MASTER THESIS

THE TRANSITION TOWARDS ZERO-EMISSION CONSTRUCTION EQUIPMENT: IMPLICATIONS FOR PURCHASING & SUB-CONTRACTING

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ABSTRACT

This thesis examines the transition of the Dutch construction sector from fossil-fuelled construction equipment towards zero-emission construction equipment. The main research question of this thesis was: **"How can Strukton organise their processes to gain access to zero-emission construction equipment?"** and the main objective was to develop a purchasing and subcontracting strategy that Strukton can use when purchasing and subcontracting zero-emission construction equipment. The research integrates transition theory with purchasing theory and frameworks to analyse how purchasing and subcontracting must adapt during and after a transition.

Findings show that Strukton's current purchasing methods are characterised by a strong project-based orientation, with limited integration into a coherent, company-wide purchasing and subcontracting strategy. On the other hand, Strukton has realised that practices that might be suitable for the purchasing and subcontracting of traditional equipment might not be as suitable for zero-emission construction equipment. Overall, purchasing practices of Strukton are well-suited to deliver short-term project success but are less effective in positioning the company for long-term competitiveness, particularly in the context of zero-emission construction equipment.

The transition from traditional equipment towards zero-emission construction equipment changes the requirements for purchasing and subcontracting. This research showed (through the use of the frameworks of Kraljic, Bensaou and Dyer) that longer-term relationships with suppliers become essential in order to gain access to the equipment. Especially due to the lack of availability and thus the increased complexity in purchasing. For equipment types that are harder to obtain and are less available in the market, a more long-term relationship is needed. While simpler more available equipment could move more towards a short-term arms-length relationship as is happening now with conventional equipment.

Furthermore, it was found that purchasing during a transition (unstable regime) differs fundamentally from purchasing in a stable market regime. During this transition, access to zero-emission construction equipment holds more complexity and increased transaction costs. Purchasing and subcontracting strategies therefore need to account for this increased uncertainty and complexity. Once zero-emission construction equipment becomes part of the regime, traditional purchasing and subcontracting methods may again apply. The purchasing and subcontracting methods are thus more related to transition phase they are in then the equipment type itself.

These findings resulted in a purchasing and subcontracting strategy that was developed and validated for use within Strukton. The final strategy differentiates the three different levels of strategic, tactical and operational purchasing. It describes for each level which purchasing decisions can be made by Strukton and which purchasing and subcontracting methods might best fit the situation. Furthermore, it describes the risks associated with each purchasing decision and offers methods to reduce or manage these risks.

SAMENVATTING

Deze thesis onderzoekt de transitie van de Nederlandse bouwsector van traditionele fosiel materieel naar emissieloos materieel. De hoofdvraag van deze thesis luidde: **"Hoe kan Strukton haar processen organiseren om toegang te krijgen tot emissieloos materieel?"** Het doel was het ontwikkelen van een inkoop- en onderaannemingsstrategie die Strukton kan toepassen bij de inkoop en onderaannemening van emissieloos materieel. Het onderzoek integreert transitietheorie met inkooptheorie en modellen om te analyseren hoe inkoop- en onderaannemingspraktijken zich moeten aanpassen tijdens en na een transitie.

De resultaten tonen aan dat de huidige inkoopmethoden van Strukton worden gekenmerkt door een sterke projectgerichte oriëntatie, met een beperkte integratie in een samenhangende, organisatiebrede inkoop- en onderaannemingsstrategie. Tegelijkertijd heeft Strukton ingezien dat methoden die geschikt zijn voor de inkoop en onderaanneming van traditioneel materieel, mogelijk niet passend zijn voor emissieloos materieel. Over het algemeen genomen zijn de huidige inkoopmethoden goed afgestemd op het succesvol uitvoeren van korte termijn projecten, maar minder effectief in het versterken van de lange-termijn concurrentiepositie van het bedrijf, met name in de context van emissieloos materieel.

De overgang van traditioneel naar emissieloos materieel verandert de eisen die worden gesteld aan de manier van inkopen. Uit dit onderzoek, dat gebruik maakte van de modellen van Kraljic, Bensaou en Dyer, blijkt dat langere termijn relaties met onderaannemers essentieel worden om toegang te verkrijgen tot het benodige materieel. Dit geldt vooral vanwege de beperkte beschikbaarheid en de toegenomen complexiteit van de inkoopprocessen. Voor materieel dat moeilijk verkrijgbaar is en slecht beperkt beschikbaar is op de markt, zijn langere termijn samenwerkingen noodzakelijk. Eenvoudiger en breder beschikbaar materieel kan daarentegen nog steeds worden ingekocht via kortere termijn relaties, zoals momenteel gebruikelijk is bij traditioneel materieel.

Daarnaast blijkt dat inkoop tijdens een transitie (instabiel regime) fundamenteel verschilt van inkoop binnen een stabiel marktregime. Tijdens de transitie is de toegang tot emissieloos materieel complexer en gaan overeenkomsten gepaard met hogere transactiekosten. Inkoopstrategieën moeten daarom rekening houden met deze toegenomen onzekerheid en complexiteit. Zodra emissieloos materieel onderdeel wordt van het gevestigde marktregime, kunnen traditionele inkoopstrategieën opnieuw toegepast worden. De keuze voor een bepaalde inkoopstrategie hangt dus sterker samen met de fase van de transitie dan met het type materieel zelf.

Op basis van deze bevindingen is een inkoopstrategie ontwikkeld en gevalideerd die gebruikt kan worden door Strukton. De uiteindelijke strategie onderscheidt de drie niveaus van inkoop: strategisch, tactisch en operationeel. Voor elk niveau wordt beschreven welke beslissingen Strukton kan nemen en welke inkoopstrategieën het meest geschikt zijn in verschillende situaties. Daarnaast worden de risico's die samenhangen met elke inkoopmethode beschreven, evenals methoden om deze risico's te beperken en te beheersen.

CONTENTS

Part I

Introduction

1 INTRODUCTION

1.1 Problem Context

An ever-increasing number of institutions are demanding lower environmental impacts from the projects that they are tendering. One of the methods currently used to reduce those environmental impacts is the use of zero-emission construction equipment. Mainly transitioning away from diesel and gasoline fuelled equipment. Instead opting for equipment fuelled by electricity or, in far lesser numbers, hydrogen.

This transition from construction equipment fuelled by fossil fuels towards zero-emission is a major innovation (Kirkels et al., 2024; Koch & Kifokeris, 2021). This requires major innovations in how propulsion of vehicles is conducted. Currently diesel or gasoline is the industry standard. However, emission-reduction requires us to move away from those fuels. A first step could be to make use of HVO100, which can significantly reduce the CO2-emission (Kourkoumpas et al., 2024). Further reduction towards a zero-emission construction site however requires further innovation and development of electrified construction equipment. For the adoption of this equipment however a larger move towards collective agreements and incentive structures that increase the willingness from all market parties to invest into this equipment is required. Only in this way will it be possible for electrified construction equipment to become adopted throughout the entire supply chain (Karlsson et al., 2020).

Because (zero-emission) construction equipment and the transition towards it plays the dominant role in this research, background information on this equipment and its classifications, the transition towards zero-emission construction equipments, and the challenges regarding this transition can be found in Appendix B.

1.2 Problem Statement

Strukton Roads & Concrete (further abbreviated to 'Strukton') has recognised the transition that the construction market is going through, and has seen an increase in zero-emission demands in tenders. This could be in the form of clients directly mandating the use of zero-emission construction equipment in the tender, or through assigning higher values to bids which make use of zero-emission construction equipment.

In order for Strukton to stay competitive and secure tenders, Strukton has been required to make several promises to clients regarding the use of zero-emission construction equipment. Most of those promises were made recently as part of framework agreements with (semi-)public clients lasting some 8-12 years. Currently, some in-house knowledge regarding zero-emission construction equipment is available within Strukton. This however is often more conducted in an ad-hoc method than an overarching strategy regarding zero-emission construction equipment. Therefore, Strukton currently aims to increase their capabilities regarding zero-emission construction equipment to fulfil its contractual requirements.

The transition to zero-emission construction equipment however does pose several challenges for Strukton. Currently, Strukton barely possess any zero-emission construction equipment, nor do they have long-term partnerships with other contractors to ensure access to this equipment. Current zero-emission projects are conducted on an ad-hoc basis of hiring subcontractors which have the equipment available. To fulfil its contractual obligation, Strukton will need to find sustainable methods of accessing zero-emission construction equipment. Establishing sustainable methods of access however also requires long-term monetary investments. These investment can pose a significant financial risk to Strukton if they cannot achieve a return on this investment.

This could be achieved through being able to structurally use this equipment on projects for which clients are willing to pay the premium for the use of this equipment. And although clients are also aiming to reduce emissions and are envisioning a larger use of zero-emission construction equipment, the practice often differs. Quite often clients would love to use the equipment but on a more project to project basis it is often discovered that insufficient financial resources are allocated to the project to also pay for this equipment. Thus reverting back to the use of conventional equipment.

This is further complicated by the fact that Strukton mainly tendered on framework agreements. Which could in theory be quite beneficial, as they could offer a long-term use case for zero-emission construction equipment, which means that long-term investments can also be made. However, the reality differs. Often, clients promote framework contracts as containing a lot of works with zero-emission construction equipment. Yet, on a project to project basis the client often offers insufficient resources for zero-emission construction equipment and the contractor is requested to conduct the works with traditional equipment. This tendency does differ from client to client, with some more willing to put their money where their mouth is. But this tendency definitely makes it harder to anticipate whether an investment in zero-emission construction equipment will offer a profitable return on investment.

In short, Strukton sees the necessity to transition towards zero-emission construction equipment as the market is transitioning towards a (near) zero-emission construction sector. However, this requires significant investments from Strukton, which is currently unsure whether they can make a return on that investment. Therefore they seek to investigate methods they can use to purchase or subcontract zero-emission construction equipment while balancing their own (financial) risk.

1.3 Research Design

1.3.1 Research Objective

The main objective of this research is to design a strategy that Strukton Roads & Concrete can use for the purchasing and subcontracting of zero emission construction equipment.

1.3.2 Research Questions

In order to achieve the research objective, several research questions are established. The main research question has been defined as follows:

"How can Strukton organise their processes to gain access to zero-emission construction equipment?"

Note that in this question "access" is meant to be read in its broadest definition, so it could include at least all of the following: the direct purchasing of equipment, the leasing of equipment, partnering with contractors that posses the equipment, and the subcontracting of works to contractors that possess the equipment. In turn, to answer this research question and support the design of a decision support strategy, several sub questions are developed. These are:

1. **What methods for purchasing and subcontracting zero-emission construction equipment are available? And what are the benefits and disadvantages of these methods?**
    - Can portfolio approaches be used to investigate the purchasing and subcontracting op zero-emission construction equipment?
    - What do portfolio approaches tell us about purchasing and subcontracting of zero-emission construction equipment, and how does this differ from traditional construction equipment?

This first question aims to investigate methods that are available to Strukton to acquisition zero-emission construction equipment. This question lays the foundation to gain a good understanding of the possible buyer-supplier relationships and both the benefits and disadvantages of each of those possible options. It aims to do so through the lens of the portfolio approaches of Kraljic, Dyer and Bensaou as further explained in chapter 4.

2. **What future developments in the purchasing and subcontracting strategies for zero-emission construction equipment can be expected in the next 10 years?**
    - Can transition theory be used to investigate the transition towards zero-emission construction equipment?
    - What does transition theory tell us about the transition towards zero-emission construction equipment and what implications does this have for purchasing and subcontracting?
    - What effect does risk have on the purchasing and subcontracting of zero-emission construction equipment?

This second question aims to investigate any future developments in purchasing and subcontracting strategies for zero-emission construction equipment through the lens of transition theory (as further described in chapter 3). These developments are part of the transition and often caused by changes in either (or both) the supply side and the demand side for zero-emission construction equipment. This question is relevant, as any future purchasing or subcontracting strategy should take into account not only the current market dynamics but also those later on. Especially since most of the contracts of Strukton are in the form of framework agreements lasting 8-12 year.

3. **What are the key requirements for Strukton in developing a purchasing strategy for zero-emission construction equipment?**

This third question aims to investigate the requirements that the designed strategy should fulfil. It examines Strukton's current business and purchasing structure, as well as the requirements for the intended decision support strategy.

4. **Which strategy could Strukton best follow to acquisition zero-emission construction equipment?**

This fourth question brings all the other questions together: the first two sub-questions as basis and the third sub-question as requirements, and aims to use their answers to design and develop a suitable decision support strategy for Strukton to use. By answering this question, we can eventually reach the research objective.

1.3.3 Limits & Boundaries

To ensure the scope of the research, several points were taken into account:

- zero-emission construction equipment entails a large amount of machinery. The research mainly focuses on equipment for the use of transportation, earthmoving operations, and foundations. This focus is in line with the main construction equipment that is currently in use within Strukton and for which the transition to zero emission still holds severe challenges to Strukton.
- although the transition to zero-emission construction equipment is a (mostly) world-wide transition, this research focuses on the Dutch market. This focus is applied mainly because the transition to zero emission construction equipment is mainly driven by national laws and regulations and the transition, and what is required for this transition, can look considerable different between different countries.

1.4 Research Relevance

The practical relevance of this research is to help organisations, especially contractors, to gain a better insight into how they can adjust their business strategies to the changes that are currently occurring in the market regarding zero-emission construction equipment. The research intents to clarify to them what the current market looks like and what can be expected of the market in the future. Furthermore, it highlights the different methods that are available to organisations to purchase or subcontract zero-emission construction equipment. At last, it specifically addressed to situation within Strukton and advises Strukton how best to acquire access to zero-emission construction equipment.

The scientific relevance of this research is to contribute to the knowledge gap regarding supplier/buyer relationships in relation to zero-emission construction equipment with special emphasis on the Dutch market dynamics. In the current literature this specific topic has been addressed only sparsely. Supplier-buyer relationships have been explored well, including specifically for the construction sector which functions on a more project-basis (G. M. Winch, 2006). However, when investigating supplier-buyer relationships most scientific literature has focussed on the client-contractor relationships, while the supplier-contractor relationship has been investigated much less (Bemelmans et al., 2012; Kadefors et al., 2007). This research aims to investigate this gap in literature by focussing more on the supplier-contractor relationship. Furthermore, the specific case of zero-emission construction equipment is still an emerging topic which is worth exploring considering the current trends towards the use of this equipment.

2 METHODOLOGY

Verschuren and Doorewaard (2007) describe the development of a research methodology and differentiates between a purely theory-based research and a practice-based research. Although this research does also contain a theoretical approach of buyer-supplier relationships, the main focus and goal of the research is practice-based. The goal of this research is namely to deliver a contribution to the practical case of Strukton by designing a decision-support-strategy regarding purchasing and subcontracting zero-emission construction equipment.

A practice-based research could focus on several different aspects or phases: Problem Analysis, Diagnosis, Design, Intervention, and Evaluation (Verschuren & Doorewaard, 2007). For this research the problem analysis has already been established, as shown in section 1.2. Therefore, this research will aim to deliver a contribution in the diagnosis and design. Diagnosis entails the understanding of the underlying structures. Design entails the development of an intervention, namely a strategy for the acquisition of zero-emission construction equipment. The last two aspects, intervention and evaluation, are not a part of this research. Intervention can be conducted by Strukton itself, while evaluation could be part of future research, but requires the intervention to be in place for some time.

In line with Verschuren and Doorewaard (2007) the first three sub questions can be considered part of diagnosis, while the fourth sub question can be considered part of design. The first three sub questions are part of diagnosis because the main goal is to find the underlying structures regarding buyer-supplier relationships, the future changes in these relationships and diagnosing the current situation within Strukton. The fourth sub question is part of design because its aim is to design a purchasing and subcontracting strategy for Strukton to acquire zero-emission construction equipment.

This research could thus be classified as a design study, with the first three research questions delivering the needed data to base the design on, while the fourth research question entails the actual design of the strategy.

In order to gain the necessary information to base the design on, a case study was conducted. This case study involved a study of the situation within Strukton. According to Eisenhardt (1989), a case study is a useful method for developing theory which aims to have a practical implication. This is also more recently supported by Yin (2018).

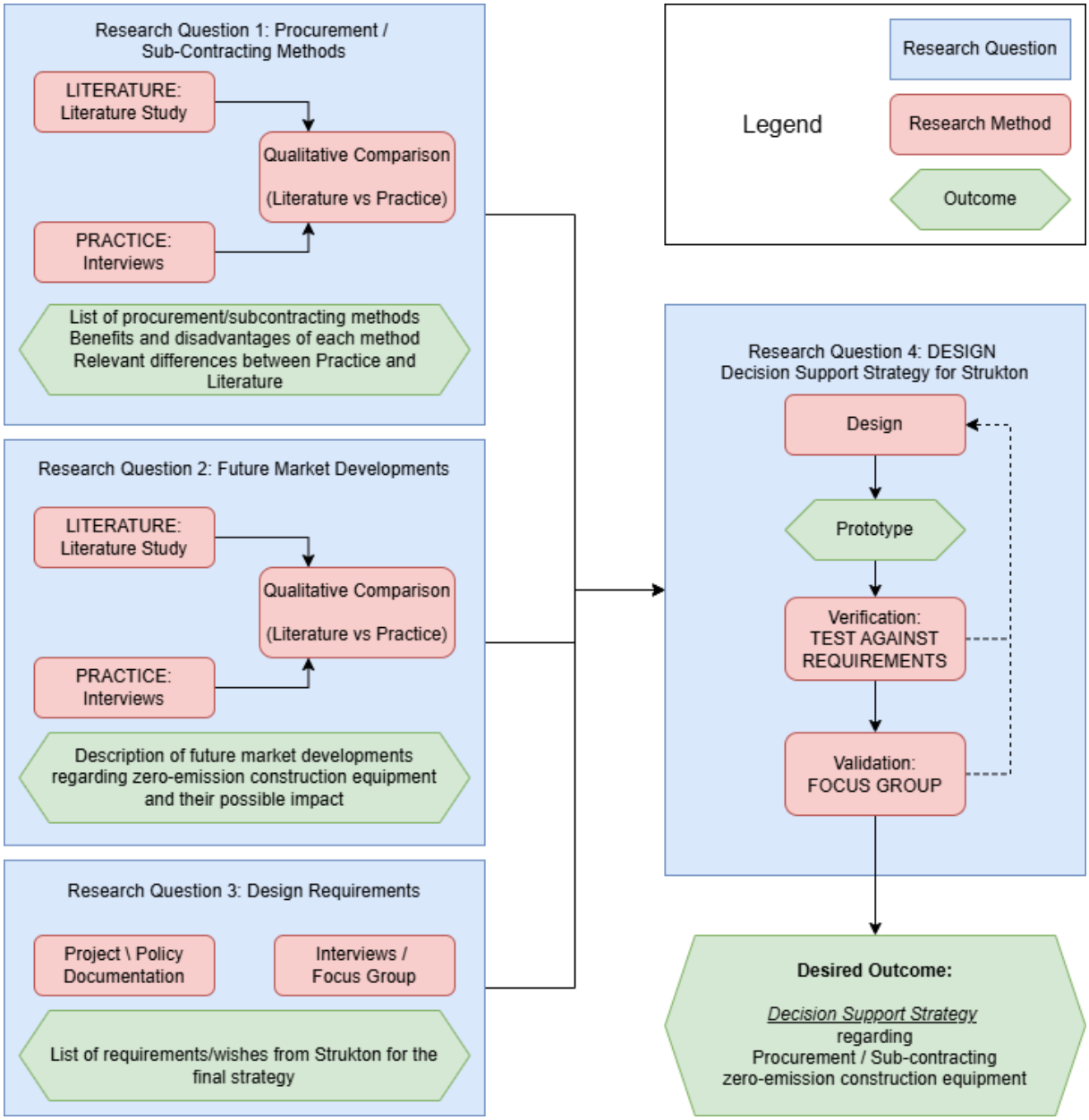
When conducting a research based on case studies, it should be considered whether a single or multiple cases should be investigated. Gustafsson (2017) provides arguments for both options. She argues that a single case study might be beneficial when studying a specific person or company. Furthermore, she argues that a single case study might increase quality and depth, due to an increase in the time spent on this single case. The selection of a single case study is further supported in the fact that this research is conducted for Strukton, and has the goal of developing a strategy suitable specifically for Strukton.

Verschuren and Doorewaard (2007) provides several suggestions to compensate for the disadvantages of a single case study. The first suggestion is to find several subcases within the

single case (for example, multiple contracts of Strukton). The second suggestion is to put a focus on triangulation, for which they differentiate between methodology-triangulations (using multiple different methodologies such as both a literature review and interviews), and sources-triangulations (using multiple different sources).

This all resulted in the research methodology as shown in Figure 2.1. As shown in Figure 2.1, different data gathering methods have been used for each of the different research questions. The methodology for research question 1 and 2 are largely the same, while both research question 3 and research question 4 require different methods. In the following sections, each of the methodologies will be explained.

Figure 2.1: Schematic Research Methodology



2.1 Literature Review

The research started with a literature review on the current information available in literature. The literature review was conducted through a narrative literature review. This allowed the investigation in a much broader scope than a systematic literature review (Bryman, 2015).

An initial search was conducted through a key-word search in academic search engines such as Google Scholar, Web of Science, and Scopus. Keywords, alongside some synonyms and variants, that were used as a starting point include:

- ”Purchasing”, ”Supply-Chain”, ”Contracting”, ”Partnering”, ”Supplier-Buyer”
- ”Zero-Emission”, ”Sustainability”, ”Green Public Procurement”
- ”Construction Equipment”, ”Non-Road Mobile Machinery”

After this initial search, citation search (looking through the references of the initial search) was used to identify further literature related to the topic, this was used in both a broadening and narrowing sense. Further tools such as ”ConnectedPapers” were used to find further relevant literature, especially prior and derivative works. As well as the relationship between different papers and the impact they had on the academic field.

The literature required for sub question 2 was harder to find in scientific literature as it might be less suitable to identify future trends, especially trends specific for the Dutch market. This kind of information is often simply not widely available in scientific literature. Therefore, the literature study included a larger amount of ’grey literature’, such as newspapers, trade magazines, government reports, and reports from branch-organisations (such as Bouwend Nederland, etc.). A watchful eye was kept to limit bias and maintain reliable data from those sources, since these ’grey literature’ do not uphold the same neutral and peer-reviewed standards that academic journals maintain.

This methodology also helps to develop a priori constructs to be used in later stages of this research, as advised by Eisenhardt (1989).

2.2 Interviews

Interviews with employees of Strukton and (sub)contractors of zero emission construction equipment have been organized to see which methods are currently applied or offered by those parties.

The selection of those employees of Strukton and (sub)contractors have been conducted in close cooperation with the supervisors of Strukton. Strukton already has a large number of relationships with different suppliers and/or (sub)contractors, which provides an easy intro into those companies. The following criteria were used to select interviewees:

1. the company is using, or has used, zero-emission construction equipment.
2. the company supplies (zero-emission) construction equipment to contractors.
3. the employee has extensive knowledge of the supply-chain of zero-emission construction equipment.

In total 8 employees of Strukton and 5 (sub)contractors have been selected and asked to participate. Of those, 6 of the 8 employees of Strukton and 4 of the 5 (sub)contractors were found to be willing to participate. The roles of each of the participants can be found in Table 2.1.

Table 2.1: Overview of Interviewees

Company:	**Function:**
Strukton	Program Manager Sustainability / Project Manager
Strukton	Purchaser
Strukton	Foreman
Strukton	Operations Manager
Strukton	Foreman
Strukton	Purchaser
Subcontractor A	Owner
Subcontractor B	Customer Relationship Manager
Subcontractor C	Director
Subcontractor D	Director

The interviews have been organised in a semi-structured style and have been tailored to each of the participants expertise. The use of semi-structured style interviews allows for enough structure to ensure all necessary topics are discussed, but also leaves enough room for interviewees to address topics they find relevant. (Kallio et al., 2016). The framework for qualitative semi-structured interviews developed by Kallio et al. (2016) has been used as a basis for the development of the interviews. This resulted in the interview template as shown in Appendix C. This template could be reduced or added to based on the exact expertise of the interviewee.

During the interviews, each of the participants were asked whether the interview could be recorded to support better processing. All of the participants accepted this request. Afterwards each of the interviews have been transcribed. This was done through either the standard transcription of Microsoft Teams, for those interviews which where held digitally, or through the use of a local version of Whisper-AI. Each of the transcripts where then checked and refined manually by re-listening to each of the interviews.

After the transcription, coding could take place to find relevant themes in each of the interviews. The benefits of coding the interviews are that it decreases bias and creates a higher transparency. In coding interviews we could assume both a inductive, deductive or mixed method of coding. For this research a mixed method was used. Coding started with a deductively derived list of codes, which followed from the literature research. During coding additional codes were found and added inductively. This required an iterative process of coding the interviews, thus going through the different interviews multiple times.

This coding thus, allowed for a more structured and systematic analysis of the qualitative data gathered from the interviews. The results of this coding can be used to compare the different interviews, as well as to detect whether a certain level of saturation has been achieved.

To support coding the software ATLAS.ti under a UT-licence has been used. Initially a total of well over 400 quotes where found which where assigned 155 unique codes. After reviewing these codes and combining for example synonyms and similar codes and removing irrelevant codes this was significantly reduced. This reducing resulted in a total of 82 codes, separated into 17 main categories. A total overview of all the categories and codes can be found in Appendix E. Included in this overview is also indicated in how many (and which) of the interviews any of the codes and categories was addressed.

To check whether enough interviews where held a code saturation test was conducted. This saturation test allows to identify if all relevant themes have been mentioned and explored in the interviews. (Braun & Clarke, 2021; Hennink & Kaiser, 2022; Hennink et al., 2017) This is done by setting the interviews in a random order and check for every subsequent interview how many new codes are discovered within that interview. As long as no (or very few) new codes

are found in later interviews it can be assumed that saturation has occurred. The results of this can be seen in Figure 2.2. From this figure it can be concluded that sufficient code saturation has been reached after the 10 interviews.

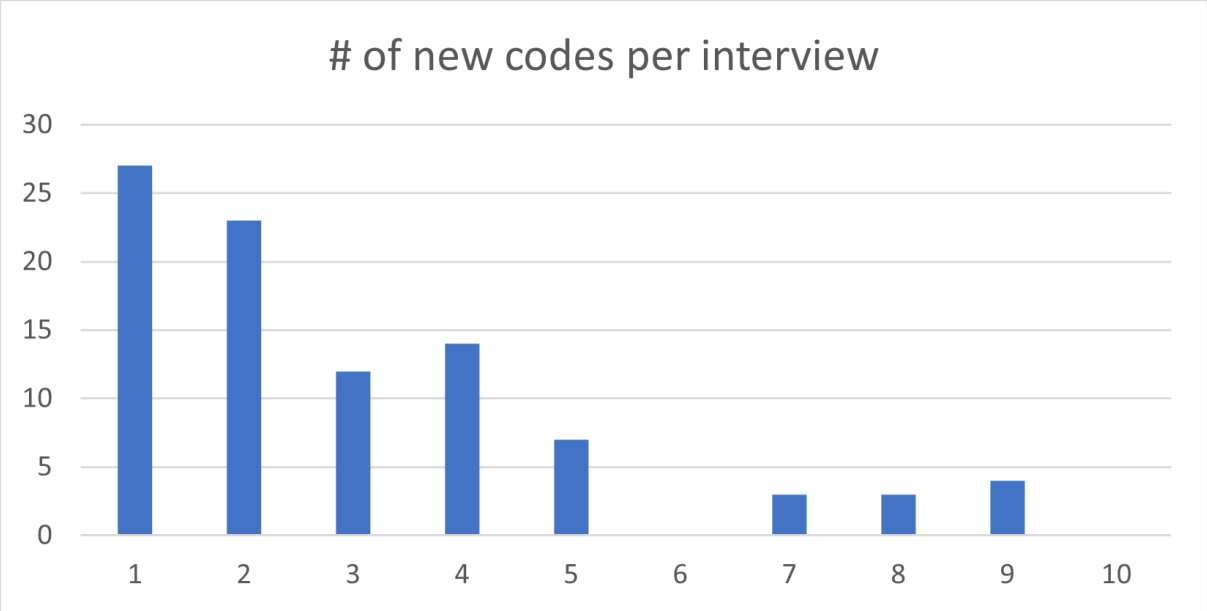


Figure 2.2: Interview Coding Saturation

2.3 Qualitative Comparison

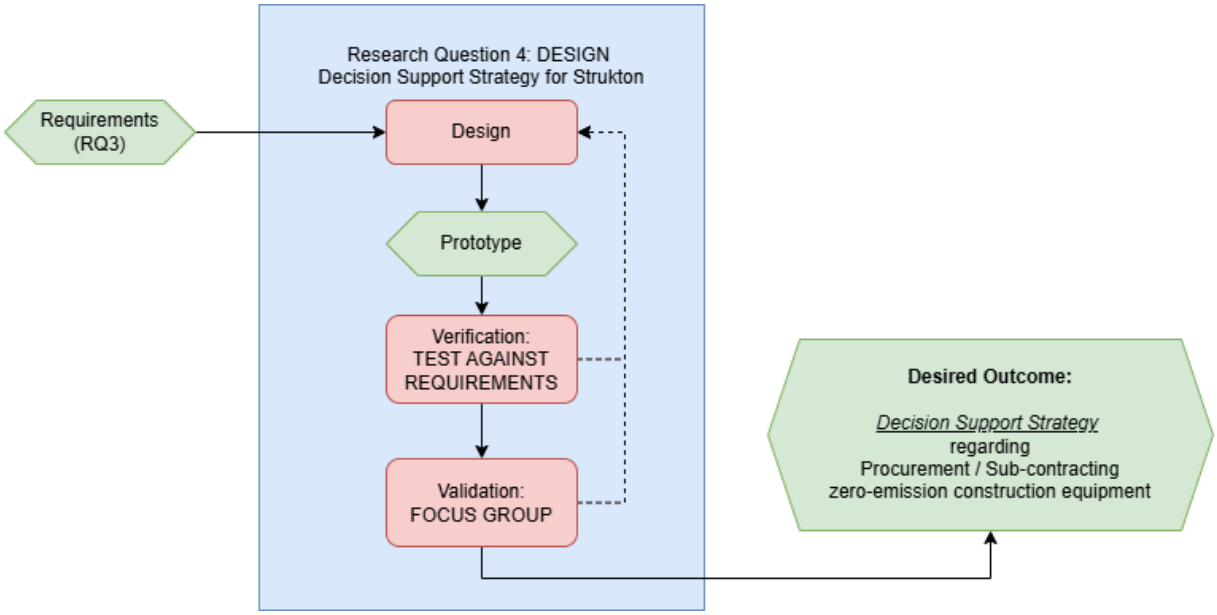
After the literature has been examined, and the interviews conducted, a qualitative comparison between the two can take place. This qualitative comparison allows to identify whether the methods described in the literature are also the methods that are used or possible in practice. This comparison does not only function to see whether the literature aligns with practice. It also serves to identify new methods (resulting from literature) that are not yet seen in practice. Or to identify methods that are seen as beneficial from the literature but are considered ill suited in practice. (Glaser & Strauss, 1967)

2.4 Design of Purchasing Strategy

The last sub question aimed to design the decision support strategy. The answers to the previous sub questions served as the basis for this design. This part thus used a qualitative analysis of the answers to all the previous questions. It aimed to develop a strategy that Strukton can use in future projects. This last question also produced the desired outcome of a decision support strategy regarding purchasing / subcontracting for Strukton to be used in future projects.

To create this design several steps needed to be taken. These steps are visualised in figure 2.3 and will all be shortly described below. The actual development of the purchasing strategy can be found in chapter 8.

Figure 2.3: Schematic Research Methodology - Design Phase



2.4.1 Design of a Prototype

At first, a prototype of the decision support strategy was designed. This design was based on the requirements as determined in sub-question 3, as well as the information gained in sub-question 1 and 2. The requirements from sub-question 3 are separated into four categories, as defined by Verschuren and Doorewaard (2007): Functional, Contextual, User, and Structural Requirements. Functional requirements are those requirements that the strategy should be able to do. Contextual requirements describe under which conditions and in which situations the strategy should be able to be employed. User requirements are describing how the user should be able to work with the strategy. At last, structural requirements are describing the intangible characteristics of the strategy that are necessary to fulfil the other requirements.

These requirements, take together with the results of sub-question 1 and 2 resulted in a functional prototype. This prototype was than further verified and validated in the following steps, and adjusted and improved upon based on the shortcomings that were noted in the verification and validation steps. This is also represented in 2.3 by the dotted lines.

2.4.2 Verification

After the prototype had been developed, verification took place. Verification entails checking whether the developed artifact is in line with the requirements. This was done by looking at each of the requirements and proofing/arguing that each individual requirement is met within the design. A full overview of the verification process can be found in section 8.3.

2.4.3 Validation

To ensure that the prototype of the decision support strategy aligns with the practical needs and expectations of the final users a validation phase was conducted. This validation phase consisted of a focus group, with employees of Strukton as participants. During the session, participants evaluated the relevance, usability and completeness of the strategy. The insights that were gathered from this focus session were then used to help refine the final strategy. This ensured that the final design is applicable in real-world situations and is in line with the business structure of Strukton.

2.4.4 Final Design of Decision Support Strategy

At last, the prototype has been improved upon based on the results from the verification and validation steps. This resulted in the final decision support strategy that can be used in the purchasing of zero-emission construction equipment.

Part II

Theoretical Background & Framework

The theoretical background in this part will provide a framework to answer the first two research questions: *"What methods for purchasing/subcontracting zero-emission construction equipment are available?"* and *"What future developments in the purchasing strategies for zero-emission construction equipment can be expected in the next 10 years?"*

- First, it will explain **Transition Theory**. This theory can later be used to investigate the market dynamics.
- Second, it will explain **Purchasing and Subcontracting**. This theory can later be used to investigate the different purchasing and subcontracting options.

3 TRANSITION THEORY

The move towards zero-emission construction equipment can be viewed as a transition. A transition from the traditional construction equipment towards zero-emission construction equipment. To better understand the dynamics in this transition and the effects it has on the market dynamics, transition theory can used. A well known and often used transition theory has been developed by Geels (2002). His transition theory can be applied to zero-emission construction equipment as well as shown by Kirkels et al. (2024) and Aalbers (2022) in a Dutch setting and Koch and Kifokeris (2021) in a Nordic setting.

The following sections will describe two parts of the transition theory as developed by Geels: the 'Dynamic Multi-Level Perspective' and 'Transition Pathways'.

3.1 Dynamic Multi-Level Perspective

Geels (2002) has developed a dynamic multi-level perspective that can be used to study and understand socio-technical transitions. For this he focusses on three interrelated levels: the landscape (macro level), the regime (meso level) and, the niche (micro level). The landscape refers to the broader context in which a transition takes places. This involves for example all the environmental pressure but also cultural and political values. These are aspects that often have a very slow change-rate but can put pressure on the regime, forcing a transition to come about. The regime represents all the dominant configurations in the current social-technological system. This involves all the established technologies, markets, regulations and practices. For example, the procurement practices from (semi)-public agencies, the existence of fossil-fuel driven equipment, the current supply chain and configurations with (sub)contractors. The niche represents the space were innovation takes place. These innovations can slowly destabilize the regime and alter it.

A visualization of this perspective can be found in Figure 3.1

3.2 Transition Pathways

A major critique of the dynamic multi-level perspective as developed by Geels is that it holds a bias towards bottom-up innovations where the regime is mainly changed by input from niches, disregarding possible transitions that are caused primarily by changes in the landscape that put pressure on the regime. (Berkhout et al., 2004)

This critique is relevant for the transition towards zero-emission construction equipment as well. The transition towards zero-emission construction equipment is namely not primarily caused by bottom-up innovations through niches, instead the landscape in the Netherlands is rapidly changing due to the current nitrogen crisis. Thus forcing a much more top-down transition.

Luckily, this critique has been addressed by Geels and Kemp (2007) and Geels and Schot (2007) by developing four main pathways through which transitions can take place. Additionally

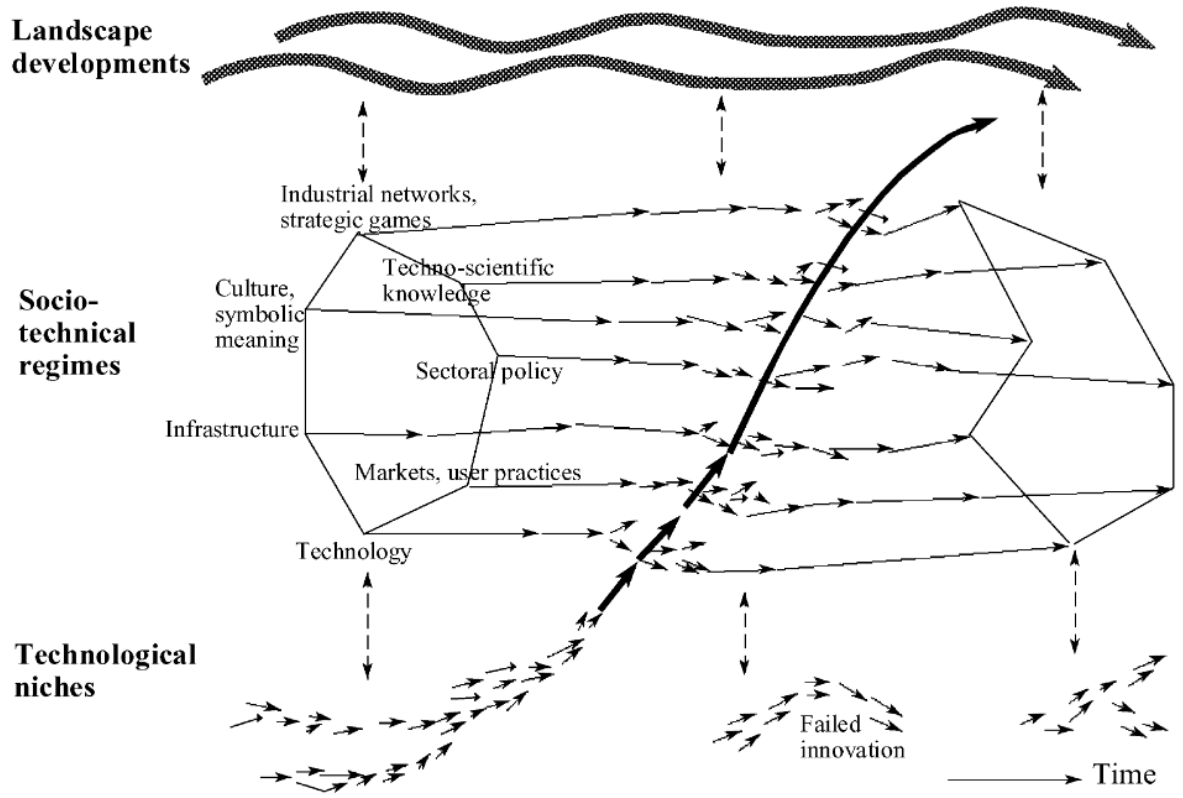


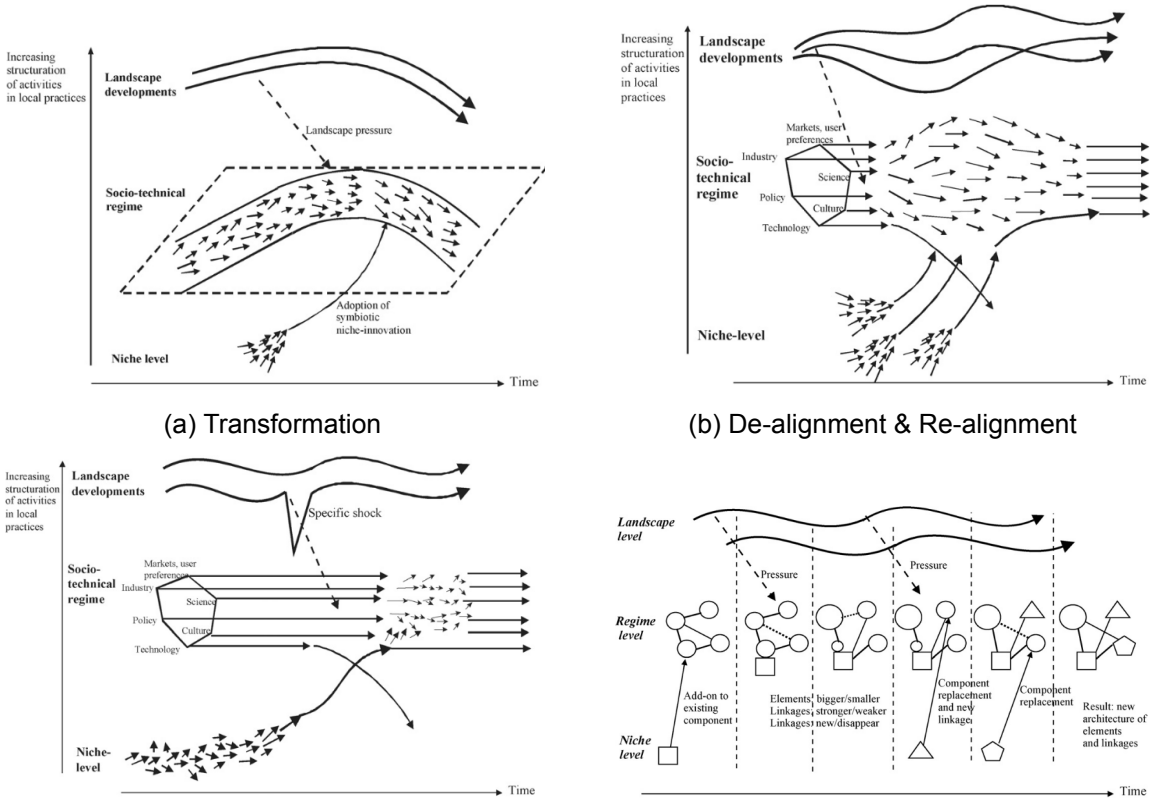
Figure 3.1: Dynamic multi-level perspective on transitions according to Geels (2002)

they argue that a sequence of transition pathways is possible. Resulting in the following list of pathways:

- **Transformation:** in a transformation pathway there is moderate pressure from the landscape, while there are no niche innovations yet. This might cause regime actors to start rearranging their activities. In this path the old regime is not replaced with a completely new regime, but grows out of the old regime.
- **De-alignment and Re-alignment:** de-alignment and re-alignment might take place when there is a sudden high pressure from the landscape. In this pathway there are not yet any well developed innovations from the niches that can take over, causing the regime to de-align. Instead of a clear preferable well developed niche, a lot of different yet-to-be developed niches exist, that might all start competing, until eventually a clear winner has been found that results in the stabilisation and re-alignment of the regime.
- **Technological Substitution:** when there is high pressure from the landscape and a clear niche-innovation has been developed it might breakthrough and cause the regime to adopt it. In this pathway there does already exist a clear and well-developed innovation, but this innovation is unable to break through because the regime is stable. The (sudden) high pressure from the landscape will destabilise the regime and allow the innovation to breakthrough and replace the current system/technology.
- **Reconfiguration:** when there is moderate pressure from the landscape and there are some niche-innovations available that might solve local problems within the regime the regime might start to adopt some of those niches. Slowly but steadily changing the regime.
- **Sequence of Transition Pathways:** When the landscape is posing 'disruptive change'

onto the regime it might set into motion a sequence of different transition pathways. 'Disruptive change' means that a slowly increasing pressure is applied on the regime from the landscape. Regime actors might thus perceive a low pressure from the landscape and start adapting, however when pressure rises different adaptations become possible. Moving again towards destabilization of the regime and the start of another pathway.

A visual representation of how these transition pathways work can be found in Figure 3.2.



(a) Transformation

(b) De-alignment & Re-alignment

(c) Technological Substitution

(d) Reconfiguration

Figure 3.2: Different Transition Pathways according to Geels and Schot (2007)

4 PURCHASING AND SUB-CONTRACTING THEORY

This chapter will introduce the various concepts necessary to investigate purchasing and sub-contracting methods. This chapter will:

- Separate Purchasing into a Strategic, Tactical, and Operational level.
- Describe the make-or-buy decision.
- Describe the broader range of purchasing options between the extremes of 'make' or 'buy'.
- Describe several frameworks that determine how to organise and structure the relationship between buyer and supplier when a 'buy'-decision is made.
- Describe the importance of risk and risk allocation in the relationship between buyer and supplier and which methods are available to manage this risk.

4.1 Strategic, Tactical & Operational Purchasing

Purchasing happens on multiple levels within an organisation. It is important to distinguish these different levels and separate purchasing policy and practice based on these different levels. (Muñoz et al., 2012; Weele, 1994) Figure 4.1 show these different levels of strategic, tactical and operational purchasing (Anthony, 1965; Weele, 1994).

The strategic level of purchasing focuses on the long-term strategic purchasing decisions. Anthony (1965) defines this level as "the process of deciding on objectives of the organisation, on changes in these objectives, on the resources used to attain these objectives, and on the policies that are to govern the acquisition, use, and disposition of these resources." This shows that the strategic level is mainly relevant for (top)-management setting company or department wide purchasing frameworks or decisions that span years. Its main focus is on setting the right objectives and policies, while lower levels focus more on the execution of those policies and achieving the objectives.

The tactical level of purchasing involves the level between the long-term strategic level and the short-term operational level. It mainly involves transforming the strategic policies into more actionable methods. According to Weele (1994) it mainly involves the defining of specifications, selecting suppliers and the contracting of broader (framework) contracts as well as managing the risks associated with the purchasing policies and decisions. The scope is also more limited than the strategic level. While the strategic level is often focussed on company or department wide purchasing policy, the tactical level focusses more on (smaller) business units.

The operational level of purchasing is more focused on the short-term day-to-day operations. Weele (1994) states that this mainly involves actions such as the ordering and expediting components of purchasing. In the case of the construction sector with its fragmented and project-based nature it often focuses at the day-to-day operation at project-level.

To conclude, purchasing operates on three levels — strategic, tactical, and operational — each with distinct roles and responsibilities. Strategic sets the long-term direction, tactical translates this into concrete plans, and operational handles day-to-day execution. Alignment between these levels is key to effective purchasing, especially in project-based sectors like construction.

Figure 4.1: Levels of Purchasing

4.2 The Make-or-Buy Decision

When an organisation requires a certain product or service the first decision that need to be made is ”do we want to make it ourselves or do we want to buy it from others?”. The outcome of this question defines the boundaries of the firm: what activities are performed in-house and which are outsourced to other organisations. (Cousins et al., 2008) The make-or-buy decision is a decision that is mainly taken at a strategic level.

Before we can answer this make-or-buy question we should first introduce the concepts of neoclassical microeconomics and the conflicting concept of transaction costs economics. The traditional view on economics is often seen as the neoclassical microeconomics. This perspective assumes three main things: a perfect competition, rational actors, and complete information. Although the idea of neoclassical microeconomics has served as a good method to describe many aspects, this view however holds some major limitation. In everyday business transactions, the assumptions of perfect competition, rational actors, and complete information often fall short. Often caused by uncertainty (lack of complete information); and human values, norms & emotion (rational actors). These characteristics cause it to be an inappropriate method of assessing the make-or-buy question. As a more fitting alternative, Williamson (1979) developed a competing concept of transaction costs economics. This concept has become an important framework to compare different purchasing strategies. Williamson (1979) argues that every transaction is associated with additional cost for achieving this transaction. The main dimensions are ’uncertainty’, ’frequency of exchange’, and ’the degree to which investments are transaction-specific’. This framework is not only useful to investigate the purchasing of products, but also of that of services such as construction equipment (Williamson, 2008; G. Winch, 1989).

Dahlman (1979) goes further into defining three main categories of transaction costs: search and information costs; bargaining and decision costs; and policing and enforcement costs. In the context of the construction industry transaction costs can be used to describe the interaction between a general contractor and a subcontractor when defining a contract. Search and information costs are those costs associated with finding subcontractors which are able to deliver what the general contractor is looking for. These costs involve both the costs for finding the subcontractor, as well as gaining the information about their abilities etc. The bargaining and decision costs are those costs associated with reaching an agreement with a subcontractor. These involve bargaining about the exact price and details of the service. At last, the policing and enforcement costs are associated with ensuring that the subcontractor adheres to the contract.

When these transaction costs increase, it becomes more and more advantages for a general

contractor to 'make' rather then 'buy'. In terms of services, such as the use of construction equipment, it means that when transaction costs are low it could be beneficial to subcontract the service to other parties. On the contrary, when transaction costs are high, it could be beneficial to ensure you have the ability to perform these services yourself.

This same principle of make-or-buy is relevant for the construction sector in general (G. Winch, 1989), and for the purchasing of zero-emission construction equipment as well. When transaction costs increase it becomes more and more advantages to 'make' (read: own) rather than 'buy' (read: subcontract) the equipment. Therefore, it can be concluded that transaction costs economics can serve as an effective tool to investigate whether or not a general contractor should acquire zero-emission construction equipment in-house or subcontract those equipment to subcontractors.

The answer to the question "do we want to make it ourselves or do we want to buy it from others?" thus determines what the boundaries of the firm should be and which level of vertical (de-)integration should be achieved.

4.3 The Spectrum between 'Make' and 'Buy'

The previous section showed that transaction costs economics is an effective tool to determine whether to make or buy. It does however look to two extremes: 'Make' or 'Buy'. In reality however a lot of options between making and buying exist.

A famous classification that shows this wider range has been developed by A. Cox. According to A. Cox (1996), contractual relations range from internal contracts (in other words: owning it yourselves) to adversarial leverages. Both of these methods represent a conflicting end of the spectrum of available contractual relations. In between these two extremes however a wide range of different contractual relations can be distinguished. He identified the following possible contractual relationships, which are also visualised in Figure 4.2.:

- **Adversarial Leverages:** The traditional methodology for procuring, in which companies are simply buying goods or services without much care for the relationship between the two parties. The typical arms-length relationships which are all to often used currently in the construction industry. Most often the best (read: cheapest) option is chosen.
- **Preferred Suppliers:** Another option would be that of 'preferred suppliers'. This option looks a lot like adversarial leverages, but distinguishes itself by limiting the amount of suppliers with which a company aims to set up supply lines. However, the buyer still holds all the power in the relationship. This does not mean that the relationship needs to be bad, but it indicates that the buyer can at any time decide to switch supplier without much loss.
- **Single Sourcing:** Single sourcing goes a step further than preferred suppliers in the fact that they limit the amount of suppliers even further. The main reason to do so is often to reduce transaction costs. In this category also the power imbalance starts to shift. Instead of all the power lying at the buyer, the supplier receives some power as it becomes harder and harder for the buyer to switch suppliers. This also encourages a more cooperative approach to the relationship.
- **Network Sourcing:** Network Sourcing assumes that ownership, control and power start to merge between the buyer and the supplier.
- **Strategic Supplier Alliances:** Within strategic supplier alliances the supplier and buyer enter into a relationship that is based on equality. They aim to align their goals and share the risk that is related to the investments they need to make.

- **Internal Contracts:** The last procurement methodology is that of internal contracts. This is also the farthest reaching method. Basically it means to acquire an in-house company to supply a certain good or service. In the case of construction equipment this could also entail the outright buying of equipment rather that gaining access to the equipment through subcontractors.

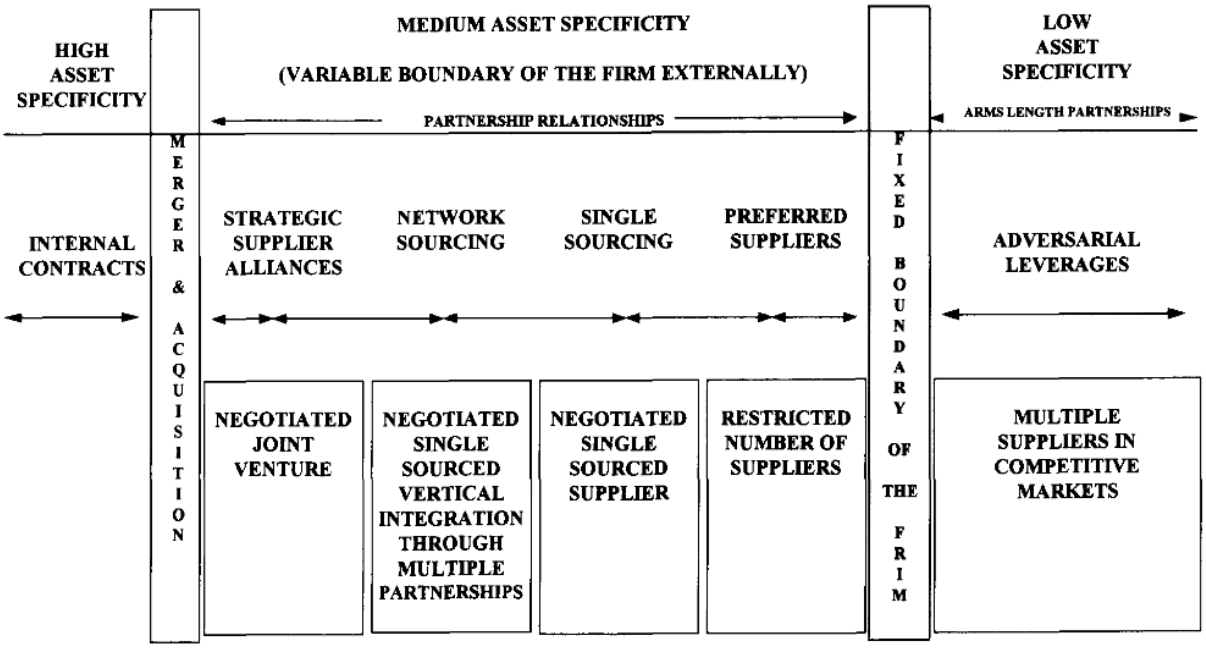


Figure 4.2: Continuum of Contractual Relations by A. Cox (1996)

These in-between variants make it possible, instead of making a strict choice between make or buy, to adopt a more nuanced and strategic approach that fits the phase of the transition and the market situation for a certain product or service.

4.4 The Relationship with the Supplier

When a construction company decides that the best situation for them is to 'buy' (read: subcontract) it becomes essential to investigate how the relationship between general contractor and subcontractor should be established.

In other words, how to organise their portfolio. The following sections will introduce three frameworks that are useful to investigate portfolio approaches that describe the relationship between buyer and supplier. these are the frameworks developed by Kraljic (1983), Bensaou (1999), and Dyer et al. (1998).

4.4.1 Kraljic

Kraljic (1983) described a matrix between the importance of purchasing and the risk/complexity of purchasing an item. The importance of purchasing takes into consideration how much impact (the lack of) a product or service has on the overall performance and profitability of an organisation. The supply risk / complexity entails how difficult it is to gain access to a product or service. This could be in the form of scarcity, technological complexity, volatility in the market and/or logistical constraints. He argues that depending on those two factors different product categories can be distinguished: strategic, leverage, bottleneck, and non-critical. For each different product category a different purchasing strategy should be used. As shown in Figure 4.3.

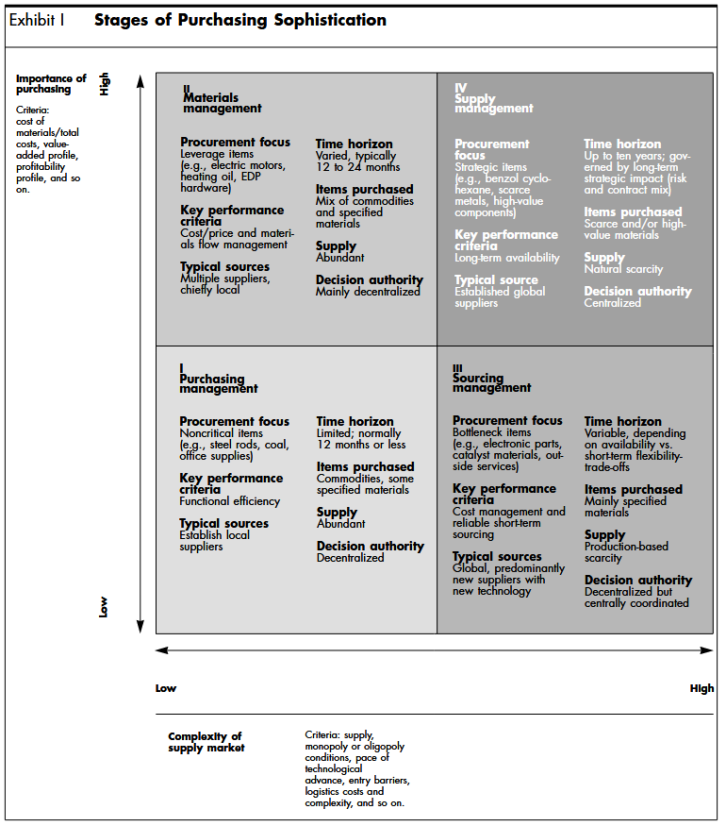


Figure 4.3: Kraljic

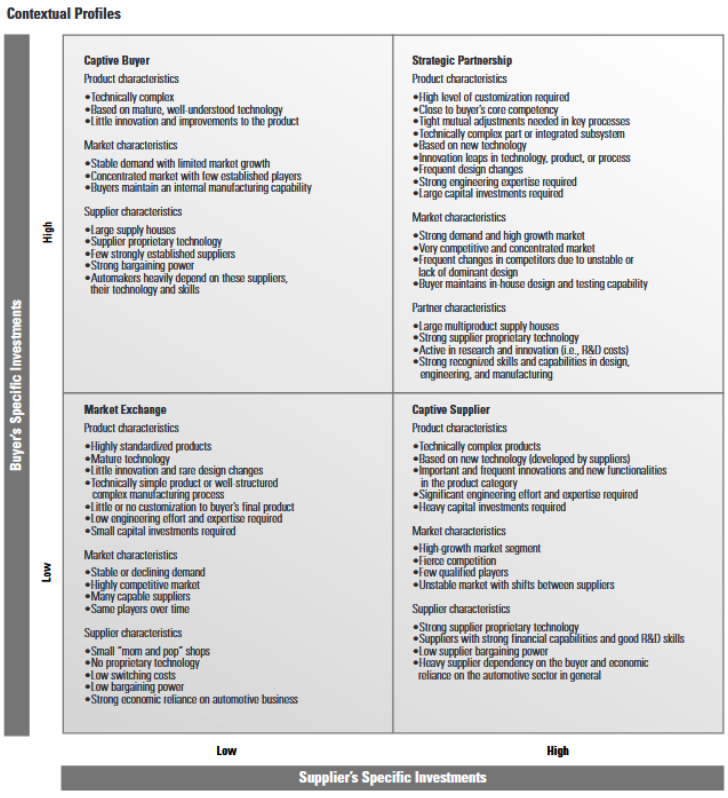


Figure 4.4: Bensaou

4.4.2 Bensaou

Bensaou (1999) mainly focusses on the relationship between buyer and supplier, mainly through the lens of level of trust, interdependence and collaboration. He argues that the kind of buyer-supplier relationship is mainly dependent on the specific investments both the buyer and the supplier are making to develop a certain relationship. As can be seen in Figure 4.4.

He argues that when both the supplier and buyer are needing low investments this turns into a standard market exchange. When both the supplier and buyer are needing high investments he argues that the wisest decision is that of a strategic partnership. However, when one of parties (either supplier or buyer) needs to conduct significantly more investments into a relationship this will lead to a power inequality which causes one of the parties to become 'captured' by the other. Thus turning into a captive buyer or captive supplier.

4.4.3 Dyer

Dyer et al. (1998) argues that it is possible to develop 'durable arm's length relationships'. Although this might sound counter-intuitive, as most often arm's length relationships are considered short-term, often having a general contractor hop between many different suppliers. Dyer however argues that this does not need to be the case. He argues that three factors impact the successful deployment of durable arm's length relationships:

- Transaction costs economics show that have to many different suppliers increases transaction costs that do not outweigh the benefits. Thus creating an incentive for a general contractor to limit the amount of suppliers.
- Economies of scale are achieved more easily if fewer supplier are involved in the process.
- Vigorous competition can be achieved even if fewer suppliers are involved. However, a precondition for this to occur is that those supplier are equally competent and managed skilfully.

However, in more modern descriptions of supplier-buyer relationships this relationship often gains the name of "preferred suppliers". Such as also shown in the distinction made by A. Cox.

Another purchasing method distinguished by Dyer is that of strategic partnerships. He argues that strategic partnerships are mainly applied when purchasing goods or services that are more specialised, rather that those goods or services that are more industry standard. In the context in the context of construction equipment it can be argued that traditional construction equipment has become quite the industry standard. For zero-emission construction equipment this is not the case yet, they can be seen as more specialised equipment. And only over time, when more and more become available might they become an industry standard item.

This distinction also has an impact on how the relationship with suppliers needs to be shaped.

TABLE 4. Contrasting Durable Arm's-Length Relationships with Strategic Partnership

	Durable Arm's-Length Relationships (Quasi Markets)	Strategic Partnerships (Quasi Hierarchies)
Product/Input Characteristics	• Commodity/standardized products • Open architecture products • Stand alone (no or few interaction effects with other inputs) • Low degree of supplier-buyer interdependence (sequential interdependence) • Low value inputs	• Customized, non-standard products • Closed architecture products • Multiple interaction effects with other inputs • High degree of supplier-buyer interdependence (reciprocal interdependence) • High value inputs
Supplier Management Practices	• Single functional interface (i.e., sales to purchasing) • Price benchmarking • Minimal assistance (minimal investment in interfirm knowledge-sharing routines) • Supplier performance can be easily contracted for ex ante • Contractual safeguards are sufficient to enforce agreements	• Multiple functional interfaces (e.g., engineering- to-engineering, manufacturing-to-manufacturing) • Capabilities benchmarking • Substantial assistance (substantial investments in interfirm knowledge-sharing routines) • Supplier performance on non-contractibles (e.g., innovation, quality, responsiveness) is important • Self-enforcing agreements are necessary for optimal performance (e.g., trust, stock ownership, etc.)

Figure 4.5: Dyer

4.4.4 Limitations of the portfolio approaches

A main problem in applying these traditional purchasing strategies in the construction sector is the difference between traditional 'streamlined firms' and that of construction firms that are functioning on a project-basis (G. Winch, 1998). This might invalidates some of the principles from these traditional purchasing strategies, thus a need for purchasing strategies that are focused on project-based firms become increasingly important.

Luckily Cox also recognized this problem and in A. Cox and Thompson (1997) then elaborates on his initial concept to create a system specific for the construction sector. According to A. Cox and Thompson (1997), a 'fit for purpose' contractual relationship should be reached between parties. However, one could then ask the question 'what is fit for purpose?' and 'how do we determine which method is fit for which purpose?'. During the development of a strategy aimed specifically for a construction company special attention should be given to these questions.

4.5 Risk Allocation

As shown in both Transaction Cost Economics and several of the frameworks, uncertainty is an important aspect in determining the relationship between buyer and supplier. This uncertainty brings with it risk. It is therefore of utmost importance to consider the risk involved with purchasing decisions. Furthermore, it becomes important to determine how to deal with the risk caused by the uncertainties associated with each of these purchasing decisions. According to Latham (1994), there are several ways of dealing with risks within the construction sector. They can be managed, minimised, shared, transferred or accepted. They should however, not be ignored.

Luckily, most actors within the Dutch construction sector recognize the existence of risks when purchasing zero-emission construction equipment. The added costs for this equipment is a

significant risk that needs to be borne by one or multiple parties. It is thus clearly not ignored.

However, the current strategy for nearly all actors within the Dutch construction sector is to transfer the risk to other parties. Public agencies are often risk averse and aim to externalise the risk towards general contractors. Those general contractors however are often working on small margins and aim to minimize risk as well. Often aiming to transfer some of the risk to their suppliers. This is also seen in the abundance of work being subcontracted. A main reason for this subcontracting is the reduction of risk and cost. This does however make it harder to achieve successful innovation. (Eriksson et al., 2007)

Transferring risk to others thus seems to be a widely used approach within the construction sector. However, when transferring risk to a contracting party, the contracting party often imposes a risk premium into their price. (Akintoye & MacLeod, 1997) This thus also means that correct risk management strategies should be employed when developing a purchasing and subcontracting strategy or policy. These strategies should be adjusted based on both the probability of the occurrence and the consequence of the risk occurring (A. W. Cox & Townsend, 1998).

4.6 Concluding Remarks

This chapter introduced several concepts necessary to investigate purchasing and subcontracting methods and that could serve as a basis for the purchasing strategy. It first separated purchasing into a strategic, tactical and operational level, allowing the investigation and the strategy to gain a more focussed approach. Secondly, it investigated the make-or-buy decision which determines when to make a product yourself or when to buy the product from others. However, a multitude of options fall between the spectrum of make-or-buy. This chapter introduced multiple frameworks (of Kraljic, Bensaou, and Dyer) that will be used in the following chapters to further investigate how the 'buy'-decision can be shaped. At last, it identified risk as an important factor in the relationship between buyer and supplier, determining or influencing many of the choses made within purchasing.

Part III

Results

The following part will describe the results of the research. It will first elaborate on the current purchasing and sub-contracting practices and strategy within Strukton. Secondly, it will investigate the market dynamics & developments and the implications those have on purchasing and sub-contracting during the transition towards zero-emission construction equipment. Thirdly, it will take a deeper look into purchasing and sub-contracting through the frameworks of Kraljic, Dyer, and Bensaou, and will investigate what future purchasing and sub-contracting methods are suitable to gain access to zero-emission construction equipment and why this differs from the methods that are suitable to gain access to traditional equipment.

Note that in this results part, references to the interviews to support findings are based on the coding in the format [CategoryCode-Interviewees] as found in Appendix E. So [A1-1,4] would reference to 'beperkt aanbod emissieloos materieel' as mentioned by interviewees number 1&4.

5 CURRENT STRATEGY & PRACTICES OF STRUKTON

Through the interviews that were held a clear overview of the current purchasing and subcontracting practices and strategy within Strukton can be established. In this chapter these practices and strategies will be elaborated on. This will happen according to the three levels: strategic, tactical & operational as defined in section 4.1.

5.1 Strategic Level

Strukton aims to organise several purchasing policies on a strategic level. However, a clear overarching strategy is still missing [I8-6]. Currently however, a sustainability vision is being worked on, which includes how to organise the purchasing of zero-emission construction equipment [I1-6]. This sustainability vision also involves the question 'were do we want to position ourselves in the market?'. As this development is partly overlapping with the research some of the strategic purchasing practices of Strukton might be altered in the (near) future. However, the research will describe the purchasing practices as currently applied within Strukton.

The strategic level will be explored through the following perspectives which resulted from the interviews:

- The Vertical (de-)integration
- The Coordination between departments
- The Order Portfolio
- The Reactive vs Proactive approach

5.1.1 Vertical (de-)integration

In the past, Strukton had a larger own 'materieeldienst'. Over the years however Strukton aimed to vertically de-integrate its organisation and abandoned large parts of its own 'materieeldienst'. At this moment Strukton has the strategic aim to limit the amount of owned equipment. They are aiming to be mainly a construction management firm. Thus primarily subcontracting works. [I4-1,7 & C1-1,4,6,9] When compared to other companies we can find that some companiees such as BAM and Heijmans still own significant amounts of equipment, especially equipment with a high-specificity. However, in general the strategy of Strukton is also that of which many traditional construction contractor firms have followed and which transformed into construction management firms (Nyström, 2019).

5.1.2 Coordination between departments

On a strategic level there is limited coordination between departments, mainly due to the project-based nature of the firm. Which limits the ability to find optimizations that could benefit Strukton as a whole. For example, Strukton has an internal company (see classification of Cox) aimed at

foundations: Terracon. However, this company is functioning largely as an independent company and even has to compete for projects within Strukton with other external companies.[C1-1,4,6,9] The same is true between different projects, the strategic focus is on profit maximization within each projects. However, there is relatively little effort invested in developing solutions that prioritize the overarching benefit to Strukton as a whole. Decision-making tends to be driven by the interests of individual projects, meaning that if a proposed solution would create negative (financial) impact for a single project, it is often rejected. Even if the long-term or organization-wide gains would outweigh the short-term losses. This project-based thinking limits the ability to implement strategies that could deliver greater value for Strukton as a whole.

5.1.3 Order Portfolio

Strukton does have a strategic aim for what kind of projects (mainly size) it want in its order-portfolio. However, regarding zero-emission construction equipment there is no strategic aim. This could entail, for example, aligning the procurement of works such that a certain amount of work for certain machines that are owned or subcontracted (on a long-term) Both could also entail aiming to get a certain percentage of works that will be conducted with zero-emission construction equipment. However, it was mentioned often that continuity of works for zero-emission construction equipment is a major factor in reducing risk. [A7-2,4,10 & B3-6,9] This is further shown that it is important to select the right clients [E7-6] as with most clients they do like the idea of using zero-emission construction equipment. However, in reality they are often unwilling to also provide the additional finances required to achieve this. [E3-2,5,6,7,9,10 & E4-4,6,10]

Furthermore, Strukton aims to create a continuous demand for ZE-equipment by signing framework agreements with clients. However, these agreements do not guarantee work for zero-emission construction equipment. [I1-6] Many of the clients simply scale back the demands for works such that they can also be conducted through the use of traditional equipment and is not willing to allocate the budget for zero-emission construction equipment.

5.1.4 Reactive vs Proactive Approach

Furthermore, Strukton has hold a reactive approach to purchasing and subcontracting. Strukton sees the use of zero-emission construction equipment primarily as a means to gain contracts rather than as a strategic long-term strategy towards the transition towards zero-emission construction equipment. They only start the search for subcontractors once they have clarity that they can perform a project. This reactive approach limits the ability of Strukton to actually gain access to zero-emission construction equipment. Since many subcontractors that own and operate the zero-emission construction equipment already use most of these on their own projects [A9-2,8], and that what is left to be used for general contractors is often send to contractors that have a longer history and are willing to take a proactive approach [A8-10] such that the subcontractor can have certainty that they will receive future works, preferably with a certain level of continuity. [A7-1,3,10]

5.2 Tactical Level

On a tactical level Strukton conducts several actions. This section will elaborate on the following topics which resulted from the interviews:

- Framework Contracts with Suppliers & Subcontractors
- Preferred Suppliers

- Methods of Purchasing & Subcontracting
- Long(er) Term Contracts

5.2.1 Framework Contracts with Suppliers & Subcontractors

To smoothen transactions Strukton aims to setup collaborations with several subcontractors and suppliers. These are mainly aimed at streamlining the process and include price agreements, payment agreements, etc. They are thus mainly focussed on reducing transaction costs. Those framework agreements do not entail availability or guarantees that Strukton can actually get the equipment. [I6-4] Furthermore, the decision to start with negotiating these framework contracts often stem from a more bottom-up approach. When the purchasing department of Strukton notices that a lot of work is done with a specific supplier/sub-contractor they might draft up a framework agreements such that future transactions are smoothened out. Rather than a top-down decision to find the best suppliers/sub-contractors.

5.2.2 Preferred Suppliers

Nonetheless, there are suppliers/sub-contractors that are seen as the preferred supplier. [H7-3,4,5,6,8] However, this is not a formal process and title. Instead it is more something that lives in the minds of those doing the purchasing & subcontracting. It is thus more tacit knowledge than actual policy. The preferred supplier model (see classification of Cox) however does offer lower transaction costs for establishing transactions and reduces risk and uncertainty because the supplier's previous results are clear.

This could however pose a problem when a transition towards zero-emission construction equipment is necessary. Suppliers that might excel in providing access to traditional equipment might not be the same suppliers that excel in providing access to zero-emission construction equipment. In current practice, Strukton still makes largely uses the same suppliers that they have always done, without too much consideration on whether this supplier is the most suitable for zero-emission construction equipment as well.

5.2.3 Methods of Purchasing & Subcontracting

The purchasing and subcontracting of zero-emission construction equipment might require a different approach than the purchasing & subcontracting of traditional equipment. [H5-10] Mainly due to the higher level of complexity involved, the limited availability and the necessary additional infrastructure needed to support this equipment. Currently, Strukton still largely uses the same purchasing & subcontracting methods for zero-emission construction equipment as they were used to with traditional equipment. [I11-5] This does not directly mean that they have not yet realised the fact that different methods might be more beneficial, but simply that they have not yet changed their purchasing & subcontracting practices.

5.2.4 Long(er) term contracts

As mentioned in the previous section, on a tactical level Strukton has noticed that gaining access to zero-emission construction equipment does require different methods of purchasing and subcontracting methods. One of the methods that they are currently looking into is in the form of long(er) term agreements with suppliers and subcontractors. [B2-1,3] However, they find it difficult to do so. This can partly be explained because there is no strategic vision regarding these long(er) term contracts. Furthermore, the risk-averse mentality can be a barrier in deciding to sign those long(er) term contracts. Current working practices aim to minimize risk, and thus contracts are often only signed when work is guaranteed. However, signing these long(er)

term contracts, inherently causes an increase in the risk that equipment is rented but no work for it is tendered/awarded. This thus requires a shift in mentality to realise new working practices and methods to deal with the (residual) risk.

5.3 Operational Level

Most purchasing within Strukton happens on the operational level. This section will elaborate on the following topics which resulted from the interviews:

- Project-Based Thinking
- Relationship-Based Selection
- Ad-Hoc Methodology
- Reducing Project Scope

5.3.1 Project-Based Thinking

Strukton, as most construction companies, functions very much on a project-based manner. Budgets and results are applied to each budget separately and foreman are judged mainly on the individual project results. This also means that purchasing and subcontracting often happens on a more project-based method, rather than a streamlined process (like in the automotive industry) [I10-1,2,4,5,6,7,8,10]. Within Strukton this project-based manner of working also resulting in a project-based thinking. Where optimization and cost-efficiencies are mainly sought within individual projects, rather than a more company wide approach.

This also becomes clear when looking to how purchasing and subcontracting is conducted. This often happens on a project-basis. Subcontractors are contracted for single projects, rather then a serial or parallel projects. Furthermore, the selection of subcontractors are mainly done by the foreman [I7-1,2,3,7] and are selected for individual projects [I10-1,2,4,5,6,7,8,10]. Although there are some preferences from a top-down method, it is still very much project-based and foreman-centred.

This shows that purchasing and subcontracting is heavily decentralized to the project-level.

5.3.2 Relationship-Based Selection

Building on the project-based thinking and the foreman centrered purchasing and subcontracting, we find that the selection is often based on relationships. The selection of suppliers/sub-contractors is thus often based on the relationship between the supplier and the project managers. They are often aware of the available suppliers/sub-contractors and have either good or bad relations with specific suppliers/sub-contractors. [H4-1,3,6,7,9] However, this might make the switch to zero-emission construction equipment harder because the foreman of those projects might not have the right knowledge about suppliers of this equipment. Nor will this information transfer easily due to the fragmented nature of projects.

5.3.3 Ad-hoc Methodology

Furthermore, these cooperations are often short-term and ad-hoc in nature. They are primarily formed to address the immediate needs of a single specific project or even part of a project. Once a project is concluded the cooperation typically dissolves.[H8-1,7] This decreases the opportunities for mutual learning or the development of more efficient, standardized ways of working together.

Furthermore, suppliers and subcontractors are often only willing to invest in zero-emission construction equipment when sufficient guarantees for future works are given. [A7-2,4,10]

5.3.4 Reducing Project Scope

What is also often observed is that foreman or project managers find that Strukton has tendered a project with the promise of zero-emission construction equipment or is in discussion with clients that might be willing to use them. But the foreman or project manager might find it hard to find a suitable subcontractor that is able and willing to provide the zero-emission construction equipment. On the short-term operational level it is then often decided to switch back to traditional equipment. [I5-4] Especially if clients are allowing it since they also benefit from this financially.

5.4 Concluding Remarks

This chapter described the purchasing practices of Strukton on a strategic, tactical, & operational level. Across the strategic, tactical, and operational levels, the purchasing and subcontracting practices of Strukton show a strong project-based orientation, with limited integration into a coherent, company-wide strategy. While the ongoing development of a sustainability vision offers potential for change current decision-making remains largely reactive and decentralized.

On the other hand it can be concluded that Strukton has realised that practices that might be suitable for the purchasing & subcontracting of traditional equipment might not be as suitable for zero-emission construction equipment. However, what methods might be more suitable is still up for debate within Strukton. Which also resulted in Strukton not (yet) adjusting their practices to better suite the purchasing & subcontracting of zero-emission construction equipment.

Overall, purchasing practices of Strukton are well-suited to delivering short-term project success but are less effective in positioning the company for long-term competitiveness, particularly in the context of zero-emission construction equipment. Addressing this will require a shift toward a more integrated and proactive purchasing and subcontracting strategy, supported by stronger coordination, clearer strategic aims, and a willingness to balance short-term project trade-offs against long-term organisational benefits.

6 MARKET DYNAMICS & DEVELOPMENTS

In chapter 3 transition theory has been introduced. This chapter will build on that theory to describe the transition from traditional construction equipment towards zero-emission construction equipment. It will do so be describing the landscape changes, the organisation of the current regime, and the developments that er happening in the niches.

Furthermore, and most important, it will investigate what can be learned from this transition and what effect this transition has on the methodology through which purchasing and subcontracting takes place.

6.1 Landscape Changes

The landscape involves external, contextual factors that influence a system. Regarding the use of construction equipment we can clearly identify a range of landscape changes that can positively or negatively impact the pressure on the regime to change towards zero-emission construction equipment. An overview of these can be found in Table 6.1. Each of these changes will be elaborated on in further sections.

Table 6.1: Landscape Changes

Positive Pressure	**Negative Pressure**
1. Legal Requirements	1. 'Ravijnjaar'
2. Schoon & Emissieloos Bouwen	2. Political Climate
3. Nitrogen Crisis	3. Net Congestion

6.1.1 Landscape pressure due to legal requirements

Every construction projects is faced with several challenges regarding NOx-deposits, CO2-emissions and particulate matter emissions. Construction equipment is responsible for large amounts of those emissions. A move to cleaner or even zero emission construction equipment is one of the main methods of reducing these emissions. In the Netherlands, these emission reductions have also been required by law. The 'Besluit Bouwwerken Leefomgeving' (article 7.19a) for example, has introduced the legal requirement to take adequate measures to reduce NOx-deposits (Rijksoverheid, 2018). While the "Klimaatakkoord" has set requirements for the reduction of CO2-emissions and other green house gases (Rijksoverheid, 2019). And at last a "Schone Lucht Akkoord" has been reached which requires a reduction in particulate matter emissions (Rijksoverheid, 2020). It is clear that all these legal requirements put a lot of pressure on the construction landscape to reduce emissions increasing the opportunities for zero-emission construction equipment to gain a foothold in the market.

6.1.2 Nitrogen Crisis

Although legal requirements have been set to reduce NOx-deposits the Dutch government has done insufficient to actually achieve the legal goals. Therefore, in 2019 the Raad van State declared the 'Programma Aanpak Stikstof' (PAS) as illegitimate, starting of the current nitrogen crisis in the Netherlands (Raad van State, 2019). This caused many construction projects to come to a halt. In order to decrease delay construction projects were forced to look into alternative methods of continuing construction projects which have significant nitrogen deposits. An alternative to this is the use of zero-emission construction equipment, thus creating more presurre onto the regime to adapt those niches.

This nitrogen crisis also explains why the Netherlands is among the first-adopters regarding zero-emission construction equipment. Other countries simply do not have the same landscape pressure due to nitrogen. The first innovators are part of the niches that are slowly introduced into the regime. Because the Netherlands is one of the first countries to make this move we see a lot of the uncertainty and risk.

6.1.3 Schoon & Emissieloos Bouwen

Furthermore, many public and semi-public actors have also recognized the need to reduce emissions, often going even further than required by law. Many of these actors have also committed to stricter requirements by signing a covenant called "Convenant Schoon en Emissieloos Bouwen" (Schoon en Emissieloos Bouwen, 2024).

This convenant is another main drivers in the transition towards emission reduction and eventually zero-emission. This concept hopes to create clarity for both government and market parties on what to expect regarding the transition to cleaner machinery. Furthermore, it aims to accelerate the transition by asked clients to commit to more stringent norms.

For this the SEB considers three main transition levels: Minimum, Basic, and Ambitious. The minimum simply describes the legal minimum that a client can request according to laws and regulations as stated in the previous section. The basic level adheres to more stringent norms while the ambitious levels makes that norms even more stringent.

The benefit for general contractors and subcontractors is that it creates more clarity about what to expect from clients. Both currently, and in the future. Many (public) clients like provinces, grid operators, waterboards and large utility companies have signed the convenant and are thus promising to use the more stringent norms, and thus more zero-emission construction equipment. This helps market parties better anticipate the amount of (future) work that will require zero-emission construction equipment, as well as which categories of machinery can be expected to move towards zero-emission first.

This convenant is thus creating additional pressure from the landscape onto the regime. Furthermore, it creates more clarity about what to expect in the future. Which in turn could help niches to develop more effective and efficiently.

6.1.4 Ravijnjaar

One of the main drivers for general contractors and subcontractor to invest in zero-emission construction equipment is based on the demand side [E1-1,3,6]. Thus, the request from clients to use zero-emission construction equipment is main driver behind the increasing market for zero-emission construction equipment. Many clients however are municipalities. Which are expecting some difficult financial years, due to political reasons their income is significantly reduced. Leading to a 'ravijnjaar' in 2026 [D5-5,8,10]. In many municipal projects, the use of

zero emission construction equipment is driven not by a direct need (e.g. nitrogen deposits or zero-emission zones) but by a wish to become more green and sustainable. However, the use of zero-emission construction equipment has been more expensive then traditional equipment. Thus, the financial problems for municipalities can result in less demand from these municipalities for infrastructure works, and especially a lower demand for zero-emission construction equipment when this is not absolutely necessary.

6.1.5 Political Climate

The political climate is seen as a major factor in the speed with which the transition towards zero-emission construction equipment takes place. The political climate could function in both directions, both positive and negative. The current Dutch Political Climate however is shifting to the right, with parties less willing to invest in and fund green solutions gaining power. Partly because they simply do not really care about 'green solutions' as well as them being less willing to raise taxes to fund these endeavours. This thus results in a negative pressure towards zero-emission construction equipment. This results in less subsidies being available for zero-emission construction equipment as well as less projects on which governement agencies are proactively asking for emission reductions (can be in the form of hard demands as well as through more softer award-criteria) [D4-3,4,5,9,10]

6.1.6 Net Congestion

Another negative pressure is exerted by the fact the Dutch electric grid is heavily congested. This results in difficulties gaining electrical connections, both for general purpose as well as for charging infrastructure necessary for construction projects. Thus, even if clients want to use zero-emission construction equipment it simply might not be possible or feasible due to the net congestion. [B10-4,5,6,8,10]

6.2 The Regime

The current regime for fossil-fuel construction equipment is still heavily stable. This is also evident in the fact that requests for zero-emission construction equipment by clients is still very limited. [E2-1,2,4,5,6,7,9]

Many of the clients are semi-public agencies, and without a clear demand from those agencies it is hard for any niche to breakthrough. This demand on the other hand can only be created when landscape pressure becomes big enough for those semi-public agencies to start changing their demands. Often this need to happen in the form of changing tender requirements. Either in the form of direct requirements or through award criteria that prioritise zero-emission construction equipment. The current status-quo however holds mainly due to procurement practices that prioritise short-term cost and risk minimization.

Furthermore, dince the benefits of the use of zero emission construction equipment are currently externalised to society (CO2 emissions, NOx emissions, etc.) there is no financial benefits to project outcome by using ZE-equipment. The use of ZE-equipment does however increase the cost and risks within the project. This could of course be slightly changed if client focus more on (for example) MKI (Milieu Kosten Indicatie). This does allow the quantification of those externalized costs. However, the use of HVO100 or zero-emission is currently producing nearly equal MKI while HVO100 is significantly cheaper (Rijkswaterstaat, 2024). Mainly driven by the fact that current power production needed as fuel for zero-emission is still done with fossil fuels, the future transition towards cleaner energy however might give zero-emission a larger benefit in

MKI. So even these changes in the regime, although well intentioned, do not directly contribute to a market for zero-emission construction equipment.

Currently we are starting to see that the regime is starting to change, especially after the landscape shock of the nitrogen crisis in 2019. As well as more and more innovations starting to mature from the niches. Furthermore the infrastructure necessary to charge zero-emission construction equipment as well as the knowledge and experience of working with this equipment is starting to increase. Thus the regime is starting to move.

6.3 Niches

The niches represent the space where alternative technologies can emerge, develop and start to compete with the incumbent regime. The following section investigate what is happening in the niches and will investigate the current maturity of zero-emission construction equipment.

6.3.1 Hydrogen vs Electric

From the niches we can identify two main innovations: electric and hydrogen fuelled construction equipment. Both have been developed because they have the ability to significantly reduce the emission from the construction sector. Booth have been in development for some time. But most interviewees, especially the subcontractors that own equipment already have concluded that electric is likely to take the lead over hydrogen [J8-3,6,8,9,10]. One of the main reasons for this is that electric is more energy efficient, as transferring electric into hydrogen already losses some 50%. But also because full-electric is safer and logistically easier. Nevertheless, some argued that hydrogen could play a role in fuelling generators to charge the equipment on locations where electricity is not readily available [J8-8].

6.3.2 Technology & Production

Furthermore, many argued that technologically electric equipment is quite well developed. However, the fabrication process around it is still in its infancy, especially with the more renowned traditional European producers. In China the fabrication process is much better, but the comfort/quality is often worse and the willingness for Dutch companies to switch to these Chinese manufacturers is still low.

Most electric equipment that is currently bought by contractors is bought as a conventional machine, which is transported to the Netherlands where several companies have specialized in transforming these fossil-fuelled equipment into electric equipment. [D2-2,3,5,8,10] When manufacturers start producing these electric variants in-house and become available 'af fabriek' it is expected that the price for these equipment can decrease significantly.

Furthermore, more and more equipment becomes available as zero-emission variant and also with ever increasing power and size [D6-2,5]. This increase in availability is also decreasing the prices for both the initial investment when buying the equipment as well as the prices that are asked by subcontractors.

6.3.3 Maturity

The above shows that the niche of zero-emission construction equipment is no longer a small niche, it has proven itself to be a viable alternative. Which is also why many contractors are starting to invest. However, it also shows that it has not yet fully matured, there are still significant developments happening. We can thus conclude that the transition towards zero-emission construction equipment is still an ongoing transition.

6.4 What does this transition mean for purchasing?

An important conclusion to make, is that the transition to zero-emission construction equipment is still in the early phases. It is still gaining momentum and has not yet changed the standard practices (regime). However, in the future it can be expected that zero-emission construction equipment becomes the norm and turn into the new regime. This has some major implications for the purchasing and subcontracting methods of those equipment as well.

First of all, it should be recognized that during the transition a higher complexity to purchase or subcontract zero-emission construction equipment will be present. It will thus be harder to gain access to the equipment during the transition. This among others increases the transaction costs of a transaction, such as the search costs and bargaining costs. The purchasing and subcontracting methods need to reflect this increase in complexity and transaction costs during the transition.

However, the current methods (such as short-term, project-based purchasing) that can be used to purchase construction equipment might become relevant for zero-emission construction equipment as well once they become part of the standard regime. [K4-4,6] However, in the mean time, which can last many years different purchasing strategies might need to be followed to successfully implement zero-emission construction equipment.

Thus, the procurement methods might be more related to whether the equipment is part of the regime or of a niche than based on the kind of construction equipment.

7 PURCHASING AND SUB-CONTRACTING

7.1 Frameworks for Relationship between Supplier and Buyer

In section 4.4 several frameworks have been introduced that can be used to investigate purchasing and sub-contracting. This section will investigate how traditional and zero-emission construction equipment fits within these frameworks of Kraljic, Dyer and Bensaou and what implications this will have for the purchasing and sub-contracting during and after the transition towards zero-emission construction equipment as described in the previous chapter.

7.1.1 Kraljic

The Kraljic matrix differentiates between the axis of 'importance of purchasing' and 'complexity of the supply market'. In the case of Strukton, construction equipment (both traditional and zero-emission) have a high importance of purchasing. Because this equipment is essential for (nearly) all projects within Strukton and their unavailability often have big consequences. The main difference between traditional and zero-emission construction equipment however is the complexity of the supply market as shown in chapter 6. Traditional equipment is often readily available and thus hold low market complexity thus placing it into the 'leverage items'-category. Zero-emission construction equipment on the other hand have a much more complex supply market, thus placing it into the 'strategic items'-category.

Note that this distinction can be different for different kinds of equipment. For trucks and excavators, the above is true. However, for more specialistic equipment, such as paving machines this is different. These also have a high complex market when they are fossil-fuelled, thus also placing it into the 'strategic items'-category. This can also be seen in the actions of many (general) contractors. They procure these high specific equipment different from for example trucks and excavators, often by buying them or taking on long-term commitments.

When considering that zero-emission construction equipment falls into a different quadrant, this also means that other purchasing and subcontracting methods and strategies should be applied. Strategic items should be purchased through a longer-term lens. By fostering long-term partnerships and joint-innovation. This is contrary to leverage items, where purchasing is much more short-term and based on competitive arms-length relationships.

7.1.2 Dyer

In the framework of Dyer the distinction between quasi markets and quasi hierarchies is made. His framework also shows why purchasing and subcontracting practices between traditional and zero-emission construction equipment is different. Traditional construction equipment is a mature product with many supplier and low relation-specific investments are needed by buyers (either financial or in knowledge about working with the equipment). Thus the competitive arms-length purchasing mechanisms are effective and efficient. In contrast, zero-emission construction equipment has a much higher asset specificity, still has limited supplier availability. This

would, according to Dyer's framework be a situation in which a quasi-hierarchy must be more effective. Thus using cooperation with suppliers, mutual trust and development and long(er)-term commitments to increase effective purchasing and subcontracting.

Dyer's framework also goes beyond the simple make-or-buy decision as is done as well by A. Cox (1996), and rather focuses a bit more on the forms of cooperation. For zero-emission construction equipment we found that in the current form a different approach is needed (quasi-hierarchy) than for traditional equipment (quasi-market). This is due to the fact that ZE-construction equipment is still a niche. However, when this matures and becomes part of the regime it is very likely to become the same as traditional equipment right now. Thus, currently a quasi-hierarchy is the most effective method, slowly moving more and more towards a quasi-market as it matures.

7.1.3 Bensaou

In the context of zero-emission construction equipment Bensaou's idea of a captive supplier is very relevant. Especially considering the current risk allocation strategy followed by many general contractors. Often, the supplier is requested to make significant investments into zero-emission construction equipment, but the general contractor is not willing to guarantee that they will actually use the equipment. It is thus understandable that suppliers might be unwilling to engage in a 'captive supplier' relationships. Rather seeking for either a strategic partnership or a standard market exchange.

Transition towards a strategic partnership however also means that the buyer (general contractor) needs to invest into the relationship. This will however increase the financial risk for the general contractor. Thus, when transitioning towards zero-emission construction equipment it becomes necessary to realise that this requires a strategic shift in what is and is not acceptable as a risk, as well as how to deal with this risk.

When comparing this classification with traditional construction equipment we find that this is again placed within a different quadrant. Namely that of 'Market Exchange'. When procuring traditional construction equipment the buyer (general contractor) needs to do very few investments. The supplier does ofcourse need to make significant investments into the equipment. However, these investments are not specific to a single project / general contractor. The supplier can simply find another contractor that would like to use the equipment.

And again, just as is found in the comparison with Kraljic, it is the additional complexity of the transition that is the main factor in the change of quadrant. Which will mean that with more widespread adoption of zero-emission construction equipment it might become again a simple market exchange like the traditional construction equipment is today.

7.1.4 What does this mean for purchasing and subcontracting of ZE-equipment?

When looking across the three different frameworks a clear picture emerges. Zero-emission construction equipment currently holds a different position in purchasing and subcontracting strategy than traditional equipment. The frameworks suggest that the current phase of the transition warrants a more collaborative, longer-term, and risk-sharing purchasing and subcontracting approach. However, this strategy should not be static. The strategy should change alongside the maturing of zero-emission construction equipment. And could return to the current methods when the transition is completed.

7.2 Risk Management

As shown in section 4.5, risk is an important factor in purchasing and appropriate risk management strategies need to be implemented. This section will investigate the possible risk management strategies for the purchasing of zero-emission construction equipment.

7.2.1 Long-term vs Short-term Relationships

As shown in the previous section about the frameworks it becomes clear that purchasing and sub-contracting zero-emission construction equipment requires a long(er) term relationship. The same was found in the results of the interviews. [M-1,3,5,7,8,9,10] Longer-term relationships however also poses some risk. One of those risks that was identified, is that the (hourly) prices for ZE-equipment could decline when more supply becomes available and prices decline because of that. A pricedrop might especially occur when electric equipment is directly produced in the factory. This is currently often not the case, instead diesel equipment is bought, and transformed into electric equipment. This increases costs significantly. When supplier are starting to produce electric equipment directly in-factory this could significantly lower prices. [D2-2,3,5,8,10] Although lower prices seem good at the long-term, especially when they become more competitive with the prices of traditional construction equipment, there are also some risks involved. Many argued that creating long-term agreements was one of the only ways to gain access to zero-emission construction equipment. [B2-1,3,9] Creating long-term agreements / contracts with subcontractors might be somewhat riskier. Since the price of the equipment might decrease during the duration of this agreement / contract. Decreasing the competitive advantages.

7.2.2 How to deal with residual risks?

Another important theme from the interviews, which was also extensively addressed in the literature is that of risk allocation. [Q-1,3,4,6,9] Currently all actors in the supply chain seem to try to minimize their own risk. Although understandable, it is impossible to minimize the risk entirely. It thus becomes the question: who need to take which part of the risk? And, how can we limit the risk the most?

Currently the client is unlikely to accepted must risk, while many of the subcontractors have taken a leading role in purchasing equipment, but even though they are still reluctant to do so unless they have near absolute certainty that they will gain a return on investment. The strategy of the general contractors currently mainly seem to minimize risk. However, the analysis in previous chapters showed that the that methodology can not be sustained if a general contractor wants to start using zero-emission construction equipment. The strategic choice to start using this equipment inherently brings with it risk. It thus becomes essential to find methods and adjust working practices in such a manner that possible residual risks can be even further solved. From the interviews several options were provided and will be elaborated on:

- Using ZE-equipment on normal projects
- Sublet to other contractors
- Have clear 'ownership' of equipment

Using ZE-equipment on normal projects: a major problem of having long-term agreements with subcontractors is that you sometimes do not have a project in which a ZE machine is requested. This can be quite expensive to have it do nothing. To limit this, the ZE-equipment could be used on regular projects. However, special attention should be given to the risk allocation and additional cost allocation in this case (see later). [F2-4,6,8]

Sublet to other contractors: Another option that was argued when there is no project for a ZE-equipment piece, is to sublet it to another contractor / project. Again as an option to offset the additional cost and risk. This methodology is especially useful when long-term contracts with suppliers or subcontractors are present, allowing Strukton to find ways to maximise the utility of the equipment and preventing losses due to the equipment not being used. [F6-4,5]However, it was noted that in order to do so someone should take 'ownership' over the rented equipment and should actively aim to exploit the equipment. as will also be explained in the following option.

Have clear 'ownership' of equipment: Furthermore, as mentioned in the previous paragraph. it was noted that the 'ownership' of equipment might be important. [C1-4,6] The term ownership here is not intended to be according to the definition 'the state or fact of owning something' but according to the definition 'the fact of taking responsibility for an idea of problem' (Cambridge University Press, n.d.).

The interviewees argued that currently the ownership of equipment mainly lays with the individual foreman on individual projects. They argued that a transition towards long(er)-term contracts with suppliers and subcontractors also requires a shift in ownership. To ensure that the equipment is consistently used and risk is reduced it should be clear who is taking ownership over those equipment and makes sure this actually happens.

7.3 Additional Cost Allocation

The use of zero-emission construction equipment brings with it additional costs. Currently the additional costs to projects within the infra sector is approximately 20% or even as low as 15% in case a direct main-connection to the grid was already present (Decisio, 2023).

CE Delft (2023) investigated the expected additional costs for zero-emission construction equipment. Specifically aimed at the Dutch market, both now and in the future. The divided these additional costs into three parts: "Bouwlogistiek", "Materieelkosten", en "Energiekosten Materieel".

Regarding the bouwlogistiek they concluded that current logistics are already close to the logistical cost for diesel. Especially small-sized vans (Bestelbusjes) are already cheaper. In the future, towards 2030 it is expected that these cost are comparable to diesel for trucks, and even cheaper then diesel for small-sized vans.

Regarding the materieelkosten, it is noted that zero emission construction equipment is, and will remain more expensive than traditional equipment. However, it is expected that those costs will in the future, only result in ca. 20% more expensive materieelkosten, while this could currently be well over a 100%. The main driver for these reducing costs is the fact that more and more equipment is produced as electric equipment in the factory. While current practice is mainly to buy diesel equipment and have them transformed into electric equipment here in the Netherlands. This is mainly the case because the Netherlands is one of the countries which have adopted the use of zero emission construction equipment (slightly) earlier than other european countries, mainly caused by the nitrogen crises.

Regarding the energiekosten, it is noted that especially the duration of the project is relevant. Shorter projects are often conducted with methods that are more expensive per kwh such as battery containers or exchangeble batteries, while longer projects often allow for bigger investments into 'bouwaansluitingen' which result in much lower kwh prices, even resulting in lower costs than diesel. Furthermore, it is expected that in the future especially the methods currently used for short-term projects will decrease significantly.

It thus becomes a question how these additional costs should be allocated. [O-1,3,4,6,7,9] The strategy should reflect this and offer clear methods of allocating those costs.

7.4 Other possible changes to working practices

7.4.1 From reactive to proactive

The reactive approach could be transformed into a more proactive approach as shown by other parties [G4-1,6,8] This means more actively defining goals for the use of zero-emission construction equipment on a strategic level. This entails structuring the orderbook in such a way that sufficient projects with ZE-equipment are tendered to have a continues flow of works for zero-emission construction equipment. [G2-3,4] But also actively go to clients and convince them of the benefits of ZE-equipment. [G1-4,6,8,10] Especially in cases where framework agreements were heavily focused on the use of ZE-equipment, but in the actual project phase this is often reduced by the client towards traditional equipment. Either for budget reasons or practical reasons. [E4-4,6,10] Currently Strukton seems to be more than willing to accept or cave into these requests. However, to ensure enough work for ZE-equipment and take a leading role it could be beneficial to take a firmer stance and actively propose to keep conducting these projects with ZE-equipment.

7.5 The benefit of transiting to zero-emission construction equipment

Often the purchasing and subcontracting is largely focused on the financial aspects, but other (positive) factors besides the financial aspects should be considered. The previous sections mainly focussed on the downsides, but there are also benefits to transiting to zero-emission construction equipment that could (partly) be used as temporary justification for higher cost / lower profits and increased risk associated with the implementation of zero-emission construction equipment.

During the interviews it was also often mentioned that there might sometimes be a bit to much focus on the (short-term) financial side of the question whether zero-emission construction equipment is feasible or not. This is a conclusion that mainly seems to be made on the tactical and operational level. Several interviewees however also argued that when looking on a more strategic level it might be beneficial from a competitive advantage perspective to start the transition towards zero-emission construction equipment. Although this might come at a short-term financial cost (or lower profits) it should be considered 'leergeld' rather than just higher costs. [F3-4,8,10] The main arguments that were used were the idea of marketing and learning.

Marketing: it was argued that using the ZE-equipment should be considered as more than simply a tool to finish a project. Instead, it could be used as a marketing tool to show what Strukton is capable of. If combined with the learning aspect, the additional cost/loss could be largely compensated as an investment in the future. [F5-4,10]

Learning: it was argued that investing in ZE-equipment right now might benefit the organization, since learning how to operate with ZE-equipment, and especially the logistical side of it, becomes essential. [J4-1,3,5,7,9] Special attention should be giving to the question "how do we transfer this learning from one project to another?". Often this can be achieved by making use of the tacit knowledge of the people working on those projects, sending them off to other projects were challenges regarding zero-emission construction equipment exist. Thus diffusing the knowledge through new projects to new people. (Hartmann & Dorée, 2015)

7.6 Concluding Remarks

The transition from conventional equipment towards zero-emission construction equipment changes the requirements for purchasing and subcontracting. This chapter first, and foremost, showed (through the use of the frameworks of Kraljic, Bensaou, and Dyer) that longer-term relationships with suppliers become essential in order to gain access to the equipment. Especially due to a lack of availability and thus the increased complexity in purchasing. For equipment types that are harder to obtain and are less available in the market, a more long-term relationship is needed. While simpler more available equipment could move more towards a short-term arms-length relationship as is happening now with conventional equipment. Thus the strategy should take into account the availability of the equipment type and determine the appropriate purchasing option (either make, buy, or somewhere in-between as defined by Cox) based on that.

Furthermore, this chapter showed several risks associated with those purchasing options, especially with longer-term contracts and offered opportunities to manage these risks, such as using ZE-equipment on normal projects, sublet to other contractors, and having clear 'ownership' of equipment. This strategy should thus also clearly state the risks associated with each purchasing method, and offer adequate solutions to those problems.

Part IV

Development of Strategy

8 DEVELOPMENT OF PURCHASING STRATEGY

The previous chapters investigated the current purchasing and subcontracting practices of Strukton, the broader market dynamics regarding the transition towards zero-emission construction equipment, and the theoretical frameworks that can guide purchasing decisions. It revealed a clear gap between the current ad-hoc, project-based approach Strukton is currently using and the long-term more collaborative methods required to effectively gain access to zero-emission construction equipment.

To address this gap, this chapter will develop a strategy that Strukton can use in the future to conduct their purchasing. This strategy is grounded in the findings from both literature and the interviews as laid out in the previous chapters.

8.1 Setting Requirements

Before the development of the strategy can start several requirements should be defined. Those requirements are separated into four categories, as defined by Verschuren and Doorewaard (2007): Functional, Contextual, User, and Structural Requirements. Functional requirements are those requirements that the strategy should be able to do. Contextual requirements describe under which conditions and in which situations the strategy should be able to be employed. User requirements are describing how the user should be able to work with the strategy. At last, structural requirements are describing the intangible characteristics of the strategy that are necessary to fulfil the other requirements.

A full overview of all the requirements can be found in Table 8.1. These requirements were derived from conversations with both the company supervisors as well as other employees from Strukton. Furthermore, the business case and strategy into which the strategy needs to be implemented could be deducted from the interviews held with employees.

8.2 Development of Prototype

After the requirements have been clearing formulated the development of the prototype of the strategy can start. This prototype is a first version of the strategy which can then be verified and validated, adjusted if necessary according to these verification and validation steps, and then result in the final purchasing strategy that can be implemented. The prototype is based on the results as described in the previous chapters. A full overview of the prototype can be found on the next page. The next sections will describe how this prototype has been developed.

The strategy is based on the same distinction of the Strategic, Tactical and Operational levels of purchasing as described in section 4.1 and through which the current purchasing practices of Strukton have been viewed in chapter 5. On all these three levels it looks into two different aspects: the purchasing and subcontracting of zero-emission construction equipment (’inkoop van emissieloos materieel’) and the risk and cost management (’risico en kosten management).

	1. Functional Requirements
1.1	The strategy allows Strukton to understand the different purchasing methods available to them.
1.2	The strategy allows Strukton to understand the benefits and disadvantages associated with each of the different methods
1.3	The strategy allows Strukton to understand the risk associated with each of the different methods
1.4	The strategy allows Strukton to identify how to deal with the risk associated with each of the different methods
1.5	The strategy allows Strukton to identify which methods to use in which context
	2. Contextual Requirements
2.1	The strategy can be used in, or is able to adapt to, future developments in the context of zero-emission construction equipment
2.2	The strategy is able to clarify the difference between purchasing traditional construction equipment and zero-emission construction equipment.
2.3	The strategy is adjusted to the working practices and business case of Strukton, and more specifically to Strukton Wegen & Beton
	3. User Requirements
3.1	The strategy should deliver results that can be understood without the need of extensive knowledge of purchasing
3.2	The strategy should be usable without any or little training
3.3	The strategy should allow the user to compare the different methods
3.4	The strategy should not only explain which methods would be best, but should also provide insights as to why this method is recommended.
	4. Structural Requirements
4.1	The strategy should be developed in a format/software that is generally accessible

Table 8.1: Design Requirements

8.2.1 Aspect 1: Purchasing and Subcontracting

The first aspect, the purchasing and subcontracting of zero emission construction equipment, starts with a decision-making framework. This decision-making framework allows Strukton to answer a set of question to determine which purchasing decision might be wisest. The decision framework largely takes the following steps:

1. **Determine where you want to position yourself as a company:** The purchasing of Zero-Emission construction equipment does not happen in isolation. It requires a clear top-down decision to market yourself as a contractor that is able to deliver projects with the use of zero-emission construction equipment. Because it takes a lot more than just "how do we purchase ZE construction equipment?" It requires a broader change in the working practices of a company.
2. **Make-or-buy decision:** The next decision is whether or not the company is able or willing to make (read:own) the zero emission construction equipment itself or needs/want to buy (read: subcontract/lease/etc.) the equipment.
3. **Determine the Duration of the Contract:** The last decision was to determine whether long-term contracts were needed to gain access to the equipment or that the same short-term, ad-hoc and project-based contracts would suffice.

Furthermore, for each of the purchasing decision that can be made an explanation why this might be the most suitable solution is given. Allowing Strukton to not only reach a suitable solution, but also to understand why this solution works.

8.2.2 Aspect 2: Risk and Cost Management

Every purchasing decision however also comes with certain risks. Especially the move towards longer-term contracts was deemed to bring along more (financial) risk. However, also doing nothing brings with it risk, namely a possible loss in competitiveness. The second aspect of the purchasing therefore gives an insight into these risks associated with each purchasing method and decision, and offers possible risk management strategies. These risks and the possible risk management strategies are largely derived from the results of the interviews.

This all resulted in the prototype as shown on the following page.

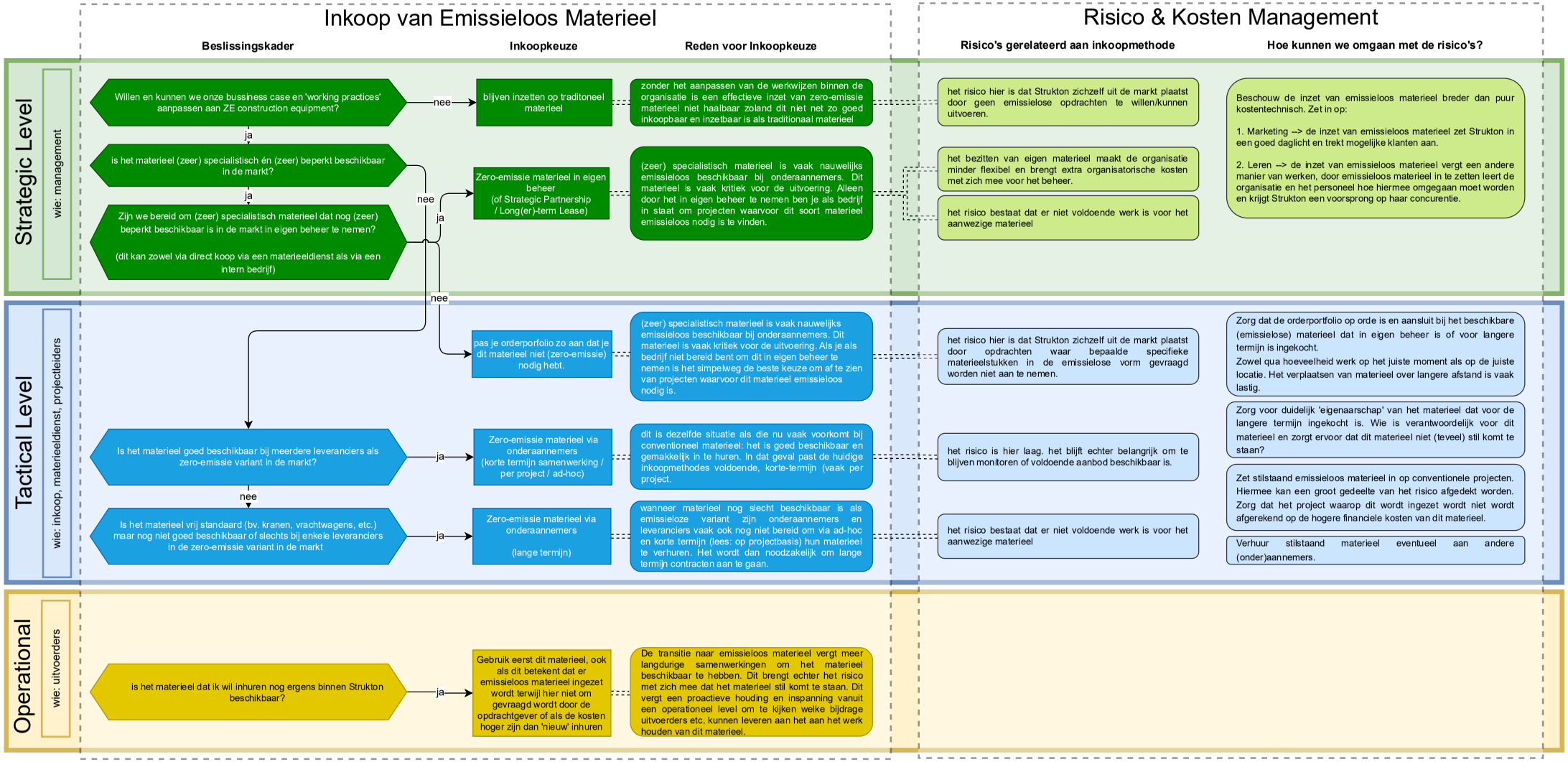

Inkoop van Emissieloos Materieel
Risico & Kosten Management
Beslissingskader
Inkoopkeuze
Reden voor Inkoopkeuze
Risico's gerelateerd aan inkoopmethode
Hoe kunnen we omgaan met de risico's?
Strategic Level
wie: management
Willen en kunnen we onze bussiness case en 'working practices' aanpassen aan ZE construction equipment?
nee
blijven inzetten op traditoneel materieel
zonder het aanpassen van de werkwijzen binnen de organisatie is een effectieve inzet van zero-emissie materieel niet haalbaar zoland dit niet net zo goed inkoopbaar en inzetbaar is als traditionaal materieel
het risico hier is dat Strukton zichzelf uit de markt plaatst door geen emissielose opdrachten te willen/kunnen uitvoeren.
ja
is het materieel (zeer) specialistisch én (zeer) beperkt beschikbaar in de markt?
ja
Zijn we bereid om (zeer) specialistisch materieel dat nog (zeer) beperkt beschikbaar is in de markt in eigen beheer te nemen?
(dit kan zowel via direct koop via een materieeldienst als via een intern bedrijf)
nee
ja
Zero-emissie materieel in eigen beheer
(of Strategic Partnership / Long(er)-term Lease)
(zeer) specialistisch materieel is vaak nauwelijks emissieloos beschikbaar bij onderaannemers. Dit materieel is vaak kritiek voor de uitvoering. Alleen door het in eigen beheer te nemen ben je als bedrijf in staat om projecten waarvoor dit soort materieel emissieloos nodig is te vinden.
het bezitten van eigen materieel maakt de organisatie minder flexibel en brengt extra organisatorische kosten met zich mee voor het beheer.
het risico bestaat dat er niet voldoende werk is voor het aanwezige materieel
Beschouw de inzet van emissieloos materieel breder dan puur kostentechnisch. Zet in op:
1. Marketing --> de inzet van emissieloos materieel zet Strukton in een goed daglicht en trekt mogelijke klanten aan.
2. Leren --> de inzet van emissieloos materieel vergt een andere manier van werken, door emissieloos materieel in te zetten leert de organisatie en het personeel hoe hiermee omgegaan moet worden en krijgt Strukton een voorsprong op haar concurentie.
Tactical Level
wie: inkoop, materieeldienst, projectleiders
nee
pas je orderporfolio zo aan dat je dit materieel niet (zero-emissie) nodig hebt.
(zeer) specialistisch materieel is vaak nauwelijks emissieloos beschikbaar bij onderaannemers. Dit materieel is vaak kritiek voor de uitvoering. Als je als bedrijf niet bereid bent om dit in eigen beheer te nemen is het simpelweg de beste keuze om af te zien van projecten waarvoor dit materieel emissieloos nodig is.
het risico hier is dat Strukton zichzelf uit de markt plaatst door opdrachten waar bepaalde specifieke materieelstukken in de emissielose vorm gevraagd worden niet aan te nemen.
Zorg dat de orderportfolio op orde is en aansluit bij het beschikbare (emissielose) materieel dat in eigen beheer is of voor langere termijn is ingekocht.
Zowel qua hoeveelheid werk op het juiste moment als op de juiste locatie. Het verplaatsen van materieel over langere afstand is vaak lastig.
Is het materieel goed beschikbaar bij meerdere leveranciers als zero-emissie variant in de markt?
ja
Zero-emissie materieel via onderaannemers
(korte termijn samenwerking / per project / ad-hoc)
dit is dezelfde situatie als die nu vaak voorkomt bij conventioneel materieel: het is goed beschikbaar en gemakkelijk in te huren. In dat geval past de huidige inkoopmethodes voldoende, korte-termijn (vaak per project.
het risico is hier laag, het blijft echter belangrijk om te blijven monitoren of voldoende aanbod beschikbaar is.
Zorg voor duidelijk 'eigenaarschap' van het materieel dat voor de langere termijn ingekocht is. Wie is verantwoordelijk voor dit materieel en zorgt ervoor dat dit materieel niet (teveel) stil komt te staan?
nee
Is het materieel vrij standaard (bv. kranen, vrachtwagens, etc.) maar nog niet goed beschikbaar of slechts bij enkele leveranciers in de zero-emissie variant in de markt
ja
Zero-emissie materieel via onderaannemers
(lange termijn)
wanneer materieel nog slecht beschikbaar is als emissieloze variant zijn onderaannemers en leveranciers vaak ook nog niet bereid om via ad-hoc en korte termijn (lees: op projectbasis) hun materieel te verhuren. Het wordt dan noodzakelijk om lange termijn contracten aan te gaan.
het risico bestaat dat er niet voldoende werk is voor het aanwezige materieel
Zet stilstaand emissieloos materieel in op conventionele projecten. Hiermee kan een groot gedeelte van het risico afgedekt worden. Zorg dat het project waarop dit wordt ingezet wordt niet wordt afgerekend op de hogere financiele kosten van dit materieel.
Verhuur stilstaand materieel eventueel aan andere (onder)aannemers.
Operational
wie: uitvoerders
is het materieel dat ik wil inhuren nog ergens binnen Strukton beschikbaar?
ja
Gebruik eerst dit materieel, ook als dit betekent dat er emissieloos materieel ingezet wordt terwijl hier niet om gevraagd wordt door de opdrachtgever of als de kosten hoger zijn dan 'nieuw' inhuren
De transitie naar emissieloos materieel vergt meer langdurige samenwerkingen om het materieel beschikbaar te hebben. Dit brengt echter het risico met zich mee dat het materieel stil komt te staan. Dit vergt een proactieve houding en inspanning vanuit een operationeel level om te kijken welke bijdrage uitvoerders etc. kunnen leveren aan het aan het werk houden van dit materieel.

Table 8.2: Verification of Prototype

	1. Functional Requirements	Verified?	Verification:
1.1	The strategy allows Strukton to understand the different purchasing methods available to them.	YES	the different purchasing methods are clearly outlined in the prototype
1.2	The strategy allows Strukton to understand the benefits and disadvantages associated with each of the different methods	YES	the 'reden voor inkoopkeuze' explains this
1.3	The strategy allows Strukton to understand the risk associated with each of the different methods	YES	the aspect 'risico en kosten management' includes this
1.4	The strategy allows Strukton to identify how to deal with the risk associated with each of the different methods	YES	the aspect 'risico en kosten managment' includes this
1.5	The strategy allows Strukton to identify which methods to use in which context	YES	by going to the 'besliskader' the differnt context are presented
	2. Contextual Requirements		
2.1	The strategy can be used in, or is able to adapt to, future developments in the context of zero-emission construction equipment	YES	the prototype can be run through again when market dynamics change (for example better or worse availability)
2.2	The strategy is able to clarify the difference between purchasing traditional construction equipment and zero-emission construction equipment.	PARTLY	the prototype does often explain the difference in 'reden voor inkoopkeuze' but this is not always possible. Focus was mainly put on the ZE
2.3	The strategy is adjusted to the working practices and business case of Strukton, and more specifically to Strukton Wegen & Beton	YES	when developing the prototype the results from the interviews have been used to align the prototype to the practices within Strukton
	3. User Requirements		
3.1	The strategy should deliver results that can be understood without the need of extensive knowledge of purchasing	YES	the wording of the prototype uses clear and easy language, specific purchasing jargon has been avoided
3.2	The strategy should be usable without any or little training	YES	the prototype is held simple and should be possible to work with a simple instruction
3.3	The strategy should allow the user to compare the different methods	YES	the different purchasing methods are clearly outlined and the 'reden voor inkoopkeuze' can be used to compare the different methods
3.4	The strategy should not only explain which methods would be best, but should also provide insights as to why this method is recommended.	YES	the column 'reden voor inkoopkeuze' answers this question
	4. Structural Requirements		
4.1	The strategy should be developed in a format/software that is generally accessible	YES	the strategy is available in a PDF format

8.3 Verification

After the prototype has been developed it can be verified. Verification means assessing whether or not the prototype fulfils all of the requirements as shown in Table 8.1. To do so, the prototype was assessed against each of the requirements individually to see whether the prototype fulfils the requirement. This was then noted in a table and an argumentation why the prototype adhered to the requirement is given. The result of this can be found in Table 8.2.

As shown in the verification table, all the requirements the prototype needed to adhere to were fulfilled.

8.4 Validation

To ensure that the strategy is useful for Strukton a validation step has been executed. For this validation step discussions with employees of Strukton have been organised to see what they think about the prototype. To aid this discussion a validation template was used as can be found in Appendix D. The validation protocol consisted of four steps:

1. Present the strategy to the participant(s);
2. Allow the participant(s) to familiarise themselves with the strategy;
3. Let the participant(s) answer multiple closed statements, a 5-point Likert-scale has been used to provide the answers; (Harpe, 2015)
4. Discus both the positive and negative aspects of the prototype and discuss possible improvements;

In total three participants responded and were willing to help validate the strategy. This number was relatively low because the validation happened over the summer and only a limited amount of people were available. The results of the closed statements can be found in Figure 8.1.

	Participant 1	Participant 2	Participant 3
Ik heb voldoende kennis om de strategie te begrijpen.	Helemaal mee eens	Mee eens	Mee eens
De strategie maakt duidelijk welke methoden beschikbaar zijn.	Mee eens	Mee eens	Helemaal mee eens
De voor- en nadelen van de verschillende methodes zijn voor mij duidelijk.	Neutraal	Mee eens	Mee eens
De risico's die samenhangen met elk van de verschillende methodes zijn voor mij duidelijk.	Helemaal mee eens	Mee eens	Mee eens
Hoe ik om kan gaan met deze risico's is voor mij duidelijk.	Helemaal mee eens	Mee eens	Neutraal
Ik heb de mogelijkheid om verschillende opties te vergelijken.	Mee eens	Neutraal	Mee eens
De strategie geeft mij inzicht in welke methode ik het beste kan inzetten.	Mee eens	Neutraal	Mee eens
De strategie geeft mij inzicht waarom ik deze methode het beste kan inzetten.	Mee eens	Mee eens	Neutraal
De strategie sluit aan op de werkwijze en businesscase van Strukton Wegen & Beton.	Neutraal	Neutraal	Mee eens
De strategie is voldoende flexibel en toekomstbestendig om mee te groeien met ontwikkelingen op het gebied van emissieloos materieel.	Mee eens	Neutraal	Neutraal

Figure 8.1: Validation Table

From the closed statements in this table we find that for most statements the participants agreed with the statement or held a neutral attitude. Not a single answer has been given in which a participant argued that they disagreed with the statement. This serves as evidence and support that the prototype serves it purpose. The two statements on which the participants were most neutral (the last two), the discussion explained why they agreed less with these statements.

Regarding 'de strategie sluit aan op de werkwijze en businesscase van Strukton', they had the idea that it does not align exactly with the current practices. However, they also agreed that changes to the current practices are required in order to effectively gain access to zero-emission construction equipment. So in summary, they agree that the changes are necessary but are still relatively sceptical as to whether the organisation is willing to change.

Furthermore, the three open questions and the discussion provided further insight into possible strong points, as well as possible points of improvements. The main insights were:

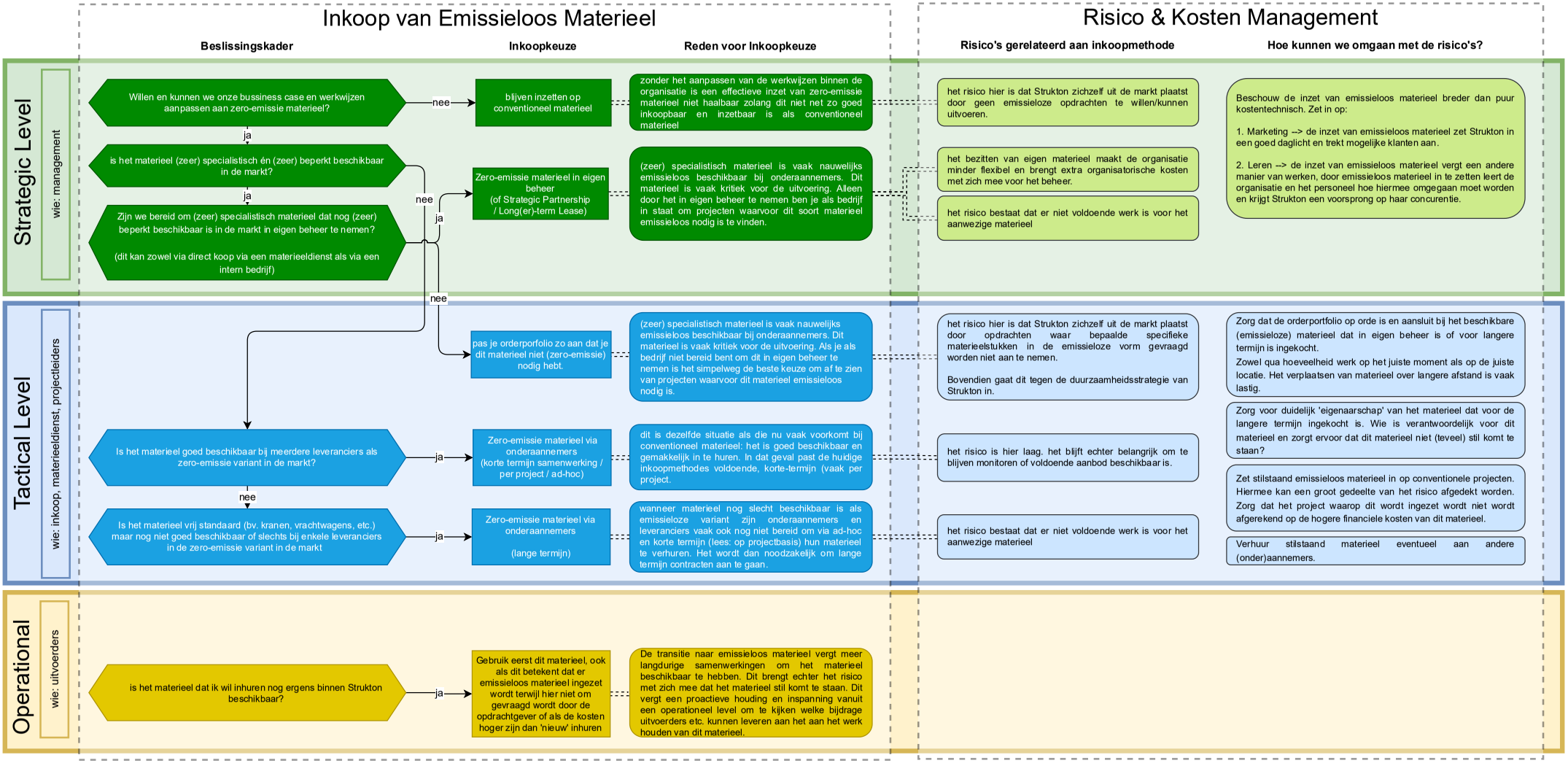
- The participants found the options and the logic clear.
- The participants agreed with the risk management options.
- The term 'working practices' was not entirely clear and was considered jargon.
- Several other wordings were mentioned to have a better alternative.
- A link to the sustainability vision of Strukton itself was missing, especially since some options should be excluded if Strukton wants to adhere to this vision.
- The participants agreed that more specialised equipment could only be accessed through longer-term contracts. However, they also noted that for very specialised equipment it can often be hard for Strukton to ensure that they have projects where they actually need this equipment. This risk was identified, as well as risk management methods to deal with this. However, they argued that the risk here could be high (both occurrence and consequences), thus there is a very large need to adjust the order portfolio to keep the equipment in use.
- They argued that for very standard equipment it could also be financially beneficial to own the equipment as part of a fixed and flexible pool of equipment. However, they also agreed that for the flexible pool the methods described in the strategy would be well suitable.

8.5 Final Purchasing Strategy

The verification and validation stages showed that the prototype already adhered to most of the requirements and was received positively. However, several points of improvements were mentioned as well. Based on the validation these suggestions resulted in several (small) adjustments to be made to the prototype. These include:

- Several spelling error have been corrected and more consistent language has been used. For example, the terms 'traditioneel materieel' and 'conventioneel materieel' were used interchangeable, this has been brought back to one single term.
- The term 'working practices' was found to be unnecessary jargon and was replaced by 'werkwijzen'.
- A clearer indication which option would result in a situation in which Strukton would go against its own sustainability vision has been provided.

Eventually this resulted in the final purchasing strategy as seen on the following page.


Inkoop van Emissieloos Materieel
Risico & Kosten Management
Beslissingskader
Inkoopkeuze
Reden voor Inkoopkeuze
Risico's gerelateerd aan inkoopmethode
Hoe kunnen we omgaan met de risico's?
Strategic Level
wie: management
Willen en kunnen we onze bussiness case en werkwijzen aanpassen aan zero-emissie materieel?
nee
blijven inzetten op conventioneel materieel
zonder het aanpassen van de werkwijzen binnen de organisatie is een effectieve inzet van zero-emissie materieel niet haalbaar zolang dit niet net zo goed inkoopbaar en inzetbaar is als conventioneel materieel
het risico hier is dat Strukton zichzelf uit de markt plaatst door geen emissieloze opdrachten te willen/kunnen uitvoeren.
Beschouw de inzet van emissieloos materieel breder dan puur kostentechnisch. Zet in op:
1. Marketing --> de inzet van emissieloos materieel zet Strukton in een goed daglicht en trekt mogelijke klanten aan.
2. Leren --> de inzet van emissieloos materieel vergt een andere manier van werken, door emissieloos materieel in te zetten leert de organisatie en het personeel hoe hiermee omgegaan moet worden en krijgt Strukton een voorsprong op haar concurentie.
ja
is het materieel (zeer) specialistisch én (zeer) beperkt beschikbaar in de markt?
ja
Zijn we bereid om (zeer) specialistisch materieel dat nog (zeer) beperkt beschikbaar is in de markt in eigen beheer te nemen?
(dit kan zowel via direct koop via een materieeldienst als via een intern bedrijf)
nee
Zero-emissie materieel in eigen beheer
(of Strategic Partnership / Long(er)-term Lease)
ja
(zeer) specialistisch materieel is vaak nauwelijks emissieloos beschikbaar bij onderaannemers. Dit materieel is vaak kritiek voor de uitvoering. Alleen door het in eigen beheer te nemen ben je als bedrijf in staat om projecten waarvoor dit soort materieel emissieloos nodig is te vinden.
het bezitten van eigen materieel maakt de organisatie minder flexibel en brengt extra organisatorische kosten met zich mee voor het beheer.
het risico bestaat dat er niet voldoende werk is voor het aanwezige materieel
Tactical Level
wie: inkoop, materieeldienst, projectleiders
nee
pas je orderporfolio zo aan dat je dit materieel niet (zero-emissie) nodig hebt.
(zeer) specialistisch materieel is vaak nauwelijks emissieloos beschikbaar bij onderaannemers. Dit materieel is vaak kritiek voor de uitvoering. Als je als bedrijf niet bereid bent om dit in eigen beheer te nemen is het simpelweg de beste keuze om af te zien van projecten waarvoor dit materieel emissieloos nodig is.
het risico hier is dat Strukton zichzelf uit de markt plaatst door opdrachten waar bepaalde specifieke materieelstukken in de emissieloze vorm gevraagd worden niet aan te nemen.
Bovendien gaat dit tegen de duurzaamheidsstrategie van Strukton in.
Zorg dat de orderportfolio op orde is en aansluit bij het beschikbare (emissieloze) materieel dat in eigen beheer is of voor langere termijn is ingekocht.
Zowel qua hoeveelheid werk op het juiste moment als op de juiste locatie. Het verplaatsen van materieel over langere afstand is vaak lastig.
Is het materieel goed beschikbaar bij meerdere leveranciers als zero-emissie variant in de markt?
ja
Zero-emissie materieel via onderaannemers
(korte termijn samenwerking / per project / ad-hoc)
dit is dezelfde situatie als die nu vaak voorkomt bij conventioneel materieel: het is goed beschikbaar en gemakkelijk in te huren. In dat geval past de huidige inkoopmethodes voldoende, korte-termijn (vaak per project.
het risico is hier laag. het blijft echter belangrijk om te blijven monitoren of voldoende aanbod beschikbaar is.
Zorg voor duidelijk 'eigenaarschap' van het materieel dat voor de langere termijn ingekocht is. Wie is verantwoordelijk voor dit materieel en zorgt ervoor dat dit materieel niet (teveel) stil komt te staan?
nee
Is het materieel vrij standaard (bv. kranen, vrachtwagens, etc.) maar nog niet goed beschikbaar of slechts bij enkele leveranciers in de zero-emissie variant in de markt
ja
Zero-emissie materieel via onderaannemers
(lange termijn)
wanneer materieel nog slecht beschikbaar is als emissieloze variant zijn onderaannemers en leveranciers vaak ook nog niet bereid om via ad-hoc en korte termijn (lees: op projectbasis) hun materieel te verhuren. Het wordt dan noodzakelijk om lange termijn contracten aan te gaan.
het risico bestaat dat er niet voldoende werk is voor het aanwezige materieel
Zet stilstaand emissieloos materieel in op conventionele projecten. Hiermee kan een groot gedeelte van het risico afgedekt worden.
Zorg dat het project waarop dit wordt ingezet wordt niet wordt afgerekend op de hogere financiele kosten van dit materieel.
Verhuur stilstaand materieel eventueel aan andere (onder)aannemers.
Operational
wie: uitvoerders
is het materieel dat ik wil inhuren nog ergens binnen Strukton beschikbaar?
ja
Gebruik eerst dit materieel, ook als dit betekent dat er emissieloos materieel ingezet wordt terwijl hier niet om gevraagd wordt door de opdrachtgever of als de kosten hoger zijn dan 'nieuw' inhuren
De transitie naar emissieloos materieel vergt meer langdurige samenwerkingen om het materieel beschikbaar te hebben. Dit brengt echter het risico met zich mee dat het materieel stil komt te staan. Dit vergt een proactieve houding en inspanning vanuit een operationeel level om te kijken welke bijdrage uitvoerders etc. kunnen leveren aan het aan het werk houden van dit materieel.

Part V

Discussion & Conclusion

9 DISCUSSION

This chapter will reflect on the findings of this research and the broader implications for both theory and practice. While the previous chapters mainly focused on designing a purchasing and sub-contracting strategy for Strukton, this chapter will take a step back and aims to interpret what these findings mean in a wider context.

First, it will reflect on the applied theory and compare this with existing literature. Second, it will describe the implications that the findings have for purchasing & subcontracting in a broader context. Third, it will describe the implications specifically for Strukton. Fourth, it will describe the limitations of this research. And fifth, it will look into possible future research options.

9.1 Reflection on applied theory & comparison with existing literature

This thesis made use of the portfolio frameworks of Kraljic, Bensaou, and Dyer. And combined the use of those portfolio models with transition theory. Normally the portfolio frameworks are used in a static environment. The application of transition theory however showed a more dynamic approach to these frameworks. Instead of simply identifying where an item is located and viewing this as a static position, unchanged by environmental impacts, it took a more dynamic approach. In this more dynamic approach an item (or service) was viewed through time as moving throughout these frameworks depending on the environmental impacts caused by the transition. For example, traditional construction equipment in Kraljic's matrix is viewed as a leverage item. Zero-emission construction equipment however is currently viewed as a strategic item. With an emphasis on 'currently', as the dynamic approach sees that this current position as a strategic item is slowly moving (back) towards a leverage item once availability increases and thus purchasing complexity decreases.

Furthermore, this thesis investigated the transition towards zero-emission construction equipment through the lens of Geels (2002). A main critic of this transition theory according to Berkhout et al. (2004), was that this theory is primarily focussed on bottom-up innovations, in which niches breakthrough into the regime. Rather than a top-down innovation, caused primarily by a change in the landscape. However, this thesis dealt with a transition that was top-down, mainly caused by a nitrogen crisis in the Netherlands. And it showed that also a top-down transition can be properly described by the transition theory of Geels as also suggested by others such as Aalbers (2022).

The findings that a more long(er)-term and more cooperative approach to purchasing and subcontracting is necessary to gain access to zero-emission construction equipment is also supported by others like Fufa et al. (2019). Although Fufa et al. primarily focusses on how zero-emission construction projects can be successfully executed, and puts less emphasis on the exact purchasing and subcontracting. This thesis thus offers a contribution towards bridging the gap on how exactly the long(er)-term purchasing and subcontracting should be organised to successfully achieve a zero-emission construction site.

At last, this thesis took the make-or-buy decision as a relevant starting point in making purchasing decisions, often determined by transaction economics as defined by Williamson (1979). This thesis however argued that a more broader range of options are available between a clear make or buy. This was also why the classification of A. Cox (1996) was used to further distinguish the options. The interviews that were held also clearly showed this broader range of options, such as the use of an internal company for foundations and the use of preferred suppliers.

9.2 Implications for Purchasing & Subcontracting

The transition towards zero-emission construction equipment has major implications for the methods and practices through which purchasing and sub-contracting is conducted. The methods and practices that are employed to gain access to conventional construction equipment are no longer efficient and effective. It need to be realised that purchasing and subcontracting during a transition requires different methods. the purchasing methods might be more related to whether the equipment is part of the regime or of a niche than based on the kind of construction equipment.

When looking across the three different frameworks a clear picture emerged. Zero-emission construction equipment currently holds a different position in purchasing and subcontracting strategy than traditional equipment. These frameworks suggest that the current phase of the transition warrants a more collaborative, longer-term, and risk-sharing purchasing and subcontracting approach. However, this strategy should not be static. The strategy should change alongside the maturing of zero-emission construction equipment.

Furthermore, this study found that risk management is an essential integral part of purchasing and sub-contracting. This can also be found in the different frameworks in which risk/uncertainty is often a main component to determine which category to place a product in. However, in practice less attention is given to how to deal with risks once equipment is obtained. In the current ad-hoc, project-based and short-term purchasing and subcontracting practices of the construction sector most risk is transferred towards (and thus managed by) the subcontractors which own the equipment. A shift towards longer-term contracts means this no longer will be available and more risk management strategies need to be applied within the organisation themselves.

Besides, many general contractors like Strukton have moved away from an equipment-owning structure and more towards becoming management firms, relying on subcontractors for the equipment. In order to gain access to this equipment those firms mainly relied on the operational level to acquire this equipment and maintain a relationship with suppliers. However, to gain access to zero-emission construction equipment a change need to be made: more purchasing and sub-contracting needs to be conducted on the strategic and operational level.

At last, the purchasing and subcontracting of construction equipment is currently mainly seen as simply a tool to 'get the job done'. Focussing heavily on the financial aspect and considering both traditional and zero-emission construction as having the same utility but with different prices and complexities. With the introduction of zero-emission construction equipment however larger logistical challenges around this equipment arise, increasing complexity and logistics. Currently this is primarily seen as a burden. However, organisation in the construction sector could view this as an opportunity to differentiate themselves from others. Thus learning how to effectively use this equipment and how to deal with the logistical challenges surrounding the equipment. This in turn will allow those companies to become experts in this and gain a competitive advantage over other organisations.

9.3 Implications for Strukton

This research investigated the current working practices within Strukton and showed that these current practices are inadequate to cope with the change in purchasing and subcontracting needs that are caused by the transition towards zero-emission construction equipment. This transition requires from Strukton a fundamental change in how to purchase and subcontract if they want to be able to effectively fulfil projects that require zero-emission construction equipment. The strategy that has been developed shows what is necessary for this to be achieved.

The next step for Strukton is to first understand their shortcomings and make a deliberate decision at the strategic level where they want to position themselves in the market and what is needed regarding zero-emission construction equipment. The next step is to identify both their need, and the availability regarding the different zero-emission construction equipment types. With this information available Strukton will be able to use the strategy to determine the most beneficial purchasing or sub-contracting method.

At last, Strukton will need to ensure that the strategy is understood and applied throughout all layers of the organisation since this involves a significant change in their working practices (especially the change from ad-hoc project-based short-term purchasing towards more long(er)-term contracts). All layers will need to understand their role and what is expected from them to manage the risk of those new working practices.

9.4 Limitations

The strategy that has been developed has to strike a balance between being concise and including all context. However, this always means that some context might not be included. The strategy aims to deliver the results of this research in a understandable and summarized manner. This allows to understand the bigger picture as well as many of the main aspects. However, it also had to exclude minor aspects or more nuanced considerations. It is thus advised to not solely rely on the strategy but also on the more elaborated version of the results as described in the results parts of this report.

Furthermore, the research was conducted on a single case: Strukton. This might mean that the results of this study might not directly transfer to other organisations. Especially considering that the working practices were solely studied within Strukton and the strategy was primarily aimed for Strukton.

9.5 Future Research

The research methodology as defined by Verschuren and Doorewaard (2007) holds multiple phases: (1) problem analysis, (2) diagnosis, (3) design, (4) intervention, (5) evaluating. This research mainly focussed on the diagnosis and design phase of the practice-based research methodology. The subsequent steps of intervention and evaluation have not been part of the scope of the research. Future research could thus focus on how to invention should occur, as well as evaluating the result of the intervention.

Furthermore, this research took the assumption that purchasing and subcontracting practices for zero-emission construction equipment are mainly different from traditional equipment due to the fact that (1) we are still in a transition, and (2) the availability is often very limited. Although the research concluded that it is likely that purchasing and subcontracting practices will return (at least to some extent) to the current practices, this is mainly based on a theoretic investigation, with some support for this based on the interviews. However, no practical proof has yet been

observed, simply because the transition is still ongoing. It is thus wise to keep a close eye on this and dedicate further research on this topic when the transition is in further stages.

At last, this study focused solely on the case of Strukton, although a lot of the underlying principles regarding purchasing and sub-contracting during a transition will hold for other firms as well, each firm is different and might require slight alterations to the strategy. Thus future research could focus on investigating how universally this strategy could be applied to other organisations, and to what extent adaptions are necessary to adjust to different organisational cultures and habits.

10 CONCLUSION

This thesis started off with the following research question:

"How can Strukton organise their processes to gain access to zero-emission construction equipment?"

In this chapter an answer to this question will be formed through answering each of sub-questions that were established in chapter 1.

1. **What methods for procuring/sub-contracting zero-emission construction equipment are available? And what are the benefits and disadvantages of these methods?**
    - can portfolio approaches be used to investigate the purchasing and sub-contracting of zero-emission construction equipment?
    - what do portfolio approaches tell us about purchasing and subcontracting of zero-emission construction equipment, and how does this differ from traditional construction equipment?
    - What effect does risk have on the purchasing and subcontracting of zero-emission construction equipment?

This thesis showed that the portfolio approaches of Kraljic, Dyer and Bensaou can be used to investigate the purchasing and sub-contracting of zero-emission construction equipment. It showed that zero-emission construction equipment currently holds a different position in purchasing and subcontracting strategy than traditional equipment. The frameworks suggest that the current phase of the transition warrants a more collaborative, longer-term, and risk-sharing purchasing and subcontracting approach. However, it also showed that this strategy should not be static. The strategy should change alongside the maturing of zero-emission construction equipment.

Furthermore, it showed that risk is an important aspect in purchasing and sub-contracting. The traditional approach of aiming to transfer virtually all risk onto subcontractors has showed to be an effective method. However, with the transition towards zero-emission construction equipment the risks are increasing and the willingness of subcontractors to accept this risk is decreasing. It thus becomes important to look into other risk management strategies such as sharing the risk or finding alternative methods of reducing and minimizing risk.

At last, it showed that in order to effectively gain access to zero-emission construction equipment it becomes important to shift away from the traditional short-term ad-hoc, project-based purchasing and subcontracting. Instead, for many equipment types, especially when availability is limited, a more long-term commitment with suppliers and subcontractors becomes essential.

2. **What future developments in the procurement strategies for zero-emission construction equipment can be expected in the next 10 years?**
    - Can transition theory be used to investigate the transition towards zero-emission construction equipment?
    - What does transition theory tell us about the transition towards zero-emission construction equipment and what implications does this have for purchasing and subcontracting?

This thesis showed that the transition theory of Geels is a valuable theory that can be used to investigate the transition from conventional construction equipment towards zero-emission construction equipment. It gives valuable insight into how this transition is unfolding and what implications is has for purchasing and sub-contracting of these kind of equipment.

It showed that during a transition purchasing or sub-contracting zero-emission construction equipment (which is still a niche) comes with a higher complexity than the standard conventional equipment (the regime). It will thus be harder to gain access to the equipment during the transition. This among others increases the transaction costs of a transaction, such as the search costs and bargaining costs. The purchasing and sub-contracting methods need to reflect this increase in complexity and transaction costs during the transition.

Nonetheless, the transition will come to an end and zero-emission construction equipment will become a standard part of the regime. When this happens the current methods that can be used conventional construction equipment might also become relevant again for zero-emission construction equipment. However, in the mean time, which can last many years different purchasing and subcontracting strategies might need to be followed to successfully implement zero-emission construction equipment.

3. **What are the key requirements for Strukton in developing a procurement strategy for zero-emission construction equipment?**

This question served to create a clear overview of what a strategy needs to accomplish for Strukton. In order to do so a list of requirements was created in section 8.1, which serves as the basis for developing the final strategy.

4. **Which strategy could Strukton best follow to acquisition zero-emission construction equipment?**

At last, a strategy for purchasing and subcontracting zero-emission construction equipment has been developed. This strategy describes how Strukton can best organise their working practices to gain access to zero-emission construction equipment.

Central in this strategy is the need to differentiate based on the kind of equipment. More complex equipment that is harder to purchase or sub-contract require more long-term commitments (quasi-hierarchy), while less complex, more standardised equipment that is more readily available in the market could shift more towards a short-term project-based purchasing and subcontracting method (quasi-market). For very specialised equipment the need to gain strategic ownership over the equipment becomes the most suitable way.

These new purchasing methods however also bring with them different risks. It is thus essential to clearly understand the risk associated with each methods, as follows from the strategy. And to understand how these risks can be managed.

This change however, does require changes in other working practices as well. It requires a broader change within Strukton throughout the strategic, tactical, and operational level.

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Appendices

A STATEMENT ON THE USE OF ARTIFICIAL INTELLIGENCE

In accordance with the guidelines of the University of Twente regarding artificial intelligence, this appendix lists all tools that have been used during the production of this Master Thesis: (University of Twente, 2023)

- During the preparation of this work, I used **Overleaf** to **produce and format the report, besides the spelling-check and error resolution no further AI-tools have been used**. After using this tool/service, I thoroughly reviewed and edited the content as needed, taking full responsibility for the final outcome.
- During the preparation of this work, I used **Zotero** to **organise and store references, non of the AI-tools have been used**. After using this tool/service, I thoroughly reviewed and edited the content as needed, taking full responsibility for the final outcome.
- During the preparation of this work, I used **ATLAS.ti** to **process and code the interviews, non of the AI-tools have been used**. After using this tool/service, I thoroughly reviewed and edited the content as needed, taking full responsibility for the final outcome.
- During the preparation of this work, I used **a local run version of WhisperAI** to **transcribe the interviews**. After using this tool/service, I thoroughly reviewed and edited the content as needed, taking full responsibility for the final outcome.
- During the preparation of this work, I used **Microsoft Copilot as part of Microsoft Teams** to **transcribe the interviews**. After using this tool/service, I thoroughly reviewed and edited the content as needed, taking full responsibility for the final outcome.

B BACKGROUND ON (ZERO-EMISSION) CONSTRUCTION EQUIPMENT

Construction projects rely heavily on the employment of construction equipment. A large variety of different kinds of equipment exist, such as trucks, excavators, pavers and rollers. Furthermore, the size of these equipment kinds can differ greatly. From small mini-excavators to large heavy equipment used for the toughest jobs imaginable.

This appendix will shortly address what construction equipment entails, how it is classified and which emission norms they need to adhere to. It will describe how zero-emission construction equipment fits into this classification. At last, it will describe the challenges regarding the introduction of zero-emission construction equipment.

B.1 Classification of Construction Equipment & Their Emissions

In the European Union a standardized classification of construction equipment exist. These categories are:

- Mobiele Werktuigen (EN: non-road mobile machinery)
- Bouwtransport (EN: construction transport)
- Vaartuigen (EN: vessels)

These classifications are useful to identify different machinery/vehicles and assign different more specific emission norms that better fit the machinery/vehicle. Furthermore, it helps to distinguish different paths for reducing emissions based on the difficulties that each of the different vehicle categories experience.

These differences can also be used in separating different machinery/vehicle categories based on their purchasing strategies, either now or in the future.

Each of these categories will be shortly explained in the following sections. A full overview of the categories and their emission standards can be found in Figure B.1

B.1.1 'Mobiele Werktuigen'

'Mobiele Werktuigen' in the EU often named 'non-road mobile machinery' are all equipment that works on construction sites, but is not normally allowed on public roads. These include for example excavators, compators, pavers, pile drivers, etc.

Non-road mobile machinery is further seperated into different categories based on their size. These categories are: 'mini equipment of <19kW', 'small equipment of 19-37kW', 'small equipment of 37-56kW', 'middle-large equipment of 56-130kw', 'large equipment of 130-560kw' and, 'extra-large equipment of >560kW'.

These non-road mobile machinery are held to stringent emission standards as set by EU directives. These are called 'STAGES'. Currently the following categories exist: 'Pre-STAGE I', 'STAGE I', 'STAGE II', 'STAGE IIIA', 'STAGE IIIB', 'STAGE IV', and 'STAGE V' (European Parliament, and Council of the European Union, 2022). with increasing numbers also indicating increasingly stringent emission norms. It could be argued that an additional category 'zero-emission' could be added which indicates that a specific non-road mobile machine uses fuel that does not emit any emissions. Furthermore, in the Dutch context many client request the use of 'HVO 100' a kind of fuel which is made from (more) sustainable elements, thus reducing the environmental impact of its use compared to standard diesel.

B.1.2 Bouwtransport

'Bouwtransport' are those vehicles that are allowed to be driven on public roads and are primarily used for construction logistics. In essence these are mainly trucks. This could include trucks used to transport earth, concrete, or asphalt. But also flatbed trucks used to transport goods and equipment. For example large steel beams or the 'mobiele werktuigen' themselves.

'Bouwtransport' is classified in the EU as either N1 (bestelauto's), N2 (light trucks) or N3 (heavy trucks).

For N1 a classification from EURO 1 to EURO 6 is used (European Parliament, and Council of the European Union, 2020b). While for N2 and N3 an emission classification of EURO I to EURO VI is used (European Parliament, and Council of the European Union, 2020a). Just as with the emission norms for non-road mobile machinery a higher number represents a more stringent emission norm. And again, it can be argued that an additional category could be reserved for zero-emission.

An important note here is that the Dutch classification as used by the RDW is slightly different as it is specifically aimed at weight. However in the context of emission reduction many laws and regulations, as well as construction clients are referring to the EU-classification.

B.1.3 Vaartuigen

The last classification is that of 'Vaartuigen'. In the context of this research this category is irrelevant and will not be further addressed.

B.2 The transition towards ZE construction equipment

The transition from construction equipment fuelled by fossil fuels towards zero-emission is a major innovation (Kirkels et al., 2024; Koch & Kifokeris, 2021). This requires major innovations in how propulsion of vehicles is conducted. Currently diesel or gasoline is the industry standard. However, emission-reduction requires us to move away from those fuels. A first step could be to make use of HVO100, which can significantly reduce the CO2-emission (Kourkoumpas et al., 2024). Further reduction towards a zero-emission construction site however requires further innovation and development of electrified construction equipment. For the adoption of this equipment however a larger move towards collective agreements and incentive structures that increase the willingness from all market parties to invest into this equipment. Only in this way will it be possible for electrified construction equipment to become adopted throughout the entire supply chain. (Karlsson et al., 2020)

To achieve this challenging transition many barriers need to be overcome and market parties should actively seek to exploit success factors that have been discovered in successful projects. Stokke et al. (2023) identified the main barriers and success factors for the implementation of

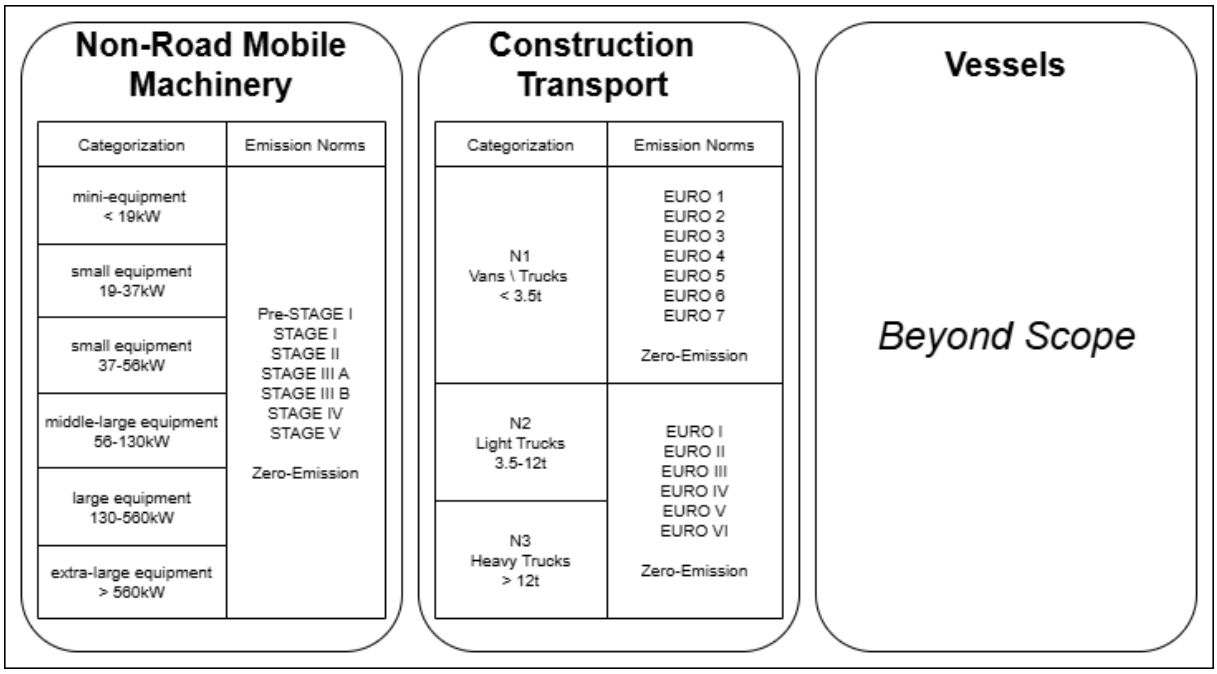

Figure B.1: Categorization of Construction Equipment and their Emission Standards

zero-emission construction equipment in construction projects. The main barriers he identified were:

- High cost of the equipment. These high costs also result in a limited market for the equipment since very few actors can, or are willing, to afford them.
- Technical barriers. The technology for electrified propulsion of vehicles is still in development. For smaller, more common equipment this is less of an problem. But for heavier equipment or equipment that needs higher power outputs there are still major challenges to develop the needed technology.
- The equipment requires local infrastructure, such as charging facilities and access to high-voltage power supplies.
- Public agencies are the main driver for implementing zero-emission construction equipment. However, this requires public agencies to have the political will to request zero-emission construction equipment.

The main success factors were identified as:

- Raising awareness of the benefits of zero-emission construction equipment can help public agencies to consider using this equipment.
- Local contractors are essential for promoting zero-emission construction equipment.
- Extensive talks with suppliers of zero-emission construction equipment are essential for creating the supply base.

C INTERVIEW TEMPLATE

Introductie:

- Kort voorstellen als interviewer
- Vragen of het interview opgenomen mag worden
- Doel uitleggen van het onderzoek zelf
- Doel uitleggen van het interview
- Zou je wellicht even kort kunnen vertellen wie je bent en wat je doet binnen [Bedrijf] ?

Vragen Gerelateerd aan RQ1

DOEL: inkoopmogelijkheden en hun voor- en nadelen in kaart brengen

- Hoe is momenteel de inkoop van (emissieloos) materieel bij jullie georganiseerd?
- Welke mogelijkheden qua inkoop van emissieloos materieel maken jullie momenteel gebruik van?
- Welke overige methodes voor de inkoop van emissieloos materieel is jullie bekend maar maken jullie geen gebruik van?
- Kun je kort benoemen wat de voor- en nadelen zijn van elk van deze methodes?
- Kun je kort benoemen waarom bepaalde inkoopmethodes momenteel gebruikt worden?
- Welke verschillen zie je tussen de inkoop van emissieloos materieel en dat van traditioneel materieel?
- Hoe verloopt de samenwerking met andere partijen?
- Hoe wordt omgegaan met het risico en de meerkosten die emissieloos materieel met zich meebrengt?

Vragen Gerelateerd aan RQ2

DOEL: toekomstige ontwikkelingen op het gebied van supply en demand voor emissieloos materieel en hun effect op de inkoop daarvan.

- Welke toekomstige ontwikkelingen zie je op het gebied van emissieloos materieel?
- Welke impact gaan deze ontwikkelingen hebben op de manier waarop jullie (emissieloos) materieel gaan inkopen?
- Hoe verwacht je dat de inkoop van emissieloos materieel er over 5-10 jaar uitziet?

D VALIDATION TEMPLATE

Stap 1: Presenteer de Strategie

Stap 2: Geef de participant de mogelijkheid om de strategie te bestuderen (ca. 15min)

Stap 3: Geeft de participant de mogelijkheid om de volgende gesloten vragen te beantwoorden op een 5-point likert-scale

1. Ik heb voldoende kennis om de strategie te begrijpen.
2. De strategie maakt duidelijk welke methoden beschikbaar zijn.
3. De voor- en nadelen van de verschillende methodes zijn voor mij duidelijk.
4. De risico's die samenhangen met elk van de verschillende methodes zijn voor mij duidelijk.
5. Hoe ik om kan gaan met deze risico's is voor mij duidelijk.
6. Ik heb de mogelijkheid om verschillende opties te vergelijken.
7. De strategie geeft mij inzicht in welke methode ik het beste kan inzetten.
8. De strategie geeft mij inzicht waarom ik deze methode het beste kan inzetten.
9. De strategie sluit aan op de werkwijze en businesscase van Strukton Wegen & Beton.
10. De strategie is voldoende flexibel en toekomstbestendig om mee te groeien met ontwikkelingen op het gebied van emissieloos materieel.

Stap 4: Geef de participant de mogelijkheid om in discussie te gaan over de volgende open vragen:

- Wat zijn volgens u de sterke punten van deze strategie?
- Wat zijn volgens u de zwakke punten van deze strategie?
- Welke verbeterpunten zou u willen aandragen?

E INTERVIEW RESULTS

The following pages include the results of the interviews as conducted according to section 2.2. The interview results show the results from the coding. The different categories are displayed in yellow and are references with letters. The subsequent codes that relate to these categories are layout underneed and references with numbers. At last, on the right side it is possible to find in which interviews which of the codes was found, as well as the total amount of interviews in which the codes were found.

Note that in the results section, references to the interviews to support findings are based on the coding in the format [CategoryCode-Interviewees] as found in the overview on the next pages. So [A1-1,4] would reference to 'beperkt aanbod emissieloos materieel' as mentioned by interviewees number 1 & 4.

			1	2	3	4	5	6	7	8	9	10	
A	○	**Beschikbaarheid Materieel**	*	*	*	*	*	*	*	*	*	*	10
	1	Beperkt aanbod emissieloos materieel	*			*			*	*			4
	2	Bij inschrijving nog geen zekerheid op materieel						*	*	*			3
	3	kortetermijn verhuur								*		*	2
	4	materieel (nog) niet beschikbaar als huur, je moet opdracht wegzetten aan onderaannemer				*					*		2
	5	materieel is al verzegd				*	*					*	3
	6	materieel staat niet meer stil omdat het te duur is								*			1
	7	onderaannemer wil pas investeren bij zekerheid werk		*		*						*	3
	8	onderaannemers gaan vooral inzetten op hoofdaannemers die echt willen en durven afnemen										*	1
	9	onderaannemers zetten materieel vooral zelf in op eigen projecten, blijft te weinig beschikbaar voor Strukton			*					*			2
	10	verandering in aanvraagduur								*			1
B	○	**Drivers & Barriers**		*	*	*	*	*	*	*	*	*	9
	1	aanschafkosten			*						*		2
	2	alleen mogelijk via langlopende contracten		*		*					*		3
	3	Continuiteit van werk						*			*		2
	4	doorgaan van projecten leidend voor inzet emissieloos					*						1
	5	elektrificatie is zeer beperkt onderdeel van emissiereductie					*	*		*	*		4
	6	garantie op werk als driver voor aanschaf, maar garantie ontbreekt					*						1
	7	genoeg werk confensioneel									*		1
	8	inzet emissieloos gedreven door stikstof			*		*	*			*	*	5
	9	inzet emissieloos vanwege award criteria						*	*			*	3
	10	netcongestie als barriere voor overstap naar elektrisch				*	*	*		*		*	5
C	○	**Eigen Materieel**	*			*		*			*	*	5
	1	inzet eigen materieel	*			*		*			*		4
	2	specialistisch materieel in eigen bezig. Onderaannemers voor de rest										*	1
D	○	**Marktontwikkeling**	*	*	*	*	*	*		*	*	*	9
	1	Dalende marktprijzen zijn gevaar bij langetermijn overeenkomsten				*							1
	2	Markt, vooral ombouw van diesel naar elektrisch		*	*		*			*		*	5
	3	oplossing stikstofcrisis kan vraag naar emissieloos beperken										*	1
	4	politiek klimaat			*	*	*				*	*	5
	5	ravijnjaar					*			*		*	3
	6	steeds grotere machines elektrisch beschikbaar		*			*						2
	7	steeds meer aanbod	*	*			*			*		*	5
	8	steeds meer werken waar emissieloos gevraagd wordt						*		*			2
	9	verwachting dalende prijzen bij meer aanbod		*	*	*							3
E	○	**Opdrachtgevers**	*	*	*	*	*	*	*		*	*	9
	1	Alleen inzet elektrisch materieel indien gevraagd door opdrachtgever	*		*			*					3
	2	Beperkte vraag vanuit opdrachtgevers	*	*		*	*	*	*		*		7
	3	Bereidheid opdrachtgevers voor meerkosten	*				*	*	*		*	*	6
	4	klanten willen graag emissieloos in de tender, maar niet in de uitvoering				*		*				*	3
	5	klanten zijn terughoudend, echte bereidheid ontbreekt			*	*						*	3
	6	SEB, teveel opdrachtgevers die alleen maar basisniveau onderschijven, en niet het ambiteuze niveau										*	1
	7	selectie van klant is belangrijk						*					1
F	○	**Oplossingsrichtingen / Voordelen**	*			*	*	*		*	*	*	7
	1	Bereidheid top-down inzet materieel	*					*				*	3
	2	emissieloos materieel inzetten op conventionele projecten				*		*		*			3
	3	leergeld				*				*		*	3
	4	lef tonen	*					*		*		*	4
	5	marketing				*						*	2
	6	materieel als Strukton verhuren				*	*						2

	7	onderaannemer ontzorgt hoofdaannemer							*	*	*	3
	8	partners zoeken voor raamwerkovereenkomst					*				*	2
G	○	**Proactief vs Reactief handelen**	*		*	*		*		*		6
	1	actief verkopen aan marktpartijen				*	*		*		*	4
	2	actief zoeken naar projecten waar emissieloos op ingezet kan worden			*	*						2
	3	orderportofeaule					*				*	2
	4	Proactief marktdenken bij andere partijen	*				*		*			3
	5	Reactief marktdenken binnen Strukton	*			*					*	3
H	○	**Samenwerkingsvormen**	*		*	*	*	*	*	*	*	9
	1	combi-deal, uitgebreidere samenwerking.					*					1
	2	operationele lease									*	1
	3	partnerschap				*			*			2
	4	samenwerking met meerdere hoofdaannemers				*						1
	5	samenwerkingsvormen veranderen. Methodes die bij traditioneel werken werken nog niet bij emissieloos									*	1
	6	Voorkeur gebaseerd op relatie	*		*			*	*			5
	7	voorkeurspartner			*	*	*	*		*		5
	8	ad-hoc	*				*					2
I	○	**Strukton strategie**	*	*		*	*	*	*	*	*	9
	1	continuiteit moet vanuit raamovereenkomst komen					*					1
	2	duurzaamheidsbeleid Strukton					*					1
	3	elke afdeling denkt voor zichzelf, geen coordinatie tussen interne bedrijfstakken								*		1
	4	geen eigen materieel, alles moet bij onderaannemers ingehuurd worden	*					*				2
	5	projectleiders binnen strukton proberen nog vaak emissieloos weer terug te schalen naar confensioneel				*						1
	6	raamovereenkomsten met onderaannemers zijn vooral gebaseerd op prijs afspraken etc.				*						1
	7	Selectie onderaannemer ligt bij uitvoerder/projectleider	*	*		*		*				4
	8	Strukton ontbreekt nog een helder beleid					*					1
	9	voornamelijk kortlopende projecten				*		*	*			3
	10	Selectie onderaannemer per project	*	*		*	*	*	*	*		*	8
	11	voor inkoop van emissieloos worden momenteel dezelfde strategieën ingezet als voor traditioneel					*					1
J	○	**Technologie / Materieel**	*	*	*	*	*	*	*	*	*	10
	1	betere technologische inzet	*					*				2
	2	klein vs groot materieel vs specifiek materieel		*		*	*			*	*	5
	3	Laadinfrastructuur	*		*	*	*	*	*			6
	4	technologische beperking, andere manier van inzet	*		*		*		*			5
	5	transitie naar elektrisch	*		*	*	*	*	*		*	8
	6	veel verschillend materieel nodig					*					1
	7	voornamelijk inzet klein materieel elektrisch	*		*			*		*		4
	8	Waterstof	*	*	*	*	*			*	*	*	8
K	○	**Transities**				*		*		*	*	*	5
	1	duidelijkheid is het belangrijkste in de transitie									*		1
	2	transitie				*		*		*		*	4
	3	transitie die dingen niet makkelijker maar moeilijker maakt										*	1
	4	na transitie weer zelfde inkoopvormen als nu, want genoeg materieel beschikbaar bij onderaannemers				*		*					2
L	○	**Intern bedrijf**	*				*				*		3
M	○	**Kortlopende vs Langlopende projecten**	*		*		*		*	*	*	*	7
N	○	**langetermijn 'intentieverklaringen', projecten, contracten**			*	*	*	*	*	*		*	7
O	○	**Meerkosten allocatie**	*		*	*		*	*		*		6
P	○	**Raamcontracten**	*			*		*	*			*	5
Q	○	**Risico Allocatie**	*		*	*		*			*		5