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Using Procurement to Leverage Sustainability Transition Dynamics in Construction: The Dutch Circular Public Procurement Case

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ABSTRACT: The ambitious climate goals set for 2030 and 2050 force nations to develop climate policies. In turn, public clients leverage their buying power to steer the transition of unsustainable industries, like the construction industry, towards sustainable industries. In the Dutch construction industry, public clients use Circular Public Procurement (CPP) as such a lever. Despite the large buying power, this CPP approach seems to have limited impact on the industry's transition, since CPP strategies are deployed on a limited number of projects. To accelerate a transition, it is key to understand transition processes. In this field, the Sustainable Market Transformation Framework (SMTF) proposes a maturity model to determine the transition dynamics. This article deploys the SMTF perspective to assess the impact of the Dutch CPP deployment on the transition towards a sustainable construction industry. The article builds on a multiple case study and expert interviews. Each case is analysed whether CPP incited firms move to more sustainable maturity, creating insights into the transition impact of various CPP-elements. In the first transition phases, three key CPP-elements are found to support the transition towards a sustainable construction industry. (1) Tendering with functional specifications incited bidders to come up with their particular circular products. This encourages competitors to develop a company's vision on circularity rather than following a prescribed solution from the project's perspective. (2) Concurrently, once projects are awarded, clients and contractors should collaborate as the exploration of innovative circular products for the industry is inherently a joint effort. This collaborative relationship facilitates knowledge creation and the development of organizational visions regarding circularity. (3) As time and budget are determinants of circular quality, it is important to have flexibility in the collaborative relationship regarding time and budget goals of the project. This flexibility should be secured by contractual conditions to foster a collaborative relationship. Once sustainable maturity is achieved – the final phase of the transition -, the same CPP-elements as in the first transition phases but with another application are found to support the transition. (I) Prescriptive tender specifications seem more appropriate as the best products are institutionalized. (II) Due to this institutionalization, clients and contractors could operate in more traditional arms-length project relationships, while (III) a tight focus on time and budget facilitates efficiency.

KEYWORDS: Circular Public Procurement, Construction Industry, Sustainable Market Transformation Framework, Market Characteristics, Innovation

1. Introduction

Our society is facing major problems regarding nature and environment. A loss of biodiversity and climate change are negative effects of resource depletion. The prevention of these negative effects belongs to the biggest challenges that our society is confronted with (Hanemaaijer, et al., 2021). Simultaneously, the world's population is growing (Hanemaaijer, et al., 2021) and will use more primary resources (Behrens, Giljum, Kovanda, & Niza, 2007). To deal with the need of efficient raw material use and the growing population, governments have set ambitious climate goals for 2030 and 2050 (European Commission, 2017).

The construction industry is a priority area to achieve the climate goals (Giorgi, et al., 2022) because it accounts for 9% of the European Union's gross domestic product (European Commission, 2022), consumes an extremely high number of raw materials and produces a high amount of waste. Estimates indicate that the construction industry accounts for 50% of the raw material use (IenM & EZ, 2016). In addition, the construction industry accounts for 850 million tonnes of construction and demolition waste per year (Sáez & Osmani, 2019).

The linear concept is still present in the construction industry (Nodehi & Taghvaee, 2022). The "linear economy is one defined as converting natural resources into waste, via production'' (Murray, Skene, & Haynes, 2015, p. 371). In contrast, a circular economy aims at disconnecting economic growth from material input by replacing the "end-of-life" concept with R-strategies (e.g. reuse, repurpose or recycle) (Ellen Macarthur Foundation, 2015; Ellen Macarthur Foundation, 2012). Therefore, the circular economy is an opportunity to address the negative consequences of the linear system (European Commission, 2017). It is expected that material supplies become less risky and the volatility of material prices will be less steep (Morgan & Mitchell, 2015). In addition, the circular economy helps in achieving environmental sustainability (Murray, Skene, & Haynes, 2015), as the carbon footprint will be reduced (Pratt & Lenaghan, 2015).

The governmental bodies, as a major client of the construction industry, leverage Public Procurement (PP) to steer transitions (Edler & Georghiou, 2007). Circular Public Procurement (CPP) is implemented to steer the transition towards a circular economy (Hanemaaijer, et al., 2021), by including circular awarding criteria in tenders (Alhola, Ryding, Salmenperä, & Busch, 2019). However, the currently performed CPP practices have resulted only in a foundation for the circular economy in the Netherlands. The process of turning circular ambitions into reality underperforms as the Dutch construction industry is still mainly operating linearly (Hanemaaijer, et al., 2021; Prins & Hanemaaijer, 2022).

To accelerate sustainability transitions, the application of transition frameworks is key (Loorbach, Wittmauer, Shiroyama, Fujino, & Mizuguchi, 2016), as it often requires "systemic

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multilevel change" (Witjes & Lozano, 2016, p. 42). As such, this study uses the Sustainable Market Transformation Framework (SMTF), which is a recently developed transition framework by Simons and Nijhof (2021). Consequently, the primary aim of this study is to analyse from an SMTF perspective to which degree the Dutch CPP practices impact the transition towards a sustainable construction industry. The article builds on empirical data from three Dutch case studies and several expert interviews. Conclusions and recommendations to accelerate the transition are drawn based on the acquired knowledge.

This article continues with a theoretical background before the methodology is explained. Subsequently, the results are analysed. Following this, results are discussed and limitations and directions for further research are given. Main conclusions of this study are drawn in the last chapter.

2. Theoretical Background

This section discusses relevant literature thematically and contextualises the study by providing background information. Circular public procurement and its application as a lever to innovate are discussed in the first section. Subsequently, market characteristics and the relation to innovations are explained. This chapter ends with an explanation of the SMTF and an introduction to the theory underlying the SMTF. The focus of this chapter lies on developing innovative circular products as this is the most important, time-consuming activity in the beginning of a complex transition (Rotmans, Kemp, & Asselt, 2001).

2.1. Circular Public Procurement as a Lever to Innovate

Public procurement is mainly used to acquire products, services and works by public agencies (Uyarra & Flanagan, 2010). European public procurement practices accounts for 14% of the European gross domestic product. This relatively large share creates opportunities to achieve the United Nations Sustainable Development Goals (United Nations, 2018). Public procurement has gained much attention since they foster the development of solutions for challenges our society is confronted with (Sönnichses & Clement, 2019; Aldenius & Khan, 2017; Grandia, Steijn, & Kuipers, 2015). Nowadays, public procurement can be further divided into sustainable public procurement (SPP), green public procurement (GPP) and circular public procurement (CPP). CPP is, in contrast with GPP and SPP, specifically aiming at a circular economy by awarding contracts based on circular criteria (Alhola, Ryding, Salmenperä, & Busch, 2019).

There is no consensus yet about what a circular economy is (Greer, 2022). Therefore, this research uses the definition of Kirchherr et al. (2017). Kirchherr et al. (2017, pp. 224-225) formulated a circular economy, based on 114 definitions, as:

> *"A circular economy describes an economic system that is based on business models which replace the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes, thus operating at the micro level (products, companies, consumers), meso level (eco-industrial parks) and macro level (city, region, nation and beyond), with the aim to accomplish sustainable development, which implies creating environmental quality, economic prosperity and social equity, to the benefit of current and future generations''.*

Replacing the end-of-life concept with so-called R-strategies requires the development of new circular business models, including innovations ranging from radical to incremental (Witjes & Lozano, 2016). Circular innovations are needed to transform the construction industry into a circular construction industry. However, the construction industry is often blamed for its low innovation rate compared to other industries. A lack of innovations in the construction industry can be related back to six main factors, which are: "clients and manufacturers, the structure of production, relationships between individuals and firms within the industry and between the industry and external parties, procurement systems, regulations/ standards, and the nature and quality of organizational resources'' (Blayse & Manley, 2004, p. 144). However, this study focuses solely on procurement systems.

A first procurement element of procurement systems that can influence innovation is the tender specification. Scholars found that an open solution space fosters innovations and generates value (Lenderink, Halman, Boes, & Voordijk, 2020; Loosemore & Richard, 2015). Specification strategies that focus on functions have the advantage that they foster innovations, as one function may lead to different systems (de Graaf, 2019). In addition, Blayse and Manley (2004) argue that a client's attitude towards detailed design requirements hampered innovation in the construction industry. This is in line with Eriksson et al. (2019), as they argue that detailed specification results in a poor solution space.

In addition, selection and awarding criteria can influence innovation development in projects. Cheng et al. (2018) found in their research that procurers sometimes adopt a risk-averse set of award or selection criteria by not including circularity criteria. The reason for this is that suppliers are potentially less motivated to put forward a bid due to the demanded environmental innovations. In addition, a lack of knowledge and experience of public organizations hampers the inclusion of innovation award criteria in tenders (Lenderink, Halman, Boes, & Voordijk, 2020; Loosemore & Richard, 2015; Cheng, Appolloni, D'Amato, & Zhu, 2018). In turn, Lenderink et al. (2020) found in their research that innovations are included in the bid of contractors if innovation is one of the award criteria.

Another procurement element which could hamper the development of innovations is the awarding method. The awarding method should be appropriate to have an effective CPP process (Cheng, Appolloni, D'Amato, & Zhu, 2018). If the chosen weights do not sufficiently reflect the actual impacts of certain aspects (e.g. amount of recycled material), it might be that ineffective bids are selected as winner (Parikka-Alhola & Nissinen, 2012). Igarashi, de Boer and Michelsen (2015) found in their research that the circularity potential of projects is hampered if circularity criteria do not have an overarching effect in the evaluation.

The awarding method often includes quality and price criteria. Best value procurement is an example where both price and quality will be used to determine who is the most competitive supplier (Dorée, Holmen, & Caerteling, 2003). Quality-driven competition is nowadays more and more common in the construction industry. With the use of soft criteria (e.g. quality, sustainability, circularity) it is tempting for suppliers to develop innovative products because innovations often have a causal relationship with more costs. Therefore, they will not be punished in the bid evaluation. Similarly, Loosemore & Richard (2015) argues that a client needs to focus on the balance between price and quality. However, despite best value procurement, Zijp et al (2020) found that savings in the contracting phase obstruct circularity in the project.

Another factor that enables or impedes the innovation process is the relationship between clients and contractors during projects. Public clients can deploy collaborative or competitive arm's length relationships in the construction industry (Eriksson, 2008). However, a pure collaboration state is not possible due to the basic principle of providing equal opportunities to bidders (Chao-Duivis,

Koning, & Ubink, 2013). The relationship between client and contractor determines whether the project focus will be on quality or costs (Eriksson, 2008). Akintoye and Main (2007) found in their research that, once a project is awarded, a collaborative relationship between client and contractor stimulates the development of innovations. Dorée and Holmen (2004) studied the successful development of innovations in the loosely coupled construction industry and found that intra-project couplings should be tightened to foster innovations. These couplings could refer to personal interactions and knowledge exchange between client and contractor.

Finally, project goals can be defined in the contract and could have an influence on innovation development during the construction phase. Time pressure in projects is an important factor in the development of innovations. Hartmann (2006) and Lenderink et al. (2020) agreed with each other by arguing that time pressure should be minimised to allow delays which are inherent in innovation processes. The body of literature focussing on collaboration underpins the flexible goals regarding time, arguing that collaboration takes time (e.g. van Waarden (1996)).

2.2 Market Characteristics and Innovations

Besides CPP, market characteristics could influence the development of innovations. One of these market characteristics is the market form. There are many different market forms, but the two ends of the market form continuum are monopoly and perfect competition (Nederlof, 1997). Between these market forms, one can identify some other market forms (e.g. oligopoly, imperfect competition) (Lowe, 1987). Each market form has a certain effect on the innovation capacity and changeability of daily processes.

A well-known debate in the construction industry is about the appropriate level of competition. Old scholars argue that more competition leads to more innovation (e.g. Arrow (1962)), however, there is no empirical evidence for these propositions. Intriguingly, Aghion et al. (2005) conclude empirically that there is an optimum between competition and innovation: the so-called inversed U-relationship. The inversed U-relationship represents that a too low level of competition or a too high level of competition in a market would lead to minimal innovation. Between the high and low competition levels, there is a moderate competition level that would result in an optimum innovation level. This would imply that both a monopolistic market and a market with perfect competition will stagnate the innovation level, as a monopolistic market has limited competition and a perfect competition market has significant competition. Consequently, an oligopoly is the most preferred market form to achieve the highest innovation levels (Aghion, Bloom, Blundell, Griffith, & Howitt, 2005). However, it is important that the oligopoly partners do not collude (Boone & Damme, 2004).

A market that competes on a price basis will eventually end up in a stagnation phase. The focus lies on static efficiency while the development of new business cycles is lagging. The prices are forced down to a level wherein a research and development (R&D) budget lacks. Eventually, there is no budget to develop innovative products and processes. The first mover needs the benefits of a monopoly situation to finance new business developments (e.g. products and processes). The static efficiency hampers progress and thus a more dynamic efficiency is recommended (Dorée, 2004). One-dimensional price competition will cause a lack of innovative products or processes.

Business to government (B2G) transactions are widely present in the construction industry. The B2G transactions are heavily influenced by political interest (e.g. sustainability) and the available budget. However, it is also possible that contractors need to buy their materials from a supplier (business to business(B2B) transaction), while they have a contract with a governmental body (Krah, 2020). As the B2G transactions are influenced by political interest, this influence will also unfold in most of the B2B transactions. In contrast with B2B transactions, B2G transactions are more risk averse as these transactions are steered with a set of requirements with minimum space for innovations. The requirements are set by a wide range of stakeholders with different interests. In turn, B2B transactions have a higher risk level than B2G transactions. It is more valuable to differentiate from other businesses with innovative ideas (Josephson, Lee, Mariadoss, & Johnson, 2019).

2.2. Sustainable Market Transformation

Sustainable market transformation is a non-linear transition process from a state with unsustainable behaviour to a state where sustainability is institutionalized. The three pillars of sustainability (i.e. social, economic and environmental) are considered during the entire transition (Ben-Eli, 2018). Edler and Georgiou (2007) argue that public procurement can support this transition by stimulating the development of innovations. However, the transition phase of a certain innovative product influences which procurement elements are more effective (Rotmans, Kemp, & Asselt, 2001). To determine the transition phase of a construction project, the Sustainable Market Transformation Framework (SMTF) of Simons and Nijhof (2021) is adopted in this study. This framework is recently published and used by the Ministry of Economic Affairs and Climate Policy and the Dutch department of public works and waterways (Dutch: Rijkswaterstaat). In contrast with other transition frameworks, this model focuses on guiding all market actors (Nijhof, Wins, Argyrou, & Chevrollier, 2022).

The causal loops underlying the SMTF and the different transition phases are described briefly in the following sections. A more comprehensive explanation of the theory underlying the SMTF and the transition phases can be found in the article of Nijhof, Wins, Argyrou, & Chevrollier (2022) .

2.2.1. Four Causal Loops in Market Transformation

The sustainability challenges our society is confronted with are the result of an imbalance within the four causal loops that are inherent in system dynamics (Meadows, 2008). The four causal loops consist of two reinforcing loops and two balancing loops. The reinforcing loops follow a continuous process of creating the same actions because of the cause-and-effect relationship. The balancing loops aims at balancing change with the opposite (Meadows, 2008) and control the reinforcing loops (2021). Within the causal loops, relationships between industry, government, non-governmental organisations (NGO's), financial institutions and knowledge institutions influence the sustainable outcome (Papachristos, 2014). The SMTF assumes that industries are dynamic and are thus able to transform by adjusting the causal loops (Geels, 2019).

The first causal loop (CL1) is a balancing loop. The potential effect of this loop becomes visible as viable alternatives are created and the conditions to change are present (Simons & Nijhof, 2021). Eventually, a more sustainable outcome is generated. The second causal loop (CL2) is a reinforcing loop and it focuses on market dynamics. Actors within a market create a supply and demand system where transactions are established. The way competitors compete determines the sustainable outcome (Simons & Nijhof, 2021). The third causal loop (CL3) is another reinforcing loop and considers the enabling environment that leads to the collective unsustainable behaviour. CL3 reinforces the outcome of CL2 as governments take advantage of the benefits (Simons & Nijhof, 2021). CL2 and CL3 create both dominance in a market (Nijhof, Wins, Argyrou, & Chevrollier, 2022). The last causal loop (CL4) is a balancing loop that describes the mismatch between effects and benefits. This loop focuses on "how the consequences of sustainability challenges are felt by the market actors who cause the sustainability problems'' (Nijhof, Wins, Argyrou, & Chevrollier, 2022, p. 354).

2.2.2. Five Transition Phases

The SMTF argues that every transforming market goes through five different transition phases (0-4), beginning with the start phase, followed by the inception phase, competitive advantage phase, the synergy phase and ending with the institutionalization phase (Nijhof, Wins, Argyrou, & Chevrollier, 2022). Figure 1 presents the last four transition phases. Phase 0 (not depicted in Figure 1) is seen as the initial phase, the transition phase in which a market has not noted a crisis yet (Kivimaa, et al., 2019).

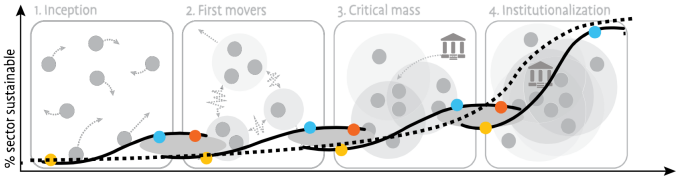

Figure 1 - Sustainable Market Transformation Model (Taken from Simons and Nijhof (2021))

Phase 1 starts with a sustainability crisis that is noticed by a group of actors, while another group of actors is still neglecting the crisis (köhler, et al., 2018). NGO's push for awareness while market actors are denying the issue because of higher costs and market position risks. The pressure to change increases during this transition phase and the first movers arise. All actors are taken different actions to deal with the symptoms of the unsustainable market, however, the root cause is not tackled and thus a large market transition is not achieved yet (Nijhof, Wins, Argyrou, & Chevrollier, 2022). The first transition phase is changing CL1 as pilot projects foster sustainable outcomes (Rotmans, Kemp, & Asselt, 2001).

In the second transition phase, the first movers are aware that they can have a competitive advantage with their sustainable way of doing business. The first movers compete to gain a market share. Competition based on the alternatives creates new market dynamics. Subsequently, CL2 is altered as the market is now also competing on sustainability as it is recognized as a valid business model (Nijhof, Wins, Argyrou, & Chevrollier, 2022).

The third transition phase is labelled as the synergy phase and this transition phase is mostly focussing on the first movers who developed sustainable alternatives. In this third transition phase, the actors are aware that competition from transition phase two is needed to create efficiency and effectivity. However, there are still some challenges that cannot be solved by competing. Therefore, it becomes in this transition phase time to collaborate with each other to create a synergy. This collaboration will result in a changing enabling environment, thereby altering CL3 (Nijhof, Wins, Argyrou, & Chevrollier, 2022).

The last transition phase is characterised as the 'new normal' and is defined as the institutionalization phase. In this stage, the government regulates the new sustainable market and the policies are adjusted to this new normal. Laggards are confronted with their lagging sustainable behaviour, thereby altering CL4. In this transition phase, the four causal loops are in balance and the outcome is a sustainable market (Nijhof, Wins, Argyrou, & Chevrollier, 2022). Appendix A contains a detailed table in which the roles of the industry, government, NGO's, financial institutions and knowledge institutions are described for each transition phase.

3. Methodology

The empirical basis of this article is gathered by applying the multiple case study design of Yin (2003). A multiple case study allows researchers to confirm results from one case with the results from another case (Yin, 1981). An overview of the case study procedure is depicted in Figure 2. The procedure consists of three main stages and these stages are discussed separately in the following sections.

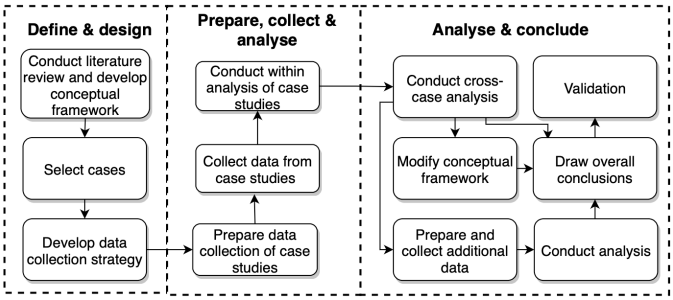

Figure 2 - Case study procedure (Taken and adjusted from Yin (2003))

3.1. Define and Design

Three cases were selected to conduct the multiple case study. The selection was done based on a set of criteria as random selection is "neither necessary nor even preferable" (Eisenhardt, 1989, p. 537). This study selected project de Parken in Apeldoorn, the circular bridge in Ulft and a modular parking garage project in a large city in the Netherlands. These projects were selected based on the following criteria: the project is procured with CPP as a lever, the project is finished and both manufacturing and civil engineering aspects are present.

The first case that was selected is a renovation project in Apeldoorn, a city the Netherlands. The project called "de Parken", comprises the renovation of public roads, pedestrian paths, sewage systems and the uncoupling of the rainwater drainage from the sewage system. Although the project has gained much attention in the media, the circularity potential is not pursued. The second case that was selected is the circular bridge project in Ulft. This project encompasses the replacement of an old bridge with a circular bridge. It was seen as a large-scale pilot project. The project type (i.e. cycling and pedestrian bridge) made it suitable to apply CPP. The project is seen as successful as the replaced bridge is almost circular. The third case that was selected is the design and construction of a modular parking garage in a large city in the Netherlands. In contrast with the other two cases, this case is not seen as a pilot project. This project is also considered as successful as it is almost fully demountable and re-useable.

A document study and semi-structured interviews were deployed in this study. This strategy provides insight into the CPP practices and their effects, and the transition phase of the selected cases. Procurement documents, selection guidelines, bids of contractors and information notices were analysed for each case. The interviews were conducted with both the clients and contractors and guided by an interview protocol. Using different perspectives provide a higher internal validity since triangulation (i.e. looking at the same phenomena from different perspectives (Gibbert & Ruigrok, 2010)) provides a stronger argumentation (Eisenhardt, 1989).

Table 1 presents an overview of the conducted interviews. The interviews belonging to the subject 'case studies' were conducted based on the aim of this study. The other interviews were conducted due to relevant findings from the case study interviews but were not part of the original research aim.

3.2. Prepare, Collect and Analyse

The conducted interviews were recorded, transcribed and sent back to the interviewees for verification. All the transcripts were approved after sending the first version. Both the documents and transcripts were analysed separately as this "allows the unique patterns of each case to emerge before investigators push to generalize patterns across cases. In addition, it gives investigators

a rich familiarity with each case which, in turn, accelerates cross-case comparison'' (Eisenhardt, 1989, p. 540).

Table 1 - Overview conducted interviews and function interviewee

Subject	Project	Organization	Role interviewee
Case studies	de Parken	Municipality	Procurer
		Municipality	Project manager
		Contractor	Project manager/ estimator
	Circular bridge	Municipality	Procurer
		Contractor	Project manager/ estimator
	Modular parking garage	University	Procurer
		Contractor	Head of department modular parking garage
Concrete paving industry	N.A.	Betonakkoord	Chairman
		Betonhuis	Sector manager concrete paving
		Supplier	Commercial director
		Supplier	Manager QHSE
		supplier	Manager product innovation and sustainability
Scalability	N.A.	Department of Waterways and Public Works	Project manager/ procurer and program manager circular bridges and viaducts

Cleverbridge ATLAS ti. 9.0 was used to code and analyse the documents and interview transcripts. The documents and interview transcripts were coded with the procedure recommended by Boeije (2010). The documents and transcripts were first open-coded, which implies that subjects of paragraphs or sentences may act as code. The second step was axial coding, which implies the identification and grouping of similar subjects or themes. The last step was to apply selective coding, which implies making the link between data fragments and literature. Axial and selective coding were applied during the cross-case analysis in the last stage of the case study procedure.

3.3. Analyse and Conclude

In the last stage of the case study procedure, the cross-case analysis was conducted and conclusions were drawn based on the analysis and literature. Furthermore, this last phase of the case study procedure was used to collect additional data as the cross-case analysis reveals that the concrete paving industry is a limiting industry in the development of circular products.

Humans are poor processors of much data (Eisenhardt, 1989). Therefore, it is valuable to apply a strategy to the cross-case analysis to avoid false conclusions. Eisenhardt (1989) discusses tactics for cross-case analysis and argues that it is more likely that unforeseen patterns or findings are captured when these tactics are used. In this study, the tactic of selecting pairs of cases and then identifying similarities and differences was used. The underlying principle is: "The juxtaposition of seemingly similar cases by a researcher looking for differences can break simplistic frames. In the same way, the search for similarity in a seemingly different pair also can lead to more sophisticated understanding'' (Eisenhardt, 1989, p. 541).

The cross-case analysis is also used to determine the transition phase of the selected cases. The SMTF differentiates between the transition phases by looking at the different roles which affected actors perform. These roles (see Appendix A), examples presented by Simons and Nijhof (2021) and the results from the cross-case analysis were utilised to determine the transition phase of the selected case studies. Eventually, the determined transition phases were validated with SMTF experts.

4. Presentation and Analysis of Empirical Results

A few CPP elements were identified that impact the transition towards a sustainable construction industry. Section 4.1 presents these emergent CPP elements and its effects. In section 4.2, the transition phase of the case studies is determined by applying the SMTF. Additional but not unexpected findings, not considered in the original research aim are presented in Section 4.3. The final section presents an overview of the key results.

4.1. CPP-elements and Effects

Table 2 presents an overview of the CPP-elements and how they are implemented for each case separately. The application of these CPP-elements and its effect are discussed in the following six sections

4.1.1. Tender Specification

Project de Parken was procured by the municipality with a rather prescriptive specification. In turn, there was not much to decide for the contractor. The materials were all purchased by the municipality and many other specifics were determined by the city architect as the project has a protected cityscape. Furthermore, some designs were already made by the client despite the construction design team contract. These designs limited the contractor to develop and implement innovative circular products. However, the circularity specification "as circular as possible'' caused much creativeness among the incited bidders.

A rather functional specification was used in the circular bridge project. There were some specifications for the bearing capacity, minimal dimensions and environmental aspects (e.g. drainage of brine). However, these specifications were not considered as limiting. Material specifications were not defined because the municipality did not want to lock in solutions during tendering. Circular specifications were prescribed rather open to increase the solution freedom in the tender. The reasons for this were: (1) the municipality's perception was that the term circularity is not yet common for all interested actors. (2) Various options can be used to achieve a certain circularity level (e.g. biobased material).

In contrast, the modular parking garage project was procured rather prescriptively. A comprehensive set of requirements and specifications was included in the tender. Furthermore, there were prescriptive specifications regarding circularity in this project. One of the circularity specifications was: "all the elements should be demountable and should comply with the circularity policy of the client''. These prescriptive specifications were not acting as an obstruction to achieve circularity according to the contractor. Reasonably, this can be explained by the fully standardised concept which can be adjusted to a lot of specifications and requirements (e.g. entrance and exit areas and parking layout).

4.1.2. Evaluation Criteria

Subjective evaluation criteria were used to assess the bids in the procurement process of project de Parken. The contractors who participate in the tender process of project de Parken were asked to record a video. This video should include the contractor's circularity vision on the project. Quantitative evaluation criteria to

Table 2 – Overview CPP-elements

CPP-element	de Parken	Circular bridge	Modular Parking Garage
Tender specification	Prescriptive	Functional	Prescriptive
Evaluation criteria	Subjective	Objective	Subjective
Tender price	Ceiling price with budget shift possibilities	Ceiling price with budget shift possibilities	Price accounts for 60% in awarding
Relationship client-contractor	Collaborative	Collaborative	Arm's length
Time pressure	High	Low	High
KOMO label	Neglected	Neglected	Neglected

evaluate circularity were not included due to perceived difficulties of the client with measuring circularity of the diverse bids. In turn, the contractor's vision was assessed by a circularity specialist during the evaluation. However, the client in project de Parken state that: "due to subjective evaluation criteria, there was a significant risk that an inappropriate contractor was chosen''.

In contrast, the circular bridge project uses objective criteria to differentiate between the bids. The circularity potential was measured by a consultancy agency as the client perceived difficulties to objectively assess the bids. However, the contractor should deliver evidence for the objective assessment themselves. The winning contractor and client perceives this objective differentiation as time-consuming, difficult and not suitable for repetition. The contractor of the circular bridge stated that: "if there was another contractor with a better bid regarding circularity, the amount of evidence was decisive in the evaluation''. So it could be that the theoretically best bid is not assessed as the best bid due to missing evidence.

The client of the modular parking garage uses the contractor's circularity vision in the project to assess the evaluation criterion circularity. The contractor of the modular parking garage project stated that: "subjective evaluation criteria in a procurement guideline has a deterrent effect''. Although the used criteria can be judged subjective, the evaluation is performed objective.

4.1.3. Tender Price

Price was not part of the awarding method in both project de Parken and the circular bridge project. A ceiling price was deployed by the clients of these projects. One of the clients stated that: "eliminating the price component in tender evaluation creates trust in the relationship with the contractor''. The contractor of project de Parken state that: "a ceiling price in a tender triggers the contractor to focus on the added value instead the costs''. Furthermore, it was possible in both project de Parken and the circular bridge project to shift budgets. This flexibility around the ceiling price allows contractors to come up with innovative products that require less maintenance but have a higher initial price.

Price was only dominant in the awarding of the contract for the modular parking garage. The contractor perceived this as a facilitator as the interviewee states: "price dominance creates efficiency and standardisation''. However, the contractor also states that for further transition rounds (e.g. substituting the steel structure with a timber structure), less focus should be on budget.

4.1.4. Relationship between Client and Contractor

A high collaboration intensity between client and contractor was identified in project de Parken. The collaboration between client and contractor was specifically chosen as the client stated: "collaboration is essential in this kind of innovative projects''. However, the collaboration intensity was not as high as intended due to staff changes. Nevertheless, the collaboration between client and contractor was perceived as facilitator for knowledge exchange. As a result, arising opportunities were leveraged and risks inherent in innovative projects were mitigated.

The circular bridge project was procured by a construction design team. There was a high collaboration intensity between client and contractor within this contract type. The findings are like those of the project de Parken. A collaborative relationship was chosen by the client because, "we could procure the project in a traditional arm's length relationship, but then we as the client will not learn from the pilot project and arising issues. Furthermore, we want to have a vote when decisions were made''. The contractor stated that a collaborative relationship between client and contractor was conducive in label the project as successful.

In turn, the client of the modular parking garage uses a design and construct contract. This contract type is characterised by limited collaboration between client and contractor. Here it was preferred to make the design without collaborating with the client. The contractor stated, "building modular parking garages is our core business. Repeating projects facilitate us to learn and to further develop and optimise our projects''. Furthermore, the client stated that they had the opinion that a construction design team will not lead to better results in the project as the modular parking garage is already institutionalized.

4.1.5. Time Pressure

The time pressure to realise project de Parken was high due to the nature of the project and promises made to stakeholders. Leaving stakeholders behind with an uncompacted sand road to have extra time to search for circular materials was not possible due to these promises. Deviation from the planning to seek circularity goals was also not allowed due to promises made to stakeholders. The high time pressure during the project caused the low amount of applied circular principles. For upcoming projects, the client stated: "we will loosen the focus on time to seek the circularity goals''. The contractor confirms the value of a low time pressure to search and implement circularity principles.

The construction of the circular bridge was not affected by time pressure. The bid-winning contractor proposes to refurbish the old bridge and strengthen it with secondary (e.g. circular) materials. Due to the low time pressure, it was possible to lift the bridge out and transport it to the place where it was refurbished. There were enough other traffic routes that could be utilised without consequences. Furthermore, it was possible to wait a few weeks longer to get the proper circular materials because of the low time pressure.

In contrast, there was a high time pressure to realise the modular parking garage project. The time pressure in the project is caused by a parking lot shortage at the University. The contractor stated that time pressure did not affect the circularity potential in the project. In turn, they state that time pressure triggers the

contractor to analyse their working methods to optimise the construction process.

4.1.6. Quality Labels

The last important finding is that clients are heavily relying on formal quality labels. In the Dutch construction industry, it is common to specify products that have a so-called KOMO quality label. As most of circular products or materials are reused or refurbished, it is not always possible to deliver those labels. In this respect, clients of both project de Parken and the circular bridge project accepted materials and products if these were visually inspected by engineers. One of them stated: "the dimensions of steel profiles are standardised and known. It is easy and possible to measure the thickness of the profiles to verify whether the quality is sufficient". This manner of accepting materials in collaboration with clients was perceived positively by the contractors as KOMO quality labels obstruct innovations. In the modular parking garage project, visual inspections performed by the contractor substitute the KOMO quality label. The contractor gives warranties on the materials to build the modular parking garage. In this way, the client knows that materials of sufficient quality are delivered.

4.2. Sustainable Market Transformation Framework

This article deployed the SMTF of Simons and Nijhof (2021) to present the three chosen case studies on a maturity model. The underlying argumentation of how a transition phase is chosen is presented for each case separately in the following three sections.

4.2.1. Sustainable Maturity de Parken

Figure 3 presents the specifics of project De Parken on the SMTF. One key aspect of project de Parken is found which suggests that the crisis is not embraced yet. This aspect is the lack of circular commitment within the municipal organisation.

There are six characteristics of project de Parken which indicate that the project is in the first transition phase. These are: a well-attended market consultation, ceiling price, ignorance of formal quality labels, functional tender specifications, incomparable offers and subjective evaluation criteria. The market consultation organised by the municipality was well attended by the industry, indicating that the market is not denying the sustainability issue anymore. The ceiling price, ignorance of formal quality labels and a functional tender specification provide opportunities and space for the contractor to develop innovative products. Many incomparable offers were offered by the bidders as different solution principles were identified. Subjective evaluation criteria were used to differentiate between the bids as governmental bodies were not able to assess the innovative bids with objective evaluation criteria.

Two key aspects are found which implies that the project should be classified in the second transition phase. Firstly, a financial institution was engaged in the tender by the contractor, thereby engaging the value chain. Secondly, collaboration as a business model was embraced by both client and contractor and can be seen as the development of new business models.

To summarise, there are characteristics that can be classified as the start of the transition (phase 0) and the competitive advantage phase (phase 2). However, most of the characteristics of project de Parken are classified in the inception phase of the transition. As such, the project can be classified under this phase.

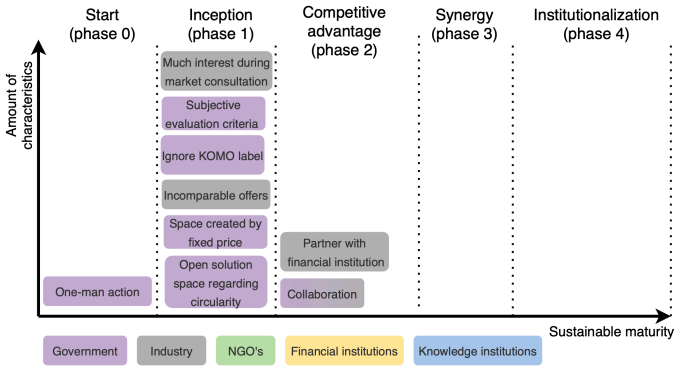

Figure 3 - Project de Parken presented on the SMTF

4.2.2. Sustainable Maturity Circular Bridge

Figure 4 presents the specifics of the circular bridge project on the SMTF. There are four characteristics of the circular bridge project which indicate that the project is in the first transition phase. These are: municipality embraced the sustainability crisis, ceiling price, ignorance of quality labels and a functional tender specification. The whole municipality embraced the sustainability crisis in the circular bridge project, indicating that the crisis is not denied. The ceiling price, ignorance of formal quality labels and a functional tender specification provide opportunities and space for the contractor to develop innovative products.

Six key aspects are found which suggest that the circular bridge project can be arranged in the second transition phase. These are: contract award fully on circularity, comparable bids offered by the industry, use of objective evaluation criteria, engagement of local timber and steel partners by the contractor and collaboration between client and contractor. Awarding the contract on circularity criteria only indicates that the municipality is recognizing the market leaders. The municipality could use objective evaluation criteria to differentiate between the comparable offers. The contractor with the best bid engaged a local timer and a steel partner in the project, thereby engaging the value chain. Collaboration as a business model was embraced by both client and contractor, suggesting the development of new business models.

Although there are some characteristics that can be classified to the inception phase (phase 1), most of the characteristics fall under the second transition phase. As such, the Circular Bridge project is characterised as a project which is in the second transition phase (i.e. competitive advantage).

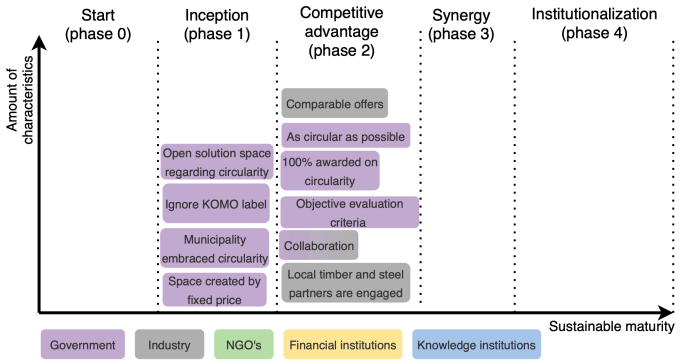

Figure 4 - Circular bridge project presented on the SMTF

4.2.3. Sustainable Maturity Modular Parking Garage

Figure 5 presents the specifics of the modular parking garage project on the SMTF. Only one key aspect of the modular parking garage project is found which suggests that the sustainability crisis is not yet embraced. This aspect is that the client of the modular

parking garage did not have the ambition to build a circular parking garage. Nevertheless, they got an almost circular parking garage.

Two key aspects are found which implies that the project should be classified in the second transition phase. Firstly, past performance is incorporated as a selection criterion. With this selection criteria, the municipality recognizes market leaders. Secondly, some local suppliers are engaged, meaning that the industry is engaging the value chain.

Six key aspects are found which suggest that the modular parking garage project can be arranged in the fourth transition phase. These are: complying with regulation, standardisation, low collaboration intensity between client and contractor, future transition rounds are noticed and the contractor will not participate in tenders without deconstruction criteria. Within the parking industry, there are norms and regulations developed for the modular parking garages. As a result, the modular parking garage concept is fully standardised, meaning that a parametric model is possible. It was therefore also not necessary, nor even preferable, to have a collaborative relationship between client and contractor. The developer of the modular parking garage is already thinking about how a timber structure can substitute the steel structure. This indicates that a new transition round is expected. The contractor of the modular parking garage indicated that it will not participate in a tender process without deconstruction criteria, implying that it will recognize leading clients.

In short, there are characteristics that can be classified as the start of the transition (phase 0), the competitive advantage phase (phase 2) and the institutionalization phase (phase 4). However, most of the characteristics of the modular parking garage project are classified in the fourth phase of the transition. Therefore, the modular parking garage project should be classified in the fourth transition phase (i.e. institutionalization).

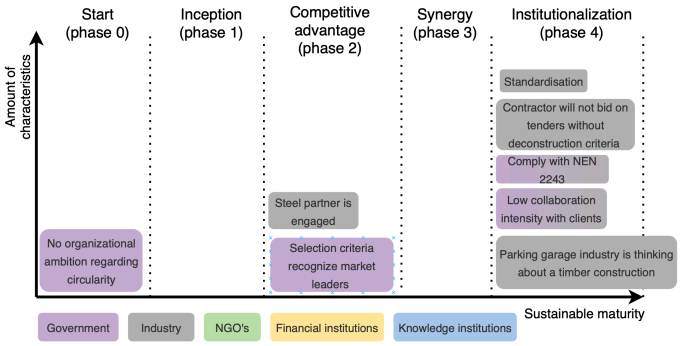

Figure 5 - Modular parking garage project presented on the SMTF

4.3. Market Characteristics Concrete Paving Market

Additional interviews, not included in the original research scope reveal that characteristics of the concrete pavement market influence the circular potential. It is found that one-dimensional price competition is still dominant. This highly competitive environment results in low margins for suppliers. Eventually, the funding of R&D activities stagnates. Although they have many potential sustainable alternatives for cement and biobased granulate, the highly competitive environment restrains suppliers to invest in R&D. However, the bid or quotation evaluators focus more and more on sustainability and thereby on circularity. Transactions are then evaluated based on price and the Environmental Cost Indicator (Dutch: Milieukostenindicator (MKI)). This evaluation provides more incentives to innovate.

Price is the only evaluation criteria when concrete paving products are traded for the private garden sector because private consumers do not value circularity. Generally, the margins within the private sector are larger than in the professional market. As a result, suppliers who participate both in the professional market and private market have more budget to spend on R&D compared to a supplier who participate in the professional market only with the same turnover. The opportunities to develop circular materials are in this respect larger. However, one must also consider that the handlings cost for the private market are much larger than for the professional market.

Despite, the low R&D expenditures, there are other triggers to develop innovative circular products. (1) Clients can specifically ask for innovative circular products. As a result, either by the contractor or directly by the client, the suppliers will be invited to develop innovative products. (2) Although there is a dominant market position, a concrete pavement supplier is always challenged by alternatives as the concrete pavement products can be easily replaced by asphalt or other alternatives.

The concrete paving market must deal with large volumes and weights during transport. Generally, suppliers of concrete paving products operate nationally because the transportation part of the MKI is neglected to promote economic prosperity at the expense of sustainability. However, all the interviewees state that transportation costs and profit have a trade-off. At a certain point, it is not profitable anymore to transport products from, for example, the east side to the west side of the Netherlands. This indicates a regional market rather than a national market.

4.4. Results Overview

Taken together, the results in this chapter suggest that there is an association between the appropriate application of procurement elements and the different transition phases considered in the SMTF. It seems that proper use of certain procurement element supports the transition towards a sustainable construction industry. Findings show that it is valuable to tender with functional specifications in the first phases of the transition. Once the project is awarded, a collaborative relationship between client and contract is supporting the development of innovative circular products. In this collaborative relationship, it is preferable to deviate from norms and regulations. In addition, the time and budget goals should have a flexible character. Releasing the time aspect is valuable for contractors to, for example, collect circular materials from other projects. Flexibility regarding budget allows contractors to come up with innovative circular products with higher initial costs compared to traditional solutions.

As soon as more sustainable maturity is achieved (i.e. the end phase of the transition), it is sufficient to have prescriptive tenders, as the best circular products are institutionalized. The project is preferably governed by an arm's length relationship between client and contractor. Norms and regulations are preferred as the product is institutionalised and scalability needs norms and regulations. In this arm's length relationship, there should be a tight focus on budget and time, as this creates efficiency and standardisation. However, repetitive projects are also a facilitator of this efficiency.

In the first phases of the transition, there are many different alternatives that should be assessed in the bid evaluation. It seems that due to these differences it is difficult to have objective criteria to assess the bids. However, this study did not find empirical evidence whether the end phase of the transition requires objective or subjective evaluation criteria.

Characteristics of the concrete pavement market influence the sustainable outcome. It seems that the price competition in the concrete paving market is limiting the R&D expenditures. The low R&D expenditures cause that circular innovations are lagging. However, pressure from other industries or from clients that are specifically demanding circular innovation is a trigger to innovate. Furthermore, suppliers who participate both in the private, as well

as public markets, have more opportunities to invest in R&D due to the higher profits in the private market.

5. Discussion and Limitations

The main aim of this study is to analyse from an SMTF perspective to which degree the Dutch CPP practices impact the transition towards a sustainable construction industry. While not all results were significant, the overall direction of results imply that proper use of certain procurement elements in relation to the transition phase supports the transition towards a sustainable construction industry. The findings from project de Parken and the circular bridge project are discussed first. Subsequently, the findings from the modular parking garage project are discussed. Following this, market characteristics are discussed in relation to the development of innovations. The last section presents the limitations of this study and directions for further research.

5.1. Developing Innovations in the First Transition Phases

This study found that public agencies should procure projects with a functional tender specification in the first phases of the transition. A functional tender specification acts as an innovation-oriented CPP-element and provides opportunities for contractors to develop innovative circular products. These findings support construction innovation literature arguing that tendering with functional specifications, within the boundaries of spatial design guidelines, provides bidders with incentives to develop innovative products (Lenderink, Halman, Boes, & Voordijk, 2020; Eriksson, et al., 2019; Blayse & Manley, 2004). In this respect, construction clients move away from a traditional risk-averse attitude as argued by Josephson et al. (2019). Contractors develop these innovative circular products based on their organization's vision rather than a one-off project's vision. This increases the effectiveness of CPP (Sönnichses & Clement, 2019) and supports sustainable goal-oriented transitions (Kemp & Rotmans, 2004).

As a result of the functional tender specification, a variety of alternatives are developed by contractors. However, findings indicate that clients perceive difficulties in determining the best bid out of these alternatives. Hyari (2017) corroborates this by arguing that bid evaluation is one of the most challenging tasks of a public agency. Furthermore, Lenderink et al. (2020) note the perceived difficulty by clients to assess innovative bids. This finding seems to indicate the need for comprehensive evaluation processes to evaluate the variety of alternatives. Tenders with functional specifications could be evaluated by an expert committee based on subjective evaluation criteria while following procurement regulations. Some subjectivity in the evaluation processes of innovations is unavoidable due to expert judgment (Lenderink, Halman, Boes, & Voordijk, 2020). However, avoiding this comprehensive assessment process could act as a barrier in the transition towards a sustainable construction industry.

Findings show that a collaborative relationship positively impacts the development of innovative circular products, knowledge creation and the development of an organization's vision regarding circularity. In line, Akintoye and Main (2007) confirm the value of collaborative relations between clients and contractors in projects to achieve innovations. On top of that, Dorée and Holmen (2004) refine the framework of Dubois and Gadde (2002) and discuss several relationships between organizations, projects and resources in terms of couplings and whether these couplings should be tight or loose to foster innovations. They found, in line with our findings, that the intra-project coupling between client and contractor should be tightened to foster the development of innovations. In this respect, the intra-project couplings refer to knowledge exchange between client and contractor due to personal interactions.

However, there is an inconsistency with the previously stated argument. Collaborative relationships do not necessarily result in innovative products. A notable example is project de Parken. This project used a construction design team contract but although the intention to innovate in the early phases of the project, staff changes caused that innovations were lacking. This is in line with Akintoye and Main (2007), as they state that the development of innovations in collaborative relationships is affected, but not limited to, by client disruptions.

In addition, a collaborative relationship between contractor and client provides opportunities to deviate from regulations and norms. The framework of regulations and norms should be wider in the first phases of the transition as this provides more opportunities to develop innovations. The uncertainty of whether an innovation will be approved or not is minimised as decisions are made in collaboration from the beginning of the project. This finding is consistent with that of van Waarden (1996) who states that innovations should be developed in a more open-regulated framework.

Another important finding was that public agencies should not have a dominant focus on tender price in the first two phases of the transition. In fact, budget shift opportunities should be incorporated. Focusing on quality instead of budget seeks circular quality and the development of innovations in the project. This finding corroborates the findings of Rose and Manly (2014) and Loosemore and Richard (2015). They observed that an overemphasis on the budget constrains the development of innovative products and moving away from lowest price tendering facilitates the development of innovations.

Concurrently, clients should pursue flexible goals regarding project delivery. This creates flexibility for contractors to, for example, search and collect appropriate materials or products in other parallel projects within the contractor's organization. These materials are often not directly available. Therefore, extra time is needed to collect the circular materials. This finding is supported by Lenderink et al. (2020) as they argue that sufficient time should be provided in the project to cope with delays inherent in innovation processes. Furthermore, time constraints are noted by Hartmann (2006) as an obstruction to innovation development. The body of literature focussing on collaboration underpins the flexible goals regarding budget and time, arguing that collaboration takes time and money (e.g. van Waarden (1996)). In addition, Simons and Nijhof (2021) argue that the conditions should be sufficient to develop innovative circular products. It seems that the flexible time and budget conditions should be secured in the contract to foster the collaborative relationship between client and contractor.

5.2. Institutionalization of the Best Product

When sustainable maturity is achieved (transition phase 4), the best alternative developed in the first transition phases is institutionalized. This study found that prescriptive tender specifications do not hamper the transition when procured products are institutionalized. If another crisis is not embraced yet, there is no specific need to incite contractors to develop innovative circular products with functional specifications. It seems that the contrary of the findings of, for example, Eriksson et al. (2019) preserve.

Prescriptive tenders do not incite contractors to develop innovations. Deviating from the standard in tenders by using a rather open tender specification could lead to additional adaption costs at the end of the project (Tadelis, 2012) as new norms and regulations are initiated by governmental bodies in the last transition phase (Simons & Nijhof, 2021). It is found that these norms and regulations should be rather closed to avoid uncertainty. This is in line with van Waarden (1996) as this author argues that closed regulation (i.e. low flexibility in regulation) leaves little room for new alternatives and provides certainty that something is permissible.

Findings show that a traditional arm's length relationship between client and contractor does not hamper the transition when institutionalized products are procured. Additional innovations in the last transition phase do not add value if solutions are locked in. Clients have a stronger tendency to tender on a lowest price base. The body of literature focussing on innovations in construction support this by arguing that there is a sunk-cost effect in relation to stimulating innovation by moving away from lowest price tendering (Blayse & Manley, 2004; Loosemore & Richard, 2015). Although there is a trend of moving away from arm's length relationships in the construction industry, this article confirms the value of arm's length relationships in the last transition phase to achieve efficiency. Tendering on a predominant price basis push contractors to make the institutionalized product more efficient by aiming at process innovations (van Waarden, 1996). However, Dubois and Gadde (2000) state that lowest price tendering hampers efficiency, thereby having a contrasting view.

In addition to the above, it is found that repetitive similar projects are key in the process of achieving efficiency. It allows contractors to learn from foregoing projects. This finding corroborates with Dorée and Holmen (2004) their revised model of Dubois & Gadde (2002). Dorée and Holmen (2004) state, that the inter-project couplings between sequential projects should be tightened to foster learning.

5.3. Market characteristics and Sustainable Outcome

The STMF of Simons and Nijhof (2021) is based on a set of causal loops (see Section 2.2). Findings from additional interviews reveal that market characteristics influence significantly whether a sustainable outcome is created or not. This study did not find evidence of which market characteristics are preferred in a certain transition phase. However, it seems that market characteristics affect the sustainable outcome in all phases.

This study found that fierce price competition in the concrete paving market limits the innovation rate as there is no budget for R&D. This is in line with the research of Masayuki (2021) as he states that quality competition leads to more innovation probability and R&D activities compared to a market which competes on price. This can be explained by the higher profitability of markets that are competing on quality (Masayuki, 2021). In contrast, this study found that R&D activities can be financed with higher profitability from private clients, within a market that is price oriented. However, despite R&D budgets, a company should also have, but not limited to, an appropriate organizational innovation capacity (Zhu & Cheung, 2017) and strategic flexibility to innovate (Medina, Lavado, & Cabrera, 2005).

The competition level (i.e. market form) influences the R&D investment. Companies in a competitive environment may have not sufficient financial means to finance R&D activities regularly, as hypothesized by Arvanitis & Woerter (2013). These authors also state that monopolistic companies are overcautious to spend resources on R&D. This view is in line with (Aghion, Bloom, Blundell, Griffith, & Howitt (2005) as they found empirically that a perfectly competitive environment or a monopolistic environment has fewer innovations. The oligopolistic market structure, however, creates significant R&D expenditures and thereby innovations, as R&D expenditures are positively correlated with innovations (Ramadini, Abazi-Alili, Dana, & Ibraimi, 2017). Although the concrete paving market shows oligopolistic characteristics, this study reveals that the fierce price competition mechanism caused the low R&D expenditures. This finding is contrary to Aghion, Bloom, Blundell, Griffith, & Howitt (2005) and Arvanitis & Woerter (2013) which have argued that amount of competitors influence the R&D expenditures. The Bertrand paradox arises, which implies that as soon market parties compete on a price basis to increase their market share, prices can be forced down to the level of variable costs. In turn, the parties do not have any budget to spend on R&D. This hampers the development of innovations and thus circularity principles in the construction industry (Maks & De Haan, 1997).

Although, concrete paving suppliers intend to operate nationally, the volume and weight of the products cause high transportation costs and force the suppliers to operate regionally. This is partly in line with Lowe (1987), however, our findings state that there is still competition in the region. This study did not find empirical evidence that regional monopolies are the result of bulky or heavy construction materials, as argued by Lowe (1987).

5.4. Limitations and Further Research

Although this study obtained useful results, the present study is not without limitations. Three major limitations of this study are identified. These limitations could be addressed in future research.

The most important limitation is that this study used only three case studies. An expansion of the sample size could lead to a higher generalization of the results. This is especially important in the construction industry as it is characterised by its uniqueness. The sample size could be increased by selecting a diversity of case studies from different domains (e.g. rail infrastructure, dike reinforcement or asphalt paving).

The study only focuses on the procurement strategies and the effects of it regarding the development and implementation of innovative circular products. However, it might be important to include project and contextual characteristics as well. The inclusion of these characteristics enables researchers to provide a more holistic view of sustainable transitions leveraged with CPP.

Finally, as we found that market characteristics influence the underlying causal loops of the SMTF, it is valuable to conduct future research whether the appropriate market characteristics differ throughout the transition phases. The business cycle (introduction, expansion, maturity and stagnation) proposed by Dorée, Holmen, & Caerteling (2003) could act as a starting point as they argue that every innovative company needs a monopoly situation to finance its innovation processes.

6. Conclusion

In the first transition phases, three key CPP-elements were identified that support the transition towards a sustainable construction industry. Firstly, it is found empirically that a functional specification in tenders is beneficial for bidders to develop and propose innovative circular products. The bidders are encouraged to develop innovative circular products based on their organization's vision rather than following the project's vision. Secondly, the transition impact could be further increased as construction companies and public agencies collaborate in projects. Essentially, collaboration is a prerequisite to develop innovative circular products. Due to this collaboration, knowledge is created and construction companies' visions regarding circularity are further developed. In addition to these two CPP-elements, time pressure and budget constraints influence the quality of the innovative circular products negatively. In turn, contractual conditions should secure flexible time and budget goals of the project to foster collaborative relationships.

Prescriptive tender specifications are more effective when sustainable maturity is achieved (i.e. the end phase of the transition). This effectiveness is caused by the institutionalization of the best alternatives from the first phase of the transition Concurrently, due to institutionalization, projects can be governed by more traditional arm's length relationships between clients and contractors. the focus on time and budget goals can be intensified. The focus on time and budget goals can be intensified as project relationships move to traditional arms-length relationships. The innovative circular products are institutionalized and a higher focus on time and budget goals results in efficiency.

An additional but not unexpected finding, not considered in the original research aim, was the significant influence market characteristics could have in the sustainable transition. Especially, competition mechanisms and important buyers and sellers impact the sustainability outcome.

This scholar suggests that public procurers and policymakers should acknowledge the sustainable transition impact of CPP-elements to deploy CPP more effectively in achieving a sustainable construction industry.

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9. Appendix A

Table 3 - The roles of different market actors in each transition phase (adapted from Nijhof, Wins, Argyrou, & Chevrollier (2022))

	Inception	**Competitive advantage**	**Synergy**	**Institutionalization**
Industry	• Stop denying the issue • Pilot CSR projects • Support foundations	• Develop sustainable business models • Engage value chains • Participate in ranking and benchmarks	• Communicate a non-competitive agenda • Form or join platform • Develop a sector strategy	• Lobby for the new normal • Recognize leading politicians • Comply with legislation
Government	• Embrace the crisis • Communicate a long-term vision • Make space for experiments and fund projects	• Emphasize long term vision • Be a launching customer • Recognize market leader	• Develop policy goas and measures • Support platforms and coalitions • Change tax incentives	• Show political leadership • Announce legislation • Remove the laggards
NGOs	• Raise awareness about the crisis • Be involved in pilot projects • Campaign against laggards	• Reward first movers and proactive corporate strategy • Name and shame the laggards • Emphasize that it is time to move on	• Be a watch dog and join platforms • Create transparency about the desired future • Pressure laggards	• Lobby the government to develop new policy • Monitor progress • Shift attention to new issues
Financial institutions	• Donate to charity projects • Finance projects via foundations • Apply negative screening to end relationships with high-risk clients	• Provide funding to frontrunners and sustainable business models • Engage with all clients, especially laggards • Apply best in class screening	• Join platforms with tax and finance expertise • Create financial solutions for scaling • Link long term investment to the new normal	• Lobby the government to develop new policy • Integrate new criteria in investment policies • Exclude unwilling clients
Knowledge institutes	• Study system loops to create awareness about the underlying problems • Identify good practices and showcase them	• Showcase good practices in research and education • Develop benchmarks and communicate periodic results • Define research agenda that could lift the entire market	• Continue to put pressure on change agenda by supporting lobbies with scientific evidence • Calculate the potentials impacts of the new normal	• Provide overview of various policy instruments • Monitor impacts of the new policy • Identify new and emerging issues