Master's Thesis Sustainable Business and Innovation:

Modes of Governance to Accelerate the Transition Towards a Circular Construction Sector: A Critical Assessment

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Abstract

The built environment has a negative impact on the natural environment. Circular economy (CE) is seen as a promising approach to reduce this environmental impact, as it facilitates the achievement of sustainable material streams. However, most CE research tends to focus on either a micro-scale (e.g., products) or a macro-scale approach (e.g., the national government). A few researchers have studied the realisation of circular buildings, although they generally neglect the processes that are required to facilitate and accelerate the transition towards CE. Therefore, this study aims to provide an advanced understanding of how the Dutch governance can successfully facilitate the transition towards a circular construction sector in the Netherlands. First, a conceptual model is developed to study the influence of governance modes on the transition towards circularity. To create this model, we used theoretical building blocks for circular building principles, the Triple Embeddedness Framework (TEF), as well as environmental governance from literature. Second, an analysis is presented in which the framework is applied to the Dutch government, using unstructured interviews and desk research. Based on the theoretical- and analytical frameworks, recommendations are provided to accelerate the demanded transition within the construction sector in the Netherlands. Namely, we found that for the realization of a circular construction sector in the Netherlands, i) the powerbase should be enlarged, ii) frontrunners and circular experts of the construction sector should be consulted in formulating policy, iii) a clear definition of circular construction is required to formulate and execute policy, iv) a method to calculate circularity performance should be developed, which includes the environmental impact of the entire life cycle of a building, disassembly and adaptively of buildings and CO_2 storage, v) development of knowledge and experience should be broadened through pilots, iv) government buildings should be used to set an example, and vi) a different taxation system with a higher taxation rate on materials and less taxation on labour activities should be implemented. Altogether, in case the government performs the recommended actions, the construction sector is expected to shift from a linear to a circular system.

Keywords: circular economy; circular construction; triple embeddedness framework environmental governance; modes of governance; drivers and barriers of shifts

Executive Summary

The construction of buildings is characterized by high impact activities and extensive material demands. Research has shown that the construction sector is one of the primary consumers of raw materials due to the great demand of non-renewable bulk resources and inadequate reuse of materials and responsible for considerable waste streams. Resulting in resource depletion and many other environmental impacts, such as land- and soil degradation, loss of biodiversity and global warming. This call for immediate action to create a more sustainable construction sector. The circular economy (CE) is seen as a promising approach to reduce environmental impact and achieve sustainable material streams. CE is based on three general principles: i) involving designing out waste, ii) building resilience through diversity, versatility and modularity, and iii) using energy from renewable sources.

The Netherlands set the most ambitious goal worldwide by targeting to be fully circular by 2050. The Dutch government formulated a sector-specific circular transition policy, activities and supporting networks for the realization of a circular construction sector. This transition policy comprises pilot test cases for circular building projects, multi-stakeholder partnerships and government support on circular material and product design for buildings. However, despite political ambitions and long-term targets on both the EU and Dutch government levels, only eight percent is currently used as secondary materials for new construction projects.

The aim of this research is to understand how governance can successfully contribute to the transition towards a circular construction sector in the Netherlands. First, a comprehensive understanding of the current mode of governance of the Dutch construction sector was provided. This showed that there are different governance features that respond to different types of governance modes, such as *centralized* (2 times), *decentralized* (2 times), *interactive* (5 times) and *public-private* (1 time) modes of governance. Second, the governance features for the realization of a circular construction sector mainly consists of a composition of features that correspond to a *centralized* mode of governance (9 times) and partly by an *interactive* (1 time) and *public-private* (1 time) mode of governance. However, there is some overlap between the mode of governance of the current construction sector in the Netherlands and the government features that are essential to achieve a circular construction sector. Still, a large part differs in terms of (policy) content and in the mode of governance. Therefore, the drivers and barriers that hamper or stimulate the transition towards a Dutch construction sector were identified and used as recommendations to accelerate the transition towards a circular

construction in the Netherlands. Firstly, the powerbase of the Dutch government should enlarge the powerbase to ensure a distribution of resources that will be in favour of the transition towards a circular construction sector. Secondly, the government should use governmental buildings to upscale circular construction and, thirdly, amend the existing building code to set stricter requirements. Fourth, the Dutch government should include stakeholders that are frontrunners or experts in the field in order to realize a feasible and progressive policy. Fifth, a clear definition of circular construction is necessary to formulate and execute policy for the construction sector. Sixth, the method to calculate circularity performance needs to include the environmental impact of the entire life cycle of a building, disassembly and adaptively of buildings and CO_2 storage in order to set performance standards of buildings. Seventh, the Dutch government should stimulate the development of knowledge and experience regarding circular construction within the sector to ensure a policy that is in line with the capabilities of the industry. Lastly, the taxation system of the Netherlands should change to a system in which materials are taxed higher and labour less.

We expect that if the recommendations are converted into practice, they can shape the conditions in which circular principles are a more desired option and destabilize the existing linear system. This will accelerate the transition towards a circular construction sector in the Netherlands.

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List of Abbreviations

CE	Circular Economy
EU	European Union
MRA	Metropole region of Amsterdam
NEA	Netherlands Enterprise Agency
ROs	Value retention options
TACE	Transition agenda circular economy
TEF	Triple Embeddedness Framework

1. Introduction

1.1 Background

The construction of buildings is characterized by high impact activities and extensive material demands (Pomponi & Moncaster, 2017). Research has shown that the construction sector is one of the primary consumers of raw materials due to the great demand of non-renewable bulk resources and inadequate reuse of materials (Faleschini et al., 2016). This unsustainable usage of materials is causing considerable waste streams (Iacovidou & Purnell, 2016; UNEP, 2009). The construction and use phase of buildings account for over 25% of the total amount of harvested wood, 13% of the world's freshwater usage, and over 40% of all energy and material flows. Therefore, the construction sector has a significant contribution to resource depletion and many other environmental impacts, such as land- and soil degradation, loss of biodiversity and global warming (Emmanuel, 2004; Tan et al., 2011). The environmental impact of the construction sector, together with the necessity to comply with carbon emissions targets, call for immediate action to create a more sustainable construction sector (Iacovidou & Purnell, 2016; Calahane, 2014).

The circular economy (CE) is seen as a promising approach to reduce environmental impact and achieve sustainable material streams (Reike et al., 2018; Ellen MacArthur Foundation, 2013; European Commission, 2020). The Ellen MacArthur Foundation (2013, 22) defines CE as: "*an industrial economy that is restorative by intention"* and formulates three general principles of CE: i) involving designing out waste, ii) building resilience through diversity, versatility and modularity, and iii) using energy from renewable sources. The idea of a circular economy is to create closed loop systems (cradle-to-cradle) in which waste is considered 'food' for a new life cycle, instead of a linear system (cradle-to-gate) in which a ´take-make-dispose´ pathway is followed (McDonough & Braungart, 2010). A shift towards a circular system implies radical changes for the construction sector (Geldermans, 2016).

The transition from a linear system to a closed loop system requires a governance framework that links all policy levels in order to create fundamental system changes (Zhong et al., 2009; Penna & Geels, 2012). The European Union (EU) has formulated a Circular Economy (CE) Action Plan that targets circularity policies and activities to all member states (European Commission (EC), 2020). The CE Action Plan presents measures to standardize circular products with the aim to empower consumers and public buyers to make responsible choices for materials and products. On the national policy-level – and in line with the CE Action Plan – The Netherlands set the most ambitious goal worldwide by targeting to be fully circular by

2050 (Netherlands Enterprise Agency (NEA), 2016). One of the primary target areas is the Dutch construction sector. To achieve this, the Dutch government formulated sector-specific circular transition policies, activities and supporting networks. This transition policy landscape comprises pilot test cases for circular building projects, multi-stakeholder partnerships and government support on circular material and product design for buildings. These activities are accompanied by tightening building laws and standards – for instance through the mandatory usage of NEAs for all new buildings – and an incremental role for the Dutch state with high circularity targets on all state procurements. Most recently the Dutch state introduced a specific subsidy that entirely focuses on low-impact and circularity for new buildings (Transitiebureau Circulaire Bouweconomie (TCB), 2019).

Next to government incentives and efforts, circular building innovations and developments have become widespread within the Dutch construction sector. The emergence of various niche companies throughout the entire construction chain is perhaps the most visible evidence of sector-wide engagement on circularity (Leising et al., 2018). New circular business models and products have been introduced in recent years, such as the application of circular insulation materials made of recycled jeans and circular lease-models for building installations or components (Calahane, 2014). Furthermore, there is a real proliferation of multi-stakeholder platforms and initiatives on all building and policy-levels (TCB, 2019; Nederland Circulair, 2020; DGBC, 2020; PlatformCB'23, 2019). Within these platforms all kinds of sector stakeholders come together to share knowledge and experiences in order to jointly create circular building concepts and develop new tools to measure circularity in buildings.

However, despite political ambitions and long-term targets on both the EU and Dutch government levels, no scalable circular building concept or standard has yet been developed (Geldermans, 2016). Also, despite hundred percent separated collection and recycling of construction materials, only eight percent is used as secondary materials for new construction projects (Schut et al., 2016). Moreover, both state and market activities are inconsistent and largely fragmented (Berenschot, 2019). Namely, the lack of unified and commonly accepted definitions, norms and standards of circular building practices is causing both confusion and resistance among stakeholders. Also, the primary focus on the design of energy efficient buildings and limited attention to the use of zero/less virgin materials contributes to this effect (Berenschot, 2019; Penna & Geels, 2012; Schut et al., 2016). Sector alignment and cooperation, from top to bottom and vice versa, are hence essential to create sustainable system changes (Nußholz et al., 2019; Geels & Kemp, 2000). In all, due to current misalignments, fragmented

activities and the limited use of secondary materials in construction, the transition towards a circular Dutch construction sector is still far away.

1.2 Problem Definition

The latest government incentive for circular construction is the most visible case of misalignment between governance and practice. The Dutch Enterprise Agency introduced a subsidy-driven scheme to stimulate the development of circular buildings. However, only one single building was able to meet the subsidy requirements since the beginning of 2018 (TCB, 2019; Berenschot, 2019). Based on sector evaluations and statements this is mainly due to vague requirements, inadequate measuring methods, and differences in perspectives on the concept of circular buildings. This indicates that it is challenging for government agencies to create a general concept of circular buildings that can be broadly applied to the Dutch construction sector (Berenschot, 2019). Furthermore, the primary focus of sustainability policies and efforts is still on energy requirements for construction processes, although this largely undermines the urgency to also cover the materials-side of sustainable construction development (Schut et al., 2016).

In general, relevant research addresses the importance of a circular economy and underlines the importance of a circular construction industry (Hossain, 2018; Nußholz et al., 2019). Still, most CE research tends to focus on either micro-scale, such as products, or on macro-scale, for example on a national level. Importantly however, scholars generally neglect to cover the impacts and potentials on meso-scale, such as individual buildings (Pomponi and Moncaster, 2016). Only a few researchers have studied the realisation of circular buildings, though they did not analyse the processes that are required to facilitate and accelerate the transition toward CE (Nuñez-Cacho et al., 2018; Leising et al., 2017; Geldermans, 2016). These different processes are the focus of governance studies. Governance refers to "*the means by which society determines and acts on goals related to the management of the environment. It includes instruments, rules and processes that lead to decisions and implementation"* (Driessen et al., 2012, p. 144). There are different modes of governance, including centralized, decentralized or public private, which all have different influences on a transition. Hence, there is a knowledge gap concerning the question of how these modes of governance influence the transition towards a circular construction sector.

1.3 Aim and Research Question

The case of the Dutch construction sector clearly demonstrates the gaps and misalignments of current academic conceptualizations and practical complications. This occurs throughout the implementation process of principles of the circular economy in relation to modes of governance. Furthermore, we see that it is difficult to create policies that can steer a whole sector in the direction of lasting system changes. It is essential to overcome these issues in order to successfully transform the Dutch construction sector. Therefore, the aim of this research is to understand how governance can successfully contribute to the transition towards a circular construction sector. This leads to the following research question:

"How can the Dutch government accelerate the transition towards a circular construction sector?"

To be able to answer this research question, three sub-questions are formulated. A comprehensive understanding of the current mode of governance of the Dutch construction sector is a precondition to further study and assess the overarching objective. Therefore, the first sub-question is formulated:

"What is the current mode of governance of the construction sector of the Netherlands?"

Secondly, to evaluate how the construction industry is affected by the implementation of the circular economy principles, the following sub-question is formulated:

"What governance features characterize the inclusion of CE activities in the construction sector?"

Lastly, to come up with recommendations regarding the question how a mode of governance can accelerate the transition towards a circular construction sector, we identify the drivers and barriers of the current circular governance. This leads to the third sub question:

"What are the barriers and drivers that influence the realisation of a circular construction sector in the Netherlands?"

By answering these sub-questions, a full assessment of the current Dutch construction sector, policy landscape, stakeholder interactions and ambitions, is completed. Through this

assessment the conceptual gaps between the promised transition towards a circular economy and the complex context of the Dutch construction sector is covered. Ultimately, it is possible to widely assess a mode of governance that stimulates a transition towards a circular construction sector and both barriers and drivers of impactful policy measures. In doing so, the current research is expected to provide insights and recommendations for effective improvements of the mode of governance for the current circular construction sector.

1.4 Relevance of the Study

The scientific relevance of this study is to address the discussed knowledge gap by providing insights in the relation between 1) the transition from a linear construction sector towards a circular construction sector and 2) the influence of modes of governance on this matter. This study can act as a foundation for future modes of governance to stimulate the transition towards a circular construction sector, and therefore contributes to a circular future.

The societal relevance of this research is to pinpoint the weaknesses of the existing governance structure. This results in recommendations to successfully facilitate the Dutch circular economy. Additionally, it contributes to the improvements in the mode of governance of the Dutch circular construction and provides recommendations to reduce virgin material use and waste streams.

2. Theoretical Background

This chapter defines the most important concepts and theories concerning the circular construction sector. Starting with a section on the principles of circular construction (2.1), followed by a section on transitions and environmental governance (2.2), and lastly a section that explains the conceptual framework that is derived from the theory is presented (2.3).

2.1 Principles of Circular Economy in the Construction Sector

The circular economy concept is trending both among practitioners and scholars, and has been defined and interpreted in many ways over the years (Kirchherr et al., 2017). For this research we use the definition of Leising and colleagues (2018), since it is specifically targeting the construction sector: *"...a lifecycle approach that optimizes the buildings' useful lifetime, integrating the end-of-life phase in the design and uses new ownership models where materials are only temporarily stored in the building that acts as a material bank*." (p. 977). The idea of buildings as a material bank, opens a new perspective on the quality of building components and materials, and how to maintain its quality. Additionally, a long-term perspective on products and materials is crucial, since the average life cycle for building is sixty to ninety years (Ma et al., 2015). In the article by Leising and colleagues (2018) it is mentioned that the construction sector acts as a key contributor to resource depletion, pollution, and climate change, whereas circular principles can be a solution to reduce the environmental impact of buildings (Leising et al., 2018; Smol et al., 2015; Pomponi & Moncaster, 2017).

Next, we describe three basic principles for circular construction. Firstly, to operationalize the principles of CE, the value retention options (ROs) framework of Reike and colleagues (2018) is often used to determine circular performance of products and materials. ROs are ten concepts and are aiming for increased circularity. These ROs and the different quality levels at which material flows can be processed in a circular manner are shown in Figure 1. Consequently, for the realization of circular constructions these ROs must be considered in order to realize circular material flows (Reike et al., 2018).

	R #	CE concept	Object	Owner	Function	Key activity customer	Key activity market actor
Downcycling	R9	Re-mine	Landfilled material	Local authorities; Land owner	New	Buy and use secondary materials	Grubbing, cannibalizing, selling (South)/ high-tech extracting, reprocessing (North)
	R8	Recover (Energy)	Energy content	Collector, municipality, energy company, waste mgt. company	New	Buy and use energy (and/or distilled water)	Energy production as by-product of waste treatment
	R7	Re-cycle	Materials	Collector, processor, waste mgt. company	Original or new	Dispose separately; buy and use secondary materials	Acquire, check, separate, shred, distribute, sell
	R6	Re-purpose (ReThink)	Components in composite products (new product with old parts)	New user	New	Buy new product with new function	Design, develop, reproduce, sell
Product upgrade	R5	Re-manufacture	Components in composite products (old product with new parts)	Original or new customer	Original, upgraded	Return for service under contract or dispose	Replacement of key modules or components if necessary, decompose, recompose
	R4	Re-furbish	Components of composite products (old product with new parts)	Original or new customer	Original, upgraded (large complex products)	Return for service under contract or dispose	Replacement of key modules or components if necessary
	R3	Repair	Components of composite products (old product with new parts)	1st or 2nd consumer	Original	Making the product work again by repairing or replacing deteriorated parts	Making the product work again by repairing or replacing deteriorated parts
Client/user choices	R2	Re-sell/Re-use	Product	Consumer	Original	Buy 2nd hand, or find buyer for your non-used produced/possibly some cleaning, minor repairs	Buy, collect, inspect, clean, sell
	R1	Reduce	Product	Consumer	N.a.	Use less, use longer; recently: share the use of products	See 2nd life cycle Redesign
	R0	Refuse	Product	Potential consumer	N.a.	Refrain from buying	See 2nd life cycle Redesign

Figure 1: ROs Framework (Reike et al., 2018)

Secondly, Nuñez-Cacho and colleagues (2018) have suggested a way to evaluate the implementation of circular economy principles in the construction sector. In other words, it is possible to measure to what extent circular principles are included in a particular building project. They propose that the construction sector must comply with six dimensions related to circular building. Four of these dimensions relate to resource management: the above described ROs, and the efficient management of energy, water, and materials. The other two dimensions refer to environmental impact: generated emissions and waste. Based on these dimensions the impact of circular construction can be determined.

Lastly, one of the first and most important notions to consider is that in order to achieve CE it is necessary to involve different stakeholders at different levels and to include the entire supply chain, from design to raw materials suppliers to end users and demolishers (Kajikawa et al., 2014). Pomponi and Moncaster (2017) identified six pillars, namely governmental, economic, environmental, technological, societal, and behavioural, that need to collaborate to successfully meet the circular economy goals. They suggest that the great challenges that lie ahead do not only involve the development of further technological innovations, but rather the role of people, both as a society and as individuals. Social relationships and collaborations are considered key to integrate circular principles in the construction sector (Bocken et al., 2016).

2.2 Transition towards a Circular Construction Sector

For a change in the construction sector from a traditional linear state to a circular system a major transition is to be made. A transition is defined as a "*substantial shift in the deep and underlying structure of [a] system*" (p. 18), for structural change over an extended period (Schneidewind & Augenstein, 2012). There are several constructs which evaluate a transition

towards a new system. Two theories are described in the current study, the Triple Embeddedness Framework of industries (TEF) theory of Penna and Geels (2014) and the environmental governance framework of Driessen and colleagues (2012).

The TEF was developed to study transition processes (Geels, 2014; van den Bergh et al., 2011). It conceptualizes firms that are embedded in 'industry regimes', which are "*industry-specific institutions that mediate their actions towards external environments.*" (Penna & Geels, 2012, p. 1001). Each industry regime contains a set of the following structural elements as shown in Figure 2: a) availability of capabilities and technical knowledge, which are necessary for the operational and innovation activities (Nooteboom & Stam, 2008); b) identity and mission, which reflect the industry's social purpose and business domain (Dutton & Dukerich, 1991); c) beliefs and cognitive frames, which explain the way an industry tackles opportunists, threats and pressure from external environments (Tripsas & Gavetti, 2000); and, d) regulations and incentives. Governance structures shape economic conditions that the industry must meet. Financial incentives and regulations can push the industry in the desired direction.

The TEF is characterized by a socio-political environment and an economic environment. For the economic environment, which accommodates suppliers and customers, selection criteria include efficiency, financial performance and competitiveness. The socio-political environment on the other hand contains non-commercial relationships between the industry and non-market actors, such as policymakers, public actors, and social movements (Turnheim & Geels, 2012). The social-political environment acts as a 'license to operate' for the industry and arises from cultural beliefs, regulatory-political pressures and social values (Penna & Geels, 2012). The TEF indicates that a sustainability transition emerges through the interaction of different actors of the socio-political environment and economic environment with the industry (Penna & Geels, 2012).

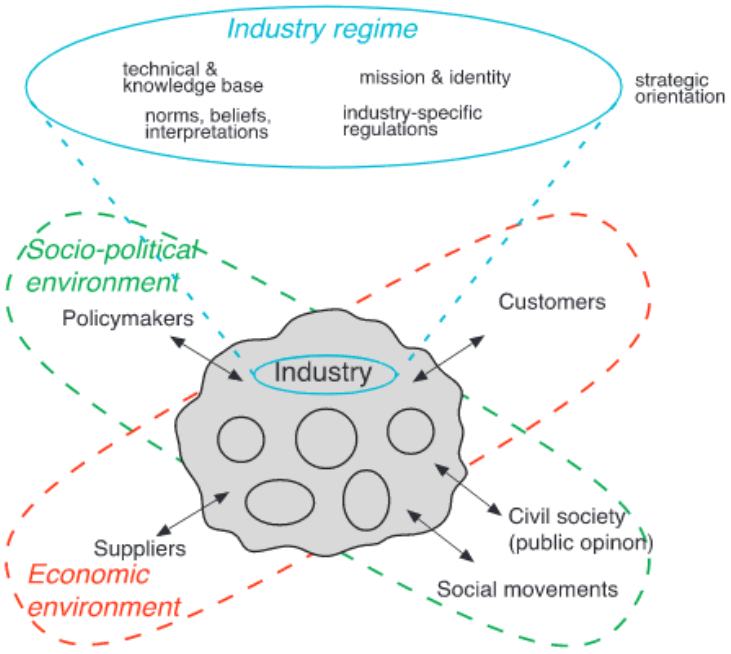

Figure 2: The Triple Embeddedness Framework of industries (Geels, 2014)

According to Penna and Geels (2012) "*industry actors are likely to resist major change, and use socio-cultural, political and (incremental) innovation strategies to defend the regime*" (p. 18). This is called a lock-in mechanism, which occurs when policies differ too much from the existing regime templates. This resistance to change can also rise when the economic principle of the policy has greater public than individual benefits (Geels, 2000; Penna & Geels, 2012). Incentives and restrictions are policy instruments that influence stakeholders to act in a certain way (Frances & Sivasailam, 1992). According to Zhong and colleagues (2008), incentives are particularly important to stimulate actions towards sustainability since "*the economic principle of the individual benefit of the activities executants are less than the public benefit coming with the activities, the organization and firms who carry out the activities cannot share the benefits from the sustainable measures as the public does*" (Zhong et al., 2008, p. 2119). It seems to not be enough to add circular elements to the current linear context. For a transformation towards a truly circular system it is necessary to gain an actual return on the circular investments. Therefore, financial incentives are required to meet environmental, social, and economic advantages, and are appealing to the goodwill of owners to invest in circular buildings (Choi, 2009; Tinker et al., 2006). Restrictions are used where incentives, such as subsidies, are neither enough nor efficient (Sentman et al., 2008). It is argued that many stakeholders are willing to change when they are forced or stimulated by such policy measures (Zhong et al., 2008).

The TEF lacks the inclusion of governance theory to describe how forms of interaction between actors lead to a regime change. Therefore, we introduce the concept of environmental governance as described by Driessen and colleagues (2012), which is defined as: "*the totality of interactions among societal actors aimed at coordinating, steering and regulating human access to, use of, and impacts on the environment, through collectively binding decisions*" (Challies & Newig, 2019). The line of thinking is compatible to TEF, since environmental governance includes rules, instruments and processes which lead to change and implementations (Driessen et al., 2012). It can shape circular environments and destabilize industry regimes by facilitating actions in a desired direction by privatizations, self-governance arrangements and government regulation (Lehtonen & Kern, 2009; Olubunmi et al., 2016; Berge & Van Laerhoven, 2011). Actor involvement, governing style and instruments and relations between policy levels can differ, depending on the mode of governance. Driessen and colleagues (2012) defined five modes of governance, i) centralized governance, ii) decentralized governance, iii) public–private governance, iv) interactive governance, and v) self-governance. The modes of governance are characterized by the relation and roles between

market, state and civil society. The framework is refined by differentiating the five modes of governance based on the variation on the following key features: actor features (consisting of initiating actors, stakeholder position, policy level, powerbase), institutional features (consisting of model of representation, rules of interaction, mechanism of social interaction) and, features content (concerning goals and targets, instruments, policy integration, policy-science interface).

There are clear similarities between the TEF theory of Penna and Geels (2012) and the governance theory of Driessen and colleagues (2012), such as the influence of a socio-political environment and actor interaction on regime shifts. However, there are also differences in the interpretation and approach of sustainable transitions and governance. The TEF of Penna and Geels (2012) shows that an industry regime is characterized by four deep structured elements, which are derived from the interaction of two environments with the industry, but lacks to explain the different forms of interaction and its characteristics. Environmental governance, on the other hand, is concerned with the interaction of actors to stimulate a transition and interventions that are aiming at decision making in order to prevent, mitigate and/or reduce harmful effects for the environment (Driessen et al, 2012).

2.3 Conceptual Framework

From the theoretical background on circular building principles, TEF, and environmental governance theory a conceptual framework is derived (Figure 3).

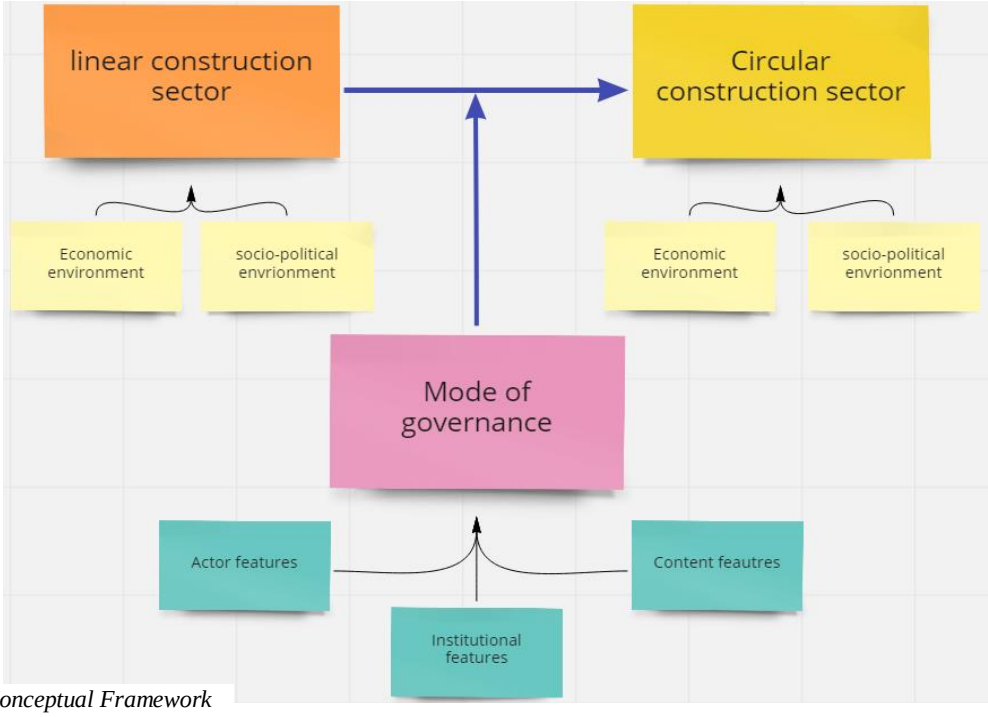

Figure 3: Conceptual Framework

The orange rectangle represents the current linear construction sector based on the corresponding socio-political and economic environments of a linear system, and is characterized by a take-make-dispose pathway. The yellow rectangle represents the future circular construction sector based on the corresponding socio-political and economic environments of a circular system, and is characterized by a closed loop system, where waste is considered food for a new life cycle. The arrow between them represents the transition from the current construction sector to the circular construction sector. This transition is made possible by the stimulation of a mode of governance as indicated by Driessen and colleagues (2012). The mode of governance is characterized by actor features, institutional features and content features, which are represented by the green rectangles. Based on the features the mode of governance can be determined. The conceptual framework illustrates our understanding of the theory, identifies the relation between concepts, and acts as a 'map' in pursuing the research.

3. Research Strategy and Methods

This chapter elaborates on the research strategy and methods in order to understand how governance can successfully contribute to the transition to a circular construction sector. First, the research strategy was outlined (3.1), followed by an overview of different research steps which are used to answer the research questions (3.2).

3.1 Qualitative Research Strategy

In the current study, a descriptive and exploratory qualitative research strategy was applied. This design entails a critical review on existing concepts and theory for empirical insights (Bryman, 2016). The decision for a qualitative research strategy is based on the following three arguments. Firstly, this strategy provides insight for practitioners to gain a better understanding of how modes of governance can accelerate the transition towards a circular economy (Bryman, 2016). Secondly, a qualitative research strategy can be seen as a suitable way to discover and identify underlying motivations, beliefs and opinions of respondents (Bryman, 2016). Lastly, a qualitative strategy is considered a suitable approach for collecting further data to test theory and to establish the conditions in which the theory will hold (Bryman, 2016).

3.2 Research Strategy Steps

A combination of different methods to collect data was used, such as desk- and literature research, case study, and semi-structured interviews. Figure 4 shows the research methods applied during each step (grey rectangles), the processes (pink circles) and expected outcomes (blue rectangles). These outcomes contributed to answering the main research question in chapter 1: "*How can the Dutch government accelerate the transition towards a circular construction sector?"*. The first step consisted of the identification of relevant stakeholders. Followed by step 2, in which an analysis of the current mode of governance of the Dutch construction sector is conducted. The characterization of governance features of a circular construction sector was studied in the third step. In step 4, the role of governance on the transition towards a circular construction sector in the Netherlands was explored.

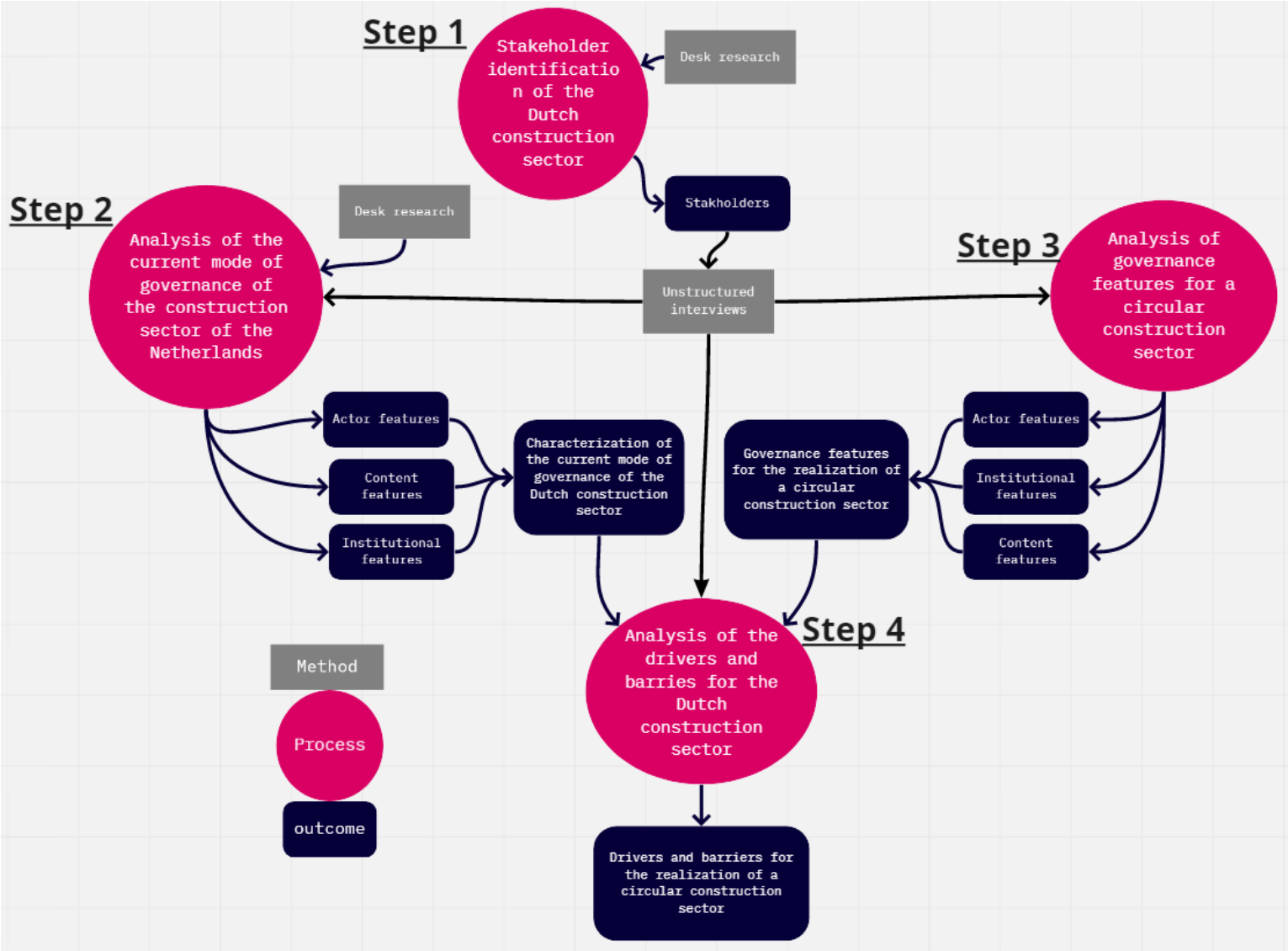

Figure 4: Methodological Framework

3.2.1 Step 1: Identification of Stakeholders of the Dutch Construction Sector

In the first step a stakeholder identification was conducted to understand which organizations were involved in formulating the strategies to achieve a circular construction sector. For the identification of stakeholders, desk research was conducted based on secondary data. Desk research typically considers "*a critical examination of existing research relating to the phenomena of interest and relevant theoretical ideas"* (Bryman, 2016, p. 14). For the desk research we used transition agendas and implementation strategies documents from the Dutch government.

3.2.2 Step 2: Analysis of the Current Mode of Governance of the Dutch Construction Sector

In the second step of the research process, the sub question: *"What is the current mode of governance of the construction sector of the Netherlands?"* was answered. To analyse the current mode of governance of the Dutch construction sector, desk research and interviews were used. Specifically, data from research articles, formal documents from the Dutch government such as the government program for circular construction and legalisation documents, and third-party research on the subject were included. Unstructured interviews with stakeholders who were identified in Step 1 were conducted, till theoretical saturation was reached (Bryman, 2012). This was achieved after conducting sixteen interviews. In general, unstructured interviews are conducted in a way that "*the possibility of getting at actors' meanings and of concepts emerging out of data collection is enhanced"* (Bryman, 2012, p. 408). The data derived from the interviews was transcribed and analysed using three sorts of coding: *open-*, *axial-* and *selective* coding. Transcriptions are available upon request. According to Charmaz (2006) coding means "*that we attach labels [concepts] to segments of data that depict what each segment is about."* (p. 3), which in the methodological rationale of this research lead to new theoretical insights (Bryman, 2016). Moreover, for the coding process the computer program NVivo was used. The coding process started with open coding. By doing so, actions and interactions to make concepts out of the data were identified and classified. Next, axial coding was used to categorize concepts and identify possible relationships between concepts. Lastly, selective coding was used to select the main categories, which represents the core of the findings. This ultimately forms the analytic core for a theory (Strauss & Corbin, 1998). The interviewees remained anonymous and were referred by the type of organization. The names of the interviewees are known to the author. These analyses allowed us to identify and characterize the current industry specific actor features, institutional features and content features. Additionally, the current mode of governance of the Dutch construction sector is characterized based on the three specified features.

3.2.3 Step 3: Analysis of Governance Features for the Realization of a Circular Construction Sector

Carrying out the second step of the method answered the following sub-question: *"What governance features characterize the inclusion of CE activities in the construction sector in the Netherlands?".* Due to time constraints, the interviews conducted with stakeholders in Step 2 are used for the analysis of governance features for the realization of a circular construction sector. The three forms of coding resulted in the identification and developments of new concepts from data, in which theory evolves, and was based on the continuous interplay

between data collection and analysis (Bryman, 2016). Therefore, we were able to identify governance features for the realization of a circular construction sector. In addition, the latter allowed us to build upon the proposed conceptual framework.

3.2.4 Step 4: Identification of Drivers and Barriers that Influence the Realization of a Dutch Circular Construction Sector

In the final step the influence of environmental governance on the transition towards a circular industry regime was investigated. With the characterization of the current mode of governance of the Dutch construction sector (Step 2) and the actor features for the realization of a circular construction sector (Step 3), we were able to indicate barriers and drivers that influence the realization of a circular construction sector in the Netherlands. By performing this analysis, we answered the third sub question: "*What are the barriers and drivers that influence the realisation of a circular construction sector in the Netherlands?".* Due to time constraints, the interviews conducted in Step 2 are used for the identification of drivers and barriers of the Dutch construction sector as well. The unstructured interview data were transcribed and analysed with NVivo using the three forms of coding. The results allowed us to suggest improvements for the mode of governance of the Netherlands with the aim to accelerate the transition towards a circular construction sector.

4. Results

This chapter discusses the findings from the analyses of desk research and the interview transcripts. First, the stakeholders who were involved in the formulation of strategy agendas with the aim to stimulate the transition towards a circular construction sector were identified (4.1). The initial identification of stakeholders is followed by an analysis of the current mode of governance of the Dutch construction sector (4.2) and an analysis of the actor features of a circular construction sector (4.3). In the last section, an exploration of the drivers and barriers that contribute to the acceleration of a circular construction sector in the Netherlands is discussed (4.4). Each section answers a sub-question and contributes to answering the main research question.

4.1 Stakeholder identification of the Dutch circular construction sector

A stakeholder identification was conducted to understand which organizations were involved in formulating the strategy to achieve a circular construction sector by 2050 in the Netherlands. The identification was carried out on a national and regional scale, since strategies have been formulated at both levels in order to accelerate the transition towards a circular construction sector in 2050 (Rijksoverheid, 2018; Regio Utrecht, 2020; MRA, 2018; Provincie Zuid-Holland, 2019).

On national level, a document of the government called *Transition Agenda circular economy* (TACE) was used to identify the most important stakeholders (Rijksoverheid, 2018). The TACE document describes the goals and ambitions for a circular construction set by the Dutch government together with a strategy for achieving these goals. This document was compiled by a *transition team* and a *transition office*. The transition team is responsible for formulating a strategy. The transition team consists of four representatives from the government, three branch organizations, two organizations of the industry, two circular construction consultancies and two research institutes (see appendix A, table 1). The 'transition office' is in charge of the execution of the formulated strategy, and consists of three executive bodies form the national government (see appendix A, table 2 for a detailed overview of the different organizations). For the execution of the formulated strategy, the transition office gets support from organizations that are part of the Dutch enterprise agency (see appendix A, table 3). The support organizations consist of multiple network-, knowledge and research organizations (Rijksoverheid, 2018).

On regional level, we have used the formulated strategic implementation programs to stimulate the transition towards a circular construction sector. Here, we have decided to focus only on the three largest regions of the Netherlands, due to time constraints. The three largest regions represent 110 municipalities of the 335 in total (Regio Utrecht, 2020; MRA, 2018; Provincie Zuid-Holland, 2019). Each region has developed its own strategy of how they will be fully circular in 2050 and formulated a strategic implementation program. We used these programs for the stakeholder analysis of each region (Provincie Zuid-Holland, 2020; MRA, 2018; Regio Utrecht, 2020).

The first region we aimed to identify is the region of Utrecht, who wrote in their implementation program that they will collaborate in an alliance called *Alliantie Cirkelregio Utrech*t to accelerate circular construction in the region (Regio Utrecht, 2020). The alliance consists of municipalities that are located in the region, multiple knowledge- network- or research organizations and a civil society organization (see appendix A, table 4). If desired by market parties, they can indirectly influence policy by joining one of the network organizations in the alliance.

The second region, the Metropole region of Amsterdam, referred in their implementation program which companies and organizations were included when formulating the transition program (MRA, 2018). In contrast to the region of Utrecht, the MRA included both commercial and public organization for the formulation of their implementation program (see appendix A, table 5). In the process they made use of various consultancy firms, such as Copper8 and Metabolic (MRA, 2018).

Lastly, the Region of Zuid-Holland did not refer explicitly to which stakeholders were involved in the formulation of the strategy or execution (Provincie Zuid-Holland, 2019). However, on their website they did mention which organizations were involved. The stakeholders included commercial organizations, research organizations and network organizations (see appendix A, table 6).

Based on the given overview of all stakeholders involved, on both national and regional level, we can conclude that similar types of stakeholders are represented during the formulation and execution of strategy. On both levels, network- knowledge and research organizations are included. In some cases, market parties are directly involved in formulating policy and strategy. In other cases, the market perspective is represented through multi-stakeholder organizations offering partnerships or branch organizations that represent a part of the industry. In sum, the identification of stakeholders provided an overview of stakeholders who were involved in the formation of policy, on both national and regional level. Subsequently, these particular

stakeholders were approached for an interview to characterize the current mode of governance of the Netherlands (4.2). Interviews with the relevant stakeholders were also used to explore the governance features for the realization of a circular construction sector (4.3) and to identify the drivers and barriers to accelerate the transition towards a circular construction sector in the Netherlands (4.4).

4.2 Current Mode of Governance of the Dutch Construction Sector

This section analyses the current mode of governance of the Dutch government on the basis of the environmental governance framework of Driessen and colleagues (2012). Driessen and colleagues (2012) characterizes the relation between market, state and civil society with actor features, institutional features, and content features. By analysing the Dutch construction sector based on these different features, a mode of governance was identified. The analysis provided the knowledge that is required to answer the first sub question: "*What is the current mode of governance of the construction sector of the Netherlands?".* First, a characterization of the actor features is depicted (4.2.1), which is followed by the characterization of institutional features (4.2.2) and content features (4.2.3). The subsections contain a summary of all important information per feature, including a brief interpretation of the analysis at the end. Lastly, a conclusion is provided that answers the first sub question (4.2.4).

4.2.1 Actor Features of the Dutch Construction Sector

The first features that contribute to the determination of how a transition is influenced by a mode of governance, are the actor features. The actor features consist of i) the *initiating actors* that initiate action for a circular construction in the Netherlands, ii) the *position* of other *stakeholders* in the Dutch construction sector, iii) the predominated *policy level* at which level stakeholders operate, and iv) the *powerbase* of stakeholders in the Dutch construction sector. Based on the analysis of the actor features of the Dutch construction sector in the following paragraphs, a characterization of key actors is made.

i) Initiating actors

The *initiating actor* represents the *"key public actors that initiate action and specify the environmental interest in policy ambitions*" (p. 147) (Driessen et al., 2012; Kickert et al., 1997). The EU has formulated a CE Action Plan, that targets circularity policies and activities to all member states (EC, 2020). The Dutch government formulated sector-specific circular transition policies, activities and supporting networks, in line with the CE Action Plan (EIA, 2016).

Furthermore, the Dutch government comprises to facilitate pilot test cases for circular building projects, multi-stakeholder partnerships and government support on circular material and product design for buildings. Also, the government's policy has been translated into policy at a regional level. Examples of this are the reports of the Metropole region of Amsterdam, the region of Zuid-Holland and the region of Utrecht. Each region has its own interpretation of the policy initiated by the government (Provincie Zuid-Holland, 2019; MRA, 2018; Regio Utrecht, 2020). For instance, the region of Utrecht is considering "*to tender more buildings where bio based or secondary materials are used as a construction material*" (a municipality).

In conclusion, policy has been shaped at European level. Accordingly, the Dutch government has given substance to the policy. which has been further specified at regional level. Further specification and execution of policy from supranational to national level and to regional level corresponds to a *decentralized* governance structure, which is described as *a government at its various levels of aggregation (subsidiarity)* (Driessen et al., 2021).

ii) Stakeholder position

Stakeholder position characterizes the position of other stakeholders in a governance structure (Kapoor, 2001). In the stakeholder identification section, it was shown that stakeholders are involved at national and regional level. It was also demonstrated that the stakeholders represent various organizations, including knowledge institutes, market parties and civil society, that are free to join most network organizations to get involved in shaping policy if desired. In addition, the Dutch government has promised in the transition agenda for circular construction that they want to facilitate and stimulate the collaboration and knowledge exchange between public and private parties on both regional and national level (TCB, 2019). As a result, there is a proliferation of multi-stakeholder platforms and initiatives on policy-levels (TCB, 2019; Nederland Circulair, 2020; DGBC, 2020; PlatformCB'23, 2019).

Interviewees confirm that policy is shaped with the involvement of stakeholders. More specifically, a circular consultant stated that: "*in the transition team for a circular construction sector we now see that an enormous number of existing interests are being represented*" and the national government stated that "*the transition agenda is not only formulated by the government, but in collaboration with stakeholders from the industry*", since "*we do not want to prescribe the industry what is necessary. We want it to evolve by itself*". To conclude, the pattern found in the answers that were given by the different interviewees suggests that the stakeholders in the Dutch construction section have *stakeholder position* with *a high likelihood of stakeholder involvement*.

iii) Policy level

The feature *policy level* is characterized by the policy level at which key actors operate (Newig & Fritsch, 2009). The Dutch government has formulated national goals and targets to reach a circular construction sector by 2050. Moreover, to comply with the national goals and targets, regions formulated circular construction strategies including incentives and restrictions for companies that operate in the specific region (Regio Utrecht, 2020; Provincie Zuid-Holland, 2019; MRA, 2018). For example, in order to be allowed to construct a building, a building developer needs to apply for a building permit. This permit consists of building requirements set by the national government, which apply to the whole country. Also, additional requirements are set by the region and/or municipality in order to meet their own policy (Rijksoverheid, 2016). The latter example shows that both the national and regional government and the municipalities can set rules. Therefore, we suggest that the policy level of the Dutch construction sector takes place at *multiple levels.*

iv) Powerbase

Powerbase is defined as "*the capacity of actors to constitute the distribution of resources, by establishing, enforcing and reproducing existing structures and institutions*." (Avelino & Rotmans, 2011, p 799). In the Netherlands the power base of the governance structure is dependent on democratic representation at the national level. Importantly, elections every four years result in a new government in The Netherlands, and every administration has different interests and priorities. This also applies for local and regional elections. Therefore, the way environmental governance is formulated and implemented is variable and dependent on the vote of society. This is underlined by the national government: "*when the elected administration finds a matter important enough, they will shine a light on the matter and invest in it*". In the current government, the power to establish, enforce and reproduce existing structures and institutions is fragmented across different ministries: "*the ministry of Home Affairs is responsible for the realization of houses and regulation and legislation for the built environment, the ministry of Economic Affairs provides incentives to stimulate circular construction, the ministry of Infrastructure and Water management is responsible for the construction of circular roads and waterways.*" According to a circular consultant the fragmented power base results in: "*the ones that care about the environment or are only partly responsible for it [the ministry of home affairs and the ministry of infrastructure and water management] do not really have the power to change it. The Ministry of Economic Affairs and*

finance are way more powerful. The latter two are responsible for shaping the market with incentives and taxation. These are the most powerful tools to stimulate the transition". Since the capacity to constitute the distribution of resources is dependent on the elections, we consider the *Powerbase* of the Dutch construction as *coercion; authority; legitimacy (democratic representation at the national level).*

4.2.2 Institutional Features of the Dutch Construction Sector

The institutional features refer to the particular "*interactions between the actors*" (Driessen et al., 2012, p. 143). As discussed earlier, the institutional features consist of i) the *model of representation* of government, industry and civil society, ii) *the rules of interaction* between actors, and iii) the *mechanism of social interaction* between actors for the realization of a circular construction sector. Based on the analysis of the institutional features of the Dutch construction sector in the following paragraphs, a characterization of the interaction between actors is made.

i) Model of representation

The feature *model of representation* is characterized by the way government, industry and civil society are represented in a governance structure and, therefore, are able to influence and shape policy. The Dutch government has formulated a plan to become a circular economy by 2050. Furthermore, the Dutch government formulated a circular action plan for the construction sector in which multi-stakeholder partnerships are one of the key elements for the realization of a circular construction sector (Rijksoverheid, 2016). This resulted in multi-stakeholder partnerships on both national and regional level in which collaboration between market, civil society and the government is stimulated. For example, the Dutch government invests in CB'23, a multi-stakeholder partnership with stakeholders from civil society, the industry and the government (TCB, 2018). According to the national government multi-stakeholder partnerships are necessary for the transition towards a circular construction sector, since, as stated in an interview with the national government "*there are a lot of different forces in the sector that are part of the transition and, therefore, influence the transition*". Therefore, they stimulated several initiatives with the aim to contribute to the interaction between the government, industry and civil society (TCB, 2018).

Moreover, multi-stakeholder partnerships between various regional parties collaborate on regional level to support the transition towards a circular construction sector. For instance, the initiative *Alliance of Circle Region Utrecht*, which is a partnership between the regional

construction sector, government and civil society (Regio Utrecht, 2020). Through mutually coordinated actions, such as pilots and research, the alliance acts as a stimulant for circular initiatives of institutions, residents and enterprises. Specifically, the involved stakeholders are both public and private entrepreneurs that contribute to creation, implementation and execution of the policy (Regio Utrecht, 2020).

In all, multi-stakeholder partnerships are, both nationally and regionally, initiated to stimulate the transition of a circular construction sector. Therefore, we suggest that the *model of representation* can be considered as *partnerships (participatory public-private governing arrangements).*

ii) Rules of interaction

Rules of interaction refer to the formal and informal rules of interaction and exchange (Ostrom, 1990). Due to the high stakeholder involvement and the model of representation in the Netherlands, civil society and the market are able to participate in policy formation and execution. All organizations and civilians are free to join foundations that are originated to facilitate public-private partnerships within their network. This is underlined by a regional network organization that facilitates these public-private partnerships, as they stated the following: "*organizations can become a partner of our foundation if they want to contribute to the acceleration of the circular economy*". Importantly, the public-private partnerships facilitate a constant and accessible interaction between the government/regions and private partners. As a consequence, stakeholders and civil society are constantly involved in the decision-making process of the Dutch government. Hence, we suggest that the *rules of interaction* can be considered as *institutions in its broadest form (formal and informal rules).*

iii) Mechanism of social interaction

Mechanism of social interaction refers to the way the sector, civil society and state interact with each other. One of the mechanisms to support the transition to a circular economy is to eliminate obstacles, such as inexperience and lack of knowledge, through stakeholder involvement (TCB, 2018). The government tries to stimulate the exchange of knowledge between private and public stakeholders, since the private stakeholders have more experience in the field and need to adjust to the policy formulated by the government (Rijksoverheid, 2016). Regional network organizations underlined the importance of this, by stating: "*partnerships and spinners are important for sharing experience and knowledge*", and "*stakeholders need to know each other*

and need to be able to find each other. They can help each other and exchange knowledge and experiences".

In addition, the government wants to facilitate pilot studies with multiple stakeholders to develop knowledge and experience (Regio Utrecht, 2020). By the exchange of knowledge and experience (based on a pilot case), more knowledge will be jointly gained regarding the realization of circular construction. This way of learning resembles what is known as social learning (Laland, 2004). Social learning through interaction and collaboration of the state, market and civil society corresponds to interactive government as defined by Driessen and colleagues (2012). As a result, we suggest that the *mechanism of social interaction* can be considered as *interactive: social learning, deliberations and negotiations.*

4.2.3 Content Features of the Dutch Construction Sector

The final features that contribute to the determination of how a transition is influenced by a mode of governance, are the content features. These features are representing the *content* of the circular construction governance of the Netherlands, and are divided into 4 sub-sections. Namely, i) the *goals and targets* that are formulated by the Dutch construction sector, ii) the *instruments* that are being used to shape environments and destabilize industry regimes, iii) the extent that *policy* is *integrated* along the system, and iv) the *policy-science interface* that is necessary for policy development, decision-making, implementation and evaluation. Based on the analysis of the content features of the Dutch construction sector in the following paragraphs, a characterization of the policy content is made.

i) Goals and Targets

The goals and targets refer to the targets and ambitions formulated by the Dutch construction sector. In 2018, The Netherlands formulated a transition agenda for the realization of a circular construction sector with relevant market parties including the following ambitions (Rijksoverheid, 2018):

- A fully equipped basecamp by 2023
- A decrease of 50% of primary resources by 2030 (compared to 2014)
- Being fully circular by 2050

The goals and targets for the construction sector that are set by the Dutch government are not considered tailor made or actor specific, since they are still relatively general and not specified to specific actors. This is underlined by a research organization, who stated that "*the conceptual framework is more or less finished. We know what we want in the future, how we like to do it,*

and which associated targets. But we are not able to substantiate it" and a regional network organization who stated: "*the formulated transition agenda [for the construction sector] is still very vague and therefore not very useful in practice*".

Since the government has formulated a plan to become fully circular in five different sectors by 2050 and set sector specific goals for the construction sector, we suggest that the *goals and targets* of the Netherlands can be evaluated as *uniform and level specific.*

ii) Instruments

Instruments is seen as a means to shape environments and destabilize industry regimes. To be more specific, the instruments are used to facilitate actions in a desired direction by providing incentives or restrictions (Lehtonen & Kern, 2009; Olubunmi et al., 2016). To be able to realize the ambitions of the Dutch government, the government developed a transition agenda including restrictions and incentives aimed at encouraging stakeholders to integrate in circular principles in buildings (Rijksoverheid, 2016).

Since 2018, building owners must demonstrate that they meet certain environmental requirements. For example, a minimum environmental performance standard and energy performance standard are required for the realization of buildings, ensuring a reduction in the environmental burden. These requirements will become stricter every year (reduction by 20% every year), enforcing the market to think more carefully about the use of materials used in buildings (TCB, 2019). Interviewees underlined the importance of a minimum environmental performance requirement: "*it is a great example on how we slowly stimulate the market to consider circular construction*" (a national government) and "*we formulated a minimum requirement for the environmental performance of buildings. The sector is free to decide how they want to meet the requirements, and, therefore not stand in the way of potential innovations*" (a regional network organization).

In addition, a specified subsidy is formulated to stimulate circular material use (Stichting Bouwkwaliteit, 2019). This subsidy stimulates building developers to apply sustainable materials in their building, such as secondary materials or renewable materials, in order to reduce the environmental burden of buildings. In case building developers meet the additional requirements of the subsidy, they receive significant financial benefits (Berenschot, 2019).

In sum, the Netherlands applies restrictions, in the form of performance standards, and incentives, such as subsidies, with the aim to stimulate the transition to a circular construction sector. For this reason, the feature content *instruments* can be considered as '*legislation,*

permits, norms and standards' and '*incentive-based instruments such as taxes and grants, performance contracts'.*

iii) Policy integration

Policy integration is characterized by the extent to which policies are integrated along the system (Jordan & Lenschouw, 2012). The Dutch government has formulated their own targets and goals regarding CE and circular construction. Each region has integrated the national goals into their own action plan and made additions independently (Regio Utrecht, 2020; Provincie Zuid-Holland, 2019; MRA, 2018). A research organization underlined this observation by stating "*every municipality has their own rules besides the rules of the government*". This form of governance corresponds to *interactive governance*. Therefore, we consider the *policy integration* of the Dutch construction sector as *integrated (policy sectors and policy levels are integrated).*

iv) Policy-science interface

Policy-science interface is characterized by the type of knowledge that is necessary for policy development, decision-making, implementation and evaluation (Bäckstrands, 2004). The Netherlands introduced a method to operationalize the circularity of buildings and to calculate circularity performance in a standardized way, which is called Milieu Prestatie Gebouw (MPG). The MPG-score is used as an indication to measure the environmental performance of buildings by the Dutch government (Stichting Bouwkwaliteit, 2019) and is expressed in the shadow costs per square meter gross floor area (GFA) per year. To be more specific, the shadow cost is the highest permissible cost level (prevention costs) per unit for the government emission control. Furthermore, the calculation of the shadow price is based on an Environmental Product Declaration (EPD), which includes impact categories measurements calculated by a Life Cycle Analysis (LCA) (Stichting Bouwkwaliteit, 2019). Additionally, the database of EPDs is incomplete, which currently makes it difficult to measure the MPG-score of a building (Berenschot, 2019). To overcome these obstacles, the government organizes feedback moments in collaboration with industry associations. These feedback moments are meant to improve and fine-tune the current calculation method and system (TCB, 2018).

Since the circularity performance is measured based on the LCA method and the fact that stakeholders have input to criticise and fine-tune the method, we interpret the *policy-science interface* as *primacy of generic expert knowledge; room for issue and time-and-place specific knowledge.*

4.2.4 Summary: Current Mode of Governance of the Dutch Construction Sector

Based on the analysis of governance features of the Dutch construction sector in the previous paragraphs, we determined how the transition is influenced by the government in the following section. First, we summarize the relevant insights in the current mode of governance of the Dutch construction sector, providing a structured overview of the current state of the transition towards a circular construction sector in the Netherlands. After that, we briefly interpret these findings by discussing what the outlined context of the current mode of governance teaches us about the features that are required to realize a circular construction sector.

We could identify several modes of governance as defined by Driessen and colleagues (2012). The actor features consist of features that correspond to *decentralized, centralized* and *interactive* modes of governance. This can be explained by the fact that policy for circular construction is formulated at different policy levels and is further specified per level. This corresponds to an *interactive* and a *decentralized* mode of governance as described by Driessen and colleagues (2012). Furthermore, the *powerbase* is dependent on the national elections that are every four years which correspond to a *centralized* mode of governance.

The institutional features, on the other hand, only consist of features that correspond to an *interactive* mode of governance. These features are characterized by this mode of governance, since the interaction between actors consist mainly out of partnerships between the market, state and civil society. Besides, the Dutch government stimulates and facilitates partnerships to formulate policy and to stimulate social learning.

The content features respond to *centralized, decentralized, interactive*, and *public-private* mode of governance. This can be explained by the fact that the *goals and targets* set by the Dutch government are both uniform and specific to the construction sector, which is a characteristic of a *decentralized* mode of governance. Also, the *instruments* of Dutch government correspond to a *centralized* and *public-private* mode of governance, since both incentives and restrictions are used. Moreover, the feature *policy integration* is characterized by an *interactive* mode of governance, since policy is conducted and specified at multiple levels and therefore it can be considered as *integrated*. Lastly, the interface between policy and science is considered as *decentralized*, since currently generic expert knowledge is used to calculate circular performance of buildings, however, at this moment there is still room for issue.

The current mode of governance in the Netherlands showed that there are different governance features that respond to different types of governance modes. In other words, this illustrates that the Dutch governance structure of the construction sector is very fragmented.

Moreover, what stands out is that circular construction is currently considered as a complex process, because little is known and there are no specific blueprints or setups. In addition, based on the previous examination of the current policy matters, we stress the urgency to realize a shift towards a system in which the financial benefit for organizations to operate under linear principles is less than to operate under circular principles. Above all, this shift requires a new perspective on existing policy matters, in which the interests of the firms and organizations have to be aligned with those of society.

4.3 Governance Features for the realization of a Circular Construction Sector

The current situation, as described in the previous paragraph, shows that the Dutch government is taking steps to accomplish the transition to a circular construction sector, but it is still unknown what this exactly entails for the government and stakeholders. Subsequently, providing insight into governance features that are required for the realization of a circular economy, allowed us to examine how the transition towards a circular construction in the Netherlands can be accelerated. To be more specific, governance features that are aimed at achieving a circular construction sector are analysed based on the environmental governance framework of Driessen and colleagues (2012). In the first subsection the actor features are studied (4.3.1), followed by a thorough examination of the institutional features (4.3.2) and the content features that are intended to contribute to a circular construction sector (4.3.3). Each subsection contains a summary of relevant information per feature, including a brief interpretation of the analysis at the end. Lastly, a conclusion is provided that answers the second sub question (4.2.4).

4.3.1 Actor Features of a Circular Construction Sector

i) Initiating actors

According to the interviewees the *initiating actor* for a circular construction sector should be the government. To illustrate, the executive body of the national government stated that: *"[The national government] needs to help and force the market in order to consider circular principles. There will always be pioneers that are stubborn and are doing things they believe in but the majority isn't like that. We need an engine that stimulates the transition and, in this case, the government is this engine*". Furthermore, a regional government stated: "*higher legislation takes precedence. Therefore, the regions are only capable of stimulating and motivating project developers. This sometimes works, but not always. Stricter legislation plays an important role in this*". Similarly, a regional network organization stated: ''*[The national*

government] has to shape the conditions in which the circular principles are considered normal and are part of the realization process and that is the most logical route.'' A research organization argued that the government should initiate circular construction hubs, in which materials can be collected and reused: "*the government should take the lead, even if only facilitating the site and the process. There are enough entrepreneurs who are interested in this, but due to the lack of locations of these hubs, it will not happen. If municipalities do this, the market will pick it up".* In sum, all four interviewees point out that the national government needs to be the initiating actor in order to shape the conditions in which circular principles are considered normal. Therefore, we consider that the *initiating actor* of a circular construction sector should be *centralized*. This means that the initiating actor should be the central government agencies.

ii) Stakeholder position

The *stakeholder position* refers to the position of the industry and civil society in relation to the government. According to interviewees, stakeholders that need to be involved in policy making for a circular construction sector should include frontrunners and experts. A circular consultant explained: "*there is a need for people who are involved in understanding construction or who are innovative frontrunners. There must be a feeling for practice*". A regional government stated: "*I think there are always parties that are willing to do so, it is important to listen to those parties and not to those who stay behind. I think the market should be heard, but the front runners should have more to say than the laggards*". In addition, a circular consultant indicates: "*we should include the innovative parties who have a clear idea of the direction and a feeling for the practice. A lot is already possible, but not everything*" and further suggested to aim for "*a number of good engineering firms, sustainability consultancies and experts that have practical experience but also a clear vision of what the sector should look like. These people must advise on how a specific theme should be resolved or adjusted*". In all. the interviewees made it clear that stakeholders should be involved in policy making. Precisely, they stated that stakeholders should consist of innovative frontrunners or experts who can consult on specific themes within predetermined boundaries. Therefore, we consider the stakeholder position as decentralized, meaning that the *stakeholder position* is an *autonomy of market stakeholders within predetermined boundaries.*

iii) Policy level

The feature *policy level* gives an indication of the policy level at which key actors should operate in a circular construction sector. The interviewees described that the policy level should be on a national level, since it would contribute to the scalability of circular construction. For example, a research organization stated the following: "*we have to prevent that municipality has their own policy, besides the policy of the government. In case we do not prevent this, it would be harder to make standardized products and buildings and therefore more expensive. Different requirements for each city takes time and costs money. We have to make it more attractive for building developers to work on a larger scale. This way we make it more interesting to invest and think about sustainability and we can set higher performance standards on circularity. I think this is the only way to make it affordable*". In addition, according to a regional government, a national policy level will contribute to a more feasible policy that is in line with practice, since it experiences pressure from both bottom up and top down. In the interview, they stated "*both a supranational body and the regions should focus on the national government. This is also called a circular sandwich. A supranational body sets the rules and the national governments are obligated to apply them. The role of regions is to channel everything we see and hear in their region to the national government. That is the pressure from below*". According to interviewees, it can be concluded that a national policy level should contribute to the scalability of circular construction. That is to say, an unambiguous national policy has the capability to ensure that a building can be realized in several places. As a consequence, a possibility to scale up is facilitated. This approach implies a more feasible policy which is in line with practice, since the economies of scale can be used from the top down pressure and the practical experience can be used from the bottom up pressure. Accordingly, we consider that the *policy level* of a circular construction sector should be *centralized*, meaning that the policy level should take place on a national level.

iv) Powerbase

The feature *powerbase* refers to the distribution of resources that have the power to change existing structures and institutions. According to interviewees, the powerbase lies mainly with the national government, as the government requires adequate means to be able to execute policy properly. To clarify, the national government stated the following: "*we are able to move faster if the budgets are bigger and there is a high priority in politics for a circular construction sector. We are able to stimulate pilot projects and monitor and regulate performance*". Thus, the availability of bigger budgets and prioritizing circular construction by the national government makes it possible to enlarge the powerbase. It is to be expected that this will enlarge

the power to distribute resources and to change existing structures and institutions. In addition, the circular construction sector should be situated within one ministry. This way, resources are bundled under the same powerbase, resulting in a more efficient, capable and knowledgeable powerbase. A circular consultant emphasized the latter by stating the following: "*it is important that circular construction is situated within one ministry in order to be more efficient, to have more influence on the industry and to build upon previous knowledge*" and added that a hierarchical governmental structure also will contribute to an increasing powerbase: "*the advantage of this is that if people in power decide something, it is actually going to take place, in comparison to a horizontal structure in which everyone is allowed to participate and nobody dares to take responsibility*".

For the existence of a circular construction sector, the powerbase should be on national level, it should be placed within one ministry, and it should have a hierarchical governmental structure. All these terms will play a role in enlarging the powerbase of circular construction and, therefore, will contribute to a better distribution of resources. This way, existing structures can be changed. Based on the findings above, it can be concluded that the powerbase of a circular construction sector corresponds with a *centralized* mode of governance, meaning that the *powerbase* is a *coercion authority; legitimacy (democratic representation at the national level).*

4.3.2 Institutional Features of a Circular Construction Sector

i) Model of representation

The feature *model of representation* is characterized by the way power is assigned to the initiating actors. Importantly, interviewees argued the importance of representation of stakeholders in policy formulation. For example, a regional network organization stated: "*we have to learn from stakeholders in order to improve and to formulate a policy*" and a research organization stated: "*public parties have a lot of buildings in their possession and are able to make them more circular and also have a time perspective. We have to obtain knowledge from them with pilots and take it to the next level by upscaling*". For this reason, stakeholders should be represented in the model of representation in order to develop knowledge and experience.

The findings above demonstrate that the national government should be considered as the most important initiating actor in a circular construction sector and that powerbase is dependent on the priority of the elected administration. Therefore, the interests of the industry should be represented in the formation of policy in order to realize a functioning circular

construction sector. This corresponds with a *centralized* mode of governance as discussed by Driessen and colleagues (2012) for the *model of representation*.

ii) Rules of interaction

Regarding the formal and informal rules of interaction and exchange between stakeholders, the interviewees describe the importance of clear rules that guarantee the circular performance of buildings and the construction process. The interviewee of the research organization explained this by stating: "*the government needs to check whether buildings are built as promised. They have to assess the impact that has been calculated beforehand and compare it with the realized building, in other words, enforcement*". Furthermore, a network organization stated: "*with formal requirements we will be able to stimulate the industry and overthink their products and supply chain*". To add, a circular consultant stated: "*the national government must set realistic and strict buildings standards and steer accordingly*". Thus, buildings should meet formal rules, such as minimum building standards that are formulated by the government. In addition, adhering to these rules should be enforced by the government. Therefore, we propose that the *rules of interaction* should be *formal rules (rule of law; fixed and clear procedures)* in order to design a circular construction sector.

iii) Mechanism of social interaction

According to a network organization: "*I strongly believe that a closer cooperation between organizations is crucial for exchanging knowledge and experience*". Many interviewees underlined the importance of social interaction for social learning. For instance, an interviewee of a regional network organization stated: "*stakeholders have to know each other and able to find each other in order to complement each other*", and a research organization stated: "*knowledge and experience that is gained due to pilot projects initiated by the government, is useful to customize governance for a circular construction sector*". More specific, close cooperation ensures that stakeholders learn from each other and complement each other where necessary and ensures a policy that is in line with the capabilities of the circular construction sector. Additionally, a regional network organization stated: "*we have to work together in a new way. Close cooperation and trust is necessary to integrate the circular principles throughout the entire supply chain, in order to reduce the environmental impact*". In other words, in a circular economy the whole supply chain needs to be integrated in the building process in order to be fully circular. Furthermore, a regional network organization underlined the importance that "*we have to make sure that every stakeholder is involved and supports this*

goal. We need to define how we want to reach this goal, and what that requires of everyone. In addition, everyone has to accept their role. That means that A) we have to get to know each other B) we have to trust each other and C) everyone has to stick to their role".

In sum, for a circular construction sector, it is of significant importance that stakeholders collaborate to exchange knowledge and experience, to improve environmental performance throughout the entire supply chain and to achieve goals together. Hence, we consider that the *mechanisms of social interaction* should *be interactive: social learning, deliberations and negotiations.*

4.3.3 Content Features of a Circular Construction Sector

i) Goals and Targets

Several interviewees have painted a clear picture of what a circular construction entails and which goals and targets should be formulated in order to pursue a circular construction sector. To illustrate, a research organization stated: "*in a circular construction sector we use resources that are in line with the possibilities that are offered by the earth with the wishes and needs of humans. If we are able to achieve both interests, we can succeed to be sustainable. The circular economy can be a means to achieve this instead of a goal itself*". According to another research organization a circular construction sector needs to be future proof in order to "*firstly, to minimize scarcity and climate change, secondly for changing wishes and demands of society, and thirdly, for new developments and innovations*". Based on the previous insights, we can conclude that the government needs to set goals and targets to "*reuse materials, like concrete, steel, wood, isolation, and recycle products when they need to be replaced*" (a municipality) to realize a circular construction sector.

In addition, a circular consultant stated that in a circular construction sector "*circular buildings are flexible and demountable in order to reduce material use. Also, bio based materials can easily be applied, and products that no longer meet the standards can easily be replaced and recycled*.". Additionally, when buildings are demountable "*all materials are still intact after being used and can be reused and applied again. In this case we are able to meet the demand over time*" (a research organization). Thus, the adaptability of buildings is important for expanding the life span of a building and materials and should be considered as a goal or target for the government.

Besides adaptability of buildings, the interviewees stated that a circular construction sector should include modular and industrialized buildings. To be more specific, modular buildings offer the opportunity to meet the demand and wishes of the society in a specific time.

For example, a municipality stated: "*take schools as an example. We see for a period of time that schools are necessary, however, after 20 years most kids are grown and their parents still live in the same neighbourhood. Modular buildings offer us the opportunity to replace the school without any material loss*". Furthermore, industrialization of buildings offers "*a higher circularity performance for a much lower price. In that case, it pays off to think about circularity. The additional costs can be divided over each product that is produced, which will result in better environmental performance*", as stated by a research organization. The economies of scale of an industrialized building process result in faster realization of buildings, which makes it more affordable to invest in circularity and implement it on a large scale. This means the government needs to formulate goals and targets to stimulate the construction of modular and industrialized buildings.

In summary, according to the interviewees, the goals and ambitions of a circular construction sector should stimulate 1) the construction of modular and industrialized buildings, 2) the adaptability of buildings, and 3) the reuse and recycling of products and materials that are applied in buildings. On an important note however, the interviewees stated that it is hard to formulate clear measurable targets at this point, since we are still in an experimental phase. A research organization stated: "*if we have more experience we can tell better what is possible*". To emphasize, a network organization stated: "*the options we have for circular construction are all still very experimental*". As a final point, we propose that the *goals and targets* for the realization of a circular construction sector should be *uniform targets and goals*.

ii) Instruments

Instruments refer to the incentives and control that a government can apply in order to shape a circular construction environment and to destabilize the linear system. An interviewee stated that incentives and control could contribute to the process of "*making the new system more payable and a more interesting option which encourages the new system and discourages the old system"* (a research organization). Based on the conducted interviews, four incentives and one restriction were identified.

Incentives come in various forms within the circular construction sector. First of all, pioneers need to be stimulated financially in order to test new products and to develop knowledge and experience. An interviewee of the national government explained this by stating that "*if we have more experience we can show what is possible. This will definitely help to develop the circular construction sector. Secondly, we can change the narrative if we are able to show the changes and possibilities of circular buildings. Thirdly, the costs: after we have the*

experience it will be cheap to reproduce". This demonstrates that an incentive is an important tool for the development of a circular construction sector.

Secondly, in order to make the circular choice the preferred choice, residual value should be calculated differently. More precisely, a research institute stated: "*if you can demonstrate that your building is worth so much after so many years, then this offers opportunities to pick long lasting or demountable materials*". If a residual value system is based on material values and on their life span and performance, rather than on a general life span of a building, it will be more interesting for building owners to choose materials more carefully. Furthermore, a municipality stated that the government should stimulate the use of lease contracts, in which products or materials remain property of the suppliers rather than building owners. The interviewee explained this by stating this "*gives the supplier an incentive to improve the quality of products, reuse products and its life span*", which results in the following: "*The pre building phase will be cheaper, the exploitation phase will be more expensive, and the application of circular principles will be more accessible*".

Thirdly, interviewees pointed out the importance of a new taxation system in which taxation on labour is reduced, taxation on materials is increased and CO_2 emissions are priced. A different taxation system with an emphasis on virgin materials and CO_2 pricing will result in higher prices for virgin materials, and hence makes circularity a more desired option. To illustrate, a research organization stated: "*we should make the new system more payable, such as no tax on materials that are being reused and lower tax on labour. We should also price the old system so it becomes more expensive to continue, for instance by a higher taxation on virgin materials*". Additionally, a circular expert stated: "*the tax on labour must decrease and the tax on materials must increase. This will also ensure that sustainable use of materials is a more interesting option*". A research organization supported the latter by stating the following: *"if we tax materials more heavily than labour, we will be more aware of the materials we use"*. A regional network organization further explained this: "*if the government introduces a CO_2-pricing system and reduces taxation on labour and increases the taxation on materials, then the new economy will receive a boost and becomes more interesting for building developers to invest in circular constructions*". In all, a lower tax on labour, a higher tax on materials and a CO_2-pricing contribute to making the circulatory system a more desired option.

Fourth, in most cases the government is the owner of a large amount of buildings that are realized for governmental or public purpose, such as schools. For this reason, the government is able to stimulate the market to become more circular. It is within their power to

tender buildings that meet the circular principles. As a consequence, this will set an example for the market and will trigger the market to become circular.

Lastly, control should be applied in order to enforce a minimum circular performance standard for buildings. Otherwise it is to be expected that laggards, who are not intrinsically motivated to change, do not shift from a linear to a circular system. This minimum requirement needs to become stricter every year, in order to force the market to apply circular principles for the realization of buildings. This requirement is also needed to stimulate a competition between suppliers for supplying the most circular product or material. In addition, local authorities must control the promised environmental performance standards to ensure that building performance standards are met. According to a research organization, a better environmental performance should be rewarded and if performance is worse than promised, it should be punished: *"in this way, circular buildings are actually realized and it pays out to be circular as a builder*". By introducing and controlling a minimum requirement for the environmental performance of buildings, it will be ensured that the entire sector complies to the circular principles.

In sum, for the realization of a circular construction sector, instruments need to facilitate the conditions in which circular principles are a more desired option in comparison to a current system. Incentives in a circular construction sector should stimulate pioneers to gain knowledge and experience and should include a taxation system with higher tax rates on materials and lower tax on labour. Furthermore, the government should use their own buildings to set an example and upscale circular construction. Therefore, we consider the *instruments* of a circular construction sector *as incentive based instruments, such as taxes and grants; performance contracts.* Additionally, control is necessary in a circular construction sector, such as a minimum environmental performance standard, to be able to force laggards to implement circular principles in their buildings. Accordingly, we consider the *instruments* of a circular construction sector also as *legislation, permits, norms and standards.*

iii) Policy integration

Policy integration is characterized by the extent to which policies are integrated throughout the system. Policy integration is considered important for a circular construction sector, since "*it is crucial that all layers of the government find circular construction important. If this is the case, a country will be able to integrate it in the way of doing*" (a research organization). A regional government underlined the importance of policy integration with the circular sandwich, as mentioned in the policy level paragraph. Here, it was discussed that pressure from bottom up and above ensures a feasible and applicable policy.

Importantly, a national network organization argued for an international standard for the calculation of circular performance of products and materials, since it will stimulate the data exchange between countries. Subsequently, a more reliable calculation method to calculate circular performance of buildings is urged. The interviewee stated: "*we have to stimulate data exchange between countries and create one standard. Having all materials and products calculated in the same way and included in one system will result in a more reliable and accessible calculation of circular performance of buildings*". Notably, a supranational body has the power to initiate a standard that should be integrated in all countries.

Furthermore, a research organization stated that policy integration at lower governmental levels, for example within regions and municipalities, is important to monitor and control circular performance of buildings. Specifically, the interviewee stated "*we must license local authorities in order to check the environmental performance of realized buildings in their jurisdictive*". Thus, knowledge about the policy regarding circular construction is necessary on a local and regional level in order to assess environmental performance of buildings in their jurisdiction.

In addition, according to a research organization, local and regional governments should not formulate their own policy. This insight is clarified by the interviewee by stating: "*this makes it harder to make standardized products and buildings. Since asking for permits in every city takes time and costs money, this would also be more expensive. Thus, we have to make it more attractive for building developers to work on a larger scale. This way we make it more interesting to invest in sustainability and we can set higher restrictions on circularity performance*". Based on the previous statement, we conclude that local and regional governments need to be in line with the national and international formulated policy.

Altogether, on the ground of the analysis of the different interviews, we highlighted four points that should be considered for the realization of a circular construction sector regarding the process of integrating policy. First of all, it is of major importance that policy is formulated top down. Secondly, policy should be integrated throughout the different governmental layers, in order to ensure a progressive and applicable policy. Thirdly the large scale of a supranational body that is able to accelerate database of products and materials and eco-design is an element that should be taken advantage of. Lastly, local governments need to check and enforce environmental performance of buildings that are realized under their jurisdictive. Given these points, we consider that the *policy integration* of a circular construction sector should be *centralized*.

iv) Policy-science interface

Policy-science interface is described as the type of knowledge that is necessary to support policy development and decision-making in favour of a circular construction sector. Also, it includes the knowledge required for the implementation and evaluation of processes that are concerned with a circular construction sector. More specifically, interviewees referred to the importance of a software tool that would allow them to calculate the circularity performance of buildings based on scientific research. For example, an interviewee of a multi-stakeholder organization stated that "*it is important to be able to measure circular performance and to link it with some concrete definitions. This way, people know exactly what they are talking about*".

One of the definitions that an interviewee of a research organization referred to is the environmental performance of products or materials. This performance can be calculated with a LCA of the product or material. As has been mentioned in paragraph 4.2.3, LCA studies need to include the entire life cycle of a product or material: from the production stage to end-of-life stage. By integrating all four stages in the LCA, as previously discussed, the performance of materials and products can be balanced out throughout the entire life cycle. In addition, interviewee of a research organization pointed out that circularity is more than only measuring environmental performance, by stating the following: "*circularity has so many aspects, such as secondary resource use, renewable resource use, virgin resource use, lifetime expansion, the ability to disassemble, adaptability of a building, and the released waste streams*". As a consequence, we need to be able to measure every individual aspect of circularity separately and we should base the calculations on scientific research. This makes it possible for builders to "*make the trade-off between circular construction criteria"*, as stated by a national network organization. In other words, using the LCA method offers the opportunity to realize a building based on the constructor's preference, while the process can still be expressed in a number that represents the circularity performance of a building. An advantage of this procedure is that it provides a chance to set a minimum performance standard for stakeholders who participate within a circular construction sector.

Overall, we stress that a *policy-science interface* for promoting the adoption of circular practices within the construction sector should be based on *primacy of generic, expert knowledge.*

4.3.4 Summary: features for the realization of a Circular Construction Sector

To evaluate the governance features that are necessary for the realization of a circular construction sector, we identified several features as defined by Driessen and colleagues (2012).

In the current section, we summarize the attributes that are most relevant to achieve circularity. We end this section by briefly evaluating the features that are demanded and how to effectively realize the required shift in government mode.

The characteristics of the actors that are concerned with achieving a circular construction sector all align with a *centralized* mode of governance. On the basis of the interviewee's statements, we concluded that the national government should be the initiating actor. In addition, the national government should decide which stakeholders need to be involved in decision making and should be responsible for formulating a policy for the entire industry. In short, the national government needs to have a high priority for the realization of a circular construction sector.

The institutional features (i.e. the interaction between the actors) are characterized by both a *centralized* mode of governance as an *interactive* mode of governance. Specifically, the *model of representation* and *rules of interaction* respond to a *centralized* mode of governance and the *mechanism of social interaction* responds to an *interactive* mode of governance. An explanation for this structure could be that the realization of a circular construction requires an extensive transition, in which learning and experience still have to be gained through close collaboration. Importantly, social learning is considered a suitable tool for this.

The content features, the traits of policy content that are targeted at accomplishing circularity, are characterized mostly by a *centralized* mode of governance. The specified features *goals and targets*, *policy integration,* and *policy-science interface* all individually conform with a centralized mode of governance. Though the feature instruments can be considered as both a *centralized* and a *public-private* mode of governance. According to interviewees, both incentives and restrictions are necessary to shape a circular construction environment and to destabilize the linear system. Here, the old system has to be broken down by control and the new system has to be developed by means of incentives.

The identification of the governance features for the realization of a circular construction sector shows which modes of governance are needed to integrate circular principles in the construction sector. The governance features for the realization of a circular construction sector mainly consists of a composition of features that correspond to a *centralized* mode of governance (9 times) and partly by an *interactive* (1 time) and *public-private* (1 time) mode of governance. However, the current mode of governance of the Netherlands is characterized by a combination of features that align with *centralized* (2 times), *decentralized* (2 times), *interactive* (5 times) and *public-private* (1 time) modes of governance. This analysis demonstrates that there is some overlap between the mode of governance of the current

construction sector in the Netherlands and the government features that are essential to achieve a circular construction sector. Still, a large part differs in terms of (policy) content and in the mode of governance. Namely, decentralized governance and stakeholder involvement plays a prominent role in the current situation, while this is not the case in the governance features for a circular construction section. Indeed, the features that are needed for circularity are characterized mainly by centralized modes of governance and involve only a part of the stakeholders in decision making. Additionally, the governance features that we demand are more thorough and elaborated. For example, they describe which stakeholders should be involved and what instruments should be used. To examine which steps, need to be taken to achieve the required application of governance features, drivers and barriers are identified in the next paragraph.

4.4 Identification of Drivers and Barriers that Influence the Realisation of a Dutch Circular Construction Sector

The previous section described the governance features that are demanded for the realization of a circular construction sector. We can conclude from the previous section that there should be a focus on a *centralized* mode of governance in order to realize a circular construction sector. In the Netherlands, there are certain factors that either stimulate or stand in the way of this shift. To come up with recommendations how the governance structure of the Dutch construction sector could comply with the demanded governance features, the drivers and barriers within the current circular governance were identified. The results of the analysis are demonstrated in the current section. Specifically, background knowledge and frames are provided to answer the third sub question: "*What are the barriers and drivers that influence the realisation of a circular construction sector in the Netherlands?".* First, the drivers that accelerate the transition towards a circular construction sector are discussed (4.4.1). The first driver is the enlargement of the powerbase of the Netherlands which ensures a distribution of resources that will be in favour of the transition towards a circular construction sector. Next, demanding circular construction for government buildings to stimulate circular construction, and using incentives to shape conditions in which circular principles are more desired are discussed. After that, we evaluated the barriers that currently hamper the transition towards a circular construction sector (4.4.2). We started with pointing out the inclusion of stakeholders that represent the existing interests, after which we discussed the lack of restrictions to destabilize the linear system. In the three sections that follow, we dealt with the barriers: lack of a clear definition of circular construction, incorrect measuring of circular performance of buildings and insufficient knowledge and

experience for the realization of a circular construction sector. Lastly, a conclusion is provided that answers the last sub question (4.4.3).

4.4.1 Drivers that accelerate the transition towards a circular construction sector

i) Enlarging the powerbase

As previously stated, the *powerbase* refers to the distribution of resources and changing existing structures and institutions. In section 4.2.1, interviewees pointed out that a circular construction sector should be the top priority for the national government and should be situated at one ministry in order to enlarge the powerbase. It is expected that a larger powerbase will ensure a distribution of resources that will be in favour of the transition towards a circular construction sector. Also, it will provide the ability to change existing structures and institutions. This change would stimulate the transition towards a circular construction sector.

According to an executive government body of the national government, circular construction is currently not a priority of the Dutch government. Specifically, the interviewee stated: "*the government does not see the seriousness of the problem and, therefore, does not dare to take any measures".* Furthermore, the interviewee explained that The Netherlands does not have an acute problem regarding resources' depletion. For this reason, the Dutch government does not feel the necessity for accelerating the demanded transition. This results in lower budgets for incentives to stimulate knowledge development and circular principles in construction. The national government underlined this by stating: "*the income of the government consists of taxpayer money. This is divided over the ministries and subjects. Momently, they find the circular economy not that important, in comparison to the energy transition, and therefore we have a relatively small budget".* In addition, she stated that "*the corona crisis is a clear example of that. Only when something is alarming enough, a budget is available ".* At this moment, the transition to a circular economy is not a priority for the Dutch government, which means that little budget is available for research and incentive schemes. With a bigger budget the Dutch government is able to stimulate the development of knowledge, experience and innovations in circular construction. Therefore, this is expected to contribute to the acceleration of the transition towards a circular construction sector.

In addition, the powerbase and mode of governance in the current representation of circular construction in the Dutch government are not efficiently coordinated. Currently, the ministry of home affairs is responsible for the realization of houses and built regulations to build, while the ministry of economic affairs is responsible for incentives to stimulate the circular construction sector. According to a circular consultant: "*within the government, no one*

is really responsible for anything and everyone points at each other" and therefore, "*the ministry of home affairs that cares most about the environment is only partly responsible for it and does not have the power to change the regime, since they are not responsible for incentives like subsidies or taxation*". In other words, the interviewee affirmed that taxation and subsidies are the most powerful tools to stimulate a transition. In all, for the transition towards a circular construction in the Netherlands, the responsibility and the tools to achieve this should be situated within one ministry.

ii) The government must tender more circular construction

Interviewees suggested that the Dutch government should use their own buildings and set functionality and quality requirements with the aim of stimulating circular construction. Furthermore, a regional network organization stated that the government should "*shape a framework with quality requirements and functionality demands rather than direct demands. Under such circumstances, the industry can be triggered without limiting the application of innovations".* If the Dutch government demands functionality and quality, the industry would be free to interpret as they prefer. Therefore, the industry would be able to include innovations that fit these requirements. Moreover, the use of government buildings stimulates the industry to develop innovations and to invest in circular construction. This action can therefore be considered as a driver.

According to a municipality: "currently, we state that 25% of our tenders should be circular. But we never defined what that entails and when a tender can be considered circular". However, this applies to one region only. According to the national government, the tenders that are used to realize circular construction by the national government is around ten percent. Therefore, the Dutch government has to tender out more of its own buildings in a circular manner. In addition, a regional network organization stated that "we have to demand a certain quality and functionality of a building in a circular way. How this will be 'solved' is something the construction industry has to deal with. They are more experienced and are able to develop products that can meet the demand". The interviewee also stated that "this way the market is free to interpret it as they want and can offer innovative solutions".

Thus, in case the Dutch government decides to use their own buildings for the realization of circular construction, more circular buildings will be realized and hence the transition will be accelerated. In addition, the government should tender buildings on the basis of functionality and quality demands. This will contribute to the development of experience and knowledge, as the buildings can serve as an example for the rest of the sector.

iii) The use of incentives to shape conditions in which circular principles are more desired

Instruments, such as incentives and restrictions, contribute to a circular construction sector since they have the potential to destabilize the existing system and stimulate a circular construction environment. To illustrate, interviewees described several instruments of the Dutch government which currently hinders or could stimulate the transition towards a circular construction sector in the Netherlands.

Currently, in the Netherlands materials and products have a lower taxation rate than labour. As circular material use requires more labour, this process is more expensive. Accordingly, a different taxation system with a higher taxation rate on materials and less taxation on labour activities will contribute to "*making the new system more payable and a more interesting option. Another option would be to price the old system so it becomes more expensive to continue like this'* (a circular consultant). These actions will result in a reduction in material use and will make reuse and recycle of materials and products a more desired choice.

In addition, a municipality pointed out the current Dutch legislation hampers the application of secondary products: "at a project, The Niue Lunet, we reused doors of the university, but it turns out that they did not comply with the new building code. Therefore, we had to pay over 250 % of the costs relative to a new door to be able to use the second hand doors". Currently, the application of new products and materials is more affordable than secondary products or materials, due to Dutch legislation. In order to accelerate the transition towards a circular construction sector in the Netherlands, the Dutch government should amend the existing building code so that secondary materials use becomes more accessible, affordable and therefore a more plausible choice.

4.4.2 Barriers of the Dutch Construction Sector

i) The inclusion of stakeholders that represent the existing interests

As stated in the previous chapter (4.2.1), frontrunners of the construction sector and circular experts should be consulted for the formulation of policy by the government in order to realize a feasible policy. While stakeholders who represent the existing interests keep being consulted, the transition towards a circular construction sector will hamper.

However, the Dutch government currently consults both stakeholders who represent the existing interests and stakeholders who are frontrunners. A regional government identified this as a barrier of the Dutch government, by stating: "*at this moment we listen too much to the market that represents the existing interests, therefore we will always run slower than we really*

could". This is something that is underlined by multiple interviewees: "*what we now see in the transition construction economy team, is that an enormous number of existing interests are being represented"* (a circular consultant) and "*I think there is a strong lobby from the concrete, steel and brick sector. They represent their own interests. There is a lot of money and history there. They see circularity as a threat. This lobby is not cooperating to speed up this matter*" (a research organization). In order to overcome this barrier, the Dutch government should no longer include the stakeholders that represent the existing interest. Instead, the government should include frontrunners and experts who support the transition towards a circular construction sector.

ii) Current restrictions do not destabilize the linear construction sector

As described in section 4.2.3, stricter requirements for the circular performance of buildings forces the construction sector to apply circular principles. Additionally, it stimulates competition between suppliers for supplying products and materials with a better circular performance. Currently, "*the minimum requirements are easily achievable and not stimulate a new way of thinking to reduce the environmental impact"* (a regional network organization) and *"at this moment, requirements are only mandatory for residential and office buildings*" (a research organization). According to interviewees, the Dutch government is afraid to tighten the performance standards for circular building. Namely, a regional government described "*there are many members who benefit from the existing system and lobby for these existing interests".* Also, an executive body of the national government stated "*the government does not have the guts to take any real steps"* and a research organization stated "*members of the current government feel that they cannot be too directive. They are afraid of the resistance of the industry".* According to an executive body of the national government, "*this is something typical of the Dutch, we are really smart in making plans for the future but we are afraid to implement the ideas".* In order to accelerate the transition from a linear to a circular construction sector, the Dutch government should not be afraid of the resistance of the industry and tighten the circular performance standards of construction.

iii) No clear definition of circular construction

According to several interviewees a clear definition of circular construction is necessary to formulate and execute policy for the construction sector. A regional network organization stated "*a clear definition and measurement tool is necessary in order to get everyone involved and for the realization of a circular construction sector*".

This is further explained by an interviewee of a municipality who stated that currently, "*the understanding of circular economy and circular construction is relatively new and not a crystallized definition yet*" and "*if you ask it multiple people, one person would suggest a building with only secondary materials and someone else will suggest a building with only renewable resources included (a research organization)".* In all, the fact that there is no clear definition of circular construction hinders the transition towards a circular construction sector, since it is harder to formulate wishes and demands from the industry.

iv) Incorrect measuring of the circular performance of buildings

As stated by the interviewees, the ability to assess the circularity performance correctly makes it possible to set performance standards. This ability also contributes to the understanding and application of circular principles in construction. Therefore, correct assessment of circularity performance can be considered a driver. Currently, the MPG, which is based on LCA's that are made of products and materials, is used to calculate the circular performance of buildings. Although being able to measure the performance of circularity should be a driver, the interviewees indicated several barriers in the interviewees indicated several barriers in the assessing method of the Dutch government.

Firstly, the MPG only includes the production stage, end-of-life stage and re-use, recycling and energy recovery stage, and does not include the use phase of a building. To illustrate, an executive government body of the national government pointed out that excluding the use phase of a building in the calculation the circularity performance of buildings is a barrier, by stating: "*this part of the life cycle has the largest impact on the environment and in this phase we use the most virgin materials like oil, gas and coal".* For this reason, the Dutch government should include the use phase in the calculation of circular performance. In addition, interviewees highlighted that the calculation method should include waste management during the life cycle of a building and the use of virgin-, secondary-, and bio based materials. A regional network organization stated that including the whole supply chain of a building is currently a difficult process for the Dutch government. The interviewee explains this by stating: "*in the construction sector it is a really difficult process to organize and redesign the supply chain of buildings, due to the complexity of buildings: a lot of stakeholders are involved during the building process "*. To organize and redesign the supply chain, "*the industry and government has to work together in a new way, and at the same time we have to adjust the restrictions and incentives and change policy. We have to be able to measure it, we have to monitor it and we have to get support from the neighbours. Also, we must redesign the supply chain. This means*

we have so many radars which must all move at the same time to realize circular constructions". By considering the entire life cycle of a building, rather than just parts of it, the environmental impact of a building or material can be calculated over its entire lifespan. Altogether, this makes it possible to make more sustainable choices and, therefore, reduce the environmental impact of a building.

Secondly, the existing MPG measuring method of the Dutch government does not include disassembly and adaptively of buildings (Stichting Bouwkwaliteit, 2019). The Dutch government should integrate disassembly and adaptively of buildings in the measuring method to calculate circular performance properly.

Thirdly, another barrier that an interviewee indicated is the appreciation of bio based materials, wood in particular, in the MPG calculation method. Specifically, the interviewee of a circular consultant stated that "*nowadays bio based materials are not measured correctly and therefore have a negative effect on the MPG-score",* since the CO_2 storage of bio based materials is not included in the life cycle. It is assumed that these materials are incinerated after the end of life. As a result, bio based materials are currently wrongly assessed and perform poorly according to the measuring method for the circularity performance of buildings. Therefore, the incorrect calculation of bio based materials can be considered as a barrier.

Lastly, another interviewee pointed out that the database of LCA's, which forms the input of the MPG, is insufficient. The main reason for this is that *"suppliers do not feel the necessity to get their product into the database",* as was stated by a national network organization. The lacking database can be considered as a barrier, since it is necessary to calculate the circular performance of a building properly. The government should stimulate the suppliers to have an LCA drawn up of their product with stricter regulation or incentives. It is expected that this intervention would motivate suppliers to become part of the MPG database.

v) Insufficient knowledge and experience for the realization of circular construction sector

For the transition towards a circular construction sector and to ensure a policy that is in line with the capabilities of the industry, the development of knowledge and experience in the field is necessary. Pilot projects are seen by interviewees as a driver for the development of knowledge and experience, since "*through pilots we gain experience and that offers us perspective and direction"* (a regional network organization) and they show the industry what is possible. According to some of the interviewees, the realization of circular construction is currently more expensive than linear construction. For example, a municipality stated: "*at this*

moment, circular construction means additional costs. Not extra building costs in particular, but mostly costs of process and learning". Similarly, a research organization stated: "*buildings with a high circularity performance are still more expensive to realize*". Pilot projects can contribute to the reduction of additional learning costs through the experience and knowledge that is obtained during the pilots.

At this moment, the Dutch government is not sufficiently stimulating pilot projects. According to an executive government body of the national government, the Dutch government "*must start and support the pilots. In case they make a mistake, they can learn from it and they should not be afraid of it".* In order to stimulate the development of knowledge and experience and to reduce the additional learning costs, the Dutch government should facilitate and stimulate pilot projects through subsidy schemes or with the buildings they possess.

In addition, the knowledge and experience which is gained from pilots is applied on a larger scale. According to a research organization, "*a lot of projects stop after a few pilots and the knowledge is not reused or implemented on a larger scale"* since the process "*asks a lot of organization, from sales to operations. Everyone has to be involved to make a change. In a lot of cases, firms are not able to integrate the ideas throughout the company to make the shift from pilots to business"*. Importantly, interviewees argued for the industrialization of buildings with the aim to scale up circular construction throughout organizations and sectors, because this "*makes developers illegible to build on a large scale and, therefore, circularity can be seen as one of the performance standards and will still be affordable"* (a research organization). Another research organization further explained this by stating the following, *"the industrialization of buildings offers the opportunity to build more buildings circular and faster in a short period*".

Furthermore, the interviewees indicated that the experience in the field of circular construction to execute circular policy in the Netherlands is insufficient. According to a regional government: "*the municipalities do not have the knowledge to build and regulate the realization of circular buildings".* For this reason, the regions should play an important role in facilitating partnerships and sharing experience and knowledge to overcome this barrier. The interviewee of a regional network organization argued for regional partnerships *"a big enough web for this, otherwise we lose track of all the stakeholders and it becomes too big".* In addition, the interviewees argued for a creation of a job function for every municipality, by which knowledge about sustainability, circularity and construction is ensured. As a result, this knowledge could contribute to the realization of circular construction in the municipalities, since the municipalities will be able to monitor and check the circularity performance.

Therefore, in order to accelerate the transition towards a circular construction sector, the Dutch government should improve the development of knowledge and the exchange of knowledge.

4.4.3 Summary

Based on the analysis of drivers and barriers of the Dutch construction sector in the previous paragraphs, we determined how the transition towards circularity can be accelerated. In this section, we first summarize the drivers that the Dutch government can apply and the barriers that need to be overcome to accelerate the transition. After that, we briefly interpret these findings by discussing what the outlined context of the drivers and barriers teaches us about the features that are required to realize a circular construction sector.

We identified several drivers that stimulate the transition towards a circular construction sector. The first driver we identified was the enlargement of the powerbase. A larger powerbase will ensure a distribution of resources that will be in favour of the transition towards a circular construction sector. It will also provide the ability to change existing structures and institutions. Secondly, the use of government buildings to upscale circular construction was pinpointed as a driver. Currently, only ten percent of the buildings owned by the Dutch government is used by the national government to realize circular construction. If the Dutch government uses their own buildings for the realization of circular construction, the transition will be stimulated even more. This action will also result in more experience and knowledge that is gained during the realization of these buildings. In other words, the buildings can serve as an example for the rest of the sector. The third driver of circularity is the use of instruments, such as incentives. These contribute to the realization of a circular construction sector in the Netherlands, since they can shape the conditions in which circular principles are a more desired option in comparison to a current system.

Furthermore, several barriers are identified that currently hinder the transition towards a circular construction sector in the Netherlands. First of all, the stakeholders that are involved in formulating policy are mostly stakeholders that represent the existing interests of the linear construction sector. They are trying to protect their interests and therefore have a negative impact on the transition towards circularity. Secondly, there is no clear definition and method to measure circular construction correctly. A clear definition of circular construction is necessary to formulate and execute policy for the construction sector. Additionally, the use phase of products and materials, CO_2-storage, and disassembly and adaptively of buildings is not included in the calculation of the circular performance of a building. Also, the database of LCA’s is considered to be insufficient. Altogether, the lack of a clear definition and

measurement method is hampering the transition towards a circular construction in the Netherlands. Thirdly, the insufficient knowledge and experience about circular construction in the Netherlands is considered to be a barrier for the realization of a circular construction sector. More specifically, the development of knowledge and experience related to circular construction is necessary to scale up circular construction and to ensure a policy in the Netherlands that is in line with the capabilities of the industry. Currently, the Dutch government does not take sufficient steps to acquire knowledge and experience. Lastly, the lack of instruments that stimulate circular construction is at this point considered as a barrier. Instruments such as restrictions contribute to the destabilization of the existing linear system of the Netherlands. Stricter requirements for the circular performance of buildings forces the construction sector to apply circular principles. However, it is not yet mandatory to apply circular principles in buildings, which means that project developers are not motivated for circular construction.

By identifying the drivers and barriers of the Dutch construction sector, we provided insight into several steps that need to be taken in order to stimulate or accelerate the transition to a circular construction sector. We noticed that several drivers and barriers are interrelated, such as the incentives and restrictions and stakeholder involvement. On the one hand, both can be considered as drivers and as barriers, because if the Dutch government decides not to use the incentives or include the frontrunners and experts in the formulation of policy, it will still hamper the transition towards a circular construction sector. On the other hand, if the Dutch government decides to implement the suggestions, it will accelerate the demanded transition. Based on the identified drivers and barriers, a thorough recommendation of actions that are expected to contribute to circularity was formulated in the next chapter, in order to provide an answer on the research question.

5. Discussion

In this chapter the interpretations and explanations of the results are discussed. We evaluated how they are related to existing literature, limitations of the research and further research recommendations. Starting with the contribution of this research (5.1). After this, limitations of the research are presented (5.2), and, lastly, recommendations for further research are provided (5.3).

5.1 Contributions

In the theoretical background it was argued that social relationships and collaboration are crucial for a circular construction sector (Pomponi & Moncaster, 2017; Bocken et al., 2016). Specifically, Bocken and colleagues (2015) have argued that social relationships and collaborations are considered key to close loops in the construction sector, which was confirmed by the findings in section 2.1. Namely, we found that social relationships and close cooperation are necessary for the dissemination of knowledge and experience. Importantly, close cooperation leads to diffusion of knowledge between stakeholders and ensures a circular policy that is in line with the capabilities of the circular construction sector.

In addition, the drivers and barriers to achieve circularity, identified in section 4.4, confirm that governance structures can shape conditions that stimulate desired environments and break down existing environments, which is also supported by Challies and Newig (2019) and Driessen and colleagues (2012). Furthermore, the findings in 4.3 demonstrated which governance features are crucial to shape conditions for the realization of a circular construction sector and to transform/dismantle the linear system. Namely, a way to shape conditions for the realization of a circular construction sector is with policy instruments, for instance incentives or restrictions. Policy instruments can stimulate pioneers and force laggards to include circular principles in construction processes. This is in line with the theory of Choi (2009) and Tinker and colleagues (2006), who have argued that incentives are required to meet environmental, social, and economic advantages. The literature also shows that incentives are appealing to the goodwill of owners to invest in circular buildings.

Furthermore, as was illustrated in section 4.4, industry stakeholders are trying to protect their existing interests, because they benefit from the linear system. This is in-line with the theory of Penna and Geels (2000), who have argued that stakeholders resist change to defend the existing regime. According to Zhong (2008) resistance to change occurs when a policy has greater public benefits than individual benefits. This is confirmed by the findings in which we

saw that stakeholders who benefit more from the linear system resist change, while society benefits from a more sustainable environment

Overall, the findings of this research fill in the knowledge gap concerning how governance features influence the transition towards a circular construction sector. More specifically, a conceptual framework was constructed to illustrate the influence of the mode of governance on the transition from linear construction towards a circular construction. By identifying the features of the current mode of governance and the features that are demanded for the realization of a circular construction sector, the conceptual framework was validated. We conducted desk research and semi structured interviews for the identification of features as well as for the analysis of demands. Subsequently, the results led to an advancement of the conceptual framework, since the findings identified the exact mode of governance and complementary governance features that influence the transition towards circularity, we were able to fill in the literature gap.

5.2 Limitations

Overall, the results of this study are mostly meeting the expectations of the proposed research. However, despite newly obtained insights and confirmations, some limitations occurred.

Firstly, the conceptual framework of section 2.3 was created to illustrate the influence of governance on the transition from a linear system to a circular system. The framework proved to be useful for the identification of drivers and barriers of the Dutch construction sector. Nevertheless, it should be noted that the conceptual framework only included the governance perspective. Evaluating more perspectives might have resulted in other outcomes. For instance, the inclusion of a multi-actor perspective to the analytical framework could give a complete approach to circular and other sustainability transitions.

The second limitation concerns the use of desk research and interviews to analyse the construction sectors and drivers and barriers. Indeed, interviews provided deeper information on the governance structure. The limitations of this approach is that answers of the participants may be biased. Also, the quality of the interview strongly depends on the interviewer. However, by conducting multiple interviews with stakeholders until theoretical saturation was reached, the validity of this study is ensured. Additionally, based on literature and theory, fewer types of stakeholders were expected beforehand. Though, along the way the system turned out to be more complex, with more actors than previously thought. As a result, it was not possible within the scope of this study to do in-depth research into the stakeholder interactions on a local scale. For this reason, follow-up research should look more specifically at local and regional contexts.

Furthermore, the interviews revealed that an important type of actor had not been discussed: the existing / established parties of the linear economy. Since circular is a niche, not all companies participate in this and are even willing to contribute ideas. This specific perspective of linear firms was not reflected quite concretely among the respondents. Therefore, it would be interesting to involve this perspective in follow-up research.

Lastly, the theme of circular economy, and specifically circular construction, is both scientifically and politically popular. The pace of new technologies, policies, business models and other developments have accelerated the number of studies and publications on the subject. Also, research in this field is widely deployed and is hence fragmented. This implies that it is almost impossible to include all new insights in this research. In this study, this means that for the theoretical background, no new literature is added since august 2020. This has, however, not negatively affected the outcomes of the research, since the framework of Driessen and colleges (2012) has not changed in such a short time.

5.3 Future Research

This study offers insight in the steps that need to be taken to achieve a circular construction sector in the Netherlands. During the study a few interesting topics emerged which could be investigated to gain more in-depth insights. In this section, we translate these points into suggestions for future research, as presented below.

Firstly, this research only included the influence of the governance perspective on the transition towards a circular construction sector. However, as Moncaster and Pomponi (2017) stated, the government is only one of the six pillars. To raise more comprehensive findings, further research should look into the influence of all six of the pillars that are related to the transition towards a circular construction sector (i.e., governmental, economic, environmental, technological, societal, and behavioural). Additionally, few interviewees referred to the inclusion of the technological innovation systems approach of Hekkert and colleagues (2007). To specify, this approach distinguishes different ‘system functions’ within a system which are required for a great adoption of an innovation or transition. Further research could use this theory to analyse the system functions that need to be in place for a transition towards a circular construction sector.

Lastly, the drivers we identified in our analyses, such as stimulating pilot projects and stricter regulation, illustrate the importance of governance interference for the acceleration of the demanded transition. However, the findings do not include the implementation processes of the identified drivers or concrete steps that can be undertaken to overcome barriers. Therefore,

further research could go more in depth on the procedure of implementing drives and overcoming barriers on different government levels.

6. Conclusion

The aim of this research was to understand how governance can successfully contribute to the transition to a circular construction sector in the Netherlands in order to reduce virgin material use and waste production. Therefore, the main research question was formulated as:

"*How can the Dutch government accelerate the transition towards a circular construction sector?"*

In order to answer the main research question, literature was used to investigate the phenomenon of circular construction, the transition theory and environmental governance. Subsequently, a conceptual framework was created to illustrate the influence that governance features have on the transition from a linear construction towards a circular construction sector. The framework was also used as a theoretical background for the analytical approach of this study. For the collection of data, a qualitative research approach was used, including desk research and interviews.

The findings show that the current mode of governance of the Dutch government consists of a combination of *centralized*, *decentralized*, *interactive*, and *public-private* governance. The *interactive and public-private* mode of governance can be explained by the observation that the Dutch government emphasises on partnerships to stimulate the development of knowledge and experience. Further, the policy of the Dutch government is not yet structured in a way that circular principles are more desired than linear principles. Stakeholders still work in a traditional way of make-waste and dispose and mainly existing interests that do not include circular principles are being heard in the sector. In particular, interviewees pointed out that if you listen to the existing interests, there will be no (or less) development towards a circular construction sector. Moreover, the instruments are not yet fully geared to stimulate circular construction. Currently, it is more expensive to realize buildings under the CE principles, than under linear principles.

The governance features that are demanded for the realization of a circular construction sector, however, consist mostly of *centralized* modes of governance and partly of an interactive *and public-private* mode of governance. In other words, we need incentives and controlling procedures that contribute to shaping a circular construction environment and to destabilizing the linear system. For the realization of circularity, an unambiguous national policy crucial to stimulate and scale up circular construction throughout the whole sector as well as to minimize

differences, such as different building requirements in regions or different measurement methods to measure circularity performance.

Several drivers and barriers that play a role in the process of accelerating the transition towards a circular construction sector were identified. Drivers such as enlarging the powerbase, the use of government buildings to upscale circular construction, and implementing instruments that stimulate a circular construction environment were pointed out. Additionally, the following actions and traits were identified as barriers; the inclusion of stakeholders that represent the existing interests, the lack of a clear definition of circular construction and the lack of a method to calculate its performance, insufficient knowledge and experience related to circular construction, and the current presence of instruments that fail to destabilize the existing system. The findings show that there are differences between the current governance features of the Dutch government and the governance features that have the potential to realize a circular construction sector. Thus, steps need to be taken to overcome the barriers and to apply the drivers, in order to accelerate the demanded transition.

Based on our findings, we formulated the following conclusions to answer the research question. Firstly, the need for a circular construction sector should be a top priority for the national government and be the responsibility of one ministry in order to enlarge the powerbase. Secondly, frontrunners of the construction sector and expert opinions should be consulted for the formulation of policy by the government in order to realize a feasible policy. Thirdly, a clear definition of circular construction is necessary to formulate and execute policy for the construction sector. Fourth, the method to calculate circularity performance needs to include the environmental impact of the entire life cycle of a building, disassembly and adaptively of buildings and CO_2 storage. This method should be implemented to be able to set performance standards and to gain a greater understanding of the environmental impact of (material) choices during the entire lifespan of a building. Fifth, the Dutch government should stimulate the development of knowledge and experience regarding circular construction within the sector. This can be achieved with the knowledge that is gained from pilot projects, for instance in which the outcome of scaling up circular construction is investigated. Importantly, gaining knowledge through pilot projects is expected to ensure a policy that is in line with the capabilities of the industry. Sixth, the Dutch government should use their own buildings to set an example for circular building and functionality and quality requirements. This action would expand the amount of buildings that are built under the CE principles and would also contribute to the development of knowledge and experience. Seventh, the taxation system of the Netherlands should change to a system in which materials are taxed higher and labour less, is

foreseen to result in a reduction of material use. This would make reuse and recycling of materials and products a more desired choice. Lastly, the Dutch government should amend the existing building code to set stricter requirements, such as a minimum standard for use of secondary or bio based materials. By doing so, secondary and less harmful material use becomes more accessible, more affordable and therefore a more plausible choice. We expect that if the recommendations are converted into practice, the transition towards a circular construction sector will be accelerated by the Dutch government.

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9. Appendixes

9.1 Appendix A – Stakeholder identification

Transition Team

Name organization	Explanation	Type of stakeholder
Eindhoven University of Technology	Research university specialized in science and technology.	Research institute
BRBS Recycling	Association for sorting firms for construction, renovation and dry industrial waste.	Branch organization
Ministry of I&W	Responsible for a safe, liveable and accessible society in the Netherlands	National government
Ministry of BZK	Responsible for affordable, safe and energy efficient homes in the Netherlands.	National government
NVB	Association for developers and builders	Branch organization
Volkerswessels	Developer and designer of buildings and builds and manages and maintains buildings.	Industry organization
Unie van Waterschappen	Responsible for the management of flood defences and water management in the Netherlands.	Government
Copper8	Consultancy for circular construction	Circular consultant
PBL	National research institute for strategic policy analysis	Research institute
Cepezed	Consultancy for circular construction	Circular construction consultant
NVTB	Association of suppliers of building materials	Branch organization
Woonbedrijf	Housing corporation with over 70.000 residents	Industry organization
Gemeente Amsterdam	Largest municipality of the Netherlands	Municipality

Table 1: Transition team of the national government

Transition Office

Name organization	Explanation	Type of stakeholder
Program leader circular construction	Representative of the RVO (executive body of the government)	Executive body of the government
Program leader ground, road and hydraulic engineering	Representative of the RVO (executive body of the government)	Executive body of the government
Program leader Residential and utility construction	Representative of the RVO (executive body of the government)	Executive body of the government

Table 2: Transition office of the national government

Support organizations of the transition office

Name organization	Explanation	Type of stakeholder

CB'23	Multi-stakeholder organization, which goal is to develop and share knowledge throughout the industry	Research organization
Cirkelstad	A network organization for leaders in the circular and inclusive construction sector. They facilitate public and private partnerships.	Regional network organization
DGBC	A network organization that is committed to making the construction sector future-proof with stakeholders and research.	National network organization
WE-Adviseurs	Independent knowledge organization that supports organization from vision development to implementation in daily practice.	Network and knowledge organization
Traject-adviseurs	Knowledge organization that uses practical knowledge of experts for integrated circular solutions	Network and knowledge organization
Het Versnellingshuis	A multi-stakeholder organization that helps entrepreneurs with the realization of circular ambitions and technicalities.	Network and knowledge organization
Platform 31	A research organization, which connects policy, practice and science to answer to the current issues.	Research organization

Table 3: Support organization of the transition office

Stakeholders Region of Utrecht

Name organization	Explanation	Type of stakeholder
Gemeente Utrecht	The biggest municipality of the region of Utrecht	Municipality
Economic Board of Utrecht	A network organization for the government, civil society and the industry for the realization of a circular economy	Knowledge and network organization
Cirkelstad Utrecht	A network organization for public and private partnerships in the construction sector in order to accelerate circular construction	Knowledge and network organization
Utrecht 10	An association of multiple municipalities in the region of Utrecht	Municipality's
Provincie Utrecht	Regional governmental body	Regional government
Gemeente Amersfoort	Second largest municipality of the region Utrecht	Municipality
Natuur en Milieu Utrecht	A foundation for a more beautiful, healthier and sustainable region of Utrecht.	Civil society organization
Utrecht Sustainability Institute	A network organization and knowledge platform for sustainable innovations in construction.	Network and research organization

Table 4: Stakeholders of the region of Utrecht

Stakeholders of the MRA

Name organization	Explanation	Type of stakeholder
MRA	The Amsterdam Metropole Area is a partnership of the provinces of North-Holland and Flevoland, 32 municipality's and the Amsterdam Transport Region	Regional government
Copper8	Consultancy for circular construction	Circular consultant
TNO	Independent research organization, which goal is to make knowledge applicable for governments and companies.	Research organization
Metabolic	Consultancy for circular construction	Circular consultant

Hogeschool van Amsterdam	University for applied science	Research organization
Amsterdam Smart City	Network and knowledge organization for innovation and cooperation for the Metropole region of Amsterdam	Network and knowledge organization
C-Creators	A network organization for public and private partnerships in the construction sector in order to accelerate circular construction in Amsterdam.	Regional network organization
Amsterdam Economic Board	A network organization for the government, civil society and the industry for the realization of a circular economy in the metropole region of Amsterdam	Network and knowledge organization

Table 5: Stakeholders of the region the MRA

Stakeholders of the Region Zuid-Holland

Province Zuid-Holland	Regional governmental body	Regional government
ICircle	A network organization for public and private partnerships in the construction sector in order to accelerate circular construction in Amsterdam.	Network and knowledge organization
Stichting de Bouwcampus	Multi-stakeholder foundation, which goal is to develop and upscale circular construction by facilitating partnerships.	Network organization
Economic board Zuid-Holland	A network organization for public and private partnerships in the construction sector in order to accelerate circular construction in the Region of Zuid-Holland.	Network organizations
Metabolic	Circular construction consultant	Circular consultant
ACCEZ Zuid-Holland	A research organization consisting out of several research universities to conduct research for accelerating circular construction.	Research organization
Amsterdam Economic Zuid-Holland	A network organization for the government, civil society and the industry for the realization of a circular economy in Zuid-Holland	Network and knowledge organization

Table 6: Stakeholders of the region Zuid-Holland