

Removing barriers in the transition
towards sustainability: An analysis of the
policy instrument sustainable public
procurement in the infrastructure sector.

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Summary

Sustainable development is recognized as a cross-sectional grand societal challenge, which needs both a global behavioural transformation and local initiatives. It is impossible to steer society towards sustainable development without effective governance mechanisms, in which governmental parties and policy instruments are essential. Being one of the largest procurement categories for local government, the infrastructure sector is very much affected by the developments regarding sustainable public procurement. However, it remains unclear which barriers hamper the transition towards sustainability in the infrastructure sector, and whether the policy instrument “sustainable public procurement” can take away these barriers. This research focuses on this gap in knowledge in transition policy and sustainable procurement processes. Knowledge on the relation between cause and barriers, and on the effects of the structural causes on the functioning of the system, gives insight in why the system fails to transition towards sustainability.

Using a qualitative approach, semi-structured interviews have been conducted and workshops and events have been attended to analyse the system of the infrastructure sector. This thesis analysed various groups of actors with different interests in the procurement process, using the Technological Innovation System as a framework for analysis. The main actors are contracting parties, tendering parties and consulting parties.

An important finding is that many barriers are connected to the institutions of the system. The barriers are also often linked to a lack of trust between various actors, and resistance to change. This resistance occurs due to habit. Procurement experts find it hard to change their behaviour because they have to change what they usually do; money-focused purchasing. To simulate innovations and sustainability in the sector, focus should be on functional description instead of technical description of the tender. This has proven to be one of the most important barriers. Other important barriers are the lack of shared vision, a lack of knowledge on the concept sustainability and uncertainty of where responsibilities of projects lie.

The current procurement model lacks flexibility and freedom to include innovations, which hampers system transformation. However, to let go of the current (unwritten) rules and change towards a more flexible, dialogue based purchasing model, a change in behaviour is needed in addition to a change in the system. In order for the infrastructure sector to undergo a transformation towards sustainability, profound changes are needed in attitudes, norms and regulations.

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1. Introduction

Recent years, the importance of local initiatives regarding sustainability has increasingly been acknowledged (Preuss, 2007; Saha, 2009). The United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro, 1992 (Earth Summit), resulted in a message stating the need for a global behavioural transformation, as sustainable development is a cross-sectional grand societal challenge (Wesseling and Edquist, 2018), which can only be dealt with long term solutions (Loorbach, 2010). Although a top-down approach for these long-term problems is often seen as outdated, it is also impossible to steer society towards sustainable development without effective governance mechanisms (Loorbach, 2010). Governmental parties are essential in this process (Sourani and Sohail, 2011; Edler and Fagerberg, 2017). Therefore, for a transition to occur, it is critical that necessary policy instrument choices are made (Kemp, 2010; Edler and Fagerberg, 2017; Wesseling and Edquist, 2018). United Nations (2018) also argues that involvement of governments would play a massive role in achieving sustainable development, purchasing policies of their agencies and departments included. As study shows that governmental organizations spend approximately 45%-65% of their budget in public procurement, increasing the focus on sustainability in this sector can have a significant impact (Bratt et al., 2013). Public procurement is a demand side policy instrument for creating transformative socio-technical niches and can thus be used to stimulate the transition towards sustainability.

(Local) governments often include sustainability requirements in the tendering process (RVO, 2018). The construction sector is one of the largest procurement categories for local government. This sector is most affected by the developments regarding sustainable public procurement (“*sustainable PP*”) (Preuss, 2009; Jones, 2013; Uttam and Roos, 2015), in which social, environmental and economical requirements are included in the purchasing and supply process (Oruezabala and Rico, 2012; Bratt et al., 2013; Uttam and Roos, 2015; Rijksoverheid, 2015). In infrastructure construction in the Netherlands, most of the work is carried out on behalf of public tenders, which means successfully implementing sustainability requirements in this sector can have a major impact (Chao-Duivis et al., 2013). Due to the relevance and potential impact this study focusses explicitly on the infrastructure construction sector (“*infrastructure sector*”).

How the transition towards a more sustainable economy should be stimulated by public organizations exactly is not clear (Iacovidou et al., 2017). The introduction of sustainable PP processes in the infrastructure industry as a way to stimulate the transition has been widely studied. However, literature on the effectiveness of sustainable PP to foster Corporate Social Responsibility (“*CSR*”) – a business’ responsiveness to social agendas - is not consistent (McCrudden, 2007; Steurer, 2010). Additionally, literature does not focus on whether this policy instrument is suitable for taking away barriers in the infrastructure sector. These barriers to effectively move the sector towards sustainability are caused by i.e. factors as a lack of dialogue, knowledge, resources and expertise (Testa et al., 2012; Bratt et al., 2013; Uttam and Roos, 2015). Dutch government has tried to obviate these barriers by

introducing the Socially Responsible Procurement manifest¹; a manifest focused on increasing sustainability. Specific themes have been linked to the social, ecological and economic aspects of this manifest, such as international social conditions; social return; environmentally friendly purchasing; bio-based purchasing; purchase circularly innovative purchasing; and small and medium enterprise (SME)-friendly purchasing. (PIANOo, 2016).

However, according to Baden et al. (2009), the effect of buyer pressure on suppliers does not necessarily have to be positive. It can also be counterproductive and result in even more bottlenecks for the infrastructure sector. An example is mock compliance, which is often used by companies to meet CSR requirements. Furthermore, the external pressure can lead to a ceiling effect, as the imposed standards would be lower than the standards companies would have set themselves (Baden et al., 2009). Therefore, it is still the question whether sustainable PP contributes to taking away barriers in transitioning towards sustainability in the infrastructure sector. This research focuses on this gap in knowledge in transition policy (Loorbach, 2010; Wesseling and Edquist, 2018) and sustainable PP processes (Jones, 2013). To address this, goals of this thesis are to 1. determine the current barriers in the transition to sustainability in the infrastructure sector; and 2. determine whether the current sustainable public procurement model used in infrastructure sector contributes to taking away these barriers.

Taking these goals into account, the following research question has been formulated: *To what extent does sustainable public procurement contribute to taking away barriers in transitioning towards sustainability in the infrastructure sector?* Answering this research question contributes to the knowledge on the effect of sustainable PP on the transition towards sustainability in the Dutch infrastructure sector. In a broader context, it contributes to knowledge on to what extent demand-side policy instruments contribute to taking away barriers in the transition towards sustainability. Determining the barriers in the transition in the infrastructure sector could lead to promising recommendations for both government as well as organisations in the Dutch infrastructure sector on overcoming these barriers.

This research is organized in the following way: Chapter two explains the theoretical framework of the research and examines how public procurement is organized in the infrastructure sector. In addition, it elaborates on the structure of the Technological Innovation System (“TIS”) framework. The next chapter deals with the methodology used for this study. Thereafter, the findings of this research are presented. Based on the literature on the TIS model and public procurement in the infrastructure sector, interviews are conducted and workshops and events are attended to get a more comprehensive picture of the problem. The results focus on the key aspects of the TIS framework. Subsequently, Chapter five discusses the results of the interviews, events and workshop discussions that were held during this research. In addition, it addresses limitations of this study and recommendations for future research.

¹ Manifest voor Maatschappelijk Verantwoord Inkopen

Chapter six summarizes the most important findings and states a number of conclusions. Lastly, Chapter seven addresses recommendations for practice.

2. Theoretical Framework

A review of academic literature and policy papers indicates that public procurement in the Netherlands is increasingly focusing on sustainability (Rijksoverheid, 2015; Uttam and Roos, 2015). Requirements for sustainability are becoming stricter, which is in line with the Socially Responsible Procurement (“SRP”) manifest (2016-2020) which is signed by most municipalities in the Netherlands. However, it is not clear what the effectiveness is of the policy instrument public procurement in this transition towards sustainability.

To analyse the ongoing transition towards sustainability in the Dutch public procurement process, various theories are relevant. Sustainable PP is complex, and issues related to it are often context dependent (Oruezabala and Rico, 2012; Uttam and Roos, 2015). Therefore, analysing the relationships between societal actors during complex societal issues is important. Using relevant aspects of the Technological Innovation System (“TIS”) framework (Hekkert et al., 2011) and knowledge on public procurement processes, this study will analyse the ongoing government processes in the Dutch infrastructure sector. It will therefore touch upon processes in all parts of the changing system and research how actors in different levels of the system are coping with changes towards sustainability.

The first section of this theoretical framework focusses on sustainable PP. It gives an insight into the current rules, norms, and barriers of the Dutch infrastructure sector and into the effectiveness of sustainable PP as a policy instrument in this sector. The second part addresses the structure of the TIS framework. The infrastructure sector is considered a TIS in this research. Analysing public procurement processes in this sector by using the TIS framework provides the opportunity to break the system down in parts, which makes it possible to define barriers and the underlying structural causes.

2.1. Public procurement in the infrastructure sector.

2.1.1. Sustainable public procurement

In the climate agreement of Paris, 195 countries agreed to limit global warming to well below 2 degrees. This requires a rapid change in energy supply, mobility systems, industries and use of materials. It thus requires every organization and sector to take steps towards climate-neutral operations. According to PIANOo (2016), a significant reduction in greenhouse gas emissions can be achieved in the own organization and in others with sustainable PP. However, sustainability entails more than environmental aspects. The United Nations General Assembly defines sustainable development as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (Emas, 2015. P1). Sustainable PP should thus entail more than applying environmental criteria in a specification.

Public procurement is a demand side policy instrument, which aims to change the behaviour of actors throughout all levels of society. It is an instrument to spend tax money properly; to stimulate the business sector through the purchasing process to develop and deliver products and services; to contribute to policy objectives; and to set a good example to other contracting authorities (Rijksoverheid, 2015; RIVM, 2018). According to Chao-Duivis et al. (2013, P135) “Procurement law is the pre-contractual law between government bodies [...] and tenderers. The aim of regulating this traffic is to give everyone a fair chance on the large government market.” During the procurement process, the procurer awards a contract to the tender that is most suitable for the project. There are three pillars: boundary conditions, selection criteria and award criteria (Chao-Duivis et al., 2013), consisting of various principles to ensure a fair process when awarding contracts (Ministry of Economic Affairs and Climate Policy, 2016). These principles focus on equality, transparency, proportionality, competition, the obligation to state reasons, and the protection of legitimate expectations. The contracting authorities are the state, municipalities, provincial authorities, waterboards, and bodies governed by public law (Chao-Duivis et al., 2013). Tenders can be everyone, dependent on the procedure. Public procurement is thus a particularly complex contract, as policy processes are always context dependent (Loorbach, 2010; Uttam and Roos, 2015). Inclusion of social and environmental criteria in these procurement processes is therefore very difficult.

Sustainable PP is defined as the inclusion of social, environmental and economic requirements in the process to change actor behaviour (Oruezabala and Rico, 2012; Bratt et al., 2013; Rijksoverheid, 2015; RVO, 2018). Its focus is on achieving goals for sustainable development through the purchasing and supply process (Oruezabala and Rico, 2012; Uttam and Roos, 2015). According to RVO (2018), realizing sustainability or social goals starts with policy making and ends with purchasing, and demands attention, knowledge and the right interventions throughout this process. Creating awareness and demand for environmentally and socially conscious products and services are therefore important factors of sustainable PP (Steurer et al., 2007). “[Sustainable PP] can consider an umbrella of issues, including health and safety at work, international labour standards, the fight against illegal and child labour and the ethical procurement of raw materials as well as human rights, philanthropy and community.” (Uttam and Roos, 2015).

According to McCrudden (2007), governments see procurement as a method of providing incentives to companies to adopt Corporate Social Responsibility (“CSR”), by putting requirements in the tenders. “[CSR] aims to better integrate social and environmental concerns into business routines on a voluntary basis.” (Steurer, 2010) Organizations can realize this by for instance incorporating ‘People, Planet, Profit’ (Triple P, or Triple Bottom Line). Both CSR and public procurement became more associated with sustainable development over time, which eventually led to the development of i.a. sustainable procurement (McCrudden, 2007). The instrument sustainable PP should thus ideally foster CSR.

Preuss (2009) states that the public sector can and must contribute to sustainability from a number of considerations. Governments are able to influence sustainable developments because of their size and steering power. With an average of 12% of the purchasing trend (of Gross domestic product (GDP)) and 29% of total government expenditures in OECD countries, public procurement has the potential to make an important contribution to the realization of government policy goals (OECD, 2018). Moreover, the government can develop more in the direction of sustainable supply chains and thus play an exemplary role (Brammer and Walker, 2011; Meehan and Bryde, 2011; Testa et al., 2012). According to Thai (2001), realization of sustainable objectives starts with defining a sustainable purchasing policy with clear guidelines and objectives.

2.1.2. Sustainable public procurement in the Netherlands

In the Netherlands, two organisations are working together on sustainable PP on behalf of the Dutch government: RVO (Rijksdienst voor Ondernemend Nederland) and PIANOo. PIANOo offers various guides, advice documents and practical examples on the basis of which sustainability conditions can be included in the tender. However, the concept sustainable PP remains unclear: The knowledge that sustainable PP is more than just applying sustainability criteria in specifications and calls for a behavioural change of both purchasing and internal clients of purchasing is not widespread yet (RVO, 2018).

The aim of the collaboration between PIANOo and RVO is to ensure that governments set a good example by aligning their own purchasing activities with the social goals that the organization has imposed on itself. Additionally, the SRP manifest has been introduced in the market and signed by most municipalities in the Netherlands (RVO, 2018). Specific themes of sustainability criteria have been linked to the social, ecological and economic aspects of this manifest (PIANOo, 2016).

Theme	Description
International social conditions	These are reflected in the working of international labor standards, such as the prevention of forced labor, slavery, child labor and discrimination.
Social return	This includes creating extra workplaces, work experience places or internships for people with a distance to the labor market. The target percentage is often 5%.
Environmentally friendly purchasing	This can contribute to energy saving, reduction of greenhouse gas emissions and the transition to renewable energy.
Bio-based purchasing	This includes purchasing renewable and organic material, which means lower lifetime costs, lower CO2 emissions or good biodegradability.

circular purchasing	In the event of circular purchasing, the purchasing party guarantees that the products or materials are used again optimally in a new cycle at the end of the life or useful life. Crucial here is value retention of products and materials.
Innovative purchasing	Innovation can be realized by the government in two ways. They can purposefully challenge the business community to develop an innovative solution for a problem. Or it can offer space to market parties to offer a developed innovative solution.
SME-friendly purchasing	This means that there are no obstacles to participating in tenders for SMEs, such as disproportionate or unclear suitability requirements, or high administrative burdens.

Fig. 1. Themes of sustainability criteria. Adapted from: PIANOo (2016)

In addition to the supporting instruments RVO and PIANOo offer one-to-one support via an expert pool, to further align supply and demand. These expert pools are created to focus on keeping the level of sustainability as high as possible during the process. They are aimed at awareness and action perspective of the organization with regard to sustainable procurement. With market consultations, the organization wants to discover what knowledge in the area of strategic sustainable PP is available on the market. Partly on the basis of the information received from this market consultation, the purchasing strategy and the form of the final tender will be determined. The target group for the infrastructure sector are decentralized authorities such as provinces, water boards, municipalities or organizations charged with carrying out a public task, that have signed the SRP manifest (RVO, 2018).

2.1.3. Public procurement in the infrastructure sector

Study shows that public procurement is a key economic activity of governmental organizations, as they spend approximately 45%-65% of their budget in public procurement (Bratt et al., 2013; Witjes and Lozano, 2016). The construction sector is one of the largest procurement categories for local government (Preuss, 2009; Jones, 2013; Uttam and Roos, 2015) and focuses on four different areas of work in the Netherlands, being infrastructure, utility, real estate, and housing construction. In the infrastructure sector in the Netherlands, most of the work is carried out on behalf of public tenders (Chao-Duivis et al., 2013). Due to the relevance and potential impact this study focusses explicitly on the infrastructure sector.

In the infrastructure sector, the traditional – or competition – procurement model is used most often. In this model, criteria for selecting tenders are mostly based on lowest price or most economically advantageous tender (MEAT) (Chao-Duivis, 2013). When the latter is the case, other criteria in addition to price can be considered (Witjes and Lozano, 2016), such as quality, technical merit, aesthetic and functional characteristics, environmental characteristics, delivery date and security of supplies (Chao-Duivis, 2013). However, there is no specific guidance for formulation of MEAT, which means the weighing for different aspects may not reflect their impacts (Hoezen et al., 2011; Uttam and Roos, 2015). To stimulate circularity and sustainability in the infrastructure sector, the Circular Economy

Implementation Program 2019-2023 states that there should be no restrictive, but stimulating laws and regulations (Rijksoverheid, 2019).

2.1.4. Effectiveness of sustainable public procurement

Many studies address the subject of public procurement, as it can be very useful in mitigating current grand societal challenges (Borrás and Edquist, 2013). However, literature does not focus on whether the policy instrument sustainable PP is fitting for taking away barriers in the infrastructure sector. Additionally, literature on the effectiveness of sustainable PP to foster CSR, or sustainability within organizations, is not consistent. For example, McCrudden (2007) states sustainable PP is an important instrument to foster CSR. Steurer (2010) on the other hand argues that public procurement initiatives are still a blank page regarding their effectiveness on CSR. This chapter elaborates on the take of different authors on these subjects, to understand better whether sustainable PP can contribute to taking away barriers in transitioning towards sustainability in the infrastructure sector.

Baden et al. (2009) raised some critical questions on the incorporation of sustainability requirements in procurement criteria. First, it is an extra administrative burden, which will increase the chance of tick-a-box, instead of real engagement of companies in CSR. This means that adding sustainability criteria in the public procurement process could result in mock compliance. Other companies could have genuinely changed their CSR quality, but don't have a quality image, while only the latter influences the awarding process. This means it can undermine internal drivers towards sustainability. Furthermore, the incorporation of sustainability requirements in procurement criteria can lead to the ceiling effect, which means that the set criteria may be seen as the ceiling instead of the floor criteria. Companies are not likely to increase their standards higher than the ceiling (Baden et al., 2009). However, companies are increasingly experiencing pressure from stakeholders such as consumer organizations, customers, suppliers, NGOs and governments and are therefore at risk of reputational damage (Carter and Jennings, 2004).

Moreover, a lack of dialogue, a lack of knowledge on what sustainability entails exactly, a lack of understanding of the complex interconnections between procurement activities, and the late and distant impacts of decisions are making transitioning to another socio-technological system a difficult process. Georghiou et al. (2014) argue that policy design overall lacks a 'clear theoretical or empirical basis for understanding how supplying to the public sector actually influences a firm's innovation capabilities and performance and in what ways desirable behaviour and outcomes can be promoted.' According to Preuss (2009) and Meehan and Bryde (2011), knowledge is an important condition for the effective implementation of public procurement and must be present and developed among those involved. A minimum level is required, in which, i.a. training can be provided (for example one-to-one support via an expert pool) (Walker et al., 2008). Additionally, external experts can be involved in sustainable PP projects to fill in gaps and to change procurement behaviour and processes (Grandia, 2015).

Even though guidelines for EU tenders and ratified laws and regulations exist, government institutions can individually add their own policy to put more or less pressure on sustainability in the tender (Bratt et al., 2013). Most of the tendering in the infrastructure industry is based on a competition model. According to Demaid and Quintas (2006), this does not necessarily stimulate the transition towards sustainability. The government is an important stakeholder and must continuously weigh several interests, such as healthy market competition and cost efficiency on the supplier side, but also stimulate innovation and employment for society (Telgen et al., 2012). However, the large costs (in time and expertise) are harder to bear for smaller firms, which increases discrimination against some bidders and thus isn't in line with the goals of a healthy market competition and cost efficiency (Baden et al., 2009; Bratt et al., 2013). 'For example, small businesses often experience greater barriers to engaging in socially responsible behaviour due to fewer resources in terms of time, money and expertise.' (Baden et al., 2009. p.431). According to Preuss (2009), mutual, transparent coordination of costs between budget holders is often a challenge for the internal organization.

It is not only the instrument mix that can form problems, but also the way these instruments are designed and implemented in a complex system (Borrás and Edquist, 2013). For instance, environmental concerns are discussed three times as often as social ones in literature focusing on public procurement (Oruezabala and Rico, 2012). A cause might be that selection of tenders on base of compliance with social issues is difficult, as these issues are often not related to the subject matter of the contract and are therefore not part of the selection criteria (Uttam and Roos, 2015). Specifying which matters can and cannot be stated as award criteria (as done by the Official Journal of the European Union) can thus hinder the incorporation of sustainability in public procurement (Uttam and Roos, 2015). According to Testa et al. (201), award criteria are however an effective means of enforcing sustainability in supply chains, but they should include more sustainable focused criteria. In 2016, the Dutch government adopted the Public Procurement Act 2012, which establishes guidelines for supplier selection in accordance with MEAT standards (PIANOo). The choice of criteria is left free, so that inclusion of sustainability criteria in public sector tenders is not guaranteed and / or self-evident.

Concluding, dialogue literature suggests there is a need for clear and proactive sustainable PP criteria. Through involvement of contractors, sustainable PP requirements "can form an essential element of the contractual framework for the environmental and social objectives to be met during project implementation" (Uttam and Roos, 2015. P.405). Dialogue is key in this process. Baden et al. (2009) suggest that a two-way dialogue, flexibility and freedom would have the biggest impact on the behaviour of companies.

2.2. Technological Innovation System (TIS)

The transformation towards a more sustainable society can be defined as a system innovation. System innovation is the change from one socio-technical system – consisting of various factors, including technology, cultural meaning, networks, infrastructure, markets, and regulation - to another. Innovation

policy can contribute to this change towards another socio-technical system, as it contributes to social objectives and helps organizations to increase their performance (Elzen et al., 2004). Various policy instruments exist which can help meet these objectives, including public procurement. However, for a successful transition, it is critical that the right policy instrument is chosen (Kemp, 2010; Borrás and Edquist, 2013; Wesseling and Edquist, 2018).

According to Hekkert et al. (2011. P13), the right policy instrument - to develop towards sustainability - should be based on “the identified structural cause for functional barriers in the innovation system.” Functional barriers are the barriers that hamper functional fulfilment. This fulfilment of the functions is needed for the transformation towards another socio-technical system. However, the structural cause for these barriers should be identified in order to choose the right policy instrument. In this case, the TIS framework can help to identify whether the already implemented policy instrument sustainable PP is an effective instrument for stimulating function fulfilment in the infrastructure industry.

A TIS is the set of actors and rules which influence the course of technological change. Analysing a TIS gives insight in the structures and processes that support or hamper development of a system. Innovation systems always consist of the same elements: actors, institutions, networks, context and technology. The importance and size of these elements can be measured using indicators developed by Hekkert et al. (2011). However, how systems function is still completely context dependent. This can be measured by analysing seven system functions. Analysing the seven functions developed by Hekkert et al. (2011) in a specific context will provide an insight in how the system functions and what the structural cause is for possible hampering of development (Hekkert et al., 2011).

Subsequently, to indicate what hampers the transition towards sustainability in the infrastructure sector, the structure of the system (step 1 of Figure 2), the seven functions (step 3 of Figure 2) and the system failures (step 4) need to be analysed. According to Hekkert et al (2007), overcoming function barriers is necessary to fulfil the seven system functions, and thus successfully transitioning from one social-technical system to another. Focus of this research will therefore mainly be on step 1, 3 and 4 of figure 2.

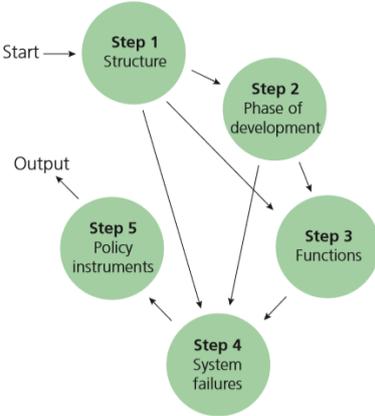


Fig 2. Schematic representation of the 5 steps in analysing a TIS for policy analysis. Hekkert et al. (2011)

2.2.1. Structure of the TIS

Step one of analysing a TIS, the structure, is important as it gives insight in the rules, actors involved, and interconnections in the system (Hekkert et al., 2011). The structure of the TIS system exists of five components. These are

- Actors, which are knowledge institutions, educational organizations, industry, market parties, governmental bodies and supportive organizations (Hekkert et al., 2011). The actors “act and thereby co-create not only products and technologies but also the institutional framework in which they function” (Klein Woolthuis, 2010);
- Networks, which are the relations and cooperation between parties (Hekkert et al., 2011);
- Institutions, which include formal and informal regulations such as politics, policies, legislation, norms and behaviour (Hekkert et al., 2011). According to Klein Woolthuis (2010) institutions are “conditions that are either specifically created by the actors, or have spontaneously evolved, that influence not only the functioning of individual actors, but also the system as a whole.”;
- Technological factors, which is the knowledge related to technology (Hekkert et al., 2011);
- External factors, this is the context of the TIS (Hekkert et al., 2011).

2.2.2. System functions in the infrastructure sector

Step three, analysing the system functions, gives an insight in where barriers potentially lie. Identifying where in the system certain barriers lie, gives an insight in the structural cause for the barriers, step four of analysing the TIS (Hekkert et al., 2011). This creates the opportunity to remove or improve them (Hekkert et al., 2011; Borrás and Edquist, 2013).

System functions

Different innovation systems have different functioning components. Evaluating how these innovation systems function exactly is a key process of innovation systems. Identifying different function barriers to effectively move towards sustainability in the infrastructure sector is important for formulating policy recommendations which stimulate function fulfilment. Researching which system function blocks the further development of the Innovation System is a necessary step for doing this (Hekkert et al., 2011). To learn which functions are problematic, indicators and diagnostic questions (Appendix 10.A) can be used when analysing the functioning of the system. Scoring each function on a 5-point Likert scale shows which system function hinders system development.

Function	Definition
Entrepreneurial activities (F1)	Presence of active entrepreneurs as a prime indication of the performance of an innovation system. To turn the potential of new knowledge development, networks and markets into concrete action to generate and take advantage of business opportunities.

Knowledge development (F2)	Activities that add to the creation of knowledge through processes of learning e.g. learning by searching, learning by doing
Knowledge diffusion through networks (F3)	Activities that lead to exchange of information. Also through learning by interacting and learning by using in networks
Guidance of the search (F4)	Refers to those activities within the innovation system that can positively affect the visibility and clarity of specific wants among technology users
Market formation (F5)	Involves activities that contribute to the creation of a demand or the provision of protected space for new technologies, for instance by the formation of temporary niche markets for specific applications of the technology by governments.
Resource mobilization (F6)	Activities that are related to the allocation of basic inputs such as financial, material or human capital for all other developments in TIS
Creation of legitimacy (F7)	Activities that counteract resistance to change or contribute to taking a new technology for granted

Fig. 3. Overview of TIS functions. Adapted from Musiolik and Markard (2011) and Hekkert and Negro (2009)

Functional barriers in the infrastructure sector

Defining the major function barriers in the transformation towards more sustainability in the Dutch infrastructure sector is a necessary step in analysing the Innovation System. There are various factors that can form a function barrier in the infrastructure sector. Most of these barriers can be covered by the seven system functions listed above, such as a lack of dialogue, competition, cost inefficient processes, institutional inertia, resistance to change and a lack of knowledge, resources, and expertise (Brammer and Walker, 2011; Meehan and Bryde, 2011; Bratt et al., 2013; Grandia, 2015; Uttam and Roos, 2015). A lack of experience in changing business models can also be an important barrier according to Witjes and Lozano (2016), as it is a necessity for changing towards sustainability. In addition, literature describes the cost aspect to explain the slow development of sustainability in the sector. According to Edler and Fagerberg (2017), the often used structured selection processes might stimulate economic efficiency, but can also lead to path dependency. Cost efficiency in purchasing is very important; the profit must exceed the costs, as governments have the task of dealing with tax money as efficiently as possible and accountability is becoming increasingly important (Brammer and Walker, 2011). The focus on costs is a clear measure of whether or not a construction company is suitable. However, sustainability is much more complicated, as it consists of many components. It is therefore difficult to replace the focus on cost to a focus on sustainability. In addition, the operationalization of the concept sustainability in organizations is experienced as complex, and the communication about it between organization and purchasing department is difficult. Defining and measuring sustainability contributes to knowledge and willingness to change (Meehan and Bryde, 2011). Organizations must be able to change standard

processes and procedures and to convert this into adapted behaviour and possibly new criteria in tenders (Grandia, 2016).

Uyarra et al. (2014) listed various important barriers and challenges for the stimulation of innovation in the construction sector (Figure 3), many of which correspond to aspects which are needed for a functional innovation system. Innovations include “all societal, technological, institutional, and behavioural practices that introduce or operationalize new structures, culture, routines, or actors.” (Loorbach, 2010. P170). These stimulate the transition to sustainability.

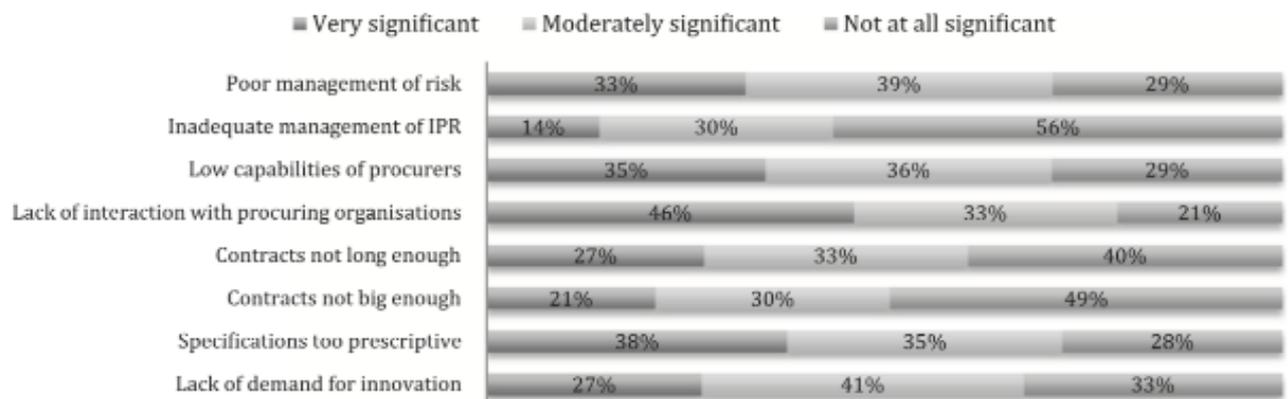


Fig. 4. Barriers in the construction sector. Uyarra et al. (2014)

2.2.3. Structural cause for functional barriers

The identified barriers can be divided in different structural components, in accordance with the TIS framework (Hekkert et al., 2011): Actors, Networks, Institutions, Technology, and Context. Each of the components contribute (or do not contribute) to fulfilling a certain function (key process). Consequently, for each system function it can be defined which components are not sufficient. When system failure occurs due to functional barriers, innovation activity hampers (Edler and Fagerberg, 2017). Knowledge on the relation between cause and barriers, and on the effects of the structural components on the functioning of the system, gives insight in why the system fails. Policy instruments can be used to remove and improve the functional barriers in the innovation system, however, which one is the right fit depends on the structural cause for functional barriers and the goal of the policy. The latter is an important factor for interpreting the results, as the focus of the policy goal has a major effect on the evaluation of how the TIS functions (Hekkert et al., 2011). Developing a sustainable procurement policy with clear guidelines and objectives is an important first step according to Thai (2001), and the success of the procurement process is then partly dependent on the application of the policy and the will to realize the goals set in it. “If the government develops policy to improve and facilitate the functioning of the TIS, then the new policy will be included in the structure which will influence the functioning of the system” Hekkert et al., 2011. P12).

In this research, the infrastructure sector is considered a TIS. Following literature, there are many barriers in this system. Whether the policy instrument sustainable PP is useful to affect all TIS functions

is researched in this study. Governments are able to influence sustainable developments because of their steering power. In theory, it is possible to take away barriers in the transition towards sustainability. However, according to Grandia and Meehan (2017), public procurement lacks a certain degree of maturity to show impact and success. This suggests that the policy instrument may not be the solution to all functional barriers in the infrastructure sector. The expectation is that public procurement addresses some barriers better than others. Analysing the TIS and identifying the structural causes for functional barriers will provide clarity about this (Hekkert et al., 2011).

3. Methods

This section elaborates on the methods of data collection and analysis to research to what extent the demand-side policy instrument ‘sustainable public procurement’ is steering system transformation by effectuating change in the infrastructure sector in the Netherlands. This contributes to knowledge on to what extent such demand-side policy instruments contribute to taking away barriers in the transition towards sustainability. This thesis addresses the following research question and sub questions: *To what extent does sustainable public procurement contribute to taking away barriers in transitioning towards sustainability in the infrastructure sector?*

- What are the barriers in the transition to sustainability in the infrastructure sector?
- How does the current sustainable public procurement model (the *traditional* model) contribute to taking away these barriers?

This thesis researches human actions within the larger social contexts and structures in which they take place. The approach is aimed at acting actors, who are not only influenced by their organizational, social and institutional context, but who themselves also influence these contexts to bring about change (Nicolini, 2009). Conducting research into practices means paying attention to this interaction with the context (Nicolini et al., 2004). To get a good insight of the practice, a research approach is needed with which this practice can be uncovered and analysed. A qualitative study offers this possibility.

This thesis uses a mixed approach of data collection via extensive literature research and in-depth semi-structured interviews, which are necessary to understand the interactions and complex interconnections of societal systems (Bryman, 2008). Questions used during the interviews are included in Appendix 10.B. (in Dutch). Additionally, several workshops and events are attended and analysed to get a more comprehensive picture of the sector. The following section will explain methods of data collection, the sample, operationalization and analyzation of data from the interviews, workshops and events.

3.1. Data collection and sample

Following literature, many stakeholders are involved in the public procurement process in the Netherlands. Based on the idea of Hekkert et al. (2011. P9), “the functioning of an innovation system

needs to be assessed by experts or key stakeholders that are active in the innovation system”. Therefore, to form a strong basis for analysing results, all parts of the system must be included in the research process. Important stakeholders, i.e., contracting parties, contractors, consulting parties, are considered when collecting data and, if necessary, are interviewed. To get a clear overview of sustainable PP in the Dutch infrastructure sector, interviewees are chosen based on their knowledge on the subject. The public procurement experts are consulting parties and a contracting party which deal with public procurement on a daily basis. The contractors are people in the infrastructure sector that are specialised in doing multiple tenders a year, are involved in various construction teams and participate in knowledge sessions. This contributes to knowledge on different aspects of the TIS. The workshops and events are included in this study to get a more comprehensive overview of the current situation relating sustainable PP in the infrastructure sector. By attending events and workshops, data from various other parties – such as developers, entrepreneurs, sector specialists - are included in this study as well.

The data collection consists of multiple steps. Figure 5 shows an overview of the interviews and anonymized contacts.

What:	Who:	Description:
Interviews	2 consulting parties	Two consulting parties, specialised in public procurement in the infrastructure sector, particularly in Rapid Circular Contracting (RCC)
	4 market parties	One infrastructure company which started in 2010 and has over 600 employees One construction company, which exists 160 years. This company has over 2500 employees and a large infrastructure department One infrastructure company with 250 employees. They exist around 60 years. One construction company with an infrastructure division. They exist 20 years and is located in multiple cities. Some locations are very small.
	1 contracting party	A big contracting party, focusing on Ground, Road and Hydraulic Engineering (GWW) (infrastructure)
Workshops	3 Community of Practice’s	Multiple stakeholders discuss sustainable PP and their (changing) role in the process. Attendees are infrastructure companies, contracting parties, developers, sector specialists.
	5 workshops Rapid Circular Contracting (RCC)	Contracting parties (municipalities) discuss new forms of public procurement which are less structured and have more dialogue, and their changing role in this process.
Events	Building Holland 10th of April 2019	Innovations are pitched by entrepreneurs to large infrastructure companies to stimulate innovation and sustainability.

Fig. 5. Interviews, events and workshops.

First, extensive literature research provides an overview of the infrastructure sector and public procurement. Additionally, it gives an insight in the main barriers that prevent development towards a sustainable infrastructure sector. This thus helps to answer the first sub question. After the literature study, interviews are conducted with the infrastructure sector experts and contracting parties (see Appendix 10.B.). These are semi-structured interviews, to give room for explanation and to create opportunity to go deeper into important and specific elements. It also ensures that the interview stays in the scope of the research (Bryman, 2008). To collect data about the structure and organisation of the system, in-depth interviews are held with public procurement experts. Conducting semi-structured interviews has proven to be an effective way to collect data in various other public procurement studies (Oruezabala and Rico, 2012; Bratt et al., 2013), infrastructure sector studies (Hartmann et al., 2014), and TIS studies (Hekkert and Negro, 2009, Musiolik and Markard, 2011).

The interviews can validate the literature study on most common barriers in the infrastructure sector. In addition, it gives an insight in where the structural cause for these barriers lies and it provides a better understanding on whether or how the policy instrument sustainable PP contributes to taking away these barriers. The interview questions are based on the seven system functions, indicators and diagnostic questions for analysing the functioning of Innovation systems of Hekkert et al. (2011) (Appendix 10.A). According to Hekkert et al. (2011, P9) “[..] the best way to assess the functioning of the innovation system is by involving a sufficient amount of experts in the evaluation by asking them very specific diagnostic questions, whether the amount of activities are sufficient and whether they form a barrier for the innovation system to further develop and move towards the following phase of development.” Furthermore, the attended workshops, community of practice’s and events give an insight in the role of various stakeholders in the public procurement process, and how their role is changing as a result of increasingly including sustainability. Different forms of public procurement are discussed, which gives insight in the thoughts and perspectives on both the ‘traditional model’ and new models and processes.

Based on the collected results, figure 6 will be filled in. The Likert Scale is used in accordance with the TIS framework. Doing this gives an indication to what extent the interviewees agree with whether the seven functions hamper the transition towards sustainability in the infrastructure sector. Using the scores from figure 6, figure 7 can be filled in. This figure visualizes whether the barriers in this function hamper the transition towards sustainability in the infrastructure sector

Functions and indicators	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
F1 - Entrepreneurial Experimentation and production	○	○	○	○	○
F2 - Knowledge Development	○	○	○	○	○
F3 - Knowledge exchange	○	○	○	○	○
F4 - Guidance of the Search	○	○	○	○	○
F5 - Market Formation	○	○	○	○	○
F6 - Resource Mobilization	○	○	○	○	○
F7 - Counteract resistance to change	○	○	○	○	○

Fig. 6. Functions and indicators. Based on Hekkert et al. (2011)

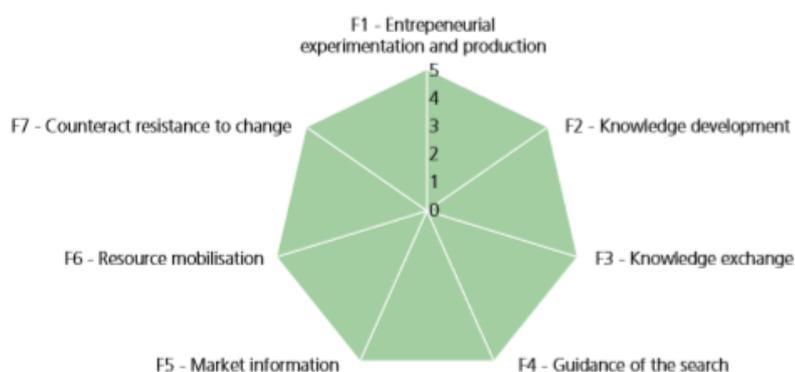


Fig. 7. Seven system functions. Hekkert et al. (2011)

Hekkert et al. (2011) describe how to best analyse the functions of the TIS framework. For most functions, they suggest mapping certain numbers. For instance, for function one they suggest mapping ‘the number of new entrants, the number of diversification activities of incumbent actors, and the number of experiments with the new technology’. For function two, ‘the number of R&D projects, patents, and investments in R&D’. Taking this study is based on semi-structured interviews, these numbers are not mapped. However, according to Hekkert and Negro (2009), “the quantitative exercise is largely intended to strengthen a basically qualitative argument rather than presenting a statistically valid argument by itself.” The interviews, workshops and events will give a good insight in the innovation system on a qualitative level.

3.2. Operationalisation

Following concepts are operationalized from the theory:

- **Corporate Social Responsibility:** “[CSR] aims to better integrate social and environmental concerns into business routines on a voluntary basis.” (Steurer, 2010) Organizations can realize this by for instance incorporating ‘People, Planet, Profit’ (Triple P, or Triple Bottom Line).
- **Public Procurement:** This is a demand side policy instrument, which aims to change the behaviour of actors throughout all levels of society. Social, environmental and economical

social aspects can be included in the purchasing and supply process. (Oruezabala and Rico, 2012; Bratt et al., 2013; Uttam and Roos, 2015; Rijksoverheid, 2015).

- **Sustainable Public Procurement:** Procurement process in which social, environmental and economical requirements are included in the process. The focus is on achieving goals for sustainable development through the purchasing and supply process (Oruezabala and Rico, 2012; Uttam and Roos, 2015). Sustainable PP is most close to the ‘traditional model’ mentioned by Choa-Duivis et al. (2013). This model is mostly used in the infrastructure sector and uses strict requirements in its tender.

3.3. Data analysis

Extensive data analysis is conducted aimed to describe the barriers in the infrastructure sector in the Netherlands to move towards sustainability, and to argue whether the current use of the policy instrument sustainable PP contributes to taking away these barriers. First literature on these subjects is collected and analysed. Following data collection from literature, interviews, workshops and events, all interviews are transcribed and coded using the program NVivo (software to analyse qualitative research data). The observations of the workshops and events are elaborated in observation reports which are also coded with NVivo. The created codes are linked to the TIS-theoretical framework. In other words, the functions of the TIS-framework are used for the coding scheme. Other codes are also created to give room to data that cannot be linked to the functions, but are important nevertheless. Next, I carry out triangulation using literature and public reports to validate the data set and answer the research question.

As it is preferred by some interviewees, information on the interviewees remains anonymous. This has no consequences for the presentation of results in this thesis.

4. Results

As mentioned in the theoretical framework, knowledge on the relation between cause and barriers, and on the effects of the structural causes on the functioning of the system, gives insight in why the system fails. Policy instruments can be used to remove and improve the functional barriers in the innovation system, however, whether sustainable PP is the right fit for this transition depends on the structural cause for functional barriers. The focus on the transition towards a more sustainable sector is an important factor for interpreting the results, as the focus of the policy goal has a major effect on the evaluation of how the Innovation System functions according to Hekkert et al. (2011).

Collecting data in different ways generated a good insight in the policy instrument public procurement. The infrastructure sector is a complex one, and perspectives on the role of sustainable PP in this sector are diverse. The following points emerged from the workshops and events: There is a lot of uncertainty about how public procurement processes might change in the near future, which puts people out of focus. In addition, many people in the industry have many insecurities regarding their knowledge on sustainability and circularity. Interviews indicate past events keep market parties and contracting

parties from trusting each other completely, which hampers knowledge exchange and flexibility in the procurement processes.

The workshops and events also showed how much sustainability is already woven into the sector. Every stakeholder - municipalities, governments, contractors and other companies - know that sustainability will play a big role in the sector and in their organization now and in the future. In-depth interviews confirmed these findings and gave insight in why certain things are what they are. For instance, expected findings were that the infrastructure sector is money driven and there is resistance to change. An interesting finding from the interviews was the lack of trust in the entire sector, and what consequences this brought. The collected data gives a good indication of what the barriers in the transition to sustainability in the infrastructure sector are, and what the role of public procurement is in this transition.

Based on the collected results, figure 8 is filled in. Doing this gives an indication to what extent the interviewees agree with whether the seven functions hamper the transition towards sustainability in the infrastructure sector. Some functions have more than one bullet, because opinions about whether these functions hamper the transition towards sustainability vary too much.

Functions and indicators	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
F1 - Entrepreneurial Experimentation and production.	○	●	○	●	○
F2 - Knowledge Development	○	○	○	●	○
F3 - Knowledge exchange	○	●	○	○	○
F4 - Guidance of the Search	○	○	○	○	●
F5 - Market Formation	●	○	○	○	○
F6 - Resource Mobilization	○	●	○	●	○
F7 - Counteract resistance to change	○	○	○	●	○

Fig. 8. Functions and indicators, results of the interviews, workshops and events

Using the scores from figure 8, figure 9 is filled in. This figure visualizes which system function hampers the transition towards sustainability most. The figure shows that *Guidance of the Search* is the biggest bottleneck, which suggests that the policy instrument public procurement can play a big role. The collected data will be elaborated on below.

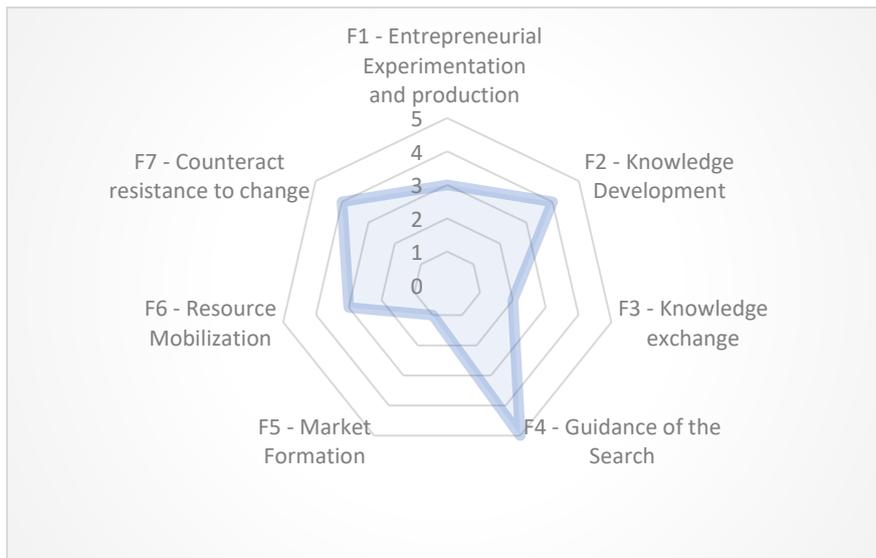


Fig. 9. Seven system functions, results of the interviews, workshops and events

4.1. Structure of the TIS

Many actors are involved in the process of sustainable PP in the infrastructure sector. Three main groups have been identified during the interviews, workshops and events. First are the contracting parties, which are governments, municipalities and other governmental parties like the Dutch Ministry of Infrastructure and Water Management. Second are the tendering parties, which are mainly contractors. Third are consulting parties, who can be governmental parties or the contractors, but can also be third independent parties. The contracting party, or governmental party, is the one that designs and publishes the tender. Various contractors can sign up for this tender, from which one will be the winner. The consulting parties can be present before and during the procurement process to guide the process. These parties organize knowledge groups, in which various parties can participate, to share and spread knowledge.

Results show that the role of governmental parties is very large, as they are the one that design and publish the tender. According to the interviewees, this means they have a lot of power to steer the market in the desired direction, as they can decide the focus of the tender and the budget that is available. Subsequently, the contractors are dependent on the choices of the contracting parties. Even though this is the case, contracting parties argue that the contractors have the opportunity to educate the government on what they think is important. However, these opportunities are limited, as the tendering process should be an impartial one. The consulting parties can therefore play a connecting role as they often have much knowledge on both the needs of the contracting and the tendering parties. They argue that they use this to make the (knowledge) gap between the other parties smaller, by organizing events, workshops, communities of practices and guiding the different parties during the process.

An important finding is that the relation between the contracting and tendering parties is difficult, as it is not always clear where responsibility of the results lies. At the same time, trust is lacking, which is not stimulating innovation and sustainability. Due to past happenings, this trust will be hard to

establish once more according to several parties. However, the parties involved are aware that this trust is necessary to make more room for innovation in the procurement process. Currently, the traditional public procurement model, most often used in the infrastructure sector, is bound to a couple of rules. Within the boundaries of these rules, there is room for a lot of innovation according to the contracting parties. However, to eliminate all risks and to make sure nothing is left to chance, the contracting parties make more (unwritten) rules to which the contractors should adhere to. According to the contractors and consulting parties, doing this reduces the room for innovation (see figure 10). This shows that there is an opportunity for innovation and therefore sustainability to grow in this sector. However, that will ask for behavioural change of all parties.

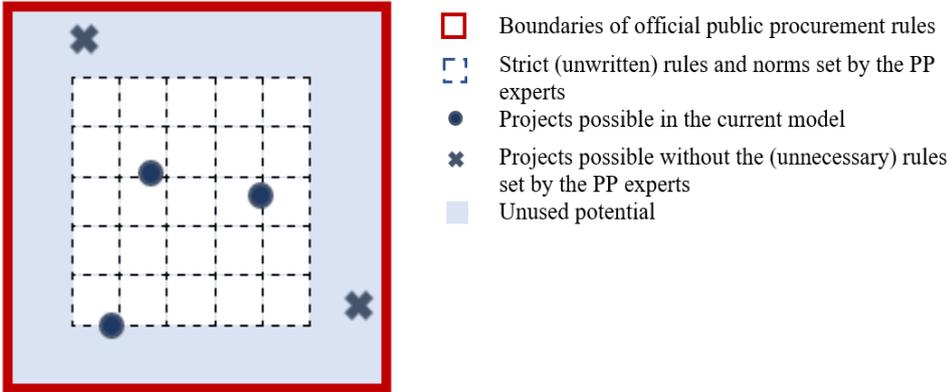


Figure 10. Visual representation of room for innovation in the public procurement (PP) process.

4.2. Functional barriers in the transition towards sustainability

4.2.1. Entrepreneurial Experimentation and production

Innovative power

Opinions on the innovative power of infrastructure companies vary. First, not all infrastructure companies have the same amount of innovative power. Innovating and keeping up with the developments is especially difficult for smaller contractors according to the interviewees. These small companies do not have the resources to have a big R&D department, and can thus not keep innovating without support or a clear structure. Secondly, procurement experts are a bit hesitant about innovation in the infrastructure sector. They argue there is a lot of creativity and innovative power in the market, but that contractors do not do much without being steered in the right direction. It is stated that the infrastructure sector is still a fairly conservative sector.

“The infrastructure sector, despite all good intentions, is still a fairly conservative sector in the end.”

Innovation stimulation in the sector

According to the consulting parties, two thirds of the tenders is still being tendered in the traditional way, mostly because that is how everyone knows how to do it. However, this traditional way of tendering

– using the competition model - slows down innovation and sustainability, according to several parties. Within this traditional setting, where everything is determined in advance, contractors find it a difficult that there is little room for their ideas and products. An often mentioned model is ‘co-creation’, which is said to be the way to stimulate innovation and creativity. However, co-creation is based on trust in projects, which is currently not present. According to market parties ‘completing a tender is like have a colouring page with thick contour lines. And the lines have numbers in it, so everyone knows how to colour it in exactly.’ This has little to do with innovation and sustainability.

In addition, companies have to consider their return on investment when they subscribe to a tender. As the revenue model in the infrastructure sector is very low, it means that there is little room to innovate. That has to do with the expenses of the procurement process. At the same time, contracting authorities do not learn how to create more room for innovation in their tenders.

“Our company completely relies on tenders, and the pressure that we have to have that work is always a lowest-price competition. At the same time [the government] asks us to invest in sustainability. That is at odds with each other.”

According to the consulting parties, about 99% of the infrastructure is from public parties. This means that tenders which stimulate innovation can have a great impact in transitioning to a more sustainable market. For this to happen more, public organizations need to pursue a policy that continuously raises the lower limit for companies to innovate. Consulting parties state that innovation can be stimulated at the same time as using it as an argument that something is possible technologically. Dialogue is crucial in this process. Even though it is not a problem according to some parties, a number of contractors will drop out as a result of this, what needs to be an everchanging, policy. Zooming in on the technical process of tenders, a lot of elements can ensure that there is more room and that innovation is created there as well according to several parties.

“The word dialogue is crucial.”

Due to the divergence of opinions on whether the barriers in this function hamper the transition towards sustainability in the infrastructure sector, both boxes ‘agree’ and ‘disagree’ are ticked in figure 8. In order to fill in figure 9, the average of this is taken, and the function is rated ‘neutral’. The barriers in this function are related to the institutional component of the TIS structure, which are the formal and informal regulations, such as behaviour and norms.

4.2.2. Knowledge Development

Knowledge development in the market

Market parties and procurement experts agree that there is a lack of knowledge development in the market. To start with, is very difficult to develop knowledge for small contractors. They have to ensure they have a specific expertise to stand out and need to be very flexible. That is the only way to distinguish

themselves. The same applies to small municipalities, as most municipalities have to organize knowledge on their own. When all they can afford is a small team, working with RAW specifications (Rationalization and Automation Ground, Water and Road Construction: a standardized method for making infrastructure specifications), it will be very hard to change. For large or medium-sized contractors it is much easier to develop knowledge, as they have the resources for it.

Stimulation of knowledge development

Contracting parties state that the market often asks for innovation and learning space. They try to obviate this by reserving a budget in the project budget and include a separate post ‘learning space’. However, there is too little knowledge in the government on sustainability, circularity, innovations and different models of procurement to educate the market, according to market parties. In addition, interviews and workshops indicate that procurement experts are anxious and see many problems ahead when anything needs to change. This means that currently, government is not able to stimulate knowledge development everywhere in the market. With the right stimulation of the government, this shouldn’t have to hamper the transition towards sustainability in the sector in the future.

This function hampers the transition towards sustainability in the sector as there is a lack of widespread knowledge on important aspects, such as the concept sustainability itself. This relates to the actor component of the TIS structure, which are among others knowledge institutions, educational organizations, and supportive organizations.

4.2.3. Knowledge exchange

Market consultations and knowledge sessions

Several ways of knowledge sharing are used in the Dutch infrastructure sector. By reviewing and using old tenders from other municipalities and provinces, a lot of knowledge is gained from colleagues. However, the main source of knowledge exchange in the market and between parties is during knowledge sessions. There are many of these sessions organized, according to all interviewees. These are organized by BouwendNederland, PIANOo and various consulting parties in the Dutch infrastructure industry. However, these initiatives within existing networks is still very limited. For instance, the level of cooperation and knowledge exchange between municipalities is still very low, even though this is increasingly happening. According to consulting parties, municipalities do not have a good approach when it comes to knowledge sharing. This has as a result that various municipalities need to re-invent the wheel regarding procurement processes. Continuous sharing between the authorities would be very helpful. Many contracting authorities come across the same things, but hardly ever really share content.

“It is a process of change, which is just very difficult.”

Market parties believe they are involved far too late in the process. This is obviated by contracting parties by experimenting early market consultation, in which they put parties together at an

earlier stage. According to the purchasers in the workshops and the interviews with the contractors, many companies find market consultation an interesting way to exchange knowledge, as information on sustainability, circular economy and innovations is provided, the market is challenged and ideas are exchanged. In addition, knowledge sessions help with translating the question and purpose into the outsourcing question. However, according to some market parties, these market consultations and knowledge sessions are still in the beginning phase. There are too many consultations which provide too little specific (product) information. 'For example, there is no knowledge session about making sewerage systems circular. It is all going about an abstraction level, about the general concept of sustainability.' Consulting parties agree with this and argue that in information meetings the main points of a project are shared in a short presentation, which means they cannot really go into the depths there. Real expert sessions in which an entire tender is discussed would be very interesting according to multiple market parties. Such sessions are organised according to the contracting parties, however the market parties seem not to be familiar with them.

Workshops and communities of practice

In addition to knowledge sessions, various workshops are organized by contracting parties. They create practice groups to inform the market about various instruments (for instance Dubocalc, which is a software tool to quickly and easily calculate the sustainability and environmental costs of GWW projects (ground-, roads-, and hydraulic engineering, or infrastructure)). During these workshops clients exchange ideas about what they encounter when using the instrument. Additionally, Community of Practices have been initiated by the municipality on sustainable infrastructure (Greendeal sustainable GWW). However, companies are hesitant to exchange ideas on innovations and there is still a lack of knowledge on circularity in the market.

“Public procurement doesn’t give enough space to look at all options and to use knowledge and experience of companies optimally.”

Consulting parties believe there is a role in training to better regulate the process and the retrieval of needs in the organizations. Knowledge should be exchanged on how to go through the procurement process without falling into technical specification; because only then the right space for innovation can be offered.

Currently, this function is not hampering system transformation. Much knowledge is shared in various ways in and between organisations. However, without the right steering from the government, knowledge sharing as it is currently done will not fulfil the needs of organizations in the future. This can be linked to the network component of the TIS structure, as the barriers are related to the relations and cooperation between parties.

4.2.4. Guidance of the Search

A lack of shared vision on how the industry and market should develop

There is not yet a shared vision to move towards sustainability in the infrastructure industry. During the interviews, it became clear that in some governmental organisations, the contracting parties, only a small group of 10 to 15 people focus on sustainable procurement. Many other purchasers do not have a clear idea of what sustainability and the Sustainable Development Goals (SDGs) entails exactly. Purchasers argue that any sector that wants to transition towards sustainability would benefit from investing in more knowledge on sustainability and circularity.

“People Planet Profit lacks one P in my opinion: Passion. Sustainability is not a trick, it must come from the heart. It is way of life.”

The infrastructure sector is not yet where it should, and can, be. The sector is very much money-driven, which means that whoever offers the cheapest service gets the offer, which is often not the best offer regarding to sustainability. In addition, there is little or no attention to quality or total cost of ownership (the total amount of costs for owning a product or using a service during the life cycle or usage cycle). It is very clear that the government is struggling with this. A counter-movement to this money-driven focus is needed, according to market parties. They state that this should be a wakeup call for the municipality, government and Dutch Ministry of Infrastructure and Water Management.

In addition to a lack of knowledge on sustainability and circularity, there is also a lack of knowledge on which procurement process model the market should focus on. Some parties use the Rapid Circular Contracting method (a circular procurement model), some MKI (Environment Costs Indicator value), some EMVI (Most Economically Advantageous Tender), some steer on EURO6 (a vehicle emission standard), some on reuse. The diversity in which clients outsource their sustainable demands means that the market no longer knows how to invest in their organizations.

“The fragmentation at which government sets out tenders creates a huge division and ensures that the market does not progress. Because we don’t know what to focus on.”

A lack of shared vision on where responsibility for the consequences of a project lies

There is a way to ensure that the infrastructure sector is more encouraged to innovate more, according to the infrastructure companies. For that to happen, the whole process must be addressed however. The more the transition in tenders is made from prescribing a RAW specification to a functional description (describing the requirements that a product or service must meet, without restricting the freedom to come up with innovative ideas), the more space for innovation is created. Market parties argue that, in

“The consequences of not fulfilling your promises in your tenders are far too low.”

the ultimate case in the infrastructure sector, it does not matter which innovations are used precisely for the procurement process: it should be about fulfilling the function or service of the product. With this, room for innovation is created, and simultaneously the person who introduces a particular innovation is made responsible for the result. What happens now is that everything is described very explicitly in the tender, and in this explicit description, an attempt is made to create space for innovation. But, the consequences of whether the projects are going well, now lie entirely with the contracting party.

It is currently not clear where responsibilities lie, even though many stakeholders agree that this should lie with the contracting parties. For market parties, it is now mainly about making a lot of money, which can be done by using worthless material that will be broken again in five years' time. The material then has to be removed by these same contractors, after which they again use new material. Contractors often know that this is bound to happen beforehand, because the tenders are set on a specific question. Monitoring that this process is optimized can be done by municipalities and governments, as they create

“The responsibility for the results of the innovation should be given back to the owner of the innovation.”

the tenders. However, some believe that the responsibility to become more sustainable, and thus the responsibility of the innovation, does not lie with just one party but with everyone. According to one of interviewees (infrastructure company), there are five focus points that a project must meet to be successful. These are; confidence, neighborhood, co-creation, creativity and reciprocity. Doing things together, with the right motivation is necessary to change.

Collaboration and knowledge exchange as a way to share vision

The number of knowledge sessions and consultation groups in the infrastructure industry is quite high. Construction teams are also increasingly in demand, in which vision documents play an important role. In this document, contractors explain their vision on the project: for a company to win the tender, their vision should comply with the vision of the contractor. This is however not part of a traditional tender.

During the workshops, the importance of all parties agreeing on key performance indicators (KPIs) in the procurement process was stated. An important part is to make a risk analysis together to provide insight into what is an important risk for all parties, and how the risk (and by whom) can be mitigated or accepted. These aspects are included in the current (traditional) procurement process, however, purchasers worry that this will not be included when adopting a new procurement model in which more freedom and flexibility are embedded.

“Clarity and continuity of the buyer is a tremendous help. So, to make it very clear to the market; this is the course and this will continue to be the course in the coming years.”

Contracting parties encourage the market to move towards sustainability by having signed a number of covenants as major clients, including Greendal sustainable GWW, Greendal sustainable logistics in the infrastructure industry and Greendal ‘Het Nieuwe Draaien’, which is about equipment on the construction site. Many companies find that very interesting and have joined. In addition, the contracting parties provide information and try to challenge the market through their tenders.

According to consulting parties, there is a major task at CROW (knowledge partner for (decentralized) market, contractors and consultancy firms) to create a sense of urgency among organizations that they have to do things differently. This should be experienced through all layers; administrative, management, implementation, so everyone can become familiar with new forms of tendering when needed. The tricky thing is that the infrastructure sector is very bulky and conservative. A lot is allowed within the law; however, along the way the industry has interpreted the law in a certain way, which resulted in the fact that the sector now has strict limits. Why some of these strict limits exist is not clear anymore. In addition, the selection process exists to be a supporting tool, and not an end in itself. However, that is not always the way it is designed. Currently, the procurement rules are taken into account because it is the way it has always been done, instead of focusing on what the sector needs to achieve. Due to these unnecessary strict procurement rules and norms, the market is not stimulated to reach its full potential, according to the market parties. This means the procurement processes need to change, which requires that a lot of new skills need to be applied through the entire procurement law. And that demands a lot from the system.

Regaining trust

Currently there is little to no trust in tenders, according to the interviewees. Everything is strict and regulated because of the fraud incidents in the past. However, this process to transition towards a more sustainable sector cannot be done alone, which means parties need to work together, to co-create. Chain collaboration is needed for that, just as reciprocity and common sense. It is stated that “the best way to ensure that the contracting parties have the right knowledge and sit at the table with the right people is mission work: lectures and workshops that are organized by people and parties who really care about sustainability, and have an intrinsic motivation.” The trust that has been damaged in the past is slowly coming back, which means more tenders are already being co-created. Actors must work together because there is no single solution: there are too many variables in regard to sustainability. The parties involved in the procurement process must come to an interpretation based on all those variables, however, a condition for this is trust.

As there have been many lawsuits and real estate frauds in the past, it makes sense that there is a procurement right and that rules are strict. In addition, public money often used to be distributed through favouritism. That is no longer happening on a large scale, but that may happen more often if a more innovative way of public procurement is introduced. Anxiousness that this will happen again is now hampering the process to move towards sustainability.

In order to change the system towards a sustainable one, all parties need to change accordingly. This means that the internal operations of every organization need to change too. However, in the current traditional public procurement model, little to nothing has to be changed in the business operations of the contractors when sustainability requirements are included in a tender. How the currently procurement process is structured is therefore not a steering mechanism which will change anything according to several market- and consulting parties. According to purchasers participating in the workshops, the traditional model even encourages contractors to cheat the system. Companies can write a beautiful story on how they want to approach the project sustainable, however don't change a bit in real life. Adding more dialogue, and taking away the requirements and demands at the start, means there is less chance on 'mock compliance'. For this to work, the party, not the story should be chosen.

To summarize, it is clear that barriers in this function hamper the transition towards sustainability in the infrastructure sector. This relates to the institutional component of the TIS structure, as barriers focus mainly on policies, regulations, behaviour and norms. The network component is also an important one in this function. The data collected during interviews, workshops and events clearly show people agree that the effectiveness of public procurement on increasing sustainability in the sector is not very large.

4.2.5. Market Formation

According to several interviewees, workshops and events, the market is sufficient to develop. Some contracting parties are more hesitant and state that market parties are very keen to develop, however, they need more incentives. Consulting parties agree that most companies are innovating because of regulations, however that some are innovating to stay ahead. The goal behind this is to continue to exist, because they know that policy is going to move in the direction of sustainability. This means they will be too late if they do not change now.

“The market is ready for this transition.”

The goal of advisory parties is to ensure that the knowledge of the government and the market is better aligned. They help with translating the question and purpose into the outsourcing question. However, it is stated that there are too many tenders that include sustainability all in a different way. This makes it difficult for companies to keep up, which in the end can cause companies to not participate in sustainable tenders anymore. Public organizations should pursue a policy that encourages innovation by changing tendering procedures. This could lead to some companies not being able to keep up, however, not all parties feel this is necessarily a bad thing as it means the sector as a whole becomes more sustainable.

This function does not form a barrier in the transition towards sustainability.

“If you can no longer keep up, your company will not be able to participate at some point. Is that so sustainable?”

4.2.6. Resource Mobilization

Human, financial and physical resources

According to interviewees, there is a considerable lack of knowledge in terms of circularity and sustainability in the infrastructure sector, especially at the smaller infrastructure companies and the regional branches of the larger companies. Contracting parties try to ensure that this knowledge gap is taken away. However, in terms of capacity, they are very limited as only a small group of people in the organization are working on this.

Market parties do not agree on whether there is sufficient knowledge about sustainability and whether there are enough opportunities for innovation in the market. Some market parties state that the sector already works smart, and construction teams are increasingly in demand. A lot is already done in infrastructure which is not always associated with sustainability, but in fact is very sustainable. It is also argued that a lack of knowledge on sustainability and circularity may not be the biggest problem. The problem is that it is not standardized yet. There are certain systems that can summarize different sustainability perspectives in a score, for instance MKI (Environment Cost Indicator) or CO2 emissions. However, using these systems correctly and structurally is not happening much yet. And even when they are used, there is still a lack of monitoring by the government, which means it is mainly searching and guessing with too little experience. When contracting authorities gain more experience with such initiatives (systems), they will in the long run have sufficient experience to also request sustainability in a more traditional way.

Company size

Big companies have enough resources (financial and human) to innovate and to invest in start-ups, which ensures having access to new innovations and technologies. Smaller companies do not have enough money and other resources to do similar actions. In addition, especially smaller companies do not always have the resources to have a competitive advantage, as they cannot always keep their information to themselves. Some need to collaborate with subcontractors when winning a tender, due to a lack of human resources. By exchanging knowledge, they are educating their own competitors, and as a result lose a lot of work to those competitors. They feel they do not have a choice other than work together, as the market is changing. In contrary to before, engineering firms are now winning tenders and making the design with the client. After that process, the contractors are involved, which means sustainability requirements are included in the design side, not on the production side. Attracting a good designing party and ensuring that a sustainable design comes out is therefore the responsibility of the governmental parties, according to the market parties. For companies like them, it means they have to either evolve and become an engineering company, or drop out. Market parties state that this is happening now as well, that companies are not participating in sustainability as they will not profit when they have to compete with engineering firms and large companies. These engineering firms sometimes do not even have a production line, so they do not manage the execution of the project. According to the construction

companies, the engineering firms win the tender by window dressing and then outsource the work, which means the engineering firms are making money, and the production companies are being exploited.

Supporting resources

There are many instruments to support both governmental and market parties to include sustainability in procurement processes. For instance, entrepreneurs are encouraged to produce sustainable products by being offered a fictional discount in tenders. Their MKI calculation (Environment Costs Indicator value) leads to an upper and lower limit, which are included in the tender. The contractor must then calculate the MKI for his own design. The challenge is to come up with a lower MKI than the contracting party has indicated, because the lower the MKI compared to the upper limit, the greater the fictional discount.

“With a small group of ten/fifteen people, we are not able to let a sector of a few thousand companies undergo a huge change in a short period of time.”

By making circularity or sustainability measurable, market parties continue to innovate. However, giving a value judgment to projects or innovations does not happen enough yet. Many tools, like the CO2 ladder, are not used a lot yet, or not properly. More proper monitoring is needed, because at the moment governments do not know exactly what they need to control. As soon as a supplier is included the measurability, such as MKI, sustainability is automatically included. So even when producers of a certain product have a MKI score that is too high, the producer will look into his LCA (life cycle assessment) and searches for ways to optimize it. However, as long as the measuring instruments are not stimulated, things will just continue as always. Currently, the infrastructure sector does innovate, but it is based on the idea of making money quickly. Not on the idea that an innovation might have a better score based on MKI.

The amount of money differs with every type of tender, however, most of them cost a lot of money, especially for small contractors. Completely switching to another procurement model, such as the co-creation model, is therefore not possible yet according to the results. This change asks for a complete other business model: that method becomes a method where engineering firms can win a tender and the contractor starts producing. According to the market parties, that is a choice some contractors will face coming years: to fully become a production company again. Like the traditional model, a co-creation model also costs money. The perception lives among people that sustainable is more expensive, and thus that a co-creation model focusing on sustainability is more expensive. However, procurement experts state this does not have to be the case, as the design just shifts, which means costs are more flexible and there is more space for innovation. The tender itself does not necessarily cost more money over the whole process. However, many parties still find it difficult to look at the big picture.

The lack of certain resources forms a barrier for some parties in the infrastructure sector. Human resources (knowledge, team) are sometimes lacking, money and budget are often an issue. The difference in what the market needs and what is offered, such as the many different ways of tendering, is quite large, because the rules are not in line with what the market needs to develop. This relates to the institutional component of the TIS structure. The smaller sized companies encounter these barriers more often than bigger contractors. Due to the divergence of opinions on whether this function is a barrier for the transition towards sustainability in the infrastructure sector, both boxes ‘agree’ and ‘disagree’ are ticked in figure 8. In order to fill in figure 9, the average of this is taken, and the function is rated ‘neutral’.

4.2.7. Counteract resistance to change

Resistance to move towards sustainability in the sector

The interviewed market parties believe that many governmental officials are not too excited about the sustainable question in procurement processes. There are many people that do not know what to do with it, but at the same time, there are also some who are driven to do something with sustainability, and who also try to convince colleagues and others of this. However, there is also a lot of resistance in the sector, which means that the motivation for sustainability in the market initially comes from the regulations. Some companies are really innovating to stay ahead. The aim behind this is to continue to exist, because they know that policy is going to move in that direction. If they do not change now they will be too late.

“It's about thinking differently.”

Many purchasers are confident that innovation and sustainability can be stimulated more in the sector and also understand that a new way of procuring may help. However, during workshops on Rapid Circular Contracting, in which the purchasers in a municipality discuss new forms of public procurement (less structured and more dialogue) and their changing role in this process, purchasers also expressed they have many concerns to change their ways. These concerns are often related to money, time and uncertainty whether they can learn to let the traditional process go. To change these processes, they can hire consulting companies, which also costs money. These factors create resistance. However, consulting parties state that, with the right approach, sustainability can certainly save money.

Influence of system and company structure.

One of the reasons that change towards sustainability is going too slow in the infrastructure sector, is because the system as a whole needs to change; a council, road authorities, civil servants, specialists, project leaders. Additionally, all actors involved are used to tendering at lowest price. It takes so long because everything has to go through that system and people have to change. Their view of the world must change, and their entire business operations must change accordingly. For this reason, interviewees argue that the more hierarchy an organization has, the more difficult it is to implement changes. This

means something has to change throughout the line to be able to change behaviour. Therefore, there must be a manager or leader who has the intrinsic motivation to do that.

Taking away resistance to moving towards sustainability

Creating stricter regulations, more monitoring and stricter sustainability policies will be followed by resistance in the market, according to various market parties. Sustainability is about the long duration, and forcing people means it does not come from within themselves. However, when a new model or process is introduced in the market, and people see it is going well, the integration of that model will go much easier. By imposing it, it creates resistance.

As stated before, the perception lives among people that sustainable is more expensive. In addition, sustainability might mean that the current procurement process needs to change. For instance in co-creation, a concept often mentioned in the interviews, the winning party is chosen earlier in the process. This can result in more stakeholder consultation and higher costs. Stakeholder management can take a long time, but that is the case in all processes. In the traditional competition model, engineering agencies work very hard at the front to specify and do everything. In the co-creation model the ambitions, needs and obstacles are moved to the front of the process, so a professional construction worker can think along about the design. This means that during the design phase, not five parties need to go through sketch design, to final, and down to price. Procurement experts state that there is a perception that it is more expensive; however, designing just shifts. Eventually, this can save money for many parties involved.

The workshops showed that there is a lot of fear within municipalities and government to actually change to a different tendering model. This is mainly due to the fact that their performances are mainly judged on budget. In addition, people are anxious to adopt a model where there is more freedom for all parties, because that freedom is based on trust. To let go of the (unwritten) rules that buyers have always adhered to, a change in behaviour is needed. However, the knowledge and expertise needed to make this change is not present everywhere.

Taking all this into account shows that resistance to change plays a relatively big role in hampering the transition towards sustainability in the infrastructure role. Norms and behaviour are factors that influence this resistance to change. This is related to the institutional component of the TIS structure.

4.2.8. Structural cause for functional barriers

For each system function it is defined which components are not sufficient. Knowledge on the structural components on the functioning of the system gives insight in why the system fails. The institutional component is a structural cause for functional barriers, as the formal and informal regulations play a big role in the in the existence and persistence of the barriers in at least four functions. The network

component, focusing on relations and cooperation between actors, is also a structural cause for functional barriers.

5. Discussion

This research identifies a clear distinction between the interest of various actors in the infrastructure sector. The majority of the sector's projects originate from public procurement (Chao-Duivis et al., 2013), which underpins the government's role in this sector (Bratt et al., 2013). While literature acknowledges this steering power from governmental parties, the question remains why it seems to be difficult to transition this sector towards sustainability. Hence, this research aimed to explore the role of public procurement as a policy instrument in the transition towards sustainability in the infrastructure sector.

The conceptual framework that was used during this research - linking the TIS framework and public procurement - is of added value, because this offered the possibility to divide the innovation system into parts, whereby barriers and the underlying structural causes were identified. This in turn contributes to knowledge about the extent to which a demand-side policy instrument can remove barriers in the transition to sustainability. The method that was used, analysing interviews, workshops and events, ensured that a comprehensive picture of the system was created. It fitted in well with the conceptual model since the variety of data collection provided insight into all parts of the system. For instance, if this study was based on only interviews, less knowledge would have been gained on the different ways of sharing knowledge and the variations of innovations in the market. Nor would it have been observed that people in different functions in the market are hesitant to change because of the novelty that the subject of sustainability still brings. This chapter elaborates on the link between results of this study and theories from literature.

5.1. Comparison of results and the TIS framework

The results of this research can broadly be linked to the structure of the TIS framework. According to Hekkert et al. (2007), the transformation towards another socio-technical system is dependent on multiple factors, and is necessary given the worldwide focus on transitioning to a more sustainable world. First, there is a need for innovative power, or *entrepreneurial activities*. Literature states that innovations would not exist without entrepreneurs, and in order to take advantage of business opportunities, the potential of innovations should be taken advantage of (Hekkert et al., 2011). However, a striking finding from results is that currently innovative solutions are available that are not yet being used. This means there is unused potential in the sector, which doesn't stimulate system transformation. According to Carlsson and Jacobsson (1997) entrepreneurship need to be present to bring technological opportunities to market. "There must be someone with the vision and daring to take action and bring all the other necessary ingredients together. [...] But without that visionary spark, nothing happens." (Carlsson and Jacobsson, 1997. P305). How public procurement is currently organized, there is too little

room for allowing more, or more daring, innovations to market. Georghiou et al. (2014) argue that governmental parties lack knowledge on their actual influence on the innovation and performance capabilities of tendering companies. Some market parties urge the government to change their procurement processes, in order to get more freedom to include useful innovations in the tenders and to optimize sustainable development.

Knowledge development is another important condition for the effectiveness of public procurement and must be present and developed among those involved, according to Preuss (2009) and Meehan and Bryde (2011). Interviews, workshops and events show that this is a barrier in the system's transition towards sustainability. Even though there is a lot of development of innovative solutions in this sector, there is no widespread knowledge on the concept sustainability and all that it entails in the market yet. To prevent this from becoming a bottleneck in the future, *guidance of the search* is needed: stimulation from governmental parties and a clear vision on how the sector is developing. Contractors argue that a lack of shared vision results in the fact that different clients outsource their sustainability demands in diverse ways, which hampers their development. According to Thai (2001) realizing clear guidelines and objectives is the first step for realizing sustainable objectives. For some market parties it is already more difficult to develop the necessary knowledge because of the size of their company or because of the size of their budget. It is harder for smaller firms to bear the large costs, in terms of both knowledge developments and money. According to Hekkert and Negro (2009) these *resources* are necessary as a 'basic input to all the activities within the innovation system'. Aschhoff and Sofka (2009) state that these resources are needed to participate in various policy instruments, including public procurement. Companies are not able to establish channels for knowledge transfers without them. Baden et al. (2009) and Bratt et al. (2013) argue that this increases discrimination against some bidders and thus isn't in line with the goals of a healthy market competition and cost efficiency, as it makes it harder for some to apply to a tender or win one.

Moreover, the *exchange of knowledge* also plays an important role in the transition towards sustainability. Mainly the speed in which the sector can change depends on this. Currently, most parties discover and learn by themselves, instead of learning from each other's mistakes and successes. These results are consistent with the results from Gieskes and ten Broeke (2000) who demonstrated that the infrastructure sector is not oriented towards improvement and learning. This could be because of the nature of the sector, being very competition sensitive. This function does not (yet) form a crucial bottleneck for the system, however without *guidance of the search* could lead to inertia. Without effective interaction between actors, network failure might occur (Klein Woolthuis, 2010). The fact that information is not shared enough also applies to contracting parties. According to the interviewees, this could and should happen more and better, however, Jamali (2006, P.816), argues that "[...] organizations are at different stages of maturity and learning on sustainability and it is difficult to draw comparisons between them. Prescribing one single formula for enhancing [sustainability] integration in a diversity of organizations and sectors is thus impractical."

A striking finding is that many barriers in the system link to the function *guidance of the search*. Market parties reason that the governmental parties have much steering power in the market, which is in accordance with Bratt et al. (2013), who argue that governments are able to influence sustainable developments with the policy instrument public procurement. As the transition towards sustainability is hampering in this sector, it has been suggested by multiple parties that a change is needed and an other procurement method -than the traditional model- can better fulfil what is needed to transform the sector in a more sustainable one. Results imply that i.a. the functions ‘*entrepreneurial experimentation*’, ‘*knowledge development*’ and ‘*counteracting resistance to change*’ would also be better utilized when the *guidance of the search* is optimized. However, to let go of the current (unwritten) rules and change towards a more flexible, dialogue based purchasing model, which gives more freedom to the infrastructure companies, a change in behaviour is needed in addition to a change in the system. In order for the infrastructure sector to undergo a transformation towards sustainability, profound changes are needed in attitudes, norms and regulations. This relates back to the institutional component of the TIS framework, of Hekkert et al. (2011), which are the rules of the game in a society. According to Hekkert et al. (2011. P.5) “Institutional structures are at the core of the innovation system concept.”

The data collected during workshops indicates that governmental parties are already slowly getting used to the idea of adopting a new procurement model, such as the participation model and the co-creation model. However, a lot of *resistance to change* is present as well. Governmental parties are not too eager to incorporate changes, due to the fact that the performances of purchasers are mainly judged on budget and time. Additionally, people are anxious to adopt a model where there is more freedom for all parties, because that freedom is based on trust. This trust is lacking due to past happenings in this sector. According to literature (Li, 2005) trust and shared vision are important factors to effective knowledge transfer. Therefore, this also causes barriers in other functions, such as *knowledge exchange*.

According to Klein Woolthuis, there is a strong network failure in the infrastructure sector: “The interactions between these actors are based on historic relations, are considered as rigid and fixed. [...] This creates strong network failures based and ‘lock-in’ in the sense that new knowledge, know-how and working routines will be hard to establish with these players and hence, the industry will tend to stay conservative.” (Klein Woolthuis, 2010. P. 517). This is in accordance with the data from interviews, which also suggest that the infrastructure sector is very conservative. These results relate to previous studies that showed that relative unfamiliarity with objectives of the change process and unfamiliarity with opportunities for a sustainable procurement process result in resistance to change and institutional slowness (Testa et al., 2012 and Grandia, 2015).

Taking into account the results of the analysed TIS framework, gives an insight in the relation between cause and barriers and in the effects of the structural components on the functioning of the system. Results show that the institutional component of the system plays a major role in failure of the

system, as it causes the unfulfillment of many of the system functions. In addition, the network component – the relations and cooperation between parties – goes hand in hand with this.

5.2. Discussion of results that have no direct link to the TIS

The general pattern in the results is that the functions *knowledge development*, *guidance of search* and *counteracting resistance to change* are most affected by barriers in the infrastructure sector, while *entrepreneurial activities*, *knowledge exchange* and *market formation* are less (or not) affected. This study also found barriers in the infrastructure sector that are not directly covered by the existing functions. However, at some level most of these barriers still relate somewhat to the function *Guidance of the Search*.

Results show that many companies in the market are currently not stimulated enough to increase their sustainability goals. According to Bratt et al. (2013), governmental institutions can individually add their own policy to EU guidelines for public procurement, to put more or less pressure on sustainability. This can be done by putting strict sustainability requirements in the tenders. However, collected data indicates that doing this sometimes leads to mock compliance; companies could prepare a quality image for purchasers, but change little in reality. These results are consistent with the results from Baden et al. (2009) who demonstrated that the buyer pressure on suppliers can be counterproductive and can lead to mock compliance. Furthermore, Baden et al. (2009) states that external pressure can lead to a ceiling effect, as the imposed standards would be lower than the standards companies would have set themselves. Results confirm that this is happening in the Dutch infrastructure sector as well. The way procurement processes are organized thus jeopardize the speed of the sector's transition towards sustainability.

Another factor that hampers this transition is the lack of dialogue, flexibility and freedom within the procurement process. According to the study of Baden et al. (2009), these factors can have a major impact on the behaviour of companies regarding public procurement. In the public procurement model that is currently most used in the Dutch infrastructure sector - the traditional model – dialogue, freedom and flexibility are not included very much. Due to constraining rules, even though there are a lot of innovations present in the market, not all of them are being used (as much). In addition, the construction companies do not have the freedom to include their innovations and ideas into the execution of the tender. Moreover, current sustainability requirements in tenders often do not take into account multiple types of sustainability values. This corresponds to previous studies, that state that selection of tenders on base of compliance with social issues is difficult, as these issues are often not related to the subject matter of the contract and are therefore not part of the selection criteria (Uttam and Roos, 2015).

Furthermore, clarity of where responsibility lies is also an important factor that hampers sustainability according to various parties. Currently, the market parties are not held accountable for the result of the innovations they deliver, as they do exactly what they are asked by the governmental party. When that doesn't turn out to be a successful project, responsibility lies with the client. This is in

accordance with results found in literature (Chao-Duivis et al., 2013), where it is stated that ownership of an the project is handed over to the client after construction. Results indicate that responsibility should be reallocated to the contractor to guarantee a successful project. However, Lædre et al. (2006) do not fully agree, as “the contractors will often charge extra if they have to take responsibility for risk, but it will still be the owner’s problem if they do not complete their work.” They propose to allocate the responsibility for risk that cannot be influenced to the client (the contracting party), as they often have better (financial) resources. Also, they propose to allocate the responsibility for risk that can be influenced to the contractor, as they are the ones carrying out the work.

Lastly, an important insight that was gained during this study, was that the size of a company plays a big role in the effect of barriers in the system on a company. Bigger companies, with more financial and human resources, seem to be less affected by barriers in the system and can therefore develop towards a more sustainable company by itself (Baden et al., 2009). In addition, big companies are less dependent of procurement processes to get innovations to market. For smaller companies this is more difficult, as they do not have the same resources. However, small companies do have the benefit that they are less hierarchical, which means they are more flexible when they need to change.

5.3. Limitations and recommendations for further research

In this research the concept of sustainability is defined rather broad. This resulted in the fact that, during the interviews, different aspects of sustainability were focused on. Some companies focused more on environmental aspects, some more on social, and some on circularity. All these aspects are part of sustainability, but not all were included in every interview. Considering that the interviewees provided their motivations and explanations and made clear which aspect of sustainability they were referring to, this did not necessarily influence the results. In addition, this added to the freedom for the interviewees to focus on specific aspects like in any semi-structured interview (Bryman, 2008).

As mentioned in the methods chapter, the analysis of the TIS framework is performed slightly different than suggested by Hekkert et al. (2011). However, results from analysing the infrastructure sector as a TIS are consistent and is therefore useful for comparison with other research on public procurement in the infrastructure sector. The TIS framework provided a good structure to analyse the infrastructure sector on a qualitative level. It clearly showed that the opinions about aspects of the TIS and public procurement vary between different groups of interviewees. This can be explained by the difference in interests that they have. Qualitative research would not have shown this so well. In addition, to perform quantitative research, a larger sample size is required. This allows the analysis of the TIS framework to be performed as suggested by Hekkert et al. (2011) and is recommended for future research to strengthen the results of this study.

Furthermore, the interviewees and workshops might have been exposed to the subjectivity of the researcher. Therefore, triangulation of the data is performed to verify and compare the findings with existing literature. In addition, the interviewees have a personal bias based on their own experiences of

public procurement, which could affect the outcome of the research. Having a larger sample size would increase the validity of the research, which is recommended for future research. However, the fact that interviewees have a personal bias would be impossible to eliminate, given that the interviewees are participating actors in the system.

Taking into account the fact that many parties agree that the public procurement processes as they are currently organized do not stimulate sustainability, further research is needed to explore whether the parties are capable of implementing and entering more flexible and dialogue oriented procurement processes. According to the procurement experts, the system as a whole needs to change and people in leadership roles should have an internal motivation to change towards sustainability. Further research is needed to explore whether changing the procurement processes will actually take away these barriers towards sustainability. What can be expected is that an other type of process (which is more dialogue oriented and more flexible) will also bring about some new barriers. Too much freedom could, according to governmental parties, also lead to misuse of the system. Case studies on procurement projects with more freedom, flexibility and dialogue (for instance the Rapid Circular Contracting method) could reveal what possible bottlenecks or pitfalls are for the actors involved.

During this research it became clear that the change towards a more sustainable sector will have a different impact on smaller contractors than on bigger contractors. Interviews showed it is far more difficult for smaller firms to bear the changes than for bigger firms. More research is needed which further compares different sizes of companies. This will demonstrate exactly what these differences are and would contribute to a understanding of the possible role of the government to support smaller companies in the transition.

6. Conclusion

In this research, the following question was focus: To what extent does sustainable public procurement contribute to taking away barriers in transitioning towards sustainability in the infrastructure sector? Answering this research question contributes to the knowledge on the effect of sustainable public procurement on the transition towards sustainability in the Dutch infrastructure sector. To answer this question, a literature study was performed to find the main barriers in the transition to sustainability in the infrastructure sector. Using the structure and diagnostic questions from the TIS framework in interviews and during workshops and events, the infrastructure sector was analysed and it was researched how the current sustainable public procurement model (the *traditional* model) contributes to taking away the barriers. Linking the TIS framework to public procurement offered the possibility to divide the innovation system into parts, whereby barriers and the underlying structural causes were identified. This contributes to knowledge about the extent to which a demand-side policy instrument can remove barriers in the transition to sustainability. The method that was used, analysing interviews, workshops and events, ensured that a comprehensive picture of the system was created.

So, which barriers were relevant in this research? To what extent do the results correspond to the TIS framework? Analysing the TIS showed there are many barriers in the infrastructure sector. First, there is a lot of anxiousness to change trusted ways and adopting a model where there is more freedom for all parties. In addition, letting go of the (unwritten) rules that buyers have always adhered to, has proven to be difficult. Also, the knowledge and expertise needed to make this change is not present everywhere. The transition towards a more sustainable sector is thus a difficult one. It has become clear that the government lacks knowledge on their influence on the innovation and performance capabilities of the sector and that contracting parties do not take the space to move in the possibilities that exist. This shows that there is an opportunity for innovation and therefore sustainability to grow in this sector

Results indicate that more dialogue, freedom and flexibility is needed in the procurement process to change to a more sustainable sector. In addition, contracting parties need to move away from the technical specifications of projects. Instead, they need to set out ambitions and goals and find a partner that can fulfil these ambitions without prescribing everything in detail. This asks for more dialogue earlier in the procurement process. In addition, trust is needed that construction companies have the right knowledge and expertise to find the best solutions for a project. However, there is resistance to change because of *habit*. Procurement experts find it hard to change their behaviour because they have to change what they usually do; from money-focused, to value-creation.

In addition, knowledge sharing (on sustainability and procurement processes) is not coordinated well. Currently, (small) municipalities often need to re-invent the wheel because there is a lack of communication and knowledge sharing. Also, there is a lack of a shared vision and alignment of goals of the government. The current diversity of sustainable tenders means that contractors no longer know how to invest in their organizations. Moreover, there is currently no clarity of where responsibility of the final project lies. This hampers sustainability, as no one is being held account for the innovations, and thus contractors do not always feel the need to finalize the project successfully. To change this, current norms and agreements need to change. Furthermore, an important insight of this study is that the size of a company plays a big role in the effect of barriers in the system on a company. Bigger companies, with more financial and human resources, are less affected by barriers in the system, and are less dependent of procurement processes to get innovations to market. For smaller companies this is more difficult, as they do not have the same resources. A benefit for small companies is that they are often more flexible because of a less hierarchical company structure.

These results indicate that function 4, *Guidance of the Search*, entails the most bottlenecks for transitioning towards a more sustainable sector. Improving factors in this function will also take away barriers in other functions. Resistance to change, a lack of coordinated knowledge sharing, and a lack of knowing where responsibility lies all play a big role in hampering a transition of the sector. Many of the barriers can especially be linked to the *institutional* component in functions, which is therefore the

main structural cause for functional barriers. This structural cause has evolved over time due to past happenings in the sector and anxiousness to change. Current norms and behaviour influence the functioning of actors, networks and thus the system as a whole. Improving the structure of the public procurement process could lead to taking away a lot of barriers. In addition to changing the policy instrument, a major change in behaviour is needed. Trust, communication and cooperation are important aspects of this behavioural change. Only when the institutions change, it is possible to fulfil system functions and stop system failing.

7. Recommendations for practice

Bringing together the most important results, this leads to the following set of recommendations. These recommendations are interesting for consulting parties, such as KplusV, to enhance their abilities to help and support both government as well as organisations in the Dutch infrastructure sector on overcoming barriers.

Preparing municipalities/contracting parties for change:

Procurement experts find it hard to change their behaviour because they have to change what they usually do; from money-focused, to value-creation. Preparing organisations to change will contribute to make this process easier. This can be done by practicing with small projects, not necessarily infrastructure-related, to show people involved what the new procurement process will entail. Consultancy companies can, in addition to providing information to purchasers, also investigate and help the entire structure of the company. It is necessary to look where the fear of people is coming from to change, in order to take away these fears. It is possible that consultants are currently helping the wrong people, who cannot change much in the company because they are judged on money spend instead of added value. The person who determines what to focus on is the person who needs to change.

Furthermore, sharing positive results from other sustainable projects before expecting everyone to cooperate will enhance the trust in similar projects. Preparing the municipalities/contracting parties for change will ensure the procurement experts get familiarized with more dialogue, flexibility and freedom in projects. This will stimulate sustainability in the infrastructure sector.

Coordinating knowledge sharing:

Currently, knowledge sharing (on sustainability and procurement processes) is not coordinated well. Various actors feel that they could benefit when knowledge sharing is more coordinated. Consultancy parties can help to structure communication between municipalities, and between contracting and market parties. Better communication between all parties contributes to a better coordination of knowledge sharing, because there are a lot of knowledge sessions that do not meet the expectations from

the actors. Better communication between the actors could prevent this by stating clearly what the expectations and needs are.

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10. Appendix

A. Overview of System Functions, indicators and diagnostic questions for analysing the functioning of the Innovation System Functions. (Hekkert et al., 2011)

Functions and indicators	Diagnostic questions (adjusted to the Dutch Construction sector)
<p>F1 – Entrepreneurial Experimentation and production Actors present in industry (from structural analysis)</p>	<ul style="list-style-type: none"> - Are these the most relevant actors? - Are there sufficient industrial actors in the innovation system? - Do the industrial actors innovate sufficiently? - Do the industrial actors focus sufficiently on large scale production? - Does the experimentation and production by entrepreneurs form a barrier for the Innovation System to move to the next phase?
<p>F2 - Knowledge Development Amount of patents and publications (from structural analysis)</p>	<ul style="list-style-type: none"> - Is the amount of knowledge development sufficient for the development of the innovation system? - Is the quality of knowledge development sufficient for the development of the innovation system? - Does the type of knowledge developed fit with the knowledge needs within the innovation system - Does the quality and/or quantity of knowledge development form a barrier for the TIS to move to the next phase?
<p>F3 - Knowledge exchange Type and amount of networks</p>	<ul style="list-style-type: none"> - Is there enough knowledge exchange between science and industry? - Is there enough knowledge exchange between users and industry? - Is there sufficient knowledge exchange across geographical borders? - Are there problematic parts of the innovation system in terms of knowledge exchange? - Is knowledge exchange forming a barrier for the IS to move to the next phase?
<p>F4 - Guidance of the Search Regulations, Visions, Expectations of Government and key actors</p>	<ul style="list-style-type: none"> - Is there a clear vision on how the industry and market should develop? - In terms of growth - In terms of technological design - What are the expectations regarding the technological field? - Are there clear policy goals regarding this technological field? - Are these goals regarded as reliable? - Are the visions and expectations of actors involved sufficiently aligned to reduce uncertainties? - Does this (lack of) shared vision block the development of the TIS?
<p>F5 - Market Formation Projects installed (e.g. wind parks planned, site allocation and constructed)</p>	<ul style="list-style-type: none"> - Is the current and expected future market size sufficient? - Does market size form a barrier for the development of the innovation system?
<p>F6 - Resource Mobilization - Physical resources (infrastructure, material etc) - Human resources (skilled labour)</p>	<ul style="list-style-type: none"> - Are there sufficient human resources? If not, does that form a barrier? - Are there sufficient financial resources? If not, does that form a barrier?

<ul style="list-style-type: none"> - Financial resources (investments, venture capital, subsidies etc) 	<ul style="list-style-type: none"> - Are there expected physical resource constraints that may hamper technology diffusion? - Is the physical infrastructure developed well enough to support the diffusion of technology?
<p>F7 - Counteract resistance to change/legitimacy creation Length of projects from application to installation to production</p>	<ul style="list-style-type: none"> - What is the average length of a project? Is there a lot of resistance towards the new technology, the setup of projects/permit procedure? - If yes, does it form a barrier?

B. Interview Questions

Deze gegevens worden volledig anoniem meegenomen in het onderzoek voor de masterthesis. Er worden geen gegevens over het bedrijf gedeeld met anderen. Er kan geen koppeling gemaakt worden tussen de gegeven antwoorden en uw bedrijf.

De volgende thema's worden gehanteerd voor duurzaam ondernemen in de bouwsector (PIANOo, 2018): Internationale sociale omstandigheden; Social return; Milieuvriendelijk inkopen; Bio-based inkopen; Circulair inkopen; Innovatie gericht inkopen; MKB-vriendelijke inkoop. Wanneer wordt gesproken over duurzaam ondernemen in de bouwsector, betekent het dat (een aantal van) deze thema's worden meegenomen in alle processen.

Interviewvragen:

- Waar komt de motivatie binnen [bedrijf/organisatie] vandaan om bezig te zijn met duurzaamheid?
- Vindt er veel innovatie plaats in de bouwsector, en is dat nodig voor een transitie richting duurzaamheid? – *wat is de rol van publiek aanbesteden hierin? Stimuleren de huidige procedures ervoor dat innovatie wordt gestimuleerd of tegengehouden?*
- Wat zijn belangrijke recente innovaties? En is de markt/sector er al klaar voor om met deze innovaties aan de slag te gaan?
- Hebben bedrijven binnen de bouwsector voldoende kennis over duurzaamheid?
- Hoe komt/komen [bedrijf]/bedrijven aan deze kennis? - *wat is de rol van publiek aanbesteden hierin?*
- Stimuleren de huidige aanbestedingsprocessen (traditioneel/competitiemodel) het om meer kennis op te doen over duurzaamheid? Op welke manier wordt dit gesteund?
- Sluit aan bij 3. Is er voldoende kennisuitwisseling? - *Tussen wetenschap en industrie, Tussen gebruikers/afnemers en de industrie, Tussen overheid en de industrie*
- Helpen de beleidsdoelen om duurzaamheid te stimuleren?
- Zijn de visies en verwachtingen van betrokken actoren voldoende op elkaar afgestemd? Hoe wordt dat gewaarborgd?
- Zijn er voldoende financiële middelen (investerings, risicokapitaal, subsidies, enz.) -*in zowel de sector als bedrijven om richting duurzaamheid te bewegen? -wat is de rol van publiek*

aanbesteden hierin? Zijn er subsidies waardoor bedrijven makkelijker in het 'verduurzaamproces' komen?

- *Is er veel weerstand in de sector tegen nieuwe technologieën, de opzet van duurzame of circulaire projecten? -van bouwbedrijven/uitvragende partijen*
- *Wat zou moeten veranderen binnen de aanbestedingsprocedures om de beweging richting een duurzame bouwsector te versnellen?*
- *Samengevat, wat zijn de belangrijkste barrières die de ontwikkeling naar een duurzame bouwsector tegenhouden? – liggen deze barrières bij de bedrijven (willingness, resistance to change), de overheid, of bij hoe de aanbestedingsprocessen op dit moment zijn ingedeeld?*
- *Wat zijn de verwachtingen met betrekking tot duurzaamheid in de bouwsector voor komende jaren?*