufacturing.

Three pillars are central to the transition agenda of the construction sector: optimal use of material for all phases in the construction cycle, use as much as possible of "inexhaustible" sources; more and high-quality reuse in construction and at the end of the use phase and the use of finite sources as efficiently as possible (Nelisen et al., 2018). These pillars lead to different design strategies. Which design strategy is applied depends on the circumstances in which a project is realized. Examples of design strategies are optimizing the service life by designing for optimal life at object, component and material level or designing for reuse by taking into account deconstruction and reconstruction at object, component and material level (Nelisen et al., 2018). Other measurements mentioned within the document to stimulate a circular economy in the construction sector are the role of the government as a launching customer, the development of a material passport and the creation of a uniform, effective measurement for circularity (Nelisen et al., 2018).

5.2.2 Municipal policy

The municipality of Amsterdam created two strategic vision documents, namely 'Structuurvisie 2040' (Municipality of Amsterdam, 2011) and 'Koers 2025' (Municipality of Amsterdam, 2016). For the public space another vision document has been set up: 'Visie openbare ruimte 2025' (Municipality of Amsterdam, 2017). These policy documents have a 'lifespan' of 5 to 20 years and form the base of all other policy documents within the municipality. What is remarkable is that circularity, related to the construction sector, is only shortly mentioned in the two firstly mentioned documents. In the 'Visie openbare ruimte 2025' the use of renewable and sustainable materials for the public space are mentioned and also attention is paid to the life span of materials used in the public space. Related to this vision document for the public space is the 'Puccini method', developed by the municipality. It (partly) includes circular thinking and forms an important policy document, because it prescribes material standards for the public space. With the Puccini method, the entire city is unambiguously, affordably and coherently set up using a number of standards (Municipality of Amsterdam, 2018). It contains general agreements about the design of public lighting and street furniture, the choice of materials and regulations for the construction of the green. Relevant for circular construction are materials that can be reused and have a long life. The Puccini method describes in particular the use of baked vowels which have a long technical life span (80 years) and can therefore easily be reused. All standard Puccini method materials (including refuse bins, concrete tiles and curbs) are reused as long as the technical condition of the material permits (Municipality of Amsterdam, 2018).

Next to the documents described above, the municipality of Amsterdam has created different policy documents that in the first place describe the progress of the circular economy in Amsterdam. This is described in to documents: 'Amsterdam circular: a vision and roadmap for the city and region' (TNO, .Fabric and Circle Economy, 2015) and 'Amsterdam circular: evaluation and action perspectives' (Circle Economy and Copper8, 2018). The main barriers that are

identified in these documents are described in the following paragraph, together with the results of the interviews.

'Amsterdam circular: a vision and roadmap for the city and region' (TNO, .Fabric and Circle Economy, 2015) is the first document that has been set up by the municipality of Amsterdam on the topic of circular economy. The results presented in this study aim to provide a substantiation to give direction to follow-up steps that the municipality can take within the transition from a linear to a circular economy. The roadmap fits to and continues on the initiatives that have already been initiated within the municipality (TNO, .Fabric and Circle Economy, 2015).

As a sequel on the vision and roadmap, an evaluation was set up that reflects on the period from 2015-2017. This evaluation document is called 'Amsterdam Circular: an evaluation and handling perspectives' (Circle Economy and Copper8, 2018). Until the end of 2017 a total of 73 'circular' projects were executed, which makes an evaluation valuable.

Because an individual evaluation of the 73 projects would be difficult to read, the evaluation was divided into value chains and instruments. These five value chains are derived from the national transition agenda, namely: construction, biomass & food, plastics, manufacturing, and consumer goods. The choice for the classification of the instruments is based on the Policy Toolkit of the Ellen MacArthur Foundation (Circle Economy and Copper8, 2018). This has been adapted to the context of the municipality of Amsterdam, in which eight instruments that affect the transition towards a circular economy, are distinguished: land allocation, spatial planning, purchasing, education and information provision, research, networking & knowledge exchange, business support & financing, and legislation & regulations (Circle Economy and Copper8, 2018).

A last policy document that the municipality of Amsterdam created on circular economy is the document 'Roadmap circular land allocation: an introduction into circular construction projects' (Metabolic, SGS and Search, 2017). Within the Roadmap an extensive analysis was made of what concrete circular construction entails and in what way the extent of circular construction can be measured quantitatively and qualitatively. Subsequently, the Roadmap offers a practical introduction to the design of a circular tender. Therefore, the roadmap contains 32 performance-based criteria that can be used to steer urban development in a circular direction (Metabolic, SGS and Search, 2017). Remarkable is that the municipality of Amsterdam, in contrast to the Dutch government, has a broader perspective on what circular construction means as it is stated within the document that circular construction encompasses the themes materials, resilience and adaptivity, energy, water, and ecosystems and biodiversity. Examples of performance-based criteria of the theme materials, which is the focus of this research, are design for dismantling, environmental impact on purchased materials or the intensity of material use in the building over its lifespan. These criteria are made measurable and concrete within the document (Metabolic, SGS and Search, 2017).

5.3 Applying the rule types of Ostrom

In this paragraph the collected data will be discussed per rule type of Ostrom. Each rule type will have the same setup: firstly a short description of the rule type will be given, followed by a recap of the barriers identified during the document analysis and eventually the identified barriers, combined with opportunities, will be discussed. An overview of all identified barriers and opportunities can be found in appendix 3 and .

5.3.1 Scope rules

A scope rule has been described as a rule that delimits the range of possible outcomes. In the absence of scope rule, actors can affect any physically possible outcomes. Scope rules most directly influence the outcome of the action arena. Based upon the analysis of the policy documents mentioned within the policy framework, the following barrier can be added to the list of scope rules:

'Internal clients still do not set sufficient circular ambitions and steer projects tightly on time and budget'. (Circle Economy and Copper8, 2018, p.23). Later on in this paragraph will be elaborated on the creating of circular ambitions. An opportunity identified within these documents is the incorporation of circular ambitions within different planning products, varying from the 'Omgevingsplan' to tenders and the creation, within spatial planning policy, of physical places available for the high-quality reuse of building products and materials at a neighbourhood level, so that market parties can develop these physical places (TNO, .Fabric and Circle Economy, 2015).

The conducted interviews showed that there is currently a lack of clarity during the tendering procedure about the requirements, demands and definition of circular construction. The unclarity relates to the lack of one clear measurement method used by municipalities (Slager, personal communication, 2019). Criticism is that due to the lack of such an uniform measurement method project developers need to figure out each different measurement method per project. This means dedicating a large amount of time on how to work with these measurement methods and figuring out how the best score can be achieved within a tendering procedure (Slager, personal communication, 2019). Providing a clear measurement method as a municipality offers market parties the possibility to specialize and optimize their ability to score well on these measurements and to achieve better results on circular construction (criteria). An uniform measuring method also prevents market parties from "bluffing" and municipalities from appointing high amounts of points to unrealistic plans (Slager, personal communication, 2019). Next to this, it is also important to add consequences when the promised results are not realized in order to make sure that the plans are executed in the right way. This might only be possible when it is clear that it is proven that the requirements can be implemented without the use of a significantly higher amount of (financial) resources.

Now, the question remains what would be a clear measurement method that is capable of measuring circularity within a project. Research (Repurpose and IMIX projecten BV, 2018) shows that the Environmental Performance Buildings (in Dutch MilieuPrestatieGebouwen, shortened by MPG) is the most suitable measuring tool for circularity. The reason for this is that it measures the environmental impact of

the construction products that are used. It scores the reuse of materials extremely well as no production process is needed, which results in a low environmental impact. The tool therefore makes it possible to value and control the amount of reuse of a building (Repurpose and IMIX projecten BV, 2018). A disadvantage of the tool is that future reuse or disassembly is not included in it. So, when the construction materials are bricked up, which constrains reuse in the future, they will not achieve a worse score on the MPG (Slager, personal communication, 2019). That is why, in order to also take the lifespan of material into account, the Total Cost of Ownership (TCO) might be included to measure circularity (Markus, personal communication, 2019).

However, circularity is not the only criteria that project developers need to live up to or perform on. Therefore, it is also considered to be important to acknowledge the relation between other sustainability topics and circularity (Markus, personal communication, 2019). For example, it is stated that insulation materials that obtain a high score on energy efficiency might receive a bad score on the MPG. Within an interview the following was stated about this:

'Yes, we are looking at the MPG, which is a good thing to request, but also light transmittance and insulation values are very important to know. It comes back to that integrated design, because we have to guarantee that we are energy neutral. That is why we also provide certain insulation values in the tender phase; we must guard that kind of principles. We, as consultants, will also check on a project-wide basis whether all performances we need are still present' (Markus, personal communication, 2019).

As earlier touched upon, in addition to a missing clear measurement method, the lack of a clear definition and clear requirements is considered to be a barrier. Related to this, there are several actions that a municipality might undertake to support project developers to build in a circular way:

- The creation of a document with a non-debatable legal text that defines what the municipality means by circular construction. Ideally, this is a clear sentence or a set of bullet points (Slager, personal communication, 2019). The definition used in this thesis might form the base for this definition.
- Formulating clear ambitions on circular construction on both a city level and within projects. Concrete and clear ambitions are easier translated to project-specific measurements and eventually into design measures and requirements in the tendering procedure. The tool 'Ambitionweb' might offer some perspectives and support on how to create these clear ambitions (Ruijtenbeek, personal communication, 2019). Ideally, the ambitions include measurable indicators as kilograms or a percentage of reuse. The ambition web is part of the Sustainable Approach GWW (ground, water, way) and is designed to determine the entire sustainability profile of a project (CROW, 2018).
- Address the necessity to build in a circular way. Project developers need a necessity to convince their investors to build in a circular way (Slager, personal communication, 2019).
- Make sure that within the municipality is enough expertise about circular construction to be supportive to market parties (Slager, personal communication, 2019).

Barriers	Rule type of Ostrom
Internal clients still do not set sufficient circular ambitions and steer projects tightly on time and budget	Scope rule
A lack of clarity during the tendering procedure about the requirements, demands and definition of circular construction.	Scope rule
A lack of a clear measuring method for reuse of materials/ resource efficiency	Scope rule

Opportunity
The use of the MPG, combined with the TCO, as a measuring method for circularity
The incorporation of circular ambitions within different planning products of a municipality, varying from the 'Omgevingsplan' to tenders
The creation of a document with a non-debatable legal text that defines what the municipality means by circular construction
Municipalities should formulate clear ambitions on circular construction on both a city level and within projects.
Municipalities need to assist in creating a necessity to build in a circular way
Make sure that within the municipality is enough expertise about circular construction to be supportive to market parties.

Figure 23 Overview of barriers and opportunities related to scope rules

5.3.2 Choice rules

Choice rules are rules that prescribe actions actors in positions must, must not, or may take in various circumstances. Choice rules most directly influence the actions of the action arena. The policy documents adds four barriers to the list (TNO, .Fabric and Circle Economy, 2015, p. 32):

'high tax on labor and low tax on raw materials ensures that it is discouraged to use reclaimed raw materials and often labor-intensive processing methods become more expensive', 'the Building Decree does not contain any guidelines which state that reuse and high-quality recycling of building materials should be preferred over downcycling or incineration', 'existing accounting rules are set to a linear economy', 'zoning plans have a restrictive effect on new functions at a specific

location, while there may be a need for them'. As an opportunity the following barrier was identified: 'require a materials passport and a dismantling plan for all new construction, transformation and renovation projects in Amsterdam'.

Both accountancy rules and taxes on labor and raw materials are determined on a European level. The latter identified barrier, the restrictive function of zoning plans, might be tackled by creating more flexibility in zoning plans or through the Crisis and Recovery Act (Crisis- en Herstel wet). Later on in this paragraph will be elaborated on the latter. The high tax on labor and low tax on raw materials ask for an adjustment of the national fiscal framework (Circle Economy and Copper8, 2018).

The Dutch Building Decree is based upon the tradition of the Dutch construction sector and therefore not adapted to a circular economy. As already identified the Building Decree does not contain any guidelines to stimulate reuse or high-quality recycling of building materials. However, during data collection another constraining function of the Building Decree has been identified. The Building Decree makes it in some cases impossible to reuse materials, because the older materials do not meet the criteria described in this law. Because of this, the reclaimed materials cannot be used within new constructed buildings (Markus, personal communication, 2019). Especially the requirements for materials on (higher levels of) apartment buildings are very strict. A way to deal with these strict requirements on materials is to be creative with the places that materials are reused (Markus, personal communication, 2019). For example, doors can be reused in the cellars of a building, since the requirements of the Building Decree do not apply here (Markus, personal communication, 2019). Also, new constructed buildings often require several certificates on a product level. It is not possible to provide these certificates for reclaimed materials since these are in many cases not available (Slager, personal communication, 2019). Therefore, it is also important to preserve these certificates, next to a list of materials that are present within a building, within a material passport in order to guarantee future material reuse.

Another barrier identified within the interviews is the term 'real estate' within law, which describes that a real estate object can only have one owner (Van der Waal, personal communication, 2018). Because of this, lease constructions within buildings of for example elevators or façades, are more difficult to implement.

Remarkable is that a zoning plan does not offer possibilities to stimulate or facilitate circular building or the re-use of materials and, as policy documents described, also do not stimulate flexibility with functions. The Crisis and Recovery Act (CRA) appears to offer opportunities for municipalities to experiment with requirements in the field of the circular economy that go beyond the Building Decree. This means that an environmental permit for constructing a building is only granted if the requirements on circularity are met (Backes and Boeve, 2018). When setting requirements through this law, municipalities are depending on the national government, which has to grant permission for this. Although there are various examples of circular requirements in the zoning plan via this route, it is not yet clear what the practical consequences or practical utility of a circular requirement in the zoning plan are. The main reason for this is that the requirements are generally insufficiently specified and described in qualitative terms (Backes and Boeve, 2018). It currently seems more effective to substitute a qualitative description of the ambition with a tightening of the Environmental Performance Buildings (in Dutch MPG) in the zoning plan (Backes and Boeve,

2018). However, the CRA route remains a fairly long process as the granting process takes around eight months.

In the new environmental plans (omgevingsplan) it is intended to set requirements for the energy performance and environmental performance of the building (MPG) on the basis of the Decision Building Environment (In Dutch Besluit Bouwwerken Leefomgeving) (Backes and Boeve, 2018). A new possibility for local authorities is to set tailor-made rules for sustainable building (the materials to be used) in environmental plans for specific areas. The Environmental Law also might offer the possibility to be more flexible with functions on different locations and therefore offer a possibility to transform buildings without demolishing the whole building. However, it will take some time before the environmental law and the environmental plan are actually put into practice.

Barriers	Rule type of Ostrom
Low tax on labor and high tax on raw materials	Choice rule
The Building Decree does not contain any guidelines which state that reuse and high-quality recycling of building materials should be preferred over downcycling or incineration	Choice rule
Existing accounting rules are set to a linear economy	Choice rule
Zoning plans have a restrictive effect on new functions at a specific location, while there may be a need for them	Choice rule
Restrictive rules on material use in the Building Decree	Choice rule
The material certificates that are often needed for circular construction	Choice rule
The term 'real estate' within law	Choice rule

Opportunity
More flexibility in zoning plans, or regulatory areas to limit the functional requirements from zoning plans
Adjustment of the national fiscal framework for promoting the circular performance of buildings
Be creative with the places that materials are re-used
The possibility offered by the Environmental Law to create rules that stimulate circular area development within the 'Omgevingswet'
Require a materials passport and a dismantling plan for all new construction, transformation and renovation projects in Amsterdam
Preserve material certificates in a material passport

Figure 24 Overview of barriers and opportunities related to choice rules

5.3.3 Pay-off rules

A pay-off rule assigns rewards or sanctions to particular actions that have been taken or based on outcomes. Pay-off rules most directly influence the costs and benefits of the action arena. Within policy documents is described that *'Financing is difficult and it can be more expensive to implement new systems or sustainable materials. This approach requires a shift from cost-oriented thinking to a life-cycle approach'* (TNO, *.Fabric and Circle Economy, 2015, p. 32*). It has been identified within policy documents that the costs for the dismantling and collection of materials can be 2.5 to 3 times higher than the costs incurred for demolition (Circle Economy and Copper8, 2018). Also, in some cases, reconstruction and reuse of a building has a greater impact on nature is than the demolition. Also it was found that it is a challenge to build social housing in a circular way (Circle Economy and tCopper8, 2018). The innovations are difficult to finance because the income of the tenant is modest compared to that of tenants of more expensive types of homes (Circle Economy and Copper8, 2018). Within the same policy document the municipality of Amsterdam states that new (temporary) financing instruments for entrepreneurs with a high risk profile are needed to stimulate circularity within the construction sector. A final barrier identified within policy documents is that there is no transparency and alignment in the market about the supply and demand of (reclaimed) building materials, which results in high transaction costs.

As already seen above, it is confirmed multiple times that both sustainable materials and reclaimed materials often are more expensive than traditional building materials. Especially reuse of materials is considered to be more expensive, because of the taxes on labor instead of materials. There are several factors that determine whether it is financially feasible to use reclaimed materials (Slager, personal communication, 2019), but generally said it might be easier to reuse materials when the volumes are high and the materials are relatively expensive (Slager, personal communication, 2019). However, the large

construction companies have put a large amount of money into their construction process to optimize it and because of this it might be a real transition to make the switch to a circular economy (Markus, personal communication, 2019). Also, construction companies often make quite small margins and therefore do not have that many resources for this transition (Markus, personal communication, 2019). This makes it a lot more difficult to purchase bio based materials or to reuse materials while at the same time creating a realistic and fitting business case. Another barrier identified during data collection is that the circular business case has not been proven yet. A higher residual value might be very interesting for an investor, but currently investors do not dare to make the profit net present towards an extra investment in year zero, since this hasn't been proven yet (Markus, personal communication, 2019). If a project developer selects on the TCO and makes a bigger investment, which creates more value for the owner of the building, but the owner is not prepared to pay the higher value in advance it is also not possible for a project developer to make this bigger investment (Markus, personal communication, 2019). Project developer AM is currently working on this circular business case with the Dutch bank ABN AMRO. As a final barrier it is stated that the construction costs in general are on a rise, while the profits are decreasing. In this scenario, when you want to purchase biobased materials or re-use materials, this adds a few percentages to the costs, which can lead to the position that the business case is not conclusive anymore (Markus, personal communication, 2019). A possibility, however, is to reduce costs on other materials. An example of this is not to use bricklaying, but a cheaper method in order to invest in biobased materials for isolation (Markus, personal communication, 2019).

These business case related barriers are a little less of an issue in the utility building, since clients are willing and able to invest more if they consider sustainability or circularity to be very important (Markus, personal communication, 2019). However, when constructing houses your clients have a specific mortgage, which forms a certain maximum. It is therefore not possible to enlarge the investment to build in a circular way without economic losses (Markus, personal communication, 2019).

Barriers	Rule type of Ostrom
The costs for dismantling and collection can be 2.5 to 3 times higher than the costs incurred for demolition	Pay-off rule
In some cases, reconstruction and reuse of a building is more expensive and the impact on nature is greater than the demolition and new construction	Pay-off rule
Circular constructions for social housing are difficult to finance because the income of the tenant is modest compared to that of tenants of more expensive types of homes	Pay-off rule
The large construction companies have put a large amount of money into their construction process to optimize it	Pay-off rule
Also, construction companies often make quite small margins and therefore do not have that many resources	Pay-off rule
The circular business case has not been proven yet	Pay-off rule
When constructing houses, your clients have a specific mortgage, which forms a certain maximum. It is therefore not possible to enlarge the investment without economic losses	Pay-off rule
There is no transparency and alignment in the market about the supply and demand of (reclaimed) building materials, resulting in high transaction costs.	Pay-off rule

Opportunity

Reduce costs on low impact materials in order to make it possible to invest in more sustainable high impact materials

Figure 25 Overview of barriers and opportunities related to pay-off rules

5.3.4 Information rules

Information rules are said to authorize channels of information flows available to participants, including assignments of obligations, permissions or prohibitions on communication. Information rules are related to the amount of information that the participants in the action arena have. Within policy documents was found that there is insufficient knowledge within the municipality about how circular criteria can be applied in the purchasing process (Circle Economy and Copper8, 2018). Related to this, suppliers deliver what has been requested by the client, but the supplier is an expert on his own product group and not the client (Circle Economy, TNO and .Fabric, 2015). Because of this, it is important to discuss the environmental performance of materials with the different suppliers. However, the moment that this discussion takes place, might be even more important. Often suppliers are involved after the design of a building has been completed, which is too late, since on this moment specifications on (the use of) certain materials have already been made. Especially on the larger parts of a building, which have a big environmental impact, it is important to involve suppliers in an early stage in order to identify the best opportunities (Markus, personal communication, 2019). For example, project developer AM discussed with among others two façade suppliers and sustainability consultants about the questions that they should ask to their suppliers in order to achieve their desired result on circularity. Together they came to the conclusion that a lease construction, a 'façade as a service', would be the most fitting. The project developer considered these discussion as very valuable (Markus, personal communication, 2019).

Another identified barrier is related to missing data of reclaimed materials and the unclarity around what the characteristics of these materials are: *'We notice that the amount of information that is available of a house plays an important role in what can be reused and what not'* (Slager, personal communication, 2019). This missing data might be about the chemical composition of the materials, the fire resistance of materials or the absence of certificates. Within one of the interviews is described how Repurpose tried to explore the possibilities for reuse of window sills during the mapping and identification of materials from a building. However, there was almost no information about the (chemical) content of the window sills and therefore the company tried to find several ways to gain more information about the content, but in the end it was not possible to identify the content of the window sills until the actual demolishing process started (Slager, personal communication, 2019). Unfortunately, they discovered that the window sills were made out of reinforced concrete, which could not be given a new destination within a new building (Slager, personal communication, 2019). However, the waste has been disposed separately and was not processed as asbestos-containing waste, so the raw materials have been preserved by recycling the reinforcement of the concrete and downcycling the concrete itself.

Barriers	Rule type of Ostrom
Suppliers deliver what has been requested by the client. However, the supplier is an expert on his own product group, not the client	Information rule
There is insufficient knowledge within the municipality about how circular revenue models and criteria can be applied in purchasing processes for specific product groups	Information rule
Missing data of materials and the unclarity around what the characteristics of the 'mined' materials are	Information rule

Opportunity
Discuss the different possibilities regarding materials with the suppliers as a project developer or municipality
Suppliers need to be involved during or before the design of a building has been made in order to discuss the possibilities of materials or building elements

Figure 26 Overview of barriers and opportunities related to information rules

5.3.5 Position rules

Position rules create positions that actors may hold. Position rules most directly influence the position of the participants within the action arena. No additional barriers were found in policy documents. During the interviews it appeared that there might be a shift in the division of roles within the construction sector. This can be related to the changing moments that different stakeholders are involved within the construction process, as we already saw with the early involvement of suppliers during the design phase of a project. This is a search for a circular chain cooperation, where the responsibilities and core tasks of stakeholders might change (Markus, personal communication, 2019).

Next to this, the way that responsibilities are divided on the different governmental levels might be considered as a barrier. In some cases municipalities are depending on or sometimes constrained by the national government as the ability to change the barriers related to laws lie with the national government. An example of this are the adjustment of Building Decree or the adaptation of the fiscal framework. However, municipalities might influence the national government by lobbying.

Barriers	Rule type of Ostrom
National governments are more powerful than municipalities	Position rule

Figure 27 Overview of barriers related to position rules

5.3.6 Boundary rules

Boundary rules define (1) who is eligible to hold a certain position, (2) the process by which positions are assigned to actors (including rules of succession), and (3) how positions may be exited (Ostrom, 2005). Boundary rules most directly influence the participants within the action arena. There were no barriers identified in both policy documents and conversations. One could say that one barrier related to these types of rules is the actual absence or lack of boundary rules within a circular construction chain, since one of the problems identified in the previous paragraph is the changing role division and especially a missing new role division. Within one of the interviews was stated that project developers do often not know how to arrange a circular construction process, which might lead to a situation where it is eventually too late to implement circular solutions. A renewed overview of rules of succession, role divisions and a visualization of a circular construction chain might form a solution for the uncertainty in the search and definition of a new role for architects, project developers and suppliers.

Barriers	Rule type of Ostrom
Lack of knowledge of project developers on how to arrange a circular construction process	Boundary rule

Figure 28 Overview of barriers related to boundary rules

5.3.7 Aggregation rules

Aggregation rules determine how many, and which, players must participate in a given collective- or operational-choice decision. For these rules the same applies as to boundary rules that no barriers were found within policy documents or the during data collection.

5.4 Conclusion

After discussing the Dutch planning system and relevant policy documents related to circular construction in The Netherlands and Amsterdam, the results of the data collection and document analysis were presented according to the rule types of Ostrom (2005) in order to answer the following question: Which institutional barriers of policy implementation in construction projects can be identified in Amsterdam and how can these barriers be explained and overcome? As earlier explained these barriers were analysed with the help of the IAD framework of [83](#)

Ostrom (2005) and classified according to the seven different rule types of Ostrom (2005) and arranged by the way that they influence the different elements of the action arena. Barriers related to the scope rules were mainly related to a lack of clarity during the tendering procedure about the requirements, demands and definition of circular construction (Slager, personal communication, 2019). This unclarity can be related to the lack of one clear measurement method used by municipalities. Providing a clear measurement method as a municipality offers the opportunity, among others, for market parties to specialize and optimize their measurements to achieve better results on circular construction (criteria) (Slager, personal communication, 2019). Based upon the conducted interviews and different documents it appeared that the Environmental Performance Buildings (EPC), in Dutch MPG, in combination with the TCO might be the most suitable measuring method for circularity within construction projects (Slager, personal communication, 2019; Markus, personal communication, 2019). The reason for this is that the EPC measures the environmental impact of the construction products that are used. The TCO is added as a measurement method in order to also take the lifespan of materials into account. In order to create more clarity around the definition and requirements of circular construction, the creation of a document with a non-debatable legal text that defines what the municipality means by circular construction is needed as well as the formulation of clear ambitions on circular construction on both a city level and within projects. The approach sustainable GWW might help by formulating these ambitions. Within scientific literature the ineffective integration of circularity within innovation policies has been identified as a barrier. It appeared that although circularity has been integrated within policy document on a national and city level that there is the need for more clarity around the concept and its requirements and in that sense there is indeed a lack of effective integration.

Another barrier identified within scientific literature is 'legal issues around the novelty of the concept', which has been classified as a choice rule. Although several legal issues were identified in this case study, the main challenge was to specify these 'legal issues'. Laws that constrained the application of the circular economy within circular projects are the Dutch Building Decree, zoning plans and European rules that are set to stimulate a linear economy. With the latter is referred to the tax on labour instead of materials and the current accountancy rules. On a national level, these legal issues were not especially related to the novelty of the concept, but mainly tried to secure the quality and safety of the materials as the Building Decree makes it in some cases impossible to reuse materials, because the older materials do not meet the criteria described for new constructed buildings (Markus, personal communication, 2019). On top of that, a large part of the new constructed houses require several certificates that cannot be provided for older reclaimed materials of which these certificates are often not available (Slager, personal communication, 2019). At last, remarkable is that a zoning plan does not offer effective possibilities to stimulate or facilitate circular building or the re-use of materials. Possibly the best way to currently stimulate circularity through a zoning plan is by lowering the EPC (in Dutch MPG) through the Crisis and Recovery Act (Backes and Boeve, 2018), although it might take several months to implement this. As stated within the theoretical framework, legal institutions are most of the time very difficult to change (Sorensen, 2015). There are however a few ways of dealing with these constraining laws. A first way is to be creative with the places that materials are reused, like the reuse of doors within the cellar of buildings, where the strict requirements on materials do not

apply (Markus, personal communication, 2019). A second way is to respond to current changes in spatial planning as it seems like the New Environmental Law might offer possibilities that were not possible within zoning plans (Backes and Boeve, 2018). There is a possibility that the material passport is made mandatory within the coming years. In order to ensure future reuse of materials it is important that material certificates of new constructed buildings are preserved within this material passport. Competition legislation was not confirmed as a barrier within this research, although it was mentioned in scientific literature.

The barriers related to pay-off rules that were mentioned within policy documents all refer to the higher costs of circular constructed houses compared to traditional housing and the lack of financial resources to pay for these costs. These higher costs were also identified within scientific literature. Besides these higher costs the path dependency of the large construction companies is constraining the transition towards circular construction, since companies have put a large amount of money into their construction process in the past, which makes a transition towards a different construction process less appealing (Markus, personal communication, 2019). Probably the best way to deal with the cost difference between traditional and circular housing is to create a circular business case that takes into account the higher residual value of circular constructed buildings. However, this circular business case has not yet been proven and therefore cannot be used yet. Where within scientific literature was found that existing business models had a constraining function, it appears in this research that it is the absence of circular business models that forms a barrier.

Barriers related to information rules mainly centred around the absence of knowledge, which might be considered to be the 'uncertainty' around the concept that has been identified in scientific literature. This uncertainty or lack of information applies on the formulation of circular criteria in the purchasing process as a municipality (Circle Economy and Copper8, 2018), but also to the identified scope rules as there is, as described, unclarity around the requirements and definition of circular construction. Another identified barrier is that suppliers deliver what the client has requested, while the supplier is the expert on his own product group. In order to gain more insight into the ordering of materials it is important to discuss the opportunities of materials in the design phase with the suppliers (Markus, personal communication, 2019). A last barrier identified was the missing data of among others the chemical composition of materials, which again confirms the importance of a material passport.

Chapter 6 Discussion

6.1 Conclusion

This thesis started with the announcement that several cities are turning to the circular economy concept in order to deal with the challenges that they currently face - varying from urbanization to future scarcity of resources (Prendeville, Cherim and Bocken, 2018). There were several reasons found why it is interesting to look at this concept on a city level, among others because a great part of the global resources and energy supply are consumed within cities. Of these global resources and energy supply consumed in cities, a large part has been consumed by the construction sector, which is why there was chosen to focus on the application of the circular economy concept within the construction sector (Radhi and Sharples, 2014). Although some authors wrote about the barriers that constrain the application of the CE concept within the construction sector, these are mainly general identifications that focus on a large set of barriers varying from social to technical barriers. Within the analysis of different these broad range of barriers both Boros (2017) and Prendeville, Cherim and Bocken (2018) institutional barriers are acknowledged and considered to be one of the most frequent and important barriers that constrain the implementation of CE policies within construction projects. Therefore, in order to provide an in-depth analysis of the institutional barriers, the following question was tried to answer in this research:

Which institutional barriers can be identified, explained and overcome in order to successfully implement CE-related policy in construction projects within cities?

In order to explain the constraining influence of institutions on the application of the CE concept within construction projects, three forms of institutionalism were compared: historic, sociological and rational. Of these types, historical institutionalism (HI) makes it possible to explain why institutional change does not happen or why it is so difficult to create or stimulate institutional changes (Hall and Taylor, 1996). Rational institutionalism (RCI), on the other hand, offers the possibility to find opportunities to create change by offering ways to analyze or find incentives and produce change (Hall and Taylor, 1996). By using these elements of HI and RCI a complete perspective of the way institutions constrain and stimulate change was offered. In order to analyze the influence of different institutional arrangements on the implementation of CE policy, the IAD framework of Ostrom (2005) was used. The IAD framework made a thorough analysis of institutional arrangements within a given situation possible by firstly describing an action arena and secondly classifying the different institutions within seven different categories. Before the execution of two case studies, a first sub question had been introduced to create a clear overview of what circular construction entails. It appeared to be important to have an understanding what the circular economy concept constitutes, since there were several different epistemological perspectives on the concept (Homrich et al., 2015). Also, there was found that the circular economy concept has a lot in common - and is often confused - with several other concepts that are currently popular within recent scientific literature

as urban metabolism and smart city. Therefore, the following subquestion was posed:

Subquestion 1: What are the main differences between traditional and circular construction?

Before coming to a definition of circular construction, the circular economy concept in general was discussed. The concept knows several definitions, but a few characteristics were identified as most of the definitions agree that circular economy is related to cyclical thinking and incorporates an idea for facing the increasing limitations of the earth's natural resources (Homrich et al., 2015; Prendeville, Cherim and Bocken, 2018). Also, most definitions refer to 3R's: Recycling, reusing and reducing. Arthur (2018) added six other R's. The distinction between the nine ambition levels that Arthur (2018) provided, helped to distinguish the importance of the large amount of measures in circular construction. Although different authors described the characteristics of the concept, there was no clear definition of the circular economy concept found. This is related to the fact that in different sectors different indicators of the concept are important (Circle Cities, N.D.). Although the principles of the circular economy are more or less the same for different sectors, the definition and operationalization of the concept might differ. This is why in this research was focused on defining circular construction instead of trying to provide a clear and official definition of the concept in general. When investigating the difference between traditional and circular construction, there was found that both consists of almost the same steps from concept towards realization. However, based upon literature, there were two important differences as circular construction takes into account use, maintenance and eventual disassembly, restructuring or reuse (Circulair Friesland, 2018). Next to this, does circularity ask for innovative development and acting and therefore is the creation of fitting conditions for innovation is essential for its success, for example in the tendering procedure. However, when one takes a closer look into the different phases of the realization of circular constructions, there can be found that within these phases there are a lot of different CE-related principles that can be applied or taken into account that do not specifically change the process, but still have an impact on the kind of topics and subjects that are taken into account (Circulair Friesland, 2018).

Eventually, there was chosen to work with the following definition of circular, since this definition has been acknowledged and defined by different parties from governmental organisations, market parties and the scientific community:

'developing, use and reuse of buildings, areas and infrastructure without using natural resources unnecessarily, the environment and ecosystems to affect. Build in a way that is economically justified and contributes to the welfare of humans and animals. Here and there, now and later.' (Nelisen et al., 2018).

After a clear understanding of circular construction and the identification of a supportive framework to analyse the influence of institutional barriers on circular construction were provided, there was started with the analysis of the institutional barriers. The second question that has to be answered in order to formulate an answer on the main question is the following:

Subquestion 2: Which institutional barriers of circular economy policy implementation in construction projects can be identified in Stockholm and Amsterdam and how can these barriers be explained?

As mentioned, the different barriers were divided into the seven rule type categories of Ostrom (2005). The first category, scope rules, are focussing on steering different participants towards the desired outcome (Ostrom, 2005). Barriers related to scope rules mainly apply to the relation between the municipality and project developers as in both Amsterdam and Stockholm the setting of the right requirements by the municipality to stimulate circular construction was the main topic of discussion. The municipality of Stockholm was struggling to set the right requirements that were needed to stimulate a reduction of construction and demolition waste and the use of more sustainable construction materials (Lennartsson, personal communication, 2019). In Amsterdam there appeared to be a lack of clear requirements and ambitions on circular construction within construction projects. Project plans or planning documents often also lack a clear and uniform definition of circular construction (Slager, personal communication, 2019). The setting of the right requirements is especially important since parties that they apply to, which are mainly project developers, often have a negative attitude towards circular construction (Lennartsson, personal communication, 2019). On top of that, there are often no consequences attached to the requirements (Lennartsson, personal communication, 2019). The lack of a clear measurement method that has been identified as a barrier, also adds up to this. These measurement methods are put in place to stimulate project developers to live up to the requirements (Slager, personal communication, 2019). However, due to the lack of an uniform measurement method project developers need to put a significant amount of time in figuring out each different measurement method per project (Slager, personal communication, 2019), which makes it unattractive to work with the circular economy concept. Because of the unclarity and struggle with the requirements there is an important relationship between scope rules and information rules as the latter might stimulate project developers to learn how to deal with new measurement methods and the (strict) requirements of the municipality. Remarkable was that policy documents often discussed circular construction in more detail than plans or documents on a project level. Therefore, it is the translation of these policies into the right requirements that forms a barrier instead of the ineffective integration within policy documents that was described within scientific literature (Bosor, 2017).

There was found that most barriers are directly influencing the actions of the participants within the action arena. Within the theoretical framework was found that these barriers, which are mainly related to law and regulation, are often most difficult to change (Sorentsen, 2015). Boros (2017) identified the legal issues around the novelty of the circular economy concept as a barrier. The main challenge in this research appeared to be specifying these 'legal issues' by identifying several laws that have a constraining or stimulating influence on the application of the circular economy concept in construction projects. These laws, differing from current accountancy rules to a tax on labor instead of materials, are arranged on both an European and national level and were often put in place to support a linear economy. On a national level, the constraining laws mainly tried to secure the quality and safety of the materials.

Barriers that effected the cost and benefits in the action arena that were mentioned within policy documents all refer to the higher costs of circular constructed houses compared to traditional housing and the lack of financial resources to pay for this costs difference (Circle Economy and Copper8, 2018; TNO, .Fabric and Circle Economy, 2015). Only the reduction of construction and demolition waste was considered to save cost and time (Jakobsson, personal communication, 2019). These higher costs were also identified as a barrier within scientific literature (Bosor, 2017). The relatively higher prices are related to the earlier discussed higher tax on labor compared to materials, which makes reuse of materials more expensive. Although in scientific literature was described that existing business models might have a constraining function, it appeared that the absence of circular business models is what forms a barrier for circular construction. The reason for this absence is that a circular business case has not been proven yet (Markus, personal communication, 2019). This barrier was only identified in the Amsterdam case study. A possible explanation for this might be that in Amsterdam is focused on reuse of materials, which asks for a new form of business models, whereas in Stockholm is more focused on minimizing waste, lowering material use and the use of sustainable materials. Financial support and subsidies for the existing system were not confirmed as a barrier during data collection or document analysis.

With new practices or concepts there always are a lot of question and uncertainties, whether it is about the costs, the risks or the method of construction. The missing data and the unclarity around reclaimed materials partly determined the possibilities to reuse materials (Slager, personal communication, 2019). An important barrier around the knowledge and information on circular construction, is the lack of acknowledgement of the necessity to build in a more sustainable way. This, as earlier mentioned under the scope rules, contributes to the high importance of strict requirements on this topic.

Positions rules directly influence the different positions within the action arena. The organization of a circular construction chain differs from a linear construction chain, as additional steps and tasks are added. This asks for a search for a circular chain cooperation, where the responsibilities and core tasks of stakeholders, like contractors or project developers might change (Markus, personal communication, 2019). This results in the situation where certain steps, like refurbishing old materials and identifying which materials are present in an old building, are added and for which no one currently feels responsible for (Matz, personal communication, 2019). One could say that a barrier related to these types of rules is the actual absence or lack of boundary rules within a circular construction chain. Within one of the interviews was stated that project developers do often not know how to arrange a circular construction process, which might lead to a situation where it is eventually too late to implement circular solutions (Slager, personal communication, 2019). Another barrier that is related to boundary rules is that in some cases municipalities are depending on or sometimes are constrained by the national government when the ability to change barriers lies with the national government. This is the case with several choice rule barriers that are arranged on a European or national level.

In the Stockholm case study an eight category has been added, namely the aesthetic performance of circular construction. This category has been added, because this barrier was mentioned in several interviews and did not fit in

the categories created by Ostrom (2005). It offers another explanation of why materials are often not reused as the volumes of leftover or reclaimed materials are often too low. When materials are purchased in one bulk, all materials in one building look the same. This is, due to the low volume often not the case with leftover or reclaimed materials (Matz, personal communication, 2019; Isaksson, personal communication, 2019).

As already stated within the theoretical framework, there are ways to overcome some of the identified institutional barriers (Boros, 2017; Prendeville, Cherim and Bocken, 2018). The rational institutionalism perspective explains why it is possible to change institutions, namely by lowering the transaction costs to make it more attractive (than the current situation). In order to identify these 'enablers' to tackle the barriers, the following sub question was created:

Subquestion 3: How can the identified institutional barriers within Amsterdam and Stockholm be overcome?

When answering the previous sub question there was found that barriers related to scope rules mainly applied to the setting of requirements. In order to identify a lack of or insufficient requirements it is important to have a strict monitoring system, which makes it possible to constantly follow the status, influence and result of the currently set requirements. Within scientific literature was stated that three things should be changed within policy to stimulate the application of the circular economy concept: openness, flexibility and cooperation (Bosor, 2017). Although during data collection was recognized that it was the translation of these policies into the right requirements that formed a barrier, the flexibility aspect might also apply to the creation of the right requirements. Ideally, it is possible to revise and optimize the requirements in time, which is mainly possible in projects with different project phases. Earlier was also already touched upon the importance of a clear measurement method for circularity in construction projects in order to make sure that project developers live up to the requirements set by the municipality. The TCO, Total Costs of Ownership, in combination with the Dutch MPG, was based upon the interviews and document analysis considered to be the most suitable measuring method for circularity within construction projects, since it measures the environmental impact of the construction materials that are used (Slager, personal communication, 2019; Markus, personal communication, 2019; Repurpose and IMIX projecten BV, 2018). Another way to ensure that project developers and construction companies live up to the formulated requirements is to combine or merge requirements with labelling or certification methods, like LEED.

As earlier acknowledged, legal institutions are very difficult to change (Sorensen, 2015). Changing these laws is mainly the responsibility of national and European governments. There are however a few ways of dealing with these constraining laws without intending to change them. A first way is to be creative with the places that materials are reused by, for example, reusing doors within the cellar of buildings or reusing materials in the interior instead of exterior (Markus, personal communication, 2019; Matz, personal communication, 2019). A second way is to respond to current changes in spatial planning law as it seems like the New Environmental Law within the Netherlands might offer ways to stimulate circular construction that were not possible within zoning plans.

Within his research Bosor (2017) mainly paid attention towards ways to overcome financial barriers that are associated with circular construction, for example by developing a circular business model and financial stimulus (Bosor, 2017; Prendeville, Cherim and Bocken, 2018). It has been confirmed that a circular business case that takes into account the higher residual value of circular construction case might help dealing with the cost difference between traditional and circular housing. However, as discussed, this business case has not been proven yet and therefore cannot be used (Markus, personal communication, 2019). Possibly the best way to deal with the higher costs for reusing materials and the use of sustainable materials is to experiment with this relatively small and short projects (Jakobsson, personal communication, 2019), so the financial resources are not locked in for a long amount of time. A last way to deal with the higher costs is to compare climate calculations and project budget throughout the project and in this way explore the possibilities regarding sustainable or reclaimed materials, for example using more expensive and sustainable materials, but using less of it (Jakobsson, personal communication, 2019).

To stimulate and support project developers to live up to the requirements of the municipality regarding circular construction, the municipality might set up different training programs and thematic seminars to support, stimulate and inform project developers to find a way to work with circular construction (Lennartsson, personal communication, 2019). The main goal is to show the importance of working with circular construction, while simultaneously providing examples of how to do it.

At last, in order to deal with the organizational changes that occur when transforming a construction chain from linear to circular, it might be helpful to create a renewed overview of the succession and role divisions of a circular construction chain. It might be most suitable to arrange this on a national level by involving different experts that are working in construction projects. This might form a solution for the uncertainty in the search and definition of a new role for architects, project developers and suppliers.

Which institutional barriers can be identified, explained and overcome in order to successfully implement CE-related policy in construction projects within cities?

It is after answering the different sub questions not possible to give one uniform and concluding answer on the main question because of the diversity of the identified barriers and the several ways to overcome these barriers. Also, the institutional context between countries might differ widely, which might lead to the identification of other barriers in countries with an institutional context that is different from the one in Sweden and The Netherlands.

Generally said, it appeared that most institutional barriers are related to laws and regulations and requirements set by the municipality during the tendering procedure. Because of the different institutional contexts, it is important to find the best fitting solution that is in line with the current institutional situation. Different solutions were suggested in order to leave room to find the best fitted solutions in the given context. At last, in this research is found that although some identified barriers might be hard to change, there are other, creative, ways to work around these sticky barriers

6.2 Recommendations

This research, in the first place, tried to give more insight into the barriers that are encountered during the application of the circular economy concept on construction projects. Next to this, it aimed at finding ways to overcome these barriers in order to stimulate circular construction. As described above there was found that during a circular construction project all kinds of institutional barriers might be encountered, which are mainly related to law and regulations, requirements and objectives and a lack of financial resources to overcome the higher costs for circular construction.

By discussing the different ways to overcome the identified barriers, there were already made different recommendations to mainly municipalities and project developers on how to deal with the identified barriers. Therefore, in this paragraph, the recommendations will focus on assigning certain priority to the different identified barriers.

As the requirements are often based upon the initial objectives of the project and therefore are determining the following phases, it is recommended to start with focussing on the creation of clear objectives on circular construction. There must be noted however that ideally the objectives are revised and adapted multiple times during the area development process.

Clear objectives, as well as the requirements, incorporate a clear definition of what is understood under circular construction. The definition that was used in this thesis might form as a base for this definition as there is already support within the construction sector for this definition, at least within the Netherlands. Ideally, the objectives include measurable indicators as kilograms or a percentage of reused materials. A last step in defining the right objectives is to already start thinking about the right measurement method. In order to make sure that project developers live up to the requirements, it is important to provide one clear measuring method that will be used to control all projects within the municipality. The eventual objectives are written down in initial planning documents or project plans within the first phase of the area development.

As earlier stated, the responsibility to change the identified constraining laws lies with the national and European government. This applies to the current accountancy rules, the tax on labor instead of materials and the national laws that determine the quality of materials. It is recommended to explore whether it is desirable and possible to adapt these laws to the principles of a circular economy. An adaptation of these laws might also partly solve the high prices for circular construction as taxes on labor are a big influencer of the costs for reusing materials.

Regarding further research it might be interesting to select a few of the identified barriers and research these barriers in more depth as this might contribute to even more concrete solutions. For example, a research into the possibilities of reusing materials in the interior. Also, as in this research only two countries have been investigated that share a similar institutional context. It might be useful to see whether a complete different institutional context has an influence on the barriers that are identified. At last, within the theoretical framework there was paid some attention to policy implementation. However, with the choice for the

IAD framework of Ostrom (2005) and the theoretical explanation of HI and RCI the focus has been put on institutions and institutional change. It could be useful to shift the focus from institutions towards policy implementation, in order to find whether this focus might find new barriers or provide new explanations for the identified barriers. A way to shift this focus is to use the policy arrangement approach. This approach offers a structured way to link policy changes to larger structural changes within society. It offers a broad starting point in understanding policy practices (Veenman, Liefferink, & Arts, 2009). The approach is based on multi-actor network models, which might also offer the possibility to provide insight into the different relations between actors when building in a circular way as it also takes into account the power relations between actors. In this light, it might especially be interesting to look more into circular chain cooperation.

Chapter 7 Reflection

In the following part a methodological and theoretical reflection will be provided. Main points of attention are the choice to use historical and institutional institutionalism as an explanation for (non existing) institutional change, the methodological choices made in this research and the use of the IAD framework to analyse institutions.

In the theoretical framework is chosen to use elements of historical institutionalism. Historical institutionalism makes it possible to explain why institutional change does not happen or why it is so difficult to create or stimulate institutional changes (Hall and Taylor, 1996). Rational institutionalism, on the other hand, offers the possibility to find opportunities to create change by offering ways to analyze or find incentives and produce change (Hall and Taylor, 1996). There was concluded that in this way a complete perspective on institutional change has been provided. Sociological institutionalism had been excluded in this research because of its focus on policy diffusion and informal institutions. However, during the research was found that informal institutions, like habits, also played a constraining function when applying the circular economy concept. An example of this is that the construction industry wanted to continue working 'as it always did'. This rises the question whether sociological institutionalism might have been to dismissed too easily.

Although the IAD framework indeed provided a systematic approach to analyze the different institutions that effect circular construction, it did not offer the possibility to compare or relate these barriers to each other. This comparative function was especially missed when trying to compare the data of the document analysis and interviews to each other. Therefore, it might be helpful to enlarge the IAD framework by adding a comparative element to the framework. A possibility is for example to research and eventually generalize on which rule types are influencing. Within this research was found that information rules and pay-off rules both influence scope rules.

Another shortcoming of the framework identified within this research is that one of the main barriers in the Stockholm case study did not fit in the framework, which is the aesthetic performance of a building. This is why an eight category has been added to the framework. Also in general it appeared to be a challenge to fit all barriers within the framework. Related to this, although the framework helped to understand and explain the institutional barriers, it might also have framed the search to the barriers by focussing too much on the different categories. This means that in the worst scenario it might have resulted in the missing out of important barriers.

Within this thesis was chosen to execute a case study, which indeed helped to provide an in-depth analysis of the institutional barriers of circular construction. Also the use of interviews contributed to this in-depth analysis by offering the different explanations behind different identified barriers. Such an explanation appeared to be crucial, since most barriers are positioned within a complex institutional context. As mentioned, the interviews were combined with a document analysis, which provided the necessary background information and made it possible to better understand the institutional context of the barriers. In order to systematically analyse and gather the collected data in order to

enlarge the reliability and validity of the research, the program atlas.ti was used. However, as the categories were already determined, the program was only used to identify the barriers and their importance and to divide them into the different rule types of Ostrom (2005). It might have been useful to analyse the different barriers dividing these into the preselected categories.

Chapter 8 Keywords

Circular economy= 'A sustainable development initiative with the objective of reducing the societal production-consumption systems' linear material and energy throughput flows by applying materials cycles, renewable and cascade-type energy flows to the linear system. CE promotes high value material cycles alongside more traditional recycling and develops systems approaches to the cooperation of producers, consumers and other societal actors in sustainable development work' (Korhonen, 2017).

Circular area development= Circular area development follows the same steps as non-circular area developments. The only difference is that it takes into account use, maintenance and eventual disassembly, restructuring or reuse and next to this the circularity ask for innovative development and acting (Bosor, 2017).

Circular construction = 'developing, use and reuse of buildings, areas and infrastructure without using natural resources unnecessarily, the environment and ecosystems to affect. Build in a way that is economically justified and contributes to the welfare of humans and animals. Here and there, now and later.' (Nelisen et al., 2018).

Implementation barrier = An implementation barrier is an obstacle that prevents a given policy instrument of being implemented or limits the way in which the instrument might be implemented (Konsult, N.D.).

Institutions= institutions are by humans created rules that structure the interaction between humans or their behaviour (Buitelaar et al., 2013).

Historical institutionalism= historical institutionalism is said to represent an attempt to illuminate how political struggles are mediated by the institutional setting in which they occur (Lockwood, et al. 2016). Historical institutionalism emphasizes path dependency and the unintended consequences of the institutional design and policies.

Policy implementation= policy implementation encompasses those actions by public and private individuals (or groups) that are directed at the achievement of objectives set forth in prior policy decisions (Meter and Horn, 1975).

Rational institutionalism= RI explains the creation of institutions as a way to reduce transaction costs of collective activity (Hall and Taylor, 1996).

Sociological institutionalism= Sociological institutionalism emphasizes cultural factors in the creation or alteration of institutions (Nichols, 1998). In the study of policy, sociological institutionalism focuses on processes of policy imitation and diffusion (Amenta and Ramsey, N.D.).

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Appendix 1 Overview of the identified barriers during data collection

1.1 Stockholm

Barriers	Rule type of Ostrom
The inspection authorities have no guidance as to how issues concerning recycling and resource efficiency should be managed within the inspections	Scope rule
Municipalities are having trouble with shaping the appropriate requirements for the desired result (circular construction)	Scope rule
The construction industry is not recognizing and acknowledging the importance and need for circular construction	Scope rule

Barriers	Rule type of Ostrom
The lower price on materials compared to labour	Choice rule
Extra volumes of materials are ordered to prevent construction delays that cause workers to wait for delivery of materials	Choice rule
The hazardous substances that are found in products that are currently being demolished and, which are now banned from use in new products	Choice rule
The requirement to notify the municipal environmental boards of the use of not entirely uncontaminated waste	Choice rule

Older materials do not comply with the current Planning, Law and Building Act, Environmental Code and building regulations.	Choice rule
Absence of law stimulating re-use of materials or the use of recycled or sustainable materials with a low carbon footprint	Choice rule

Barriers	Rule type of Ostrom
The coordination between activities that generate waste or surplus materials that is suitable for construction purposes and suppliers of conventional ballast	Pay-off rule
The waste from an activity is often only sufficient for a small part of a construction project, which causes added costs to be incurred when not all the materials can be sourced from one single location.	Pay-off rule
Taxes on labour instead of materials	Pay-off rule
It takes more time (and thus money) to look into how you need to re-use materials	Pay-off rule

Barriers	Rule type of Ostrom
No acknowledgement of the problem or necessity to reduce waste of project developer	Information rule
Project management does not acknowledge the necessity of waste reduction	Information rule

Too little knowledge on how to achieve the requirements regarding circular construction	Information rule
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Barriers	Rule type of Ostrom
Organizational structures of project developers	Position rule
New tasks or steps within the circular construction chain that no one feels responsible for (yet)	Position rule

Barriers	Rule type of Ostrom
The volumes of reclaimed and leftover materials within construction projects are too low	Aesthetic performance

1.2 The Netherlands

Barriers	Rule type of Ostrom
Internal clients still do not set sufficient circular ambitions and steer projects tightly on time and budget	Scope rule
A lack of clarity during the tendering procedure about the requirements, demands and definition of circular construction.	Scope rule
A lack of a clear measuring method for reuse of materials/ resource efficiency	Scope rule

Barriers	Rule type of Ostrom
Low tax on labor and high tax on raw materials	Choice rule

The Building Decree does not contain any guidelines which state that reuse and high-quality recycling of building materials should be preferred over downcycling or incineration	Choice rule
Existing accounting rules are set to a linear economy	Choice rule
Zoning plans have a restrictive effect on new functions at a specific location, while there may be a need for them	Choice rule
Restrictive rules on material use in the Building Decree	Choice rule
The material certificates that are often needed for circular construction	Choice rule
The term 'real estate' within law	Choice rule

Barriers	Rule type of Ostrom
The costs for dismantling and collection can be 2.5 to 3 times higher than the costs incurred for demolition	Pay-off rule
In some cases, reconstruction and reuse of a building is more expensive and the impact on nature is greater than the demolition and new construction	Pay-off rule

Modular homes are in most cases only acceptable for social housing. These are difficult to finance because the income of the tenant is modest compared to that of tenants of more expensive types of homes	Pay-off rule
The large construction companies have put a large amount of money into their construction process to optimize it	Pay-off rule
Also, construction companies often make quite small margins and therefore do not have that many resources	Pay-off rule
The circular business case has not been proven yet	Pay-off rule
When constructing houses, your clients have a specific mortgage, which forms a certain maximum. It is therefore not possible to enlarge the investment without economic losses	Pay-off rule
There is no transparency and alignment in the market about the supply and demand of (reclaimed) building materials, resulting in high transaction costs.	Pay-off rule

Barriers	Rule type of Ostrom
Suppliers deliver what has been requested by the client. However, the supplier is an expert on his own product group, not the client	Information rule

There is insufficient knowledge within the municipality about how circular revenue models and criteria can be applied in purchasing processes for specific product groups	Information rule
Missing data of materials and the unclarity around what the characteristics of the 'mined' materials are	Information rule

Barriers	Rule type of Ostrom
National governments are more powerful than municipalities	Position rule

Barriers	Rule type of Ostrom
Lack of knowledge on how to arrange a circular construction process	Boundary rule

Appendix 2 Overview of the identified opportunities during data collection

2.1 Stockholm

Opportunity

An increase in the reuse of materials requires that authorities design appropriate and clear regulations, provide guidance, inspect and enforce, and collaborate with each other and with all actors subject to such regulation

The putting in place of clear requirements by the municipality on waste management should occur in building permits and supervision of the waste management of construction.

The revision of requirements during different phases of a project

A strict monitoring system in order to measure the performance of project developers and identify (a lack of) requirements

The alignment of requirements and ambitions with certification systems

Opportunity

Chemical treatment of soil on site with the use of bacteria's

The permit authority might be able to impose requirements to promote reductions both in the quantities of waste that are generated and in the quantities of hazardous substances that are present in the waste

Focus on material reuse in the interior instead of exterior

Use materials for the superstructure (exterior) with a high recycled percentage

Opportunity

The strongest force behind the use of waste is the avoidance of transport and landfill costs

Comparing climate calculations and project budget and taking time to look into the possibilities

Starting with smaller or shorter projects

(Be open minded for) Creating a design which is flexible and a design in which there are no strict material requirements on shape or form

Opportunity

Involving (sustainability) experts within the design phase of a construction project

Opportunity

Set up several training programs to teach necessity of the requirements by the municipality

Organize training programs as a municipality to learn the project developers how to achieve the strict requirements within the area

As a municipality, provide examples of earlier projects where they build successful, bringing in specialists for education

Create training programs as a project developer on circular construction for your project management teams

Testing different materials in order to see what is possible from a sustainability perspective

Opportunity

Contact a company that is able to take leftover from construction projects

Organize a system within the organization to transfer leftovers from project to project

Coordinate activities that generate waste or surplus materials

Testing different materials in order to see what is possible from a sustainability perspective

2.2 The Netherlands

Opportunity

The MPG, combined with the TCO, as a measuring method for circularity

The incorporation of circular ambitions within different planning products, varying from the 'Omgevingsplan' to tenders

The creation of a document with a non-debatable legal text that defines what the municipality means by circular construction

Formulate clear ambitions on circular construction on a city level as well as within projects.

Create or help to create a necessity to build in a circular way

Make sure that within the municipality is enough expertise about circular construction to be supportive to market parties.

Opportunity

More flexibility in zoning plans, or regulatory areas to limit the functional requirements from zoning plans

Adjustment of the national fiscal framework for promoting the circular performance of buildings

Be creative with the places that materials are re-used

The possibility offered by the Environmental Law to create rules that stimulate circular area development within the 'Omgevingswet'

Require a materials passport and a dismantling plan for all new construction, transformation and renovation projects in Amsterdam

Preserve material certificates in a material passport

Opportunity

Reduce costs on low impact materials in order to make it possible to invest in more sustainable high impact materials

Opportunity

Discuss the different possibilities regarding materials with the suppliers.

Suppliers need to be involved during or before the design has been made in order to discuss the possibilities of materials or building elements

Appendix 3 Interviewguide

Introduction (concepts, goals and position)

What do you understand under circular economy?

What do you understand under circular economy in area development?

In which context are you working the on circular economy?

How are you involved in this circular area development project?

How is circularity embedded in the project (what is the role of circularity within the project) and what are the concrete goals regarding circular building?

Description action arena

What was your position (company/municipality) within the your organisation?

What were your tasks?

When were you engaged in the process? Do you think this was the right moment?

What were the responsibilities of you during the project? (also from a financial perspective).

Where lie the most benefits and costs for you to build in a circular way?

Barriers/opportunities circular building (general)

What are the most important barriers that you identified during the project? (for example law that prohibited the activity)

Were you able to find a solution on these barriers?/How did you deal with these barriers?

What are the most important opportunities that you identified during the project?

Barriers/opportunities (per category/barrier)

Within literature I ordnenend the identified barriers in different categories. Each of these categories know several barriers. Which barriers do you recognize per category? And which opportunities?

(Providing overview of already identified barriers)

Closing the interview