# Breaking Barriers for Innovation within Design & Construct contracts

## Towards a Roadmap for Sustainable Procurement

Master Thesis Civil Engineering & Management

P.M. Beeker

Thesis advisors:
ir. K. Th. Veenvliet (University of Twente)
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UNIVERSITY OF TWENTE.

Grontmij

Final version
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# Voorwoord (Preface)

Plato heeft ooit eens gezegd: *“Het begin is het belangrijkste deel van het werk.”* Voor deze quote moet ik terug naar de filosofielessen in de brugklas. Het begin van mijn wetenschappelijke opleiding, die na vele jaren afgerond wordt door het document wat nu voor u ligt. Sinds het begin van dit jaar heb ik mij verdiept in het fenomeen ‘Duurzaam Inkopen’. Het citaat van Plato is op meerdere manieren toepasbaar op mijn onderzoek. Zo kan de conclusie samengevat worden in deze ene zin: hoe eerdere je begint na te denken over duurzaamheid binnen een project, hoe beter het resultaat. Ook het begin van het proces van mijn afstudeeropdracht heeft in belangrijke mate het resultaat beïnvloed. In het staartje van het woelige jaar 2009 ging ik op zoek naar de kern van de opdracht, een zoektocht die enkele maanden in beslag heeft genomen en waardoor vaak een specifieke rode lijn leek te ontbreken. Karel en Sander wisten mij er telkens weer op te wijzen deze rode lijn te vinden, en hebben mij perfect door het proces geleid. Mijn eerste woord van dank gaat dan ook uit naar hen. Elma en Stephan wisten mij als experts op het gebied van respectievelijk ‘duurzaamheid’ en ‘inkopen’ te ondersteunen bij het begrijpen van de belangrijkste elementen van dit onderzoek, waarvoor mijn dank. In zijn geheel kijk ik met plezier terug naar de vele interessante discussies die ontstonden tijdens de bijeenkomsten.

Voor mijn onderzoek heb ik meerdere mensen geïnterviewd en gesproken, die met interessante en vernieuwende perspectieven kijken en mij geholpen hebben bij het analyseren van het vraagstuk. Naast hen gaat ook mijn dank uit naar Jelmer, Nico, Ton, Tjark en Stefan waarmee ik de workshop heb kunnen uittesten en de deelnemers van de ‘echte’ workshop, naast Sander en Stephan, Harm, Martijn, Iris, Pieter, Peter en Ron.

Met Elma heb ik al een wat langere geschiedenis dan de andere begeleiders. Het begin van de nieuwe opleiding ABCDE (later Industrieel Ontwerpen voor de Bouw) was ook het begin van mijn masteropleiding. Elma heeft dit samen met Wim Poelman opgezet en mijn master veel kleur gegeven. Reizen naar Istanbul en Sarajevo, meedoen aan een tv-show, een boek ontwerpen, rondleidingen van de architecten van “the Wall” en “Westraven”, spreken op diverse symposia en de vele bedrijven daaromheen leren kennen. Ik had het niet willen missen!

Wanneer ik helemaal terug ga naar het begin zijn daar mijn ouders en opa en oma, zij hebben mij alle ruimte gegeven er een supermooie studententijd van te maken! Mijn broer en zus hebben hiervoor de weg vrijgebaand en zijn dan ook mijn grote voorbeelden. Veel steun heb ik ook gehad van Marit, die mij tijdens de stage elke ochtend op tijd uit bed schopte.

In januari begin ik als adviesmedewerker binnen hetzelfde team bij Grontmij.

Veel plezier met het lezen van mijn scriptie.

28 oktober 2010

Mees Beeker

## Management Summary

Innovation is the engine that will enable a sustainable future (Mann and Dekoninck, 2003; Souchkov, 2010). This is a leading principle in this thesis, which deals with innovation in the civil engineering industry. The thesis focuses on a specific goal: to encourage a contractor to build in a sustainable way for the Operate and Maintenance (O&M) phase of the buildings' lifecycle, within a Design & Construct (D&C) building model. It will pose that innovation on the long run will lead to solutions that decrease use of energy, materials, dimensions and dynamics for a specific problem. The thesis maps barriers for innovation during the initial stages of the building life cycle and proposes TRIZ ('Systematic Innovation') as a methodology to encourage innovative processes during this stage. It exposes the importance of encouraging innovation by governmental bodies and other clients during the procurement stage to be able to change the construction industry to a more socially responsible industry. The research has been carried out at Grontmij B.V. in de Bilt within the purchasing and contract management section of Team Projects.

The theoretical methodology used for this thesis is a classic problem solving cycle introduced by van Strien (1997) and adapted by van Aken et al. (2007). It defines the problem, produces an analysis and diagnosis and formulates a plan of action. The reader will find a theoretical analysis which reflects the result of a literature study (including information gained from a two-week TRIZ summer course) on sustainable development and innovation and provides insight on the used point of view of the concept of sustainable procurement. Supported by a literature study and interviews with experts, the analysis also maps the business process, exposes barriers of the stated problem and proposes TRIZ as a methodology. A workshop 'TRIZ' was organized to validate the potential of the methodology in addition to the current process. With these findings a conceptual Roadmap is designed and presented.

This thesis reveals the real challenges that have to be faced within a specific part of the building process, the procurement stage. With this result the company is able to consult their clients on relevant issues during the procurement stage. This thesis combines two topics, 'innovation' and 'sustainable development'. It shows the importance of the recent culture shift towards a more innovation stimulating environment when dealing with the current demand for solutions that are socially responsible. By making the link between these two topics, it becomes clear that barriers for innovation are also applicable to demanding solutions that meet criteria on sustainability, especially for the phases after realisation of a construction within D&C contracts.
Specifically for the procurement stage, the thesis shows that aspects concerning 'sustainability' should be part of a total approach, including the process and all tender documents a client needs to create in order to put the tender on the market.
TRIZ is introduced as a tool to effectively and efficiently design innovative solutions to specific problems. TRIZ may be expected to play a significant role in ensuring that people, planet and profit are able to not only co-exist, but also flourish in a sustainable future. The methodology focuses on reaching a higher *degree of ideality*; it decreases harmful effects and costs and increases useful effects.
As a final result a practical set of steps that forms a Roadmap has been developed and presented.

In conclusion, the advantages associated by using this roadmap can be summarized by three major points:

- Innovation is the engine that enables a sustainable future. In order to encourage innovation the client should focus on it as early as possible in the building lifecycle and to do so deal with the barriers for innovation that arise during the process.
- Concerning the initial stages of the building lifecycle, three issues need specific attention: specify functionally; compensate the contractors sufficiently for their efforts and be aware of the difficulties in valuing 'sustainability'.
- The presented roadmap provides the client with a unique way to pave the road for a contractor to build an object that meets the criteria of sustainability during the Operate & Maintenance phase.

Presently, during the contracting stage, sustainability is 'added' into one of the tender documents as a trade-off. It is expected, by using the roadmap, the goals of sustainable development can be reached on the long run, without compromises to function or cost.
It is recommended that Grontmij uses the Roadmap to support and consult their clients enabling them to encourage a contractor to build an object that meets specific sustainability criteria in the Operate and Maintenance phase.

Further research is needed to respond to the current development of Systems Engineering in the construction industry and possibilities to integrate TRIZ, it is expected that Systematic Innovation (TRIZ) can be adapted and positively contribute to this approach.

# Samenvatting (Dutch summary)

Innovatie is de motor voor het totstandbrengen van een duurzame toekomst (Mann en Dekoninck, 2003; Souchkov, 2010. Dat is de rode draad die beschreven wordt in deze scriptie: het behandelt innovatie binnen de Grond- Weg- en Waterbouw. Deze scriptie focust op een specifiek doel: Het prikkelen van de opdrachtnemer tot duurzaam bouwen voor de beheer- en onderhoudsfase van de levenscyclus van het object, binnen een Design & Construct overeenkomst. In de scriptie wordt gesteld dat op de lange termijn innovatie zal leiden tot oplossingen die het verbruik van energie en materialen verminderen en omvang en complexiteit verminderen voor een specifiek probleem. De barrières die totstandkoming van innovatie beperken binnen de eerste fases van de levenscyclus van het gebouwde object worden omschreven en TRIZ wordt aangedragen als methodologie om innovatieve processen te ondersteunen tijdens deze fase. De scriptie belicht het belang van het stimuleren van innovatie door overheidsinstanties en andere opdrachtgevers tijdens de aanbestedingsfase, om hen in staat te stellen de bouwindustrie te veranderen naar een meer maatschappelijk verantwoorde industrie. Het onderzoek is uitgevoerd bij Grontmij B.V. in de Bilt onder het Team Projects bij inkoop- en contractmanagement.

Voor deze scriptie is de theoretische methodologie van van Aken e.a. (2007) toegepast voor het oplossen van problemen, een klassieke cyclus voor probleemoplossing. De scriptie beschrijft het probleem, geeft een analyse en diagnose weer en formuleert een plan van aanpak. De lezer zal een theoretische analyse vinden die het resultaat weergeeft van een literatuurstudie (inclusief informatie verworven tijdens een twee weken durende summer course TRIZ) over de termen Duurzaamheid en Innovatie en geeft inzicht in het gebruikte perspectief voor duurzaam inkopen. Ondersteund door deze studie en interviews met experts, geeft de analyse het bedrijfsproces weer, belicht deze de barrières voor het gestelde probleem en introduceert TRIZ als methodologie. Een workshop ‘TRIZ’ is georganiseerd om het potentieel van de methodologie te valideren als toevoeging aan het huidige proces. Met deze resultaten is een conceptueel stappenplan ontworpen en gepresenteerd.

Deze scriptie onthult de ware uitdagingen die aangegaan moeten worden binnen een specifiek deel van het bouwproces, het inkoopproces. Met dit resultaat is het bedrijf in staat klanten te adviseren over relevante zaken tijdens deze fase. De scriptie combineert twee onderwerpen, ‘innovatie’ en ‘duurzame ontwikkeling’. Het toont het belang aan van de recente cultuurverandering richting een meer innovatie stimulerende omgeving, die omgaat met de huidige vraag voor maatschappelijk verantwoorde oplossingen. Door deze koppeling te maken wordt het duidelijk dat barrières voor innovatie ook toepasbaar zijn op de vraag naar oplossingen die voldoen aan duurzaamheidscriteria met de nadruk op de fases na realisatie van een object binnen design en construct contracten.

Wanneer er gekeken wordt naar het inkoopproces, laten de resultaten van de scriptie zien dat aspecten die te maken hebben met ‘duurzaamheid’ een onderdeel moeten zijn van een totale benadering, met inbegrip van de processen van alle aanbestedingsdocumenten die een opdrachtgever moet maken om een uitvraag op de markt te kunnen zetten.
TRIZ is in dit onderzoek geïntroduceerd als tool om effectief en efficient innovatieve oplossingen te ontwerpen voor specifieke problemen. Het wordt gesteld dat TRIZ een belangrijke rol kan spelen om ervoor te zorgen dat People, Planet en Profit niet alleen kunnen samengaan maar ook kunnen gedijen in een duurzame toekomst. De methodologie richt zich op het behalen van een hogere graad van Ideality, het vermindert de schadelijke effecten en de kosten en verhoogt de bruikbare effecten.
Als eindresultaat van het onderzoek is een praktische set van stappen ontwikkeld en gepresenteerd die samen een Stappenplan vormen.

Kortom, de voordelen die aan dit stappenplan gekoppeld kunnen worden, kunnen worden samengevat in drie hoofdpunten:

- Innovatie is de motor voor het totstandbrengen van een duurzame toekomst. Om innovatie te stimuleren moet een opdrachtgever zich zo vroeg mogelijk in het proces van de bouwlevenscyclus hierop richten en om dit te doen moet de opdrachtgever weten om te gaan met de barrières voor innovatie die voorkomen tijdens dit proces.
- Lettend op de initiële fases van de levenscyclus van een object, verdienen drie punten extra aandacht: Specificeer functioneel, compenseer de opdrachtnemer voldoende voor zijn inspanningen en wees ervan bewust dat het moeilijk is de waarde van ‘duurzaamheid’ te bepalen.

- Het gepresenteerde stappenplan biedt de opdrachtgever een unieke mogelijkheid om de weg vrij te maken voor de opdrachtnemer om een object te bouwen dat voldoet aan de criteria voor duurzaamheid voor de beheer- en onderhoudsfase.

Het wordt aanbevolen dat Grontmij dit stappenplan gebruikt om klanten te adviseren en ondersteunen, om hen in staat te stellen de opdrachtnemer te prikkelen om een object te bouwen dat voldoet aan de criteria voor duurzaamheid voor de beheer- en onderhoudsfase.

Nader onderzoek is nodig om te reageren op de huidige ontwikkelingen in de markt rondom het opzetten van de methodologie van Systems Engineering in de industrie en het integreren van de methode van TRIZ hierin. De verwachting is dat Systematische Innovatie (TRIZ) kan worden ingepast in dit proces en een positieve bijdrage kan leveren aan de benadering.

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## Terms and definitions

| Term | Definition (section number) |
|---|---|
| **Building stages** | Initiative, Design, Build, Operate & Maintain, Disposal or Recycle (2.2, 3.1, page 70) |
| **Civil Engineering** | Discipline that deals with the design, construction and maintenance of the physical and naturally built environment, including works such as bridges, roads, canals, dams and buildings. (In Dutch: Grond- Weg- en Waterbouw: GWW) |
| **Contractor** | The contractor realizes parts of the building cycle; depending on the collaboration form (Appendix A.1). In this thesis the contractor is responsible for the design and construction (D&C) of an object. |
| **Design & Construct (D&C)** | Integrated cooperation concept; the contractor takes responsibility for both the design and construction of a construction (3.1.1, appendix A.1) |
| **EMAT** | Economically Most Advantageous Tender (Dutch: EMVI) |
| **Employer, Client** | The Employer or Client takes initiative for a project; it should not be confused with a client of Grontmij. |
| **Framework, Procedure, Roadmap** | The *Framework* for innovation is the context within a project innovation can be implemented, for example the laws, regulations or policy from a public body or client.<br>For (Procurement) *Procedure* see 'Procurement'.<br>The *Roadmap* is the proposed result of this thesis. |
| **Innovation** | Innovation is a *new idea* which is *successfully implemented* and has a *recognized value*. (2.3) In this thesis can be seen in two contexts, project specific and process specific (1.1) |
| **Lifecycle** | All stages of the building life, including a connection between the last and the first stage (2.2) |
| **Procurement** | The acquisition of appropriate goods and/or services to meet the needs of the purchaser. Public bodies often define processes intended to promote fair and open competition for their business while minimizing exposure to fraud and collusion. (3.1.2) |
| **Output specification** | Document stating the demands or requirements of the client. (Vraagspecificatie) |
| **Sustainability** | Sustainability during the procurement process is *"a process and/or product innovation resulting from the briefing or design phase that will optimize the flexibility, use of energy, water and material of the object during the operate and maintenance phase and minimizes waste during the demolition phase."* (3.1) |
| **TRIZ** | The theory of inventive problem solving. It is a problem-solving, analysis and forecasting tool derived from the study of patterns of invention in the global patent literature. (1.4, 3.2) |

# 1 Breaking barriers for innovation

Innovation is the engine that will enable a sustainable future (Mann and Dekoninck, 2003; Souchkov, 2010). This is a leading principle in this thesis, which deals with innovation in the civil engineering industry, under the title: "*Breaking Barriers for Innovation within Design & Construct Contracts - Towards a Roadmap for Sustainable Procurement*". The thesis maps barriers for innovation during the initial stages of the building life cycle and proposes TRIZ as a methodology to encourage innovative processes during this stage. It exposes the importance of encouraging innovation by governmental bodies and other clients during the procurement stage to be able to change the construction industry to a more socially responsible industry. The thesis has been carried out at Grontmij B.V. in de Bilt at the purchasing and contract management section of Team Projects.

The thesis will focus on a specific goal: to encourage a contractor to build in a sustainable way for the Operate and Maintenance (O&M) phase of the buildings' lifecycle, within a Design & Construct (D&C) building model. A model in which the contractor is responsible for the Design and Construct phases (also see section 3.1). It will pose that innovation on the long run will lead to solutions that decreases use of energy, materials, dimensions and dynamics for a specific problem. A framework encouraging innovation is needed to implement an innovation within a project; figure 1 illustrates this process and project specific form. The framework of the innovation process is the context within a project innovation can be implemented, for example the laws, regulations or policy. The innovation process is the evolution of a solution developed during several projects. Project specific innovation relates to everything within a project lifecycle that can be seen as innovative, such as using a new sort of material, using a different building process or a new approach for operation or maintenance. The thesis will show that there are barriers that only affect innovation as a process, barriers that only affect it within a project, and barriers that affect both.

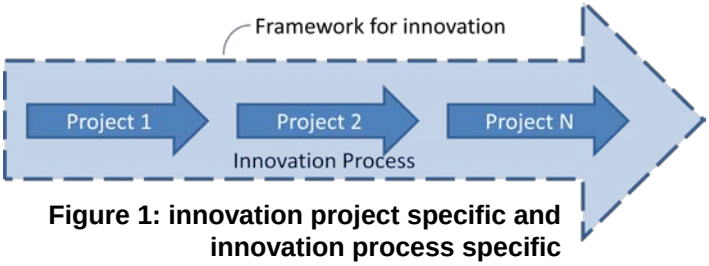



**Figure 1: innovation project specific and innovation process specific**

Systematic innovation tools (such as TRIZ) may be expected to play a significant role in ensuring people, planet and profit are able to not only co-exist, but also flourish in a sustainable future. Effective 'sustainable' design solutions will *not* emerge from traditional trade-off and compromise based innovation strategies. (Mann and Dekoninck, 2003)

The remainder of this chapter is written in six sections. Section 1.1 will focus on the motivation for a 'sustainable' procurement. Section 1.2 illustrates the context and framework of the thesis. Section 1.3 will state the problem definition, goal and research questions. Section 1.4 will discuss the research methodology and introduce TRIZ. In section 1.5 the relevance is stated and the chapter concludes with a reading guide for this thesis, in section 1.6.

## 1.1 Purchasing and procurement

The Dutch government spends more than 50 billion Euros for purchasing and procurement. This represents a substantial share of the market including office facilities, road and construction work, transport and energy. Giving the good example to procure and purchase in a way that meets sustainability criteria, the government wants to stimulate the market for producing products that meet 'environmental' requirements. In 2010, the national government wants to purchase 100% products that meet these requirements. Municipalities strive after 75% in 2010 and 100% in 2015. Provinces and water boards set the goal at 100% at the year 2015. (VROM, 2010)
To support Dutch governments to reach its goal, AgentschapNL provides guidelines. For example "*De handreiking duurzaam inkopen en aanbesteden*" (Sustainable Purchasing and Contracting guideline) from Senternovem (2010) supports Dutch governments (local and national) in environmental purchasing. The guideline can be used as a tool for using the 'criteria documents'. These documents describe 52 product groups of sustainability criteria which governments can use considering purchasing. Some examples of a product group are "Office buildings", "Demolition of buildings", "Public Transport" and "Roads". To meet the obligation it is necessary in any case to incorporate the minimum requirements in the specifications and contracts.

The general opinion on these criteria is that it is not sufficient enough yet, but the urge for socially responsible measurements on this topic is growing (several interviewees brought this to attention, appendix B).

## 1.2 Grontmij & D&C in the Civil Engineering industry

Grontmij B.V., having around 8000 employees, is a service provider for design, consultancy, management, engineering and contracting in the environmental, water, energy, building, industry and transportation sectors. The ambition of Grontmij is "*to lead the industry in developing sustainable practices. In doing this Grontmij places environmental considerations at the heart of their activities where their main focus and priority is to play a major part in addressing the effects of climate change*." (Grontmij, 2009) This project focuses on Team Projects and the department contract and purchasing management consisting of about 25 employees in total. Team Projects deals with increasing the feasibility, fit, predictability and value of investment projects. Recently, the market and government have been asking for a form of procurement that focuses on sustainability, which for example should result in objects built with a lower energy use. Within a Design and Construct (D&C) contract, the contractor is not responsible for the construction's lifecycle. For the client, the challenge arises to form the D&C contract in such a way that the contractor will be encouraged to develop an object that meets criteria on sustainability. Grontmij should address this opportunity, to show the client a process resulting in a new form of procurement and so generating more employment.

This master thesis describes several issues regarding Sustainable Development in the Civil Engineering industry. It aims to show that 'sustainability' is not implemented at one point during a project; but has its impact on several levels in different phases of the building life cycle. Figure 2 frames the area of this research. Figure 2 is divided in 2 sections, theory and practice. The theory includes a study for a methodology that is able to be used at every stage of the lifecycle. The practice is the context of Design & Construct, which specifically has its impact on the form of collaboration between client and contractor; both theory and practice are elaborated in Appendix A and briefly mentioned in chapter 3.

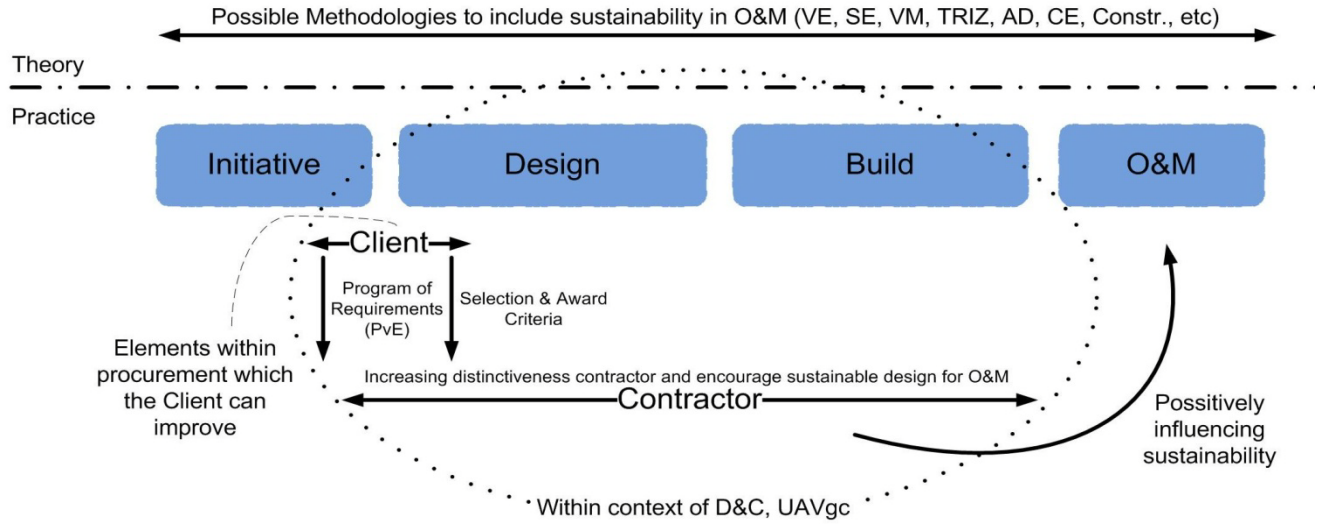



**Figure 2 Context and framework of thesis**

## 1.3 Problem definition, goal and research questions

It is a challenge to develop an object that deals with all aspects of the lifecycle, because the responsibilities (and with that, the risks) are divided between several stakeholders. For example, in a Design and Construct process, the client might want a bridge which has minimized maintenance work in its lifetime, but the contractor does not design and build this preferred bridge, because maintenance is not his responsibility. Some sustainability challenges have to be dealt with in specific parts of the building process. Requirements will become fixed over time, and changing those requirements in a later stage will have financial disadvantages. 'Sustainability' is a specific quality requirement, the earlier this requirement is taken into consideration, the more effect it will have in the end. The **problem** formulated by Grontmij is:

*"Contractors are not encouraged to design sustainable solutions for the operate & maintenance phase within a D&C building model."*

A new opportunity rises to develop and build objects (bridges, buildings, roads, quays, etc.) that for example use less energy or material. Sustainable procurement is a new development in the building process, particularly in the procurement phase. The practical implementation of this new form of procurement forms a challenge for the contracting department. How should the procurement process be set up to make a real difference in a sustainable point of view? The **goal** of this research is:
*To develop a roadmap of ideas within part of the construction process (from the initiative until procurement) which will show that sustainability is included in the tender of a D & C contract.*

To reach this goal the following **main question** needs to be answered:
*What steps should the client take during the concept and development phase within a D & C project in the civil engineering sector, in order to encourage the contractor to develop an object that is sustainable in the operate and maintenance phase?*

This question will be answered in this thesis using the following 5 **sub questions**:
1) What are the main steps taken by the client in the concept and development phase?
    - Which constraints emerge concerning sustainability in a D&C project?
        - In procurement procedure
        - In contracting procedure
2) What are the main problems developing an object that is sustainable in the operate and maintenance phase?
    - Analyze the lifecycle of a civil engineering object from back to front of the building process;
        - From the perspective of the client
        - From the perspective of the contractor
3) Which methods exist to encourage a contractor to develop a sustainable object in a D&C project?
4) What methods should be used at control points in the concept and development phase?
5) What recommendations can be given in the concept and development phase?

## 1.4 Research methodology & introducing TRIZ

The steps a client can take stated in the main question will be part of a roadmap. The design of such a roadmap is a business problem solving project which is undertaken to improve the performance of the procurement process at Team Projects of Grontmij. A classic problem solving cycle is used introduced by van Strien (1997) and adapted by van Aken (2007). The first two phases of the cycle are the “problem mess” and the “problem definition”, which were presented in the previous sections. The next phase of the cycle is the “analysis and diagnosis” phase which is the analytical part of the project. This phase produces specific knowledge on the context and nature of the problem. During the “plan of action” phase of the cycle one designs the solution for the problem and the associated change plan. The last two phases of the cycle are intervention and evaluation. Usually the last two phases of the regulative cycle are not part of a master thesis, as it can take several years to get a result. In section 1.6, the two phases are illustrated in figure 3.

### *1.4.1 The analysis and diagnosis (phase 1)*

According to van Aken et al. (2007) three approaches should be combined to produce a diagnosis; empirical, theoretical and process-oriented analysis. In chapter 2 the reader will find a theoretical analysis which shows the result of a literature study (and information gained from the TRIZ summer course) and provides insight on the point of view on the concept of sustainability is used. Chapter 3 is a combination of the three forms of analysis it maps the business process, explores causes of the problem and proposes a methodology, it is a result of a literature study (and summer course) and interviews with experts. The sub questions 1 and 2 will be answered as a result of the Analysis and Diagnosis phase.

### *1.4.2 Plan of action (phase 2)*

According to van Aken et al. (2007) the plan of action involves solution design and change plan design. The basic idea on which the business problem solving project is based holds that the successful realization of the designed solution should result in the solution of the defined business problem. That solution is a procedure (in this thesis a *‘roadmap’*) supporting the business system, together with its internal and external interfaces. The results of chapters 2 and 3 explain what methodology could be successful in reaching the stated research goal; when it should be implemented in the procurement procedure; and what barriers it should expect or try to overcome. A workshop ‘TRIZ’ is organized to validate the potential of the methodology as addition to the

current process. With these findings a conceptual Roadmap is designed and presented in chapter 5. The sub question 3, 4 and 5 will be answered as a result of the Plan of Action phase.

### *1.4.3 Introducing TRIZ*

As a part of 'literature study for the thesis' a *summer course TRIZ-fundamentals* was attended at Twente University. It consisted of 80 hours of lectures and workshops given by Valeri Souckov and Tom Vaneker. As a result the certificate of "**Advanced TRIZ practitioner**" was obtained.

Systematic innovation is based on 1500 person-years of research into the dynamics of system evolution. This research includes the study of over 2 million innovations and analyses of technical and business systems across all fields of human endeavor. These contributions to knowledge are also known under the acronym **TRIZ** - the theory of inventive problem solving (TRIZ is an acronym of the Russian "**T**eoriya **R**esheniya **I**zobretatelskih **Z**adatch"). TRIZ helps to avoid trial and error problem solving by employing generalized patterns distilled from previous solutions. A second important tenet from TRIZ is that inventive problem solving requires the elimination of contradictions, as opposed to 'design-by-compromise' approaches. TRIZ researchers hold that (1) the advancement of inventions obeys certain universal principles of creation, (2) all innovations across industries and sciences follow a handful number of inventive principles, (3) technology evolves according to certain trends, (4) the idealization of a solution is a process to destroy conflicts and trade-offs or to transform harmful elements of a system into useful resources (Mann & Dekoninck, 2003, Mao et al. 2009). Section 3.2 will further elaborate on TRIZ and introduce extended TRIZ, xTRIZ, the methodology that is used eventually for finding effective 'sustainable' design solutions.

As TRIZ is a strong *problem solving* tool, and the thesis formulates a *problem* that needs to be solved, several analyses in this thesis were conducted using TRIZ tools and concepts, Function Analysis and Root Conflict Analysis+. For this thesis the tools were used individually to analyze and structure the barriers clearly, which is a strong feature of these two tools. The use of the tools in this thesis should be seen separately to the proposal of using TRIZ in the procurement process, but can be considered as an example of the broad application possibilities of TRIZ.

## 1.5 Relevance

Considering sustainable development in the Netherlands for solutions reducing the depletion of natural resources, one should look at the construction industry. A quarter of the total traffic, a third of the domestic waste and half of the carbon footprint comes from this industry (Lichtenberg, 2009).
The construction market seems to be willing to take its social responsibility to deal with challenges concerning global warming, depletion of raw materials, excessive energy use and other issues concerning sustainability. This thesis reveals the real challenges that have to be faced within a specific part of the building process, the procurement stage, to meet this market demand. With this result the company is able to consult their clients on relevant issues during the procurement stage.
The implementation of a new methodology for inventive problem solving is another benefit; the company can use this methodology during several stages of the building process to improve systems functionality or to solve a specific problem. By following the formulated roadmap the use of this methodology will focus on issues regarding market's demand.

## 1.6 Reading guide for the thesis

This master thesis is divided into 7 chapters, see figure 3. Chapter 2 illustrates a background study on definitions of the meaning of the terms *sustainable development* and *sustainable building* and will be connected to the evolution theory of technology (chapter 2, figure 9 and 10).
Chapter 3 puts focus on sustainable procurement and methodologies for innovation. It forms the backbone of the report and illustrates all barriers for innovation found during the thesis research. It shows that at this point in time, incorporating sustainability in the construction industry is just starting and has quite some barriers to overcome.
Chapter 4 will give an example of using TRIZ during the procurement process to overcome some of the barriers found in the previous chapter. The workshop was organized to introduce TRIZ to members of the Project Team and evaluate together if TRIZ as a methodology has potential to become part of the sustainable procurement procedure. An existing case is used; this case was the reason for the problem formulation at the

company.
Before stating the points of discussion, conclusions and recommendations in chapters 6 and 7, chapter 5 will illustrate a roadmap and a practical implementation of several possibilities the company can use to encourage the process of innovation during the initial stages of the buildings lifecycle.
Besides these 6 main chapters, the appendices show several studies on different issues, such as the procurement process, building cooperation models and design methodologies. Also the elaborated interviews and workshop briefing can be found.

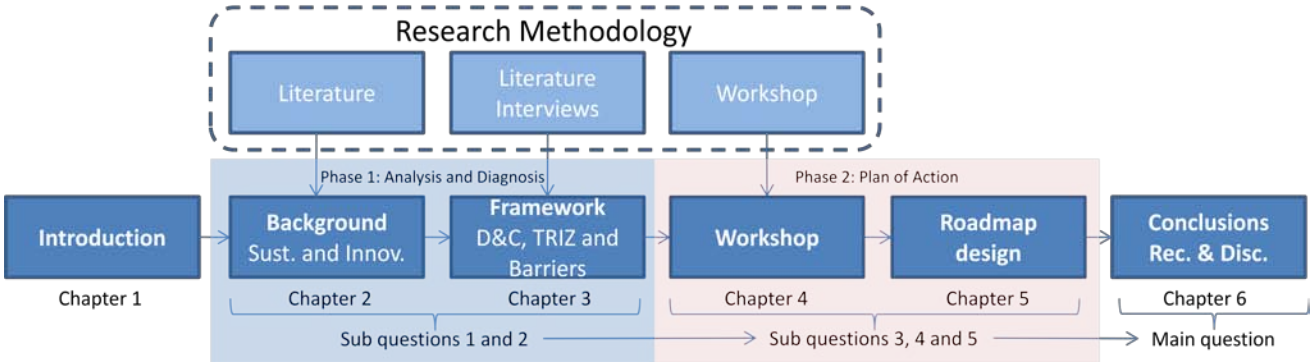
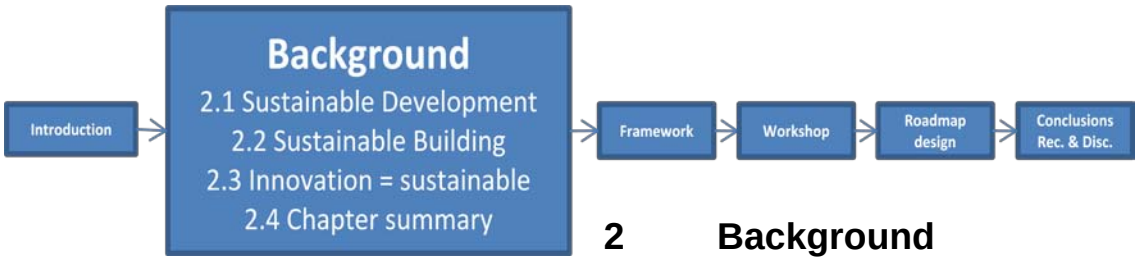



**Figure 3 Reading guide, 'Literature' also includes a 2-week summer course *TRIZ-Fundamentals* by Valeri Souchkov, 2010**




# 2 Background

In recent years the public and private sector of the building industry focus on sustainable development of the sector. Both public and private sector have their own reason and approach how to realize this. From the viewpoint of the Dutch Cabinet, sustainable development is a priority issue. The Cabinet aims to counter any non-sustainable trends by providing support to the pioneers of sustainable development, by promoting national and international collaboration and by placing considerable emphasis upon innovation (VROM, 2010). This ambition for sustainable development opens the door to sustainable production in the construction and infrastructure sectors. This can be on a small scale by expressing preferences on using sustainable materials or on a larger scale asking an integrated approach of design, implementation and management & maintenance (Bouwend Nederland, 2010).

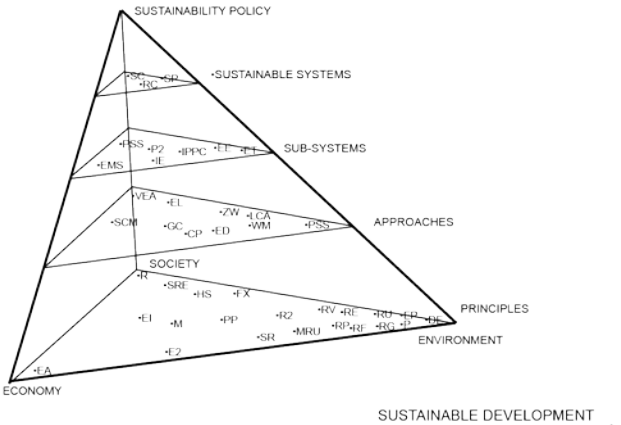
Brown et al. (1987) state *"definitions of sustainability and sustainable development vary across contexts and scales. Depending on the definition, it can either develop into a realistic goal or remain a utopian ideal. Different societies have different cultural expectations of sustainable development further complicating the process. Finally, setting the priorities of sustainability is value-laden and so requires a clear definition from the outset."* When doing research on sustainability it is desirable to define and choose the appropriate definition of sustainability for this particular report.
The emergence of the term sustainable development will be described, followed by its implications on the building industry and the procurement phase in particular. As the Dutch Cabinet stated (VROM, 2010), emphasis should be upon innovation, the explanation of the link between innovation and sustainable development completes this chapter.

## 2.1 Sustainable Development

Glavič and Lukman (2007) reviewed 51 sustainability oriented terms and their definitions. They state that sustainable development could be introduced as a process or evolution (also see 2.3). Numerous definitions of sustainable development are attainable but, in principle, they remain similar to the one from 1987. In that year the World Commission on Environment and Development (i.e. Brundtland's Commission) defined sustainable development as *"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts:*

- *the concept of 'needs', in particular the essential needs of the world's poor, to which overriding priority should be given; and*
- *the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs."*

In its broadest sense, the strategy for sustainable development aims to promote harmony among human beings and between humanity and nature. (Brundtland, 1987).
Glavič and Lukman (2007) proposed a hierarchical and interdependent concept illustrated in figure 4. The two underlying principles of the Pyramid of Glavič and Lukman (2007) are the definitions of sustainable development by Brundland (1987) and the triple bottom




CP, cleaner production; DE, degradation; EA, environmental accounting; ED, eco-design; EE, environmental engineering; EI, ethical investment; EL, environmental legalisation; EMS, environmental management strategy; ET, environmental technology; E2, eco efficiency; F*X*, factor *X*; GC, green chemistry; HS, health and safety; IE, industrial ecology; IPPC, integrated pollution prevention and control; LCA, life cycle assessment; M, mutualism; MRU, minimization of resource usage; P, purification; PC, pollution control; PO, policy; PP, "polluter pays" principle; PSS, product service system; P2, pollution prevention; RC, responsible care; R, reporting to the stakeholders; RE, recycling; RF, remanufacturing; RG, regeneration; RP, repair; RU, reuse; RV, recovery; R2, renewable resources; SC, sustainable consumption; SCM, supply chain management; SD, sustainable development; SP, sustainable production; SR, source reduction; SRE, social responsibility; VEA, voluntary environmental agreement; WM, waste minimization; and ZW, zero waste.

**Figure 4: Classification of sustainability oriented terms (Glavič and Lukman, 2007).**

line or PPP by Elkington (1994). Elkington and his company SustainAbility began using the term “Triple Bottom Line” (TBL) in public, with early launch platforms, including an article in the *California management Review* on ‘win-win-win’ business strategies in 1994. In 1995, they also developed the 3P formulation, ‘people, planet and profits’ see figure 5, later adopted by Shell for its first *Shell Report* and now widely used in the Netherlands as the 3Ps (Henriques and Richardson, 2004). Triple Bottom Line accounting attempts to describe the *social* and *environmental* impact of an organization's activities, in a measurable way, to its *economic* performance in order to show improvement or to make evaluation more in-depth.

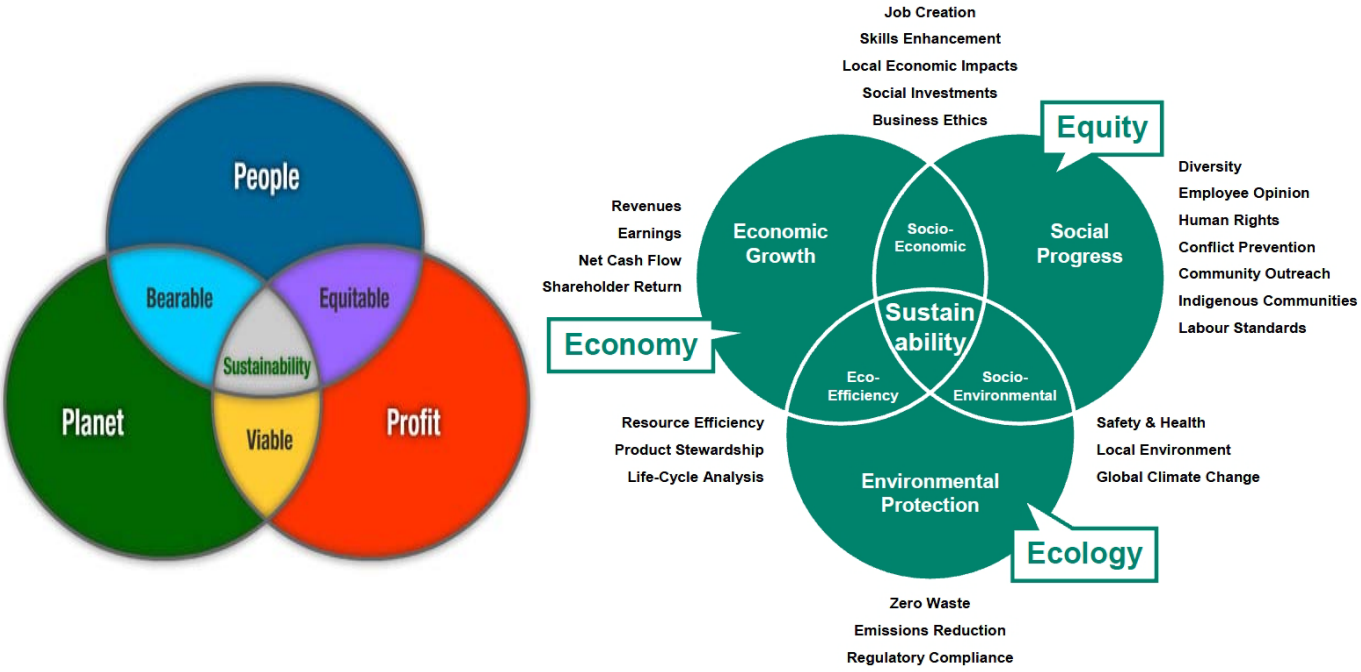



**Figure 5: Left: The triple bottom line is also referred to as the 3p's: People, Planet and Profit. Right: The Sustainability Challenge (van Ree & van Meel, 2007)**

Challenges that rise from The Triple Bottom line are illustrated by van Ree and van Meel (2007) in Figure 5. They point out that from a social point of view; a development has to enhance the quality of life. From an economic point of view, a development has to be cost-effective over time. From an environmental point of view, a development has to be resource efficient (decrease use of raw materials). This challenge will affect the entire industry including all its transactional and contextual stakeholders.

## 2.2 Sustainable Building

The statement by Brown et al. (1987) from the introductory text of this chapter about varying definitions of sustainable development is also applicable to the definition of sustainable building. According to Kats (2003) the definition of a sustainable building is innately subjective. The range of definitions of what constitutes a green or sustainable building includes: BREEAM, BEPAC, CEEQUAL, HK-BEAM and LEED. These green building programs balance various dimensions of “greenness” through a necessarily subjective weighting. Kats gives as a description of “Green” or “Sustainable” Buildings: *buildings that use key resources like energy, water, materials, and land much more efficiently than buildings that are simply built to code. They also create healthier work, learning, and living environments, with more natural light and cleaner air, and contribute to improved employee and student health, comfort, and productivity. Sustainable buildings are cost-effective, saving taxpayer dollars by reducing operations and maintenance costs, as well as by lowering utility bills.*
A more generic definition is stated by the US EPA (2010): *“Sustainable building is the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a structures' life-cycle from siting to design, construction, operation, maintenance, renovation and deconstruction. This practice expands and complements the classical building design concerns of economy, utility, durability, and comfort.”*

Strategic alignment of the building process with the sustainability challenges (figure 5) resulted in the overview illustrated in figure 6 (van Ree & van Meel, 2007). The authors show that the social challenge mainly has

implications during building maintenance intervals. Similarly the economic and environmental challenges have implications during the building service life and the building total life respectively. In order to simultaneously take on all components of the sustainability challenge one has to focus on the building life-cycle. Again, this implies a careful review of the first stage of the planning stage: the briefing phase.

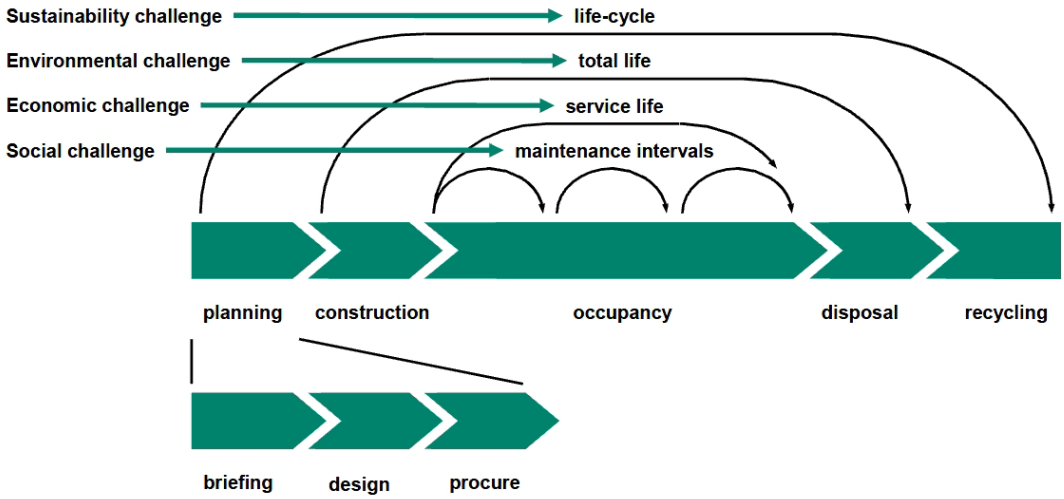



**Figure 6 *Life cycle integration:* (traditional) building stages and their challenges (van Ree and van Meel, 2007)**

So the lifecycle has to be analyzed. The last phase of the building's life cycle must again be connected to the first phases of the cycle, see figure 7. The ideal object regarding criteria on sustainability has to be projected in the last phase of the process; working backwards shows the critical points in the phases prior to the last phase. Deconstruction, the last phase, concerns dealing with waste, which might be seen as actually a form of inefficient use of resources. One can use the Ladder of Lansink or the more elaborated Ladder of Delft (Durmisevic, 2006) which involves preventing or reducing the waste actually generated (figure 8).


**Figure 7: Building life cycle**

This ladder can be used to analyze the building process starting at the highest rung of the ladder in the last phase of the process, working backwards and try to keep as high on the ladder as possible, reducing waste during the life of the object. The presented ladder focuses on *material* waste; a similar approach should be possible to set targets for reducing pollution, environmental degradation, energy and water consumption.

To use energy sources efficiently and reduce waste, pollution and environmental degradation, the operate and maintain phase and disposal phase have to be analyzed.

Table 1 (page 21) illustrates the last two phases of the building process, the reason of the existence of the process (*"why"*), the possibilities to achieve desired results (*"how"*) and the impact of the phase on people, planet and profit (*"impact"*). Lines can be drawn to show the effects caused by lack of maintenance and/or operation on possibilities to recycling. For example, a lack of flexibility causes the facility to become obsolete in a faster pace; if the facility isn't maintainable it will be given up after service more quickly, etc. These effects should be taken into account in the Planning phase and are the

1) Prevention
2) Construction reuse
3) Element reuse
4) Material reuse up cycling (Cradle2Cradle)
5) Material reuse down cycling
6) Useful application
7) Immobilisation with useful application
8) Immobilisation
9) Incineration with energy recovery
10) Incineration
11) Landfill

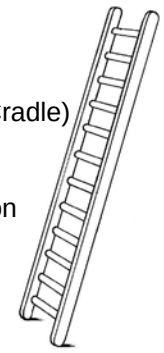


**Figure 8: Ladder of Delft**

responsibility of the client/operator, the contract that will be drawn up should encourage the contractor to Design & Build to achieve the highest possible rung of the Ladder, by considering the Maintenance & Operate and Recycling phase during the Design & Build phase.

Rackwitz et al. (2004) states that obsolescence is the most common reason for disposal of a civil construction. The forms of obsolescence, abstracted from Langston et al. (2008):
(1) Physical obsolescence: while all objects experience natural decay over time, accelerated deterioration leads to reduced physical performance and obsolescence. Natural decay is not considered an attribute of obsolescence but rather of age.
(2) Economic obsolescence: the period of time over which ownership or use of a particular object is considered to be the least cost alternative for meeting a business objective governs investor interest and obsolescence based on economic criteria. Economic obsolescence can also include the need for location change.
(3) Functional obsolescence: change in owner objectives and needs leads to possible functional change from the purpose for which an object was originally designed. Many clients of the building industry, particularly in manufacturing industries, require a building for a process that often has a short life span.
(4) Technological obsolescence: this occurs when the object or component is no longer technologically superior to alternatives and replacement is undertaken because of expected lower operating costs or greater efficiency.
(5) Social obsolescence: fashion or behavioural changes (e.g. aesthetics, religious observance) in society can lead to the need for object renovation or replacement.
(6) Legal obsolescence: revised safety regulations, building ordinances or environmental controls may lead to legal obsolescence.

This section showed that sustainability concerns a lifecycle approach; focus on only one phase of the cycle can have a negative impact on other phases in relation to criteria for sustainable development. The goal of this thesis focuses specifically on the O&M phase; this phase has a strong link to the next phase which is deciding to recycle or to dispose. Similar to the O&M phase, within a D&C building model, the contractor is not responsible for the Recycle or Disposal phase, therefore this last phase of the lifecycle is also taken into account for this study as it has such a strong connection to the degree of sustainability of the construction *after* realisation.

On the next page, table 1 illustrates the last two phases, operation and maintenance and disposal and recycle. The actual statements we should have in sight when building in a way that meets criteria on sustainability are:

- Prevention of disposal is the most sustainable solution;
- Obsolescence is the most common reason for disposal.

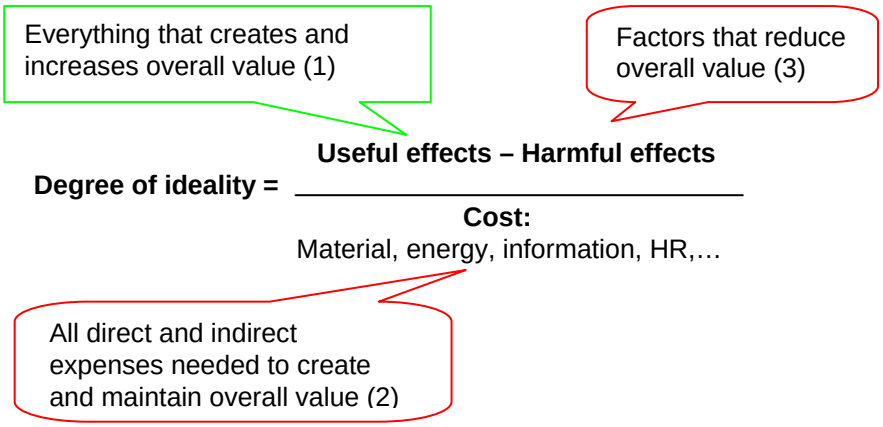
Prevention of disposal means preventing a system or a sub-system to be built. This is possible when its desired function can be delivered by another system or sub-system. The desired function a system should provide can be optimized in two ways, the *useful effects* (1) of a system increases, and/or the *costs* (2) decreases.
The forms of obsolescence stated by Langston et al. (2009) are all forms of *harmful effects* (3) an object or service can contain. The following section will illustrate that these three drivers to build in a way that meets criteria on sustainability are the same as the drivers for innovation.

| Maintenance & Operate | Recycling/Disposal |
|---|---|
| Why? (Ryall 2010, Prorail, 2008, Rackwitz et al., 2004) | Why? (Rackwitz et al., 2004, Langston et al., 2008) |
| To retain/improve:<br>• Reliability<br>• Availability<br>• Maintainability<br>• Safety<br>• Sustainability<br>- Save energy<br>- Save non-renewable resources<br>- Re-cycle building materials<br>- Reduce pollution<br>- Reduce interference of the natural water household<br>-(and much more)<br>• Usability<br>• Efficiency<br>• Flexibility<br>• (other .ilities) | • the facility is given up after service or failure,<br>• the facility is systematically replaced after failure,<br>• the facility is renewed (repaired) after deterioration,<br>• the facility is renewed due to obsolescence.<br>(1) Physical obsolescence<br>(2) Economic obsolescence<br>(3) Functional obsolescence<br>(4) Technological obsolescence<br>(5) Social obsolescence<br>(6) Legal obsolescence |
| How? (Ryall, 2010, Geitner & Bloch, 2006) | How? (Durmisevic, 2006) |
| • Maintenance/Asset management<br>• Planned/Scheduled Maintenance<br>- Periodic (Preventive)<br>- Condition Based (Predictive)<br>- Planned improvements<br>• Unplanned/Corrective maintenance<br>- Demand based<br>- Upgrading (Bad actor management) | Waste management according *Ladder van Delft*<br>• Long term planning<br>1) Prevention<br>• Design for Disassembly<br>2) Construction reuse<br>3) Element reuse<br>4) Material reuse up cycling<br>5) Material reuse down cycling<br>• Chemical processing<br>6) Useful application<br>7) Immobilisation with useful application<br>8) Immobilisation<br>• Burning<br>9) Incineration with energy recovery<br>10) Incineration<br>• Disposal<br>11) Landfill |
| Impact (Gilchrist & Allouche, 2004, Ryall, 2010, Geitner & Bloch, 2006) | Impact (Barton et al., 1996, Durmisevic, 2006) |
| • Energy use<br>• Water use<br>• Material use<br>• Deferrable/Forced Downtime<br>• Traffic<br>(Closure of road, travel delay etc)<br>• Economic activities<br>(Loss of income, tax revenues etc)<br>• Pollution<br>(Noise, dust, vibration, air/water pollution)<br>• Ecological/Social/Health<br>(Surface disruption, reduced quality of life) Also see | • Waste streams separated into recyclable, burnable and non-burnable materials.<br>• Waste-independent burden<br>(examples)<br>- Resources used in capital equipment<br>- Visual intrusion by the facility<br>- Fuel used for transport<br>- Traffic congestion<br>• Waste-dependent burden<br>- process related<br>For example: CO, dioxins<br>- product related<br>For example: $CO_2$, $CH_4$ from anaerobic congestion<br>• Landfill |

**Table 1: Why a new phase of the lifecycle starts, how to approach the phase and the impact on the environment. Two lines illustrate possible links between the stages.**

## 2.3 Innovation is the engine for a Sustainable Future

This section is written by making use of information gained from a two-week workshop by Valeri Souchkov (2010). An innovation is a *new idea* which is *successfully implemented* and has a *recognized value*. Innovation is a major driver for a company that wants to distinguish themselves from other companies in the same market. A company wants to be able to do "more with less" in respect to their competitors.
Looking at a system (which can be anything, from a business process to a cup of coffee), three drivers can be distinguished to be wanting to innovate: increase useful effects, decrease harmful effects and decrease 'cost'. Doing this evolves the system to the *highest degree of ideality*:




Artificially created systems / products / services tend to evolve towards the *highest degree of ideality*. The degree of ideality is not absolute. Ideality might only be regarded *within a specific context* in which a system operates, and will depend on *how much a system is "fit" to its super system's niche*. A 'super system' is everything that does not belong to a system but connects to a system. A system with a higher degree of ideality within the same specific context (purpose), the same Main Parameter of Value, and the same super system's niche will always win against a competitive system. It is very important to remember that a Main Parameter of Value of a certain product/system can change over time because the super system's demands tend to change over time as well.
Figure 9 illustrates the ideality growth. When a new function is created the implementation of it needs expenses to create value and deliver functionality. The bell-curve illustrates the initial growth of expenses followed by a decrease in expenses. During the ***expansion phase*** of the bell-curve, we introduce new subsystems to a system which increase the overall functionality and the degree of performance of the system. However, this introduces contradictions which reveal at later evolution stages, and increases costs and complexity to deliver the needed functionality and performance. During the ***convolution phase*** of the bell-curve, system improvement is achieved by eliminating subsystems via function sharing or by transition to more advanced materials and fields.
The performance of a system is presented in an S-curve, When the maximum performance of a function that creates the main value is reached we can cut costs or increase quality or reduce variability. When the maximum value of the ratio Benefit/Cost is achieved within a given system principle a new way that provides a performance jump (S-jump) to a main system function is found, or a transition to a super system is made. This transition can be the merging with similar products, or transferring functionality to a super system. Also the quality of ideas and the profitability are shown in figure 9.

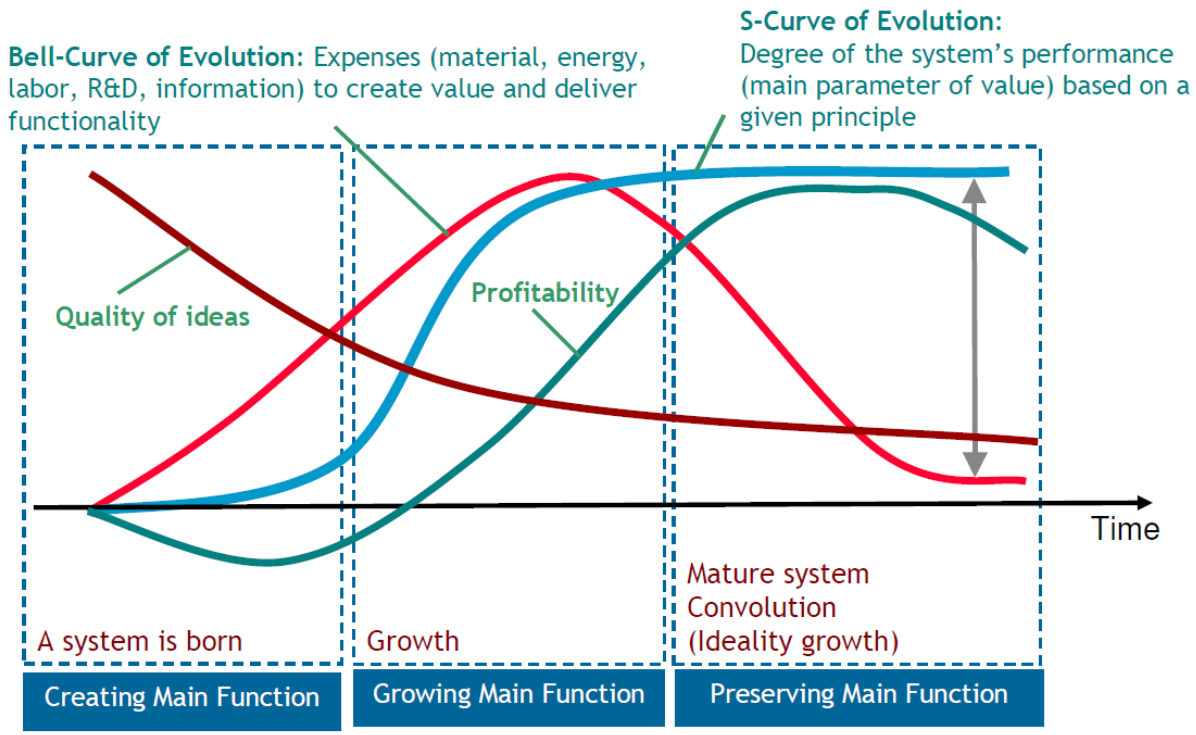



**Figure 9 Models of System Evolution (Souchkov, 2010)**

According to the theory of Functional Evolution of Systems (Souchkov, 2010), 11 stages of functional evolution can be distinguished:

1. Appearance of a system delivering a new main function
2. Appearance of auxiliary functions which help main function delivery
3. Appearance of other (auxiliary) functions related to usability, comfort, convenience, control, utilization, etc.
4. Adaptation of a system and its main function to work with different types of products.
5. Evolution of a super system which enables the system's life-cycle, expands system's applications and introduces system variations.
6. A system is merged with another system to produce a multitude of main functions.
7. Transition to another basic principle of main function delivery
8. Reduction of correcting and servicing functions
9. Convolution of the system to an "ideal object" while preserving full functional performance of a latest system.
10. Full transfer of the main function to a super system.
11. Full elimination of the main function.

As an example let's consider a bridge. The main function is for a person to get from A to B, without touching the river water. In the prehistoric age the function is created. In the medieval age (Charles bridge in Praha) wide rivers can be crossed (function increase), but a massive amount of materials, energy and dimensions (every brick stuck to another brick is one dimension) is needed. Nowadays a carbon bridge is designed, light, few columns etc. The first half of the 11 stages is covered by the expansion phase of the bell curve. The second half of these stages is covered by the convolution phase. What we actually see in this evolution of technology is an increase of dynamics, use of energy, mass and dimensions in the expansion phase and a decrease of it in the convolution phase. Figure 10 illustrates the bell curve of technological evolution. $S_n$ illustrates the possible necessary S-jumps. The further a system is modified, evolved, the closer it will get to the degree of ideality. The highest degree of ideality, as shown in the figure, is **full function**

**elimination.** Figure 10 shows that when systems are allowed to evolve 'naturally' they produce a period of increasing complexity – during which time, although customer benefits are increasing, costs and harms may be getting worse – followed by a period of decreasing complexity, when, having delivered all the possible or required benefits, the only remaining strategies for increasing net value are to reduce cost and eventually harm (Mann & Dekoninck, 2003).

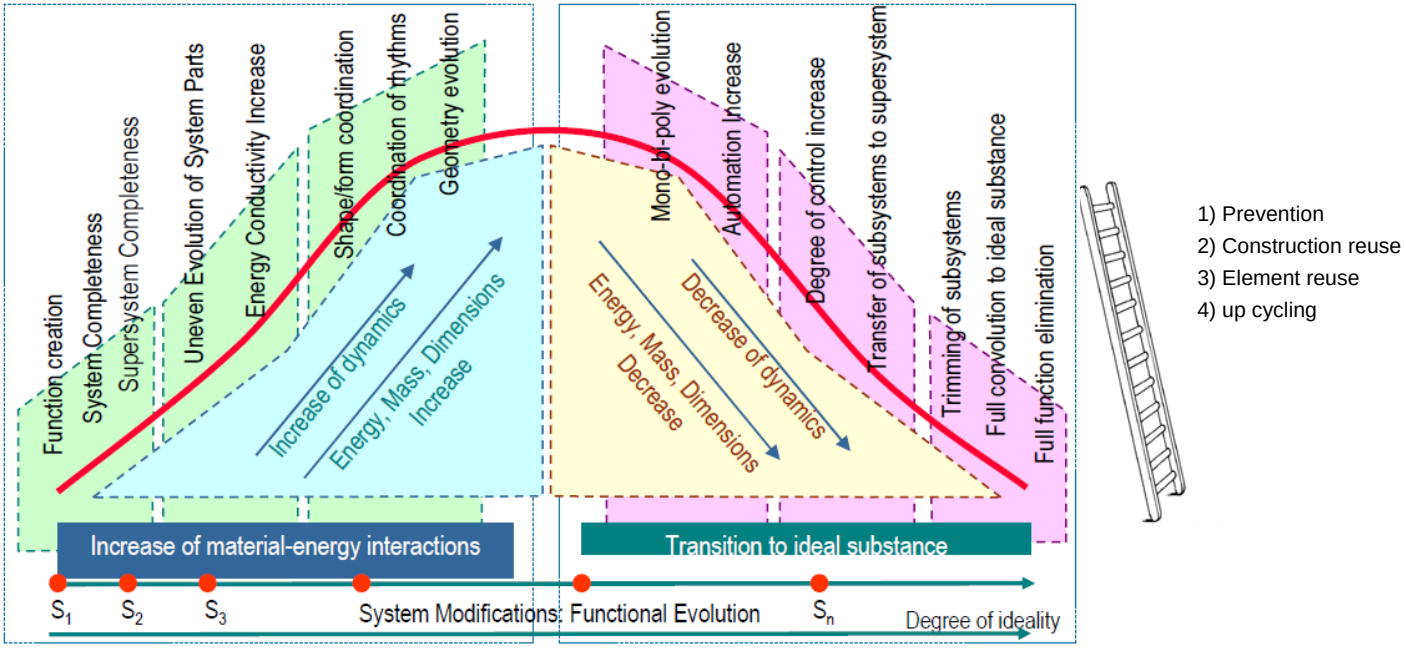



**Figure 10: Phases of Technological Evolution, and the Ladder of Delft.**

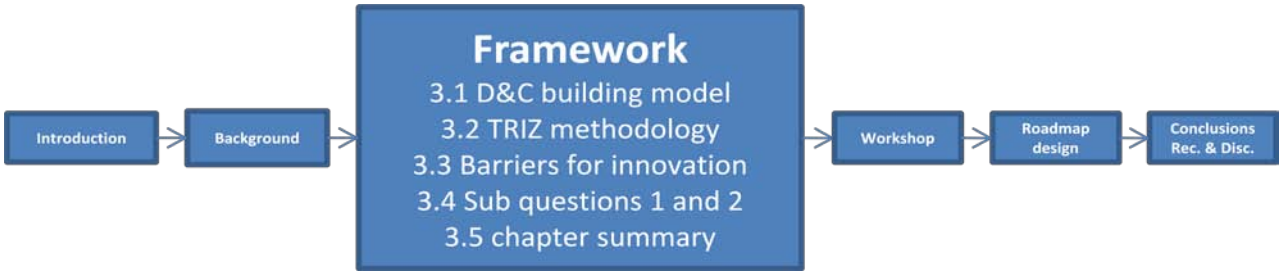
Figure 10 also illustrates the ladder of Delft (Durmisevic, 2006) from section 2.2. *Prevention of waste* and *full function elimination* both means: 'a system is not needed (anymore) in the first place', which is the most 'sustainable' solution. It is also directly shown by figure 10, the more a function and system evolves, the less energy and mass it consumes and the dimensions and dynamics decrease. It all fits in the earlier stated definition of *sustainable development* and *sustainable building*.

## 2.4 Chapter summary

This chapter reviewed the terms sustainable development and building and used the theory of Technological Evolution to illustrate a connection between innovation and sustainability. In the introduction of this thesis (section 1.1) it was proposed to use two views on innovation, one as a process of innovation and one as innovation in a specific project. The conclusions of this chapter can now be summarized and assigned to one of these views:

- A definition or ambition for sustainable development and building varies across contexts and scales. Most organisations are using a global definition, for each specific project more detailed challenges (figure 5) should be set, a choice can be made between **[Project specific]**:
    - Zero waste, Emissions & Energy Reduction, Regulatory Compliance;
    - Resource Efficiency, Product Stewardship, Life-cycle analysis;
    - Safety & Health, Local Environment, Global Climate Change.
- Every project can be projected from back to front, starting at the disposal phase (table 1).
    - Prevention of disposal is the most sustainable solution;
    - Obsolescence is the most common reason for disposal.

  A project can start by regarding waste and obsolescence as a future problem during the initial phase, which needs to be resolved during the design phase. **[Project specific]**
- To be able to build in a way that meets criteria on sustainability on the *long* run, the focus has to be on 'innovation'. To suit the current market demand, 'sustainability jargon' can be used; the main driver should always be optimizing the degree of ideality (figure 10). **[Process specific]**




# 3 Theoretical Framework: Sustainable Innovation during the initial phases

The research goal and main question stated in section 1.3 consist of several terms that will be explained in this theoretical chapter. *'Part of the construction process'* and *'D&C'* are terms that will be explained in section 3.1. It will answer the questions at *what point* in the building process most gain for sustainability is made, by answering sub question 1: *What steps are taken by the client in the concept and development phase?* '*A roadmap of ideas'* is a search for methodologies (Appendix A.2) that can be used to increase innovation, the result of this search can be found in sections 3.2 and 3.3. 'Encouraging the contractor to innovate' and the 'Client's role to encourage innovation' has also been studied, section 3.3. These last 2 sections will answer the question *which methodology* most fits to innovate and *what barriers* obstruct innovation in the building industry at this point, which answers sub question 2: *stating the main problems for developing an object that is sustainable in the operate and maintenance phase*. The answers are a result of an extensive literature study and interviews with different experts on this topic. Combined with chapter 2, this chapter will finalize the "Analysis and Diagnosis" phase of the regulative cycle by van Aken (2007).

## 3.1 The D&C building process and sustainable procurement

Appendix A.1 shows an extensive study on collaboration forms between client and contractor. In almost all contract forms, the client is responsible for the initial and program phase and partly the design phase. The initial focus of the research will be the Design and Construct (D&C) form of collaboration. The details of this form will be described in the following section.

### *3.1.1 Design & Construct*

Until some years, the term *integrated contract* was unknown and the type of agreement was referred to as the 'design and construct', 'design and build' or 'turnkey' contract. Nowadays the term integrated contract is preferred, as it indicates that design and execution are in the hands of a single party and that a turnkey project is delivered. The party in control of the project may be the contractor, but also the designer or another party altogether. Design and actual construction are united in a single contract, which is why the term 'integrated contract' has taken hold (Bruggeman et al, 2008). Although the term integrated contract is preferred in a legal context. Most literature and practitioners refers to Design and Build (D/B) or Design & Construct (D&C). The term D&C will be used in this research instead of IC, for integrated contracts. Anumba et al. (1996) illustrated the traditional D&C process in figure 11. In this conventional process, the client engages a professional consultant/adviser (usually an architect) who develops an outline design which forms the basis for tenders by prospective D&C contractors. After assessing the tenders, the client appoints a contractor who then produces the detailed design to be used for the construction phase of the project.

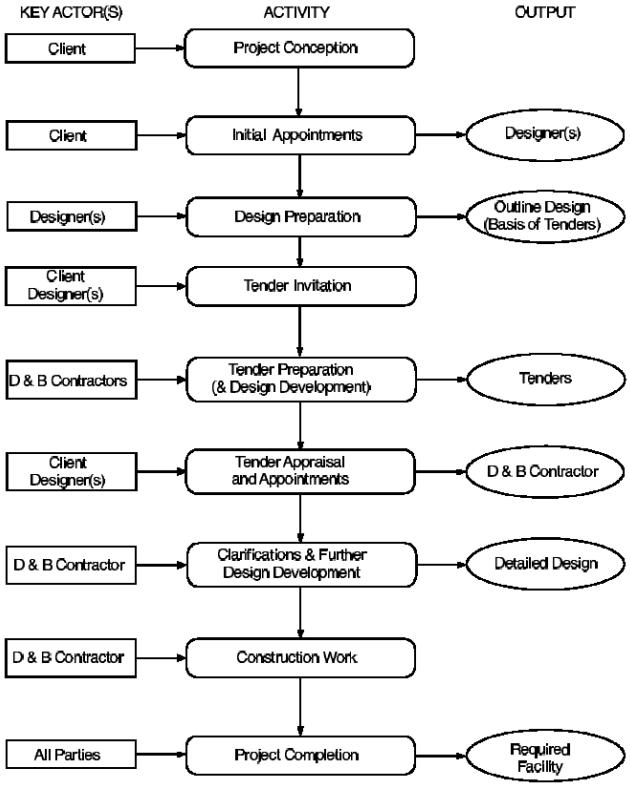



**Figure 11: Process of Design and Construct**

Why focus on a D&C contract in particular? The division of the responsibilities between client and contractor (Appendix A.2) is important considering sustainable building. In a D&C contract the contractor is not responsible for the life cycle of the construction. The client has to define his needs in such a way that the contractor has to design and construct a construction that meets criteria on sustainability. In other contract forms, for example the traditional cooperation concept, the client will design most of the construction and can consider life-cycle aspects. With DBFM it is expected that the contractor, which will also be responsible for maintenance, will also incorporate life-cycle thinking into the design. Therefore, especially with integrated contracts like D&C, it is difficult to assure at the concept stage a sustainable construction will be build in the realisation, maintenance and operate phase.

As mentioned in the previous chapter about Sustainable Development, during the initial stages the emphasis should be on giving room for 'innovation'. A publication of p3bi by van der Veen and Caerteling *"Logisch consistente varianten Design & Construct*" (logical consistent variants of D&C) (2003) mapped several forms of D&C and tried to find the effects of these variants. The arguments of choosing a particular form of D&C are:

- Constructability;
- Throughput (doorlooptijd);
- Technological innovation;
- Distinct division of risks and;
- Transaction costs.

In practice, achieving technological innovation appears to be disappointing during a D&C project. To facilitate innovation the following aspects are important:

- Early transfer (from Employer to Contractor);
- Much communication;
- Balance of risk; the Employer should dare to take more risk and guarantee for the innovative part of the contract;
- Sufficient time should be given for the submission of tender documents;
- There should be no limitation for the form of working methods for the contractor.

Some of these aspects are the opposite of aspects from other forms of D&C mapped by van der Veen and Caerteling (2003). For example, if the argument to choose D&C is *transaction costs* the transfer should be as late as possible, and the submission time as short as possible to limit the transaction costs. The *throughput* argument also tries to minimize time and costs as efficient as possible. An Employer should make a clear decision on which D&C form has his interest and know the consequences and possibilities that come with that form.

The five aspects to facilitate innovation were part of interviews taken during the process of this thesis (see appendix B). Some opinions of the interviewees on these aspects:

- Early transfer (from Employer to Contractor);

*"Be very clear in the formulation of your output specification. If you are working with a result oriented procedure, explain clearly what you want."*(Steenbruggen) *"The earlier construction companies are involved in the process, the better they can introduce their knowledge. It is possible to start the dialogue faster; also the selection process should be concluded earlier."* (Duineveld). Schweitzer adds to that: *"the bigger part of the process is awarded to one contractor, the better he can optimize his process."*

- Much communication;

*"Be transparent in everything you do, explain why a party is rejected in a clear way."(*Krombos)

- Balance of risk; the Employer should dare to take more risk and guarantee for the innovative part of the contract;

*"Worst that can happen is a judge discharging a procurement procedure; it is only a matter of time. An employer must dare to take these risks."*(Krombos) *"New techniques are not accepted quickly, this forms a bottleneck for innovation. During only a few projects, client and contractor share risks of innovation."* (Duineveld)

- Sufficient time should be given for the submission of tender documents;

*"New innovative products or processes should be developed already; every tender phase will be too short to develop an innovation."* (Duineveld, and similar remark by Schweitzer)

- There should be no limitation for the form of working methods for the contractor.

*"We are used to dictate our specifications to a contractor; nowadays we should say 'bring it on, surprise us with your design'".* (Steenbruggen) *"Ask a good question and you will get a good answer, if you are not able to ask a good question than just state what you want."* (Duineveld)

Except for the forth aspect, the interviewees agreed on the aspects stated by van der Veen and Caerteling. The comments from the interviews show that barriers on innovation partially emerge from a practical context. Further barriers and contradictions for innovation that meets criteria on sustainability during the tender stage are presented in section 3.3.

### *3.1.2 Sustainable Procurement*

The previous section illustrated the organization of the *Design & Construct* building process. This section will elaborate on the procurement process.
The purchasing function is in a critical position to influence an organization's response to concerns about the natural environment, also see figure 12. As purchasing takes on a more strategic role in an organization, and is integrally involved with the formation of trading partnerships, it is expected that such influence will only grow. (Zsidisin & Siferd, 2000)

The previous chapter described sustainable development and sustainable building. As the procurement process of the building industry influences sustainability the most the definition of 'sustainability' changes and becomes more specific. For this research I will use the following definition:

Sustainability during the procurement process is *"a process and/or product innovation resulting from the briefing or design phase that will optimize the flexibility, use of energy, water and material of the object during the operate and maintenance phase and minimizes waste during the demolition phase."*

**Procurement process**

*Procurement procedures*

Presently, the context of the procurement procedures is formed by Directive 2004/18/EC (European Parliament 2004). Articles 28-34 of the Directive define the procurement procedures. In article 28, the Directive states that contracting authorities shall apply their national procedures, adjusted for the purposes of the Directive. They shall award their public contracts by applying the *open* or *restricted procedure*. Only in specific cases and circumstances, contracting authorities may apply a *competitive dialogue*, *a negotiated procedure* or *other procedures*. (also see Appendix A.1, Dreschler, 2009)

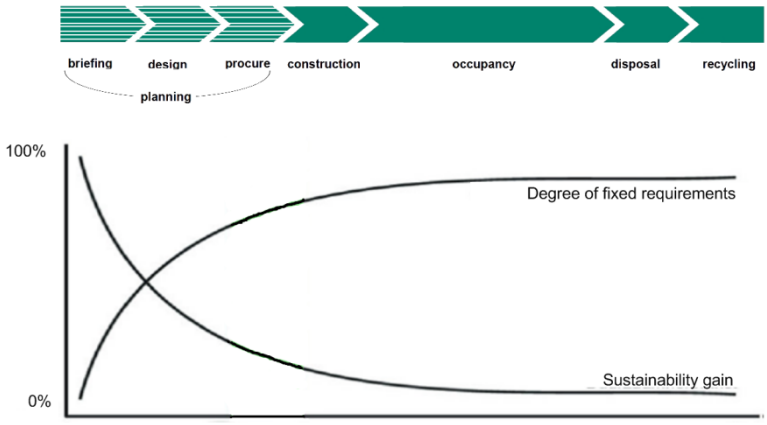



**Figure 12 influence of purchasing on sustainable advantages (van Ree van Meel, 2007, RWS 2001 and SenterNovem, 2010)**

*Selection and award of contract*

For each form of collaboration the Employer/Client needs to find a partner. In principle this process consists of two sub-processes: selection, and the award of the contract. For all procedures, suppliers should first be checked on the *minimum standards* (also known as preconditions and demands). Noncompliance to these standards will provide ground for exclusion. Besides checking on minimum standards, the restricted procedure, the competitive dialogue and negotiated procedures make use of *selection criteria* (to prove economic and financial standing of the suppliers) as well. The open procedure does not use selection criteria. (also see Appendix A.1, Dreschler, 2009)

De Ridder and Noppen (2009) give an example of a procedure for a Design-Build, fixed price, contract. The standard procedure for selection of tenderers consists roughly of the following steps:

1. Invitation to pre-qualify by means of e.g. advertising in relevant newspapers such as COBOUW;
2. Analysis of received pre-qualification data based on: company/joint-venture structure, experience, resources, financial position, general suitability etc. Normally ca. 6 tenderers (short list) will be selected for further application;
3. Submission of tender documents and receipt of tenders (formal offer). The selected contractors each tender on the basis of the Client's project concept. This concept is worked out by the tenderer to such a level that he is able to offer a price including construction cost, site cost, general cost, profit and risk, and – if applicable – the capitalized maintenance cost.
4. Adjudication of all tenders. The client assesses the tenders in accordance with the evaluation criteria and raises further point requiring clarification, if any. He rejects non-conforming tenders and advises tenderers concerned. Because proposed design concepts are a fundamental part of the offer, both the assumptions and the anticipated performance shall be checked. Obviously the lowest price is still the most attractive, though not the only, governing criterion.
5. Declaration of intention. The assessment results in a ranking of tenderers in which the price-quality ratio of the various offers is the main criterion. The tenderer with the most favourable price-quality ratio receives a letter of intent for (planned) collaboration. This offers both parties the opportunity to settle any matters on which they disagree. Especially the required performance is an important issue.
6. Negotiation. By means of negotiation both parties have to come to an agreement. Main subject is of course an acceptable performance of the project concept. Another aspect is the cost-consequence in case of possible design variation.
7. Decision on contract award. After all items have been positively negotiated and tasks, responsibilities obligations, modes of payment, distribution of risks etc. have decided upon, the final offer can be accepted and the contract awarded.

*Problems in the procurement process*

The Procurement Handbook (Leidraad Aanbesteden) is written to help (Dutch) procurers during the process. A key publication leading to this handbook was "Beter aanbesteden in de bouw" (RRB, 2006). An important conclusion of that publication was that current (European) procurement legislation especially encouraged the interest of *fair competition* (table 2). In some cases it creates an imbalance with other interests, like primary interest of parties concerned, the efficiency interest and the interest of innovation. The analysis of the publication states that not the European procurement law causes this imbalance. The real problem lies within the cases where the procurer is not able to deal with the freedom it gets within the procurement law. This means it is not a question about law, but a question about *procurement policy*, or a lack of it in this case. Professional procurement policy is seen as the solution for balancing all interests.

| **Decisions on:** | **Can influence or favour one of the following interests:** | | | |
|---|---|---|---|---|
| | Primary interests | Efficiency interest | Innovation | Fair competition |
| Collaboration Agreement | X | X | X | |
| Requirements | X | X | X | X |
| Risk division | X | X | | |
| Procurement Procedure | X | X | | X |
| Selection Criteria | X | X | | X |
| Award Criteria | X | X | X | X |
| Invitation | X | X | | X |
| Clarification/ Information Exchange | X | X | | X |
| Evaluation and selection of tenders | X | X | | X |
| Evaluation of the offer | X | X | | X |

**Table 2: Decisions influencing interests during the procurement process (RRB, 2006).**

Again, concerning gain on sustainable (and so innovative) development during the procurement process barriers emerge from a practical context. Further barriers and contradictions for innovations that meet criteria on sustainability during the tender stage are presented in section 3.3.

This section explained which phases exist in a D&C building process, and elaborated on the importance of the purchasing department to make a real effort of sustainable building. It revealed some barriers emerging from the process constraining sustainable development and innovation in the building sector.
During the study on this thesis it became clear the general system of the building industry is by far not optimized to encourage innovation. Every time the *why*-question was asked a finger was pointed towards another aspect of the process, and another, and another. If the system is by far not optimal, why bother to change a minor aspect; it will never fit perfectly and the effect is unpredictable. To improve the process of sustainability and innovation two matters have to be dealt with; what framework of methodology should be used to fit the process into (2.2) and what barriers need to be overcome to encourage innovation and sustainability during the initial stages of the building process (2.3)?

## 3.2 Systematic sustainable innovation using xTRIZ

Section 1.4 shortly introduced TRIZ as a methodology that can be used to improve innovation, which should be seen as the main driver for sustainable development. The process of choosing a methodology took considerable time and is summarized in Appendix A.2. Systems Engineering (SE), Value Methodologies (Value Engineering (VE) and Value Management (VM)) and TRIZ were further investigated. As presented in table 6 of Appendix A.2 all methods score a positive average, and are all applicable to improve the building process.
The four methods discussed are modules of existing techniques and methodologies. SE, VE and VM can be complemented with TRIZ at those points where they do not score sufficient. According to Hua et al. (2006) many researches that integrate or compare TRIZ with different creativity tools, methods and philosophies prove that TRIZ provides the most useful help to designers for developing high-level products. One of the researches on integration of TRIZ and VE compares the definition of 'value' in VE to the TRIZ concept of ideality and finds it is similar; hence, there exists a particular link between the two tools. Hua et al. note however, dealing with too many techniques together in the same process, does not necessarily improve the efficiency of the process.
Mao et al. (2009) reach a similar conclusion. The creativity phase is critical to the success of a value engineering exercise, in which the brainstorming technique is deployed to generate ideas. One shortcoming of the brainstorming technique is its lack of direction in problem solving, and consequently the efficiency is low in generating innovative and useful ideas. To overcome this shortcoming, they explored the possibility of incorporating the theory of inventive problem solving (TRIZ) into the workshop session of the value engineering exercise. Their proposed process is quite similar to the approach of xTRIZ (extended TRIZ) proposed by Souchkov (2010, and Appendix A.3).

### *3.2.1 Systematic Innovation and TRIZ*

Systematic innovation is based on 1500 person-years of research into the dynamics of system evolution. This research includes the study of over 2 million innovations and analyses of technical and business systems across all fields of human endeavor. These contributions to knowledge are also known under the acronym TRIZ (pronounced TREEZ). TRIZ is the Russian acronym for *Teoria Reshenia Izobretatelskih Zadatch*, the Theory of Solving Inventive Problems. This proven algorithmic approach to solving technical problems began in 1946 when the Russian engineer and scientist Genrikh Altshuller studied thousands of patents and noticed certain patterns. From these patterns he discovered that the evolution of a technical system is not a random process, but is governed by certain objective laws. These laws can be used to consciously develop a system along its path of technical evolution - by determining and implementing innovations. (Mann & Dekoninck, 2003; Abdlalla et al., 2005; Souchkov 2010 and TRIZ.org, 2010).

Abdalla et al. (2005) describe TRIZ as one of the more sustainable methodologies: TRIZ focuses on the use of "existing" resources and elimination of contradictions. This concept is at the core of sustainability and can be further strengthened by reducing the amounts of used resources and avoiding the introduction of new resources as much as possible. In TRIZ, the solution ideas are generated, usually, by identifying the Ideal Final Result (IFR; also see section 2.3 'degree of ideality').
The goal of an *optimal* IFR can be stated as "A function of a system is delivered while there is no system to deliver the function" (Souchkov, 2010). The evaluation of solution ideas in TRIZ is conducted by seeing whether the new solution gets the system closer towards ideality or the IFR (Abdalla et. al., 2005).

TRIZ helps to avoid trial and error problem solving by employing generalized patterns distilled from previous solutions (figure 13). A second important tenet from TRIZ is that inventive problem solving requires the elimination of contradictions, as opposed to 'design-by-compromise' approaches. TRIZ researchers hold that (1) the advancement of inventions obeys certain universal principles of creation, (2) all innovations across industries and sciences follow a handful number of inventive principles, (3) technology evolves according to certain trends, (4) the idealization of a solution is a process to destroy conflicts and trade-offs or to transform harmful elements of a system into useful resources. (Mann & Dekoninck, 2003; Mao et al. 2009).

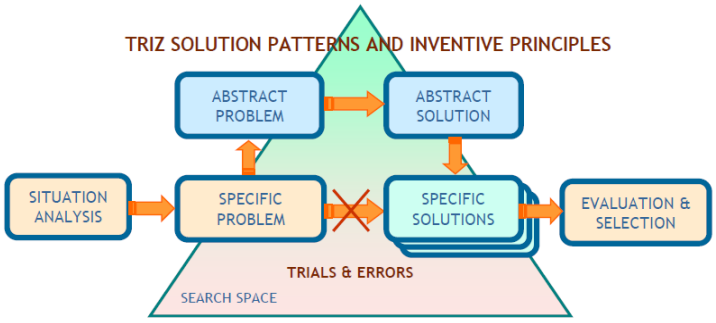



**Figure 13: How TRIZ solves problems (Souchkov, 2010)**

From 1946 till now TRIZ has been evolving. Nowadays a lot of TRIZ tools try to optimize the innovation process. This process can be divided into three phases: Ideation (initiative), Design and Implementation. TRIZ focuses on the Ideation phase, the front end of innovation. This 'Fuzzy front-end' is very poorly supported by scientific and systematic methods. The combination of techniques and data-bases used in this methodology fills the gap. Between 1998 and 2004 different organizations with TRIZ expertise developed their own versions of TRIZ (ITRIZ, TRIZ+, xTRIZ, CreaTRIZ, OTSM-TRIZ), thus a set of TRIZ tools developed under a guidance of Altshuller before 1998 is now titled "Classical TRIZ" to avoid confusion (Souchkov, 2010).
xTRIZ or Systematic Innovation evolves classical TRIZ further by adding techniques and organizes processes of innovation. The process is illustrated in figure 14.

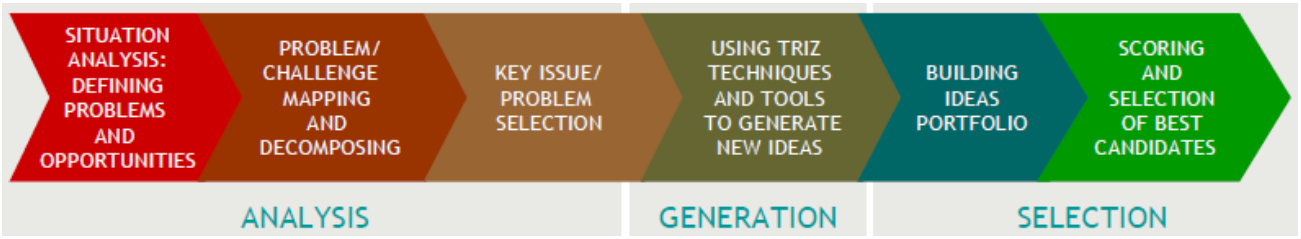



**Figure 14: Generic TRIZ Process (Souchkov, 2010)**

*3.2.2 No traditional trade-off*

According to Mann & Dekoninck (2003) effective 'sustainable' design solutions will not emerge from traditional trade-off and compromise based innovation strategies. TRIZ states that inventive solutions eliminate trade-offs rather than accepting them, and that there is a defined set of inventive strategies to help eliminate such trade-offs. This is relevant to environmental design because designers generally believe that to improve reliability, quality, sustainability or any other aspect of a design inherently means that some other aspect of the design must get worse. In effect, the uncovered inventive principles and their related trends of evolution enable users to identify the discontinuous innovation strategies that successfully overcome the trade-offs and compromises that the large majority of businesses assume are fundamental and unavoidable.

Souchkov (2010) explains a "right" solution within TRIZ will have five main features:

1. Solves a problem **in full**: a desired result is fully achieved, no compromise;
2. A contradiction is eliminated in a **"win-win"** way;
3. Has the highest degree of **costs-effectiveness**, or preferably, **free** (or **"ideal"**);
4. Produces **no harmful side** effects;
5. Provides **extra benefits**.

During the process of evaluating alternative solutions, these five main features should always be present and the 'winning' solution should always score positive on all these five features: no compromise. This can be a utopia, to score positively on all features, but it should always be the goal at the horizon. Also the solution process can be sub-optimal due to for example budget or time limitations.

### *3.2.3 xTRIZ*

TRIZ is complex. It contains many techniques and knowledge bases. Learning full TRIZ takes considerable time. Currently TRIZ is available as a number of independent modules that can be learned and used independently (Souchkov, 2010). xTRIZ (extended TRIZ) is one of the modules that try to balance efficiency and effectiveness of all necessary steps of the process. Table 2 shows a selection of tools that are part of the xTRIZ process. Appendix A.3 is a source for more information on this methodology.

| Technique | What it does | When to apply |
|---|---|---|
| **Root Conflict Analysis+ (RCA+)** | Helps with analyzing a problem and extracting all underlying contradictions and conflicts. | We would like to understand the underlying roots of a problem and all contributing factors. |
| **Function Analysis** | Helps with building functional models of systems and identifying sets of interaction/interface problems. | We would like to analyze a system and identify problems and challenges related to system's functioning. |
| **Value-Conflict Mapping (VCM)** | Helps with understanding what systems demands result in conflicts and reveal hidden conflicts and demands. | We would like to investigate future evolution potential of a system, product or service. |
| **Contradiction Matrix and 40 Inventive Principles** | Provides generic recommendations on how to resolve specific contradiction and generate out of the box ideas. | After RCA+ or if a problem is represented as a contradiction. |
| **Scientific Effects (Technology)** | Helps to find natural (scientific) effects which are capable of delivering the desired technical function. | After we identified what technical function needs to be delivered. |
| **Inventive Standards** | Provides patterns of solutions indicating how to change a structure of a system to solve a problem. | After Function Analysis or a problem is represented as a number of interacting components. |
| **ARIZ: Algorithm of Solving Inventive Problems** | Helps to translate "non-solvable" problem to solvable by reframing the problem and fighting mental inertia. | After other TRIZ techniques do not lead to a desired result. |
| **Technology and Products Evolution** | Helps with understanding the driving factors of a system evolution, identification of its evolutionary potential, and creating next generations of system. | We would like to develop innovative concepts for future generations of systems, products and services. |

**Table 2: xTRIZ toolbox (a selection, Souchkov, 2010)**

### *3.2.4 Systematic innovation adapts to Systems Engineering*

From the four methodologies compared in Appendix A.2, the market currently focuses mostly on developing Systems Engineering to fit in the processes of the Civil Engineering industry. Grontmij is doing several pilot projects using the theory of Systems Engineering (SE). The Stena Line project is one of these pilot projects and used during the workshop described in the next chapter. Therefore it makes sense to briefly look into the possibilities of adapting the proposed methodology of TRIZ to the methodology of Systems Engineering. The theory of SE is shortly as follows (more information can be found in Appendix A.2):

Clients are increasingly focused on specifying the problem and buying products and services instead of dealing with designing solutions to these problems. Contractors are dealing more and more with the overall responsibility for the design and construction and come up with innovative ideas. Among others, this renewal calls for transparency and focus on clients. The principles, methods and techniques of Systems Engineering contribute to this perfectly (Leidraad SE, 2009).

According In ‘t Veld (2002) a system is, within a defined objective, a collection of interrelated distinct elements. A system is always a part of a larger whole. How the system is seen and defined depends on the interests and responsibilities of the viewer. This system is called the “System of Interest”. The larger whole is the System of Systems in which several “Systems of Interest” are located.
To give an example, a railway station is a system of interest and is part of a bigger mobility system. The railway station system is part of the rail transport system (which also includes the train system, energy system and traffic control system). The transport system is part of the mobility system which also includes air, water and road transport. Within the railway station system there are also smaller systems like catering systems and ticket booth systems. (Leidraad SE, 2009)

A lot of similarities between the process of Systems Engineering and Systematic Innovation can be found. Hua et al. (2006) did not specifically focus in their study on implementing TRIZ in SE, it is assumed that such a study will result in a similar conclusion, that when integrating TRIZ within SE, TRIZ provides the most useful help to designers for developing high-level products. xTRIZ is a newer version to the original TRIZ and is on its own a total problem solving tool, see figure 14. As SE is a methodology which is currently being developed in the construction industry, it is recommended to do research on the possibilities to and advantages of integrating TRIZ within SE. It can be assumed that the industry will accept such adaptations to an existing methodology than introducing a totally new methodology.

## 3.3 Barriers and contradictions for Sustainable Innovation during the initial stages of a D&C process.

### *3.3.1 Root Conflict Analysis+ and Functional Analysis*

Some would say the construction industry is not an innovative industry. To find out what barriers and contradictions exist concerning innovation in the industry during the tender stage several guidelines and articles have been studied and six interviews (Appendix B) among experts of sustainable procurement have been carried out. These references can all be linked to 'innovation' or 'sustainable development' within the first stages of the building process. Some articles specifically mentioned barriers or opportunities for sustainable innovation during the procurement phases, from other articles barriers were abstracted from the context. Some issues are already (insufficiently) being dealt with. In order to level all issues every issue is stated as if it is not being dealt with yet. The thought behind this form of formulation is that all issues have to be stated in the analysis to get a good total overview. Otherwise when insufficient issues are considered to be working correctly, and therefore not mentioned in the analysis, emphasis is lacking to improve the aspect. This list of issues is a first result; Appendix C.1 to C.5 shows which issue is stated by which reference. A structure was lacking in the list of issues. In order to structure the list RCA+ (also see appendix A.3.1) is used. This tool clarifies causes and groups of causes. The issues from the list were analyzed to find main parameters and grouped together; issues causing other issues were linked. An iterative process followed and six levels of barriers were conducted.

Figure 15 illustrates the first level of six barriers. This level is divided into three pairs; the client (public procurer), the contractor and the level of knowledge. Every pair has a *general* component and a *tender* specific component.

In general the client's organization and structure are causing barriers and contradictions. Tender specific, a client has to formulate his demands and has to be able to select and award a capable contractor. In general the contractor's organization and business model is slowing down innovation. Tender specific the contractor has to be able to offer a solution to client's demand, and in order to do so, he has to find subcontractors to form a partnership. On top of this we find a 'level of knowledge' this concerns lifecycle thinking in general and guidelines and rules to deal with procurement laws and contract models. These six components are the most important barriers to innovation considering the tender stage.

Behind each component there are several underlying barriers and contradictions. In Appendix C a full *Root Conflict Analysis+* (RCA+ by xTRIZ) can be found which illustrates the complexity of being able to boost innovation in the construction industry. The first level of underlying barriers and contradictions (21 in total) are analyzed on interactions between each other. Using the method of Function Analysis (FA by xTRIZ), existing and potential problems within a system related to system's functionality are identified. Appendix D shows the Function Analysis for these 21 factors. Negative, insufficient and positive interactions between components are revealed. Resources are identified to innovatively redesign a system by trimming its components and share functions without sacrificing overall functionality, quality and performance. Section 5.1 presents the result of the FA. The RCA+ and FA are designed to be able to optimize the system. The result will be a set of recommendations how to encourage innovation in the industry in general. By encouraging the innovation process, sustainability gain will be reached as explained in section 2.3. The result will also show the potential of focusing on the client's side of the tender stage. The first two sub-questions of this master thesis will be answered in this chapter.

**Sustainable Innovation**

An innovation is not necessarily sustainable in the first place. As can be seen in figure 10 of section 2.3, an innovation will first lead to an increase in material and energy use etc. and later in the process this usage will decrease. A *Sustainable Innovation* can be process specific or project specific. Process specific innovation will lead to a more sustainable solution on the long run, as concluded in section 2.3. Project specific is a combination of the definitions of innovation (page 20) and sustainability (page 25).

Project specific Sustainable Innovation is a *new process and/or product* resulting from the *briefing* or *design* phase that will optimize the *flexibility, use of energy, water and material of the object during the operate and maintenance phase and minimizes waste during the demolition phase* which is *successfully implemented* and has a *recognized value.*

So in general, innovation as a process will lead to more sustainable solutions. To try to speed up the process, within a project, the goal can also be to reach project specific forms of sustainable innovation. According to Mann and Dekoninck (2003), TRIZ is able to speed up this process, by making 'technology evolution jumps'.

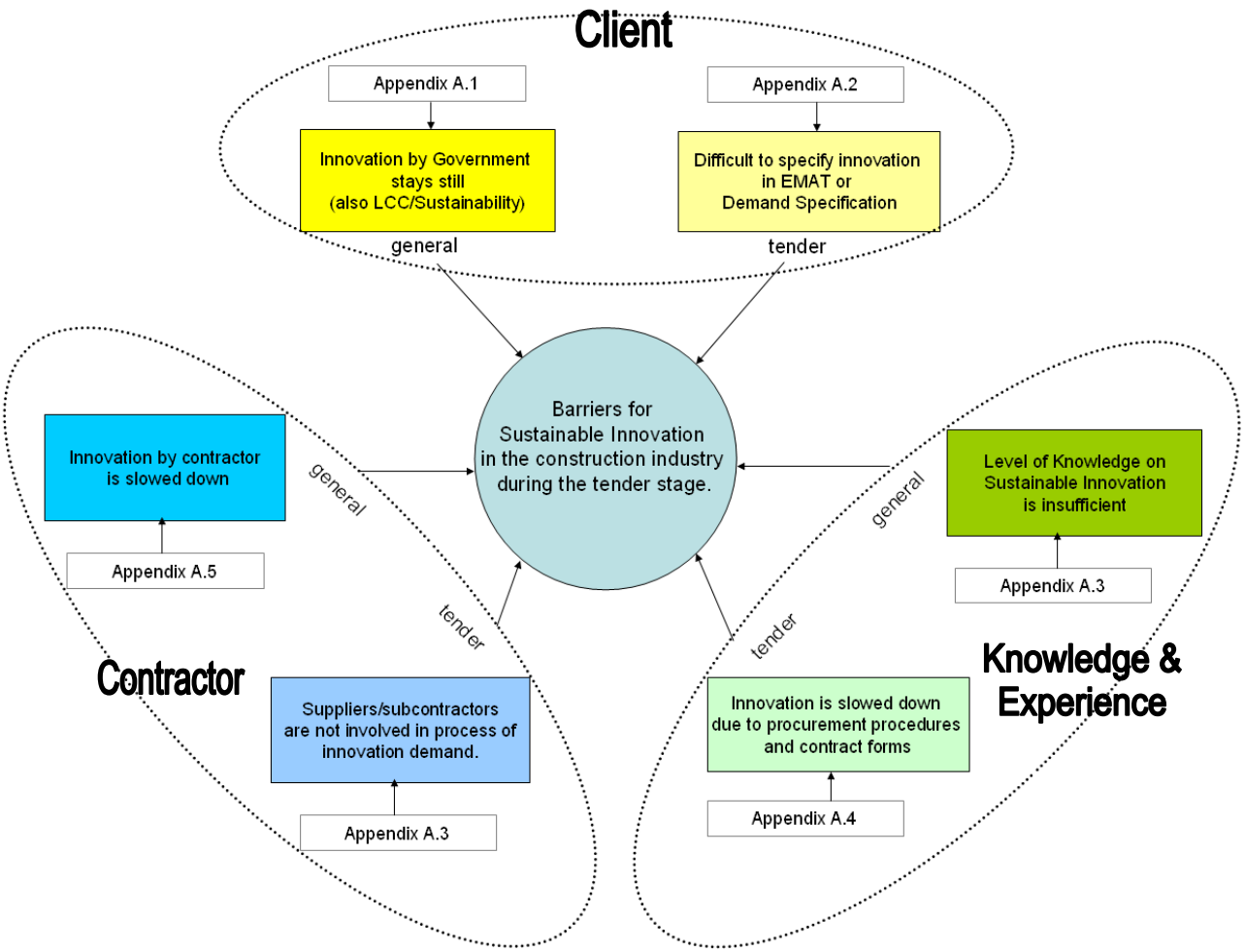



**Figure 15 RCA+ Barriers and Contradictions for sustainable innovation**

### *3.3.2 Government*

*Sustainable Innovation demand by Government stays still.*

Appendix C.1 and C.2 illustrate the RCA+ models for the (public) procurer. Lack of clear policy is seen as one of the bigger barriers for innovation. No policy means not being able to respond on time to new demands. Developing innovative solutions takes time and investments. An amount of certainty is needed of future demands for companies to start developing new products. Budget and policy also goes hand in hand, from a total budget every department gets his part. To encourage lifecycle thinking the division of budgets needs to be altered. Finally policy on how to deal with risks needs to be formulated. To encourage a contractor to actually realize a sustainable innovation part of the risk might be taken by the client, the amount of risk and in which specific cases the client will do this should also be formulated in policy. It is all part of a more transparent process where client and contractor know what to expect from each other. (Interviews, IISD 2009, RRB 2008, BNL 2008 and Dorée 2001)

Some governmental bodies have their own procurement department; most small departments outsource this process. Choosing to outsource or not is also a form of policy. To put more emphasis on it, it is mentioned as a separate component. The lack of a 'professional' procurement department does not mean the employers are not professionals, in this analysis it means they do not focus on the need for change. Procurers are too attached to use their own methods, mostly traditional methods. They lack knowledge how to encourage innovation, how to use new methods. Using EMAT criteria and still focusing on lowest price and in an early stage prescribing very detailed designs. Tasks a contractor should do are being done by the client mostly because the procurer is not yet able to formulate the demand in a proper way. (IISD 2009, RRB 2008, CROW 2007 and Erikson & Westerberg 2010)

Sustainable innovation is not always measurable in advance. Therefore it is not always possible to know the outcome and so advantages from the solution might not even reach the client. In case of a *public* procurer the advantages should reach the public and should be traced back to the government so the public sees the work

done by the government. Another barrier for sustainable innovation is the limitation of possible contractors for the work, only a handful big contractor firms are able to deal with big projects. The fewer competitors the less distinction is needed, meaning there is no urge to innovate. (BNL 2004, CROW 2007, RRB 2008).
Five components hinder sustainable innovation considering the (public) procurer in general:

- No Policy
- No professional procurement department.
- Advantage of sustainable solution does not reach client.
- Innovation is difficult to measure in advance.
- Limited competition.

*Difficult to specify innovation in EMAT or Output specification.*
Erikson & Westerberg (2010) state using soft parameters (EMAT) in the bid evaluation will improve innovation and environmental values. Several interviewees mentioned applying EMAT criteria as the possibility to demand innovation. Mr. van Bruggen (CROW, Appendix B.4) even stated EMAT criteria to be the hinge to shift from traditional models to more innovative (D&C, DBM, etc.) models.
Clients also have to find a right balance between price and EMAT; it is argued that EMAT-criteria only function when factored in for 40% or more. Also the amount of main-criteria should be limited to put emphasis on those parts of the project that are of value for the client. (BNL, 2004)
Upfront more costs have to be made before starting a project. These costs occur because definitions and goals on what to achieve have to be formulated. The offers have to be valued, tested and verified in advance. Formerly this was unnecessary because in a traditional model most risks and designs were already finished before a contractor had to construct it. This process of designing to many details upfront by the client is still going on during more innovative building models. Guidelines are written (and will be written in the future) how to release this way of working and specify demands in a more functional way. As long as this shift has not been realized the power of EMAT-criteria or output specification is not used fully. (Interviews, IISD 2009, Dorée 2001, CROW 2007)
As stated in section 3.2.3 according to Mann & Dekoninck (2003) effective 'sustainable' design solutions will not emerge from traditional trade-off and compromise based innovation strategies. A combination of the different points of view on definitions, unclear benefits and too detailed specifications can positively influence this traditional compromise based strategy.

Five components hinder sustainable innovation considering the possibilities the (public) procurer can use during the tender phase:

- No focus on EMAT;
- Different points of view on definitions;
- Unclear benefits;
- Specification is too detailed;
- Higher costs upfront.

**Specifying functionally (functioneel specificeren)**

From the interviews

During the interviews, the issue of specifying functionally was raised several times. Mr. Steenbruggen remarked that *de Woonplaats* started a pilot to specify functionally (resultaat gericht onderhoud, result orientated maintenance). Together with TNO research they are investigating this new approach on how to enter the market. He stated it is really working the other way around, they are used to state exactly what they want, but now they ask the market to come with solutions that fit the requirements best. Mr. van Bruggen (CROW) adds that this form of market approach is very new. The coming years they will investigate the results and experiences of both client as market. He also argued that there is no specification that is solution free (oplossingvrij specificeren) in the public area. All built objects have to make a whole, a total system, to fit into that system specifications have to be stated. Ms. Duineveld (BouwendNederland) agrees, and mentioned it is difficult to specify functionally, if you are not able to do that properly then just state what you want (traditional approach). At the moment RWS is working with the following approach, specifying functionally and asking to score a specific score with DuboCalc, the contractor has to show during the process he is achieving both, as Mr. Schweitzer (RWS) explained during the interview.

### *3.3.3 Contractor/subcontractor*

*Sustainable Innovation is slowed down by contractor.*

Appendix C.3 and C.5 illustrate the RCA+ models for the contractor.

One of the main reasons heard and read when it comes to innovation or sustainability is: “the client does not ask for it”. No demand from the client is caused by several components. One is already mentioned in the previous section, no policy means no demand. Another barrier is conflicting goals between client and contractor. The client wants to see what he gets, the contractor has to connect to this demand but to implement his specialty he needs some freedom in elaborating his design. The design has to be tested but a risk of cherry picking exists, resulting in a less detailed design and mutual nervousness or as Dorée (2001) stated: double-bind, double blind. From a contractors point of view the client does not know what his possibilities are to demand. The contractors are not able to show their knowledge and capabilities, and are dependent of the knowledge of the client. (Interviews, RRB 2008, CROW 2007, Dorée 2001 and Eisenhardt 1989)

Another emerging component is the risk of investment. This is a ‘normal’ business concept; investment on innovation implies a form of risk. The difference between an industrial market and the construction market is the idea that contractors work with projects instead of processes. An applied innovation is financially not recovered from one project. Several projects are needed to create a positive return on investment. The investments can be regarded as too high, but that is a relative concept. It is relative to the expenditures (R&D) and income (recovered costs). The R&D budget of construction firms is lower than the budget in other industries (Schmidt & Corvers, 2009). The investments made are not recovered because the contractor does not receive an incentive from the client; the contractor does not seize opportunities for green economic stimulus from the government; or the contractors make unprofitable pre-investments, taking big risks to make the offer. For the contractor it is also difficult to prove the concept is working, partly this can be explained because the contractor does not get self-control on performance evaluation. Not being able to prove a concept forms a risk, which is a source of conflicts. No communication on risk division in early stages and on sustainability motives of the client increases the potential of conflicts. (IISD 2009, RRB 2008, BNL 2008, Dorée 2001, Erikson & Westerberg 2010 and Schmidt & Corvers 2009)

After implementing an innovation into a project the intellectual property might be transferred to the client. This causes the last barrier for slowing down innovation from contractor’s side in general: it is hard to protect innovation. Cherry picking concerns contractors because clients sometimes use ideas from one contractor by demanding the same from another contractor. The procurement procedures state as a principle that all contractors should be treated equal (level of playing field) so information given to one contractor also has to be given to another contractor. Offering innovative solutions will mostly result in openness from the client to other contractors loosing the innovative concept to them. When it is possible to protect this intellectual property, with licenses for example, a contractor has nothing to fear. But not all intellectual property is fit for a license or a patent. (Interviews, RRB 2008, Dorée 2001 and Schmidt & Corvers 2009)

Three components hinder sustainable innovation considering the contractor in general:

- No demand from client;
- No return on investment;
- Hard to protect innovation (intellectual property).

*Suppliers/subcontractors are not involved in process of innovation demand.*

The articles used to illustrate barriers do not mention this problem a lot. During the interviews the involvement of subcontractors was shortly mentioned. Still this barrier is worth mentioning as one of the main components which hampers sustainable innovation. Within a bottom-up approach, sub-contractors have the actual knowledge of carrying out the work. Where the main contractor can be considered as the *logistic* brains, the sub-contractors can be considered as the *engineering* body. Sub-contractors are experts in a specific field of technology. Just as the problems occur between client and contractor, as described so far, similar problems occur between contractor and sub-contractor. Clients are not involved in choosing sub-contractors making it difficult to get a grip on the market potential. Forming partnerships and improving the supply chain will improve possibilities for innovation: *stand strong together*. Innovations from sub-contractors can be implemented in some Lifecycle applications (DuboCalc for example, see Appendix B.6), but a specific course has to be taken to test and verify it. Other tools do not offer this possibility, using these tools will exclude the use of innovation and so forms a barrier. (Interviews, IISD 2009, BNL 2008, Erikson & Westerberg 2010).

Mr. van Amstel explained material use will be pushed to the background; it can be linked to the competition principle. It is not possible to favor or penalize a contractor in favor of the use of a specific material. The Central Team concluded that material use should follow from the functional description of the demand.
Two components hinder sustainable innovation considering the side of specific suppliers, subcontractors:

- Client and contractor do not jointly involve in selection and integration of subcontractors;
- Specific products are not integrated into LCC applications.

**Protecting intellectual property of the contractor**

From the interviews

One of the questions raised during the interviews concerned the protection of intellectual property of the contractor. The EU procurement procedures ask for an open and transparent process. It is assumed that contractors are afraid their ideas will be lost without compensation in this process, due to cherry-picking and the concept of level of playing field (all new information that is given to one contractor also has to be given to the others). The interviewees who were asked to respond on this assumption agreed that something needed to change in order to encourage contractors to offer innovative ideas. Mr. Krombos (prov. Overijssel) added that there have not been any sufficient innovations in the last 10 years. Mr. van Amstel (Megaborn/IngenieursNL) mentioned that there is too little investment on research and development. CROW published an article on 'Open Licences' (CROW, 2009). Mr. van Bruggen noticed there is not enough support at the moment, probably as a lack of confidence and amount of value we want to give such a license. Ms. Duineveld thinks a lot more can be established using the *dialog* adding that there is still a long road ahead. RWS is working on this issue, how to protect intellectual property, arrangements between client and contractor have to be made states Mr. Schweitzer.

### *3.3.4 Procedures, knowledge, experience and guidelines*

Knowledge and experience might be developed or obtained by a client or a contractor, also knowledge institutes, building associations or consultancy companies can develop knowledge on sustainable development. Therefore the level of knowledge is not grouped under either the contractor or client.

*Level of knowledge and experience on Sustainable Innovation is insufficient.*

Appendix C.3 and C.4 illustrate the RCA+ models for the level of knowledge and experience.
The first chapters of this thesis already emphasized that sustainable development is an emerging science. Guidelines and tools on how to deal with a new demand for sustainability or how to translate demands into demands that meet criteria on sustainability are being developed. Giving a value to sustainability seems a hard issue, which is already mentioned in the previous sections. The report of IISD (2009) on Lifecycle costing tools and the conducted interviews revealed several barriers concerning the level of knowledge and experience. LCC tools are not sufficient; an LCC optimal result is not necessarily a result that meets criteria on sustainability. LCA tools are only concerning points of view of the developers of the tool. It is impossible to include everything into a tool. It is referred to as 'The Data Challenge'. LCC tools cannot be completed due to gaps in research. Finally, competence in conducting LCC and interpreting its findings correctly is lacking.
Three components that hinder sustainable innovation regarding level of knowledge in general:

- Tools are not sufficient;
- The data challenge;
- Lack of competence in conducting LCC and interpreting its findings.

*Innovation is slowed down due to procurement procedures and contract forms.*

In 2005 the contract model UAVgc became a standard contract model, between 2000 and 2004 it has been developed and evaluated by several parties. Innovative building models are indeed innovative as in, not widely known and used. A culture shift towards the use of innovative building models is just starting. At the moment most construction activities are done in a traditional way. A shift from a process driven building model to a result driven building model. Where it used to be the client who had to know everything, now the client has to let go what he doesn't know. It is difficult to raise the level of integration between client and contractors in an early stage. (Interviews, CROW 2007, Erikson & Westerberg 2010)
This culture shift is also related to the second component, a lack of clear guidelines to encourage sustainability or innovation. As it is all new to the industry, guidelines are being written but not fully sufficient yet. Specific laws on sustainable procurement are missing, incomplete or not consistent. Procurers have

restricted freedom of choice and are subjected to the equality and transparency principles following from these laws; making it difficult to combine designs from different tenderers. It is not clear when to apply a lifecycle analysis into the process and who is responsible for applying it. (Interviews, IISD 2009, RRB 2008 and Dorée 2001)
Finally Dorée mentions the contractor is not compensated sufficiently. Some of the interviewees agreed to this point and others thought it to be a part of the business risk. Contractors see market consultation as giving free advice. The selection stage takes considerable time and effort for the contractor, where the compensation given is by far not sufficient to reimburse the costs. Clients need to make a selection faster to decrease amount of 'wasted' investments by contractors.
Three components concerning sustainable innovation and procurement procedures and contract forms:

- Culture shift is just starting.
- Lack of clear guidelines to encourage sustainability or innovation.
- No sufficient compensation for the contractor.

From the interviews

### The Value of Sustainable Development

To be able to award on EMAT usually price and 'added value' are added up in order to see which offer is the economically most advantageous tender. The award criteria other than 'Price' (so the *value* of the bid) have to be converted to a price in order to be able to add them up. The value of a bid is the performance of that bid, determined by the procurer and expressed in monetary terms (Dreschler, 2009).
In order to use award criteria encouraging sustainable development, value of this criterion has to be determined. During the interviews all interviewees were asked if they are able to value criteria for sustainability, most of them used "awarding value" (gunnen op waarde) by CROW, but added that not every criterion is suitable for this approach, especially sustainability oriented criteria. Ms Duineveld and Mr. van Amstel added; a governmental body has to have a vision on sustainable development, with this vision they are able to give aspects of sustainability a value. They have to state their own rules of the game. It would be best if these rules and visions are consistent through different bodies. Mr. Schweitzer mentioned that DuboCalc calculates a score (Milieu Kosten Indicator) stating costs, but these are not considered to be the actual costs. None of the respondents used a tool or mentioned a tool that was able to give sustainability a real value, covering all aspects. It can be questioned if it is even possible. The authors of "Quick scan Value Quantification" PSIbouw (2006) state in their report that it is not a tool that is lacking to quantify value, in contrary, there are too much tools and possibilities to quantify value. But the same discussion rises as in defining 'sustainable development', as Brown et al. 1987 was quoted previously in chapter 2: "*the definitions vary across contexts and scales [...], it can either develop into a realistic goal or remain a utopian ideal. Different societies have different cultural expectations of sustainable development further complicating the process."* Zooming in on the tools presented by PSIbouw, all tools with a focus on the *environment* were not accepted as value quantifying tools by their control group. Tools that try to define costs of the whole life cycle (LifeCycleCosting, LCC) find similar problems, it will always be a discussion what to incorporate into the software and how to use parameters (IISD 2009). Mr. van Amstel worked for over two years on a Life Cycle Assessment tool, and discovered the same. He states LCA can give an indication, but should not be used as a hard calculating tool (Appendix B).
So as the interviewees already pointed out; general policy should be formulated with a vision on sustainable development.

## 3.4 Conclusions to sub question 1 and 2

1) What are the main steps taken by the client in the concept and development phase? Which constraints emerge concerning sustainability in a D&C project?

Section 3.1 illustrated the building process and focused on the initial phases. Figure 12 showed that the 'sustainability gain' has to be obtained very early in the process. A client has to decide what he wants, and in what kind of collaboration he wishes to achieve it. If a client chooses a D&C model, and has a wish for an object that uses less energy, material or achieves another goal regarding sustainability, then he should focus on encouraging innovation. He has to become aware of the barriers shown in section 3.3. The RCA+ model illustrates most constraints for sustainable innovation in a D&C project. Three pairs of main barriers for sustainable procurement can be distinguished.

- Client
  - At the moment there is not a clear policy how to deal with sustainable procurement; a professional procurement department is not always present in an organization. The advantage of a solution that meets criteria on sustainability does not reach the client, making it hard to justify a specific choice. One of the reasons is that innovation is difficult to measure in advance, making it also hard to award an offer based on such an aspect. Limited competition forms a barrier for encouraging contractors.
  - Tender specific, at the moment clients are not yet used to award on EMAT. Different points of view on definitions on 'sustainability' contractors make their own assumptions or requirements are multi-interpretable; Unclear benefits, difficult to test, verify and value; Specification is too detailed; Higher costs upfront.
- Contractor
  - A contractor will not offer an innovation if the client does not demand it. No return on investment. Hard to protect innovation due to the risk of cherry picking and level of playing field.
  - Client and contractor do not jointly involve in selection and integration of subcontractors; Specific products are not integrated into LCC applications (demanding a specific license protected material is not allowed).
- Knowledge & Experience
  - Tools are not sufficient. The data challenge, methods are always limited to data available in application; Lack of competence in conducting LCC and interpreting its findings.
  - Culture shift is just starting, from traditional procurement towards innovative procurement. Lack of clear guidelines to encourage sustainability or innovation within this new culture. Contractors are not compensated sufficiently for their design efforts during Design & Construct cooperation, contractors see it as giving free advice and transfer costs are too high.

2) What are the main problems developing an object that is sustainable in the Operate and Maintenance phase?

Developing an object that meets criteria on sustainability in the Operate and Maintenance phase has similar aspects as developing an innovative object. The three boxed texts in section 3.3 abstracted from the interviews illustrate most of the problems.
Traditionally specifying a demand gives only little design freedom to the contractor. The innovative procurement procedures give space to a more functionally specified demand. This new approach has major implications to the whole building process and is just starting to find its way through the industry.
An object which is sustainable for the O&M phase sometimes consists of an innovative or new idea or approach brought forward by a contractor. It is assumed that contractors are afraid their ideas will be lost without compensation in this process, due to cherry-picking and the concept of level of playing field.
The third issue is the value of such an object. The contradiction on this issue is that the best solution will reduce use of materials or energy use, which means a reduction of (initial) costs for the client, developing such a solution will probably increase initial costs for the contractor. The client is not yet able to value this material or energy reduction sufficiently and so not able to award the contractor for their efforts on doing so.

## 3.5 Chapter summary

- The adjective ‘sustainable’ in Sustainable Innovation can be explained in two ways: Innovation on the long run (a sustainable run) will lead to more sustainable solutions concerning material and energy use etc; Project specific the definition used for sustainable innovation is a combination of the stated definitions of innovation and sustainability. Project specific Sustainable Innovation is a *new process and/or product* resulting from the *briefing* or *design* phase that will optimize the *flexibility, use of energy, water and material of the object during the operate and maintenance phase and minimizes waste during the demolition phase* which is *successfully implemented* and has a *recognized value.*
- Technological innovation is possible within a D&C building model, if it encourages early transfer; much communication; balance of risk (Employer should take more risk); sufficient time for the submission of tender documents (but actual innovation should already be designed) and a functionally specified demand to decrease design limitations of contractor.
- Sustainability gain is reached mostly during the earliest stages of the building lifecycle. Before an output specification is formulated, questions raised in chapter 2 have to be answered.
- Decisions on Collaboration Agreement; Requirements and Award Criteria can influence the interest of innovation.
- Several methodologies can be used to integrate lifecycle thinking in the process. xTRIZ has a slight advantage to the rest and is chosen as a methodology to encourage innovation.
- The government (Employer) is taking steps in order to create a context for encouraging innovation. A lack of clear policy from the government how to deal with quite a lot of practical issues forms the main barrier hampering the creation of this context.
- The first point made in this summary is negatively affected by a lack of knowledge and experience. The assumed positive effects which are tried to be reached by the *culture shift* are hampered by a traditional way of thinking how to deal with a project. Or as one of the interviewees stated: “the new process turns our way of working 180º into the other direction”.
- A contractor should be able to receive a positive return on investment from his innovative ideas. Using a dialogue can prevent the effect of level of playing field; using open licenses can prevent cherry picking. Accepting alternatives during the selection and award stage and using a jury to score these alternatives also encourages contractors to distinct themselves in a project.


# 4 Case Stena Line, using TRIZ

The previous chapter illustrated several barriers for innovation within a project or as a process in general. Blocking the process of innovation hampers sustainable development, as showed in chapter 2.
TRIZ is presented as a methodology that increases innovation in a project and as such be a part of the innovation process presented in section 1.1. During a case study the potential of this methodology is studied. As the methodology is quite new for the industry (only a few architects are using it currently (Souchkov, 2010)). The case was designed as an acquaintance with TRIZ. At the end an inquiry is completed by the participants, to get an idea of the possibilities of TRIZ at Grontmij during the initial phases of the building process.

## 4.1 Case Stena Line

The Port of Rotterdam NV (Port Authority, Havenbedrijf) commissioned Grontmij to draw a Design and Construct contract and to accompany the tender for the replacement of the existing quay wall in the Benelux Haven (Benelux Port) for the arrival of Stena Line (figure 16).


**Figure 16 Benelux Port, Port of Rotterdam**

The aim of the Port of Rotterdam Authority is to enhance the port of Rotterdam's competitive position as a logistics hub and world-class industrial complex. Not only in terms of size, but also quality. The core tasks of the Port Authority are to develop, manage and run the port and to maintain a speedy and safe service for shipping.
Together with their partners they aim towards a multipurpose, sustainable, safe and attractive port that meets the high demands of society. (Port of Rotterdam, 2010)

Stena Line is one of the world's largest ferry companies with a modern fleet of 34 vessels and Europe's most comprehensive route network consisting of 17 ferry routes in Scandinavia and around the UK. By constantly developing its products and services, Stena Line has achieved a strong position with significant market shares on all its market sectors.
Stena Line has built two new freight transportation ferries that should be able to operate in the Port of Rotterdam (PoR). The transportation principle is roll on roll of. Roll-on/roll-off (RORO or ro-ro) ships are vessels designed to carry wheeled cargo such as automobiles, trucks, semi-trailer trucks, trailers or railroad cars that are driven on and off the ship on their own wheels. This is in contrast to lo-lo (lift on-lift off) vessels which use a crane to load and unload cargo.
RORO vessels have built-in ramps which allow the cargo to be efficiently "rolled on" and "rolled off" the vessel when in port. While smaller ferries that operate across rivers and other short distances still often have built-in ramps, the term RORO is generally reserved for larger ocean-going vessels.

The existing quay wall is too short and has to be replaced. Grontmij's objective is to make sustainability an important component in this tender; sustainability should also be visible in the design and implementation, ultimately realizing a sustainable new quay wall.

The criteria stated by output specification were quite detailed. The requirements stated for the case were less detailed in order to encourage finding creative solutions.

During the workshop the case was stated as:

- A quay in the harbor of Rotterdam needs to be replaced.

- The harbor authority is asking for optimal Total Cost of Ownership and a sustainable as possible lifecycle.
- The client (Stena Line) will use the quay for the coming 50 years.
- The client wants to change its capacity from 1 to 2 vessels.
- These are RoRo vessels
- The client wants to store goods on the side of the quay.
- The length of the quay is too short to moor 2 ships behind each other.
- The neighbors (market competitors) should not be hindered on the water or land.

## 4.2 Workshop Set-up

In TRIZ several different paths can be taken to find innovative solutions. There are three possible points of departure: solving a specific problem; system optimisation or creating what's next (Appendix A.3). The path of system optimisation was chosen, because it includes a function analysis, and therefore it fits into supporting the use of 'specifying functionally'. The contradictions found can be solved with either the 76 inventive principles or the 40 inventive standards. Due to the complexity of TRIZ the 40 inventive standards were used in the end, this module is quite easy to understand and use. 80% of all TRIZ practitioners use this module; only 10% know how to use the 76 inventive standards (Souchkov, 2010).
Next to that another goal of this workshop was to make the workshop participants enthusiastic for TRIZ; the 40 principles have that effect on most people (as is my experience).

The agenda of the workshop afternoon was as follows:

- 30 min introduction to TRIZ and Case
- 45 min Function Analysis (Appendix A.3.2)
- 15 min Coffee Break
- 60 min Using 40 Inventive principles (Appendix A.3.3)
- 30 min presenting results
- 30 min evaluation and discussion

The workshop participants are all employers of Grontmij. The group consisted of 8 people from 3 different departments, and included a team leader (Team Projects), several seniors (with expertise in contracting, quay walls and sustainable harbours), a project manager and several juniors (with expertise in SE, case Stena Line and Sustainable Development). Three other people were invited, but were occupied and cancelled.
The workshop was kept at Grontmij de Bilt, in a meeting room. To facilitate this workshop only a few tools are needed; for the Function Analysis a whiteboard, a red and black marker and three colours of post-its are needed; for finding creative solutions with the 40 inventive principles, the Contradictions Matrix of Altshuller and the 40 inventive principles are needed (TRIZ40, 2010). The evaluation consisted of an enquiry on TRIZ in relation to several aspects of the procurement process (Appendix E.1).

### *4.2.1 Try-out of the workshop*

A week before, as a test if this set-up is sufficient, a try-out was organised with several students of Twente University. 5 students (2 master students Industrial Design Engineering both 'Advanced TRIZ practitioners', 2 master students Civil Engineering and Management and 1 bachelor student Health Science) were asked to participate in the workshop. As a result of this try-out it became clear that three hours is too short to complete the workshop, especially the Function Analysis took more time than expected, but was completed eventually. The workshop was extended for an hour and a half.

After a short practice the idea of a function analysis is understood easily, therefore, as a backup, an elaborated function analysis (the result of the try-out) was made in advance for the real workshop, in case the time problem existed during the real workshop (which it did).

## 4.3 Result and evaluation

### *4.3.1 Result of the function analysis*

As just mentioned in section 4.2.1 the function analysis could not be completed within time. The group managed to define the system, find sub-, super components and products of the system and found relations between 6 different components. The result so far was almost the same as the result of the try-out group.

After the coffee break the group used this function analysis to find important contradictions that could be solved with the 40 inventive principles. Appendix E shows a picture of the two results.

Two important contradictions were abstracted:

- The quay walls blocks the water but the water erodes the quay walls;
- The water area is needed to dock the vessels but the water area is occupied by the neighbours.

The first contradiction was chosen, it was closest to the existing problem with the case Stena Line.

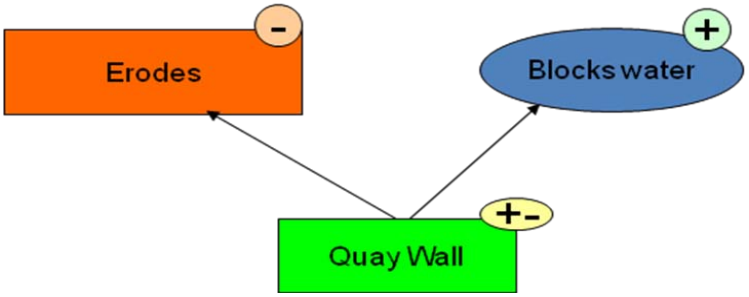



**Figure 17: Contradiction from Function Analysis**

*4.3.2 Result of the Contradiction Matrix and 40 inventive principles*

The group was divided into 4 couples who worked with this contradiction. First the specific harmful effect and useful effect were translated into the abstract effects of the matrix. The different groups found the below stated abstract formulations to be fitting the problem. The results were not checked by the workshop leader before advancing to the next step, it resulted in some disputable interpretations. These are mentioned in *italic* in the following table:

| *Harmful effects* | *Useful effects* |
|---|---|
| Area of immobile object (6) | Stability of object (13) |
| *Volume of immobile object (8)* | *Weight of immobile object (2)* |
| Stability of immobile object (13) | Area of moving object (5) |
| Durability of immobile object (16) | Weight of moving object (1) |

Using the contradiction matrix, the couples found several principles and tried to find 2 or 3 solutions to the contradiction per principle. To give some examples of the principles they took a look at:

| *Principle Number (in sets from the matrix)* | *Principle Name* |
|---|---|
| 39;<br>3;<br>35;<br>23. | Inert Environment<br>Local Quality<br>Parameter Change<br>Feedback |
| 2; (this set was also found by student group)<br>10;<br>19;<br>30. | Taking away<br>Prior action<br>Periodic action<br>Thin films and flexible shells |
| 7;<br>17;<br>4;<br>35. | Nesting<br>Another Dimension<br>Asymmetry<br>Parameter Change |

Every group presented 2 solutions they created using these principles:

- Using a film between the quay wall and the quay;
- Build a sluice to prevent salt water to enter the harbour;
- Use a film on the quay wall that creates a vacuum to prevent air to erode the wall;
- Freeze the soil;
- Alter the shape of the quay wall to prevent waves eroding it;
- Use a jetty instead of a quay wall;

- Use a specific sort of anchor that prevents eroding;
- Use propellers to extract energy from wave generation and as a mitigating effect slowing the erosion down.

### *4.3.3 Evaluation*

As it was clear from the start, the workshop would be too short to really put emphasis on finding and elaborating creative solutions to this specific problem. Therefore an inquiry was created to evaluate the methodology (result can be found in Appendix E.1), and also time was taken to discuss TRIZ at the end of the workshop.

Some critical remarks from participants on the workshop:

*No emphasis is put on sustainable development;*

As explained in previous chapters TRIZ is searching for the highest d*egree of ideality*, a solution with a higher *degree of ideality* is in essence more sustainable than a solution with a lower *degree of ideality*. If the urge rises to emphasize on specific sustainable aspects, two alterations can be implemented into the current workshop:

- Add sustainable super components ('$CO_2$', 'Maintenance' or 'Energy' for example) to the function analysis, for example on green post-its, and find the interactions from/to these components.
- Use sustainability oriented criteria during the scoring of the alternatives found.

The step that had not been taken during this workshop was to define what was meant with 'sustainable building'. If this had been done, it would have been possible how to score, and what to incorporate as sustainable super systems in the function analysis.

*Although TRIZ deals with mental inertia; given solutions fitted existing solutions.*

This is probably caused by the lack of experience how to use TRIZ, by the workshop leader and the participants. During the workshop the sort of solution to the problem that was tried to be solved was sometimes too technical; it was at the wrong level of detail. The problem definition was already too detailed for the system that was defined, which responds to the last remark:

*Good problem definition is still very important.*

A function analysis or root conflict analysis+ which should be executed prior to finding creative solutions is an important step, which normally takes several days and some hours of expert meetings to execute properly. During the workshop no time was taken to specify the problem as good as it should be. Also RCA+ would be a better tool to find a specific problem than Function Analysis, which focuses on system optimization, RCA+ was not part of this workshop.

**The inquiry and discussion**

All participants were enthusiastic about this new approach. During the discussion the question was raised if it is possible to state contradictions found as an EMAT-criteria. Also an important difference was stated between TRIZ and other methodologies that TRIZ also incorporates Super Systems, in such a way that it can become a resource to the solutions found.

They agreed partly or wholly to the statements that TRIZ can help the client or themselves in specifying functionally. Almost all participants agreed that TRIZ can be a useful tool during every stage of the building's lifecycle, except two participants who partly disagreed on using TRIZ during the construction phase. 6 participants fully agreed that finding contradictions puts the problem into a different perspective. TRIZ can be a useful tool added to SE or VE and can be of value to all design processes at Grontmij (one partly disagreed on this last statement). At last the participants agreed that TRIZ can be used during sustainable procurement and will fundamentally result in a sustainable solution. The exact scores can be found in Appendix E.1.

**Concluding**, this TRIZ workshop was a first step towards using the methodology during the procurement stage. It has potential to become a part of the process, but several issues need to be found out.

- To make the methodology more fitting to current *green* needs, emphasis on specific parts of sustainability can be added at specific moments, such as the Function Analysis or the Multi-criteria analysis. This should be formulated together with the client.
- The process should be slightly adjusted, to find the right balance between time invested and finding useful results.
- Finding contradictions is a new approach that can be useful in functional specification, for example to formulate it as an EMAT-criteria.


# 5 Breaking barriers for innovation during the initial stages

In the explanation of the context of this thesis (section 1.1) it was mentioned that innovation needs to be encouraged within a project and as a process (figure 18) to be able to encourage contractors to build in a way that meets criteria on sustainability for the operate and maintenance phase. The previous chapters showed that on these two levels several barriers exist that hamper the total process of innovation. To make it possible to build objects that use relatively less energy, materials, water or produce waste in the end during its lifecycle, a new approach is needed, which is only possible within an innovation encouraging environment.

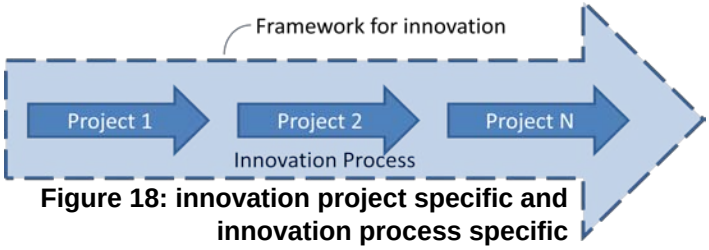



**Figure 18: innovation project specific and innovation process specific**

As explained in chapter 2.3 innovations eventually will always evolve to a new technology that decreases energy use, material use, dimensions and dynamics, also when 'sustainability' is not the main driver. On project level the application of innovations with similar goals is mostly hampered by the fact that the process is not optimal.

Every chapter concluded in a summary identifying aspect on project or process level. Chapter 2 stated three general rules that should be followed; the first two are project specific, the third process specific:

- Define clearly and more detailed what is meant with sustainability;
- Every project should be analyzed from back to front, starting at the disposal phase.
- To be able to build in a 'sustainable' way on the *long* run, the focus has to be on 'innovation'. The main driver should always be optimizing the degree of ideality (figure 10).

Chapter 3 consisted of an extensive study on barriers of innovation. Table 3 shows which barriers should be dealt with within a project or a process.

| Barrier | Project specific | Process specific |
|---|---|---|
| • No Policy | | X |
| • No professional procurement department | | X |
| • Advantage of sustainable solution does not reach client | X | |
| • Innovation is difficult to measure in advance | X | |
| • Limited competition | | X |
| • No focus on EMAT | X | |
| • Different points of view on definitions | | X |
| • Unclear benefits | X | |
| • Specification is too detailed | X | |
| • Higher costs upfront | X | |
| • No demand from client | | X |
| • No return on investment | X | |
| • Hard to protect innovation (intellectual property) | | X |
| • Client and contractor do not jointly involve in selection and integration of subcontractors | | X |
| • Specific products are not integrated into LCC applications | X | |
| • Tools are not sufficient | | X |
| • The data challenge | | X |
| • Lack of competence in conducting LCC and interpreting its findings | | X |

| | | |
|---|---|---|
| • Culture shift is just starting | | X |
| • Lack of clear guidelines to encourage sustainability or innovation | | X |
| • No sufficient compensation for the contractor | X | |

**Table 3: Barriers: project or process specific.**

Chapter 4 illustrated the possibilities of using TRIZ during the procurement stage. The methodology has potential to become a part of the process of a project, but several issues need to be found out (see section 4.4.3). TRIZ is mostly used as a *project specific* module to be able to innovate.

## 5.1 Functional interactions of 21 barriers

Appendix D shows the function analysis of the interactions between the 21 barriers stated in the previous sections.
There are two goals of a Function Analysis. First, identify as many as possible negative/ missing/ insufficient/ excessive/ poorly-controlled interactions that exist or *might* exist between two components involved to the interaction. Second, identify resources to innovatively redesign a system by trimming its components and share functions without sacrificing overall functionality, quality and performance (xTRIZ, 2010). Trimming is an action that eliminates one component and moves all functions and interactions of that component to other components. In the production industry this method is used to optimize products or create new products. In this case we do not speak of a product, but more of a system or super system. Functions of some components are somewhat less clear and sometimes subjective, compared to functions of a specific industrial product. Still this method can be used to show which of the 21 barriers are causing most harmful interactions and should be dealt with first. Figure 19 illustrates an example "*from* 'No Policy' *to* 'No demand from client'". De red curly arrow is the symbol used for a 'harmful effect'. The colors of the rectangles are similar to the six main barriers as in figure 15. 21 components and 254 interactions are not really suitable for a graphical FA as in figure 19; therefore Appendix D is designed as a matrix.

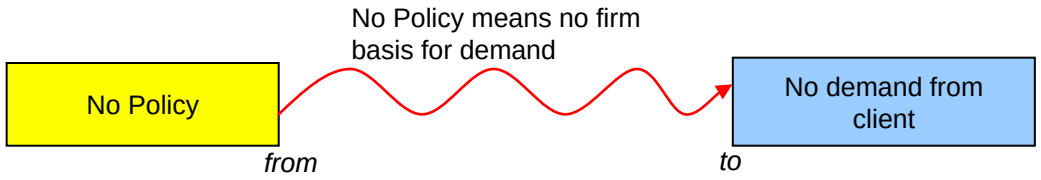



**Figure 19 Example of a harmful interaction between two components.**

Table 5 shows seven components accounting for 50% of all interactions. Trimming the first component 'No Policy' means that for all 22 interactions from and to this component the harmful interactions caused by 'no policy' have to be eliminated. Or in normal words, this FA not only shows 'No Policy' is an important barrier, it also shows on *which* components policy has to be formulated to encourage sustainable innovation in the construction industry during the tender stage.
Considering the culture shift a similar argumentation can be given. The culture shift interacts in 20 different ways with other components. 'Shifting' means something is already changing, in order to change into the right direction taking sustainable innovation as main driver, the FA shows what has to be taken into consideration.

| Interactions *From + To* | Components hindering sustainable innovation in the construction industry. | |
|---|---|---|
| **22** | **No Policy** | **Process** |
| **20** | **Culture shift is just starting.** | **Process** |
| **18** | **Innovation is difficult to measure in advance.** | **Project** |
| **18** | **No professional procurement department.** | **Process** |
| **15** | **Lack of clear guidelines to encourage sustainability or innovation.** | **Process** |
| **14** | **Unclear benefits of innovation.** | **Project** |
| **14** | **Specification is too detailed.** | **Project** |

**Table 4. 7 components cause 50% of all interactions.**

The fewer components exist in the system, the easier it gets to encourage innovation for a contractor. First the focus is on the process specific part of innovation. Four process specific components are trimmed in the remainder of this section. Section 5.2 focuses on the project specific part of innovation; 5.2.4 shows the trimming of all project specific components including the three mentioned in table 4.

*No Policy*
Sustainable development is a public issue that needs a clear and consistent policy. Time should be invested for organizing an integral sustainability approach. A well stated policy entails goals on the short, mid and long term. On the short term a clear definition for sustainable procurement should be stated. Preferably a set of definitions which form together a total definition, a client can make a choice which definition he will use for a specific project, contractors can specialise their products to a specific definition set and make an offer at the moment a client is requesting it. On the midterm a professional procurement department can be formed, or when it already exists be altered, that becomes a more central part of the process. This department has to learn and get experience in using EMAT-criteria (3 or 4 main criteria), how to deal with subjectivity (make use of a jury), how to protect innovation from (license or dialogue) and compensate (create more budget in advance) the contractor, how to specify functionally (make real use of the concept of Design & Construct), how to use LCC (find suitable software that fits the set of definition used), how to deal (show courage) with uncertainties concerning innovation (divide risk 50-50 with contractor) and write guidelines for these topics. This department can be a central team between different departments and try to overcome the barrier of budget division on the long term. For different phases the department can use pilot projects to test their new policy.
A consultancy company also has to be able to deal with these aspects, as the government can outsource their needs to such a company.

*Culture shift is just starting.*
At the moment, the culture shift is slowed down by several different aspects. As stated by one of the interviewees, these new building models are the world upside down. Instead of demanding a contractor to build fully detailed specifications and conditions specified by the client, the client has to select and award a contractor who is able to make a design and construct it. The aspects that slows down this shifting to more innovative building models are difficulties to measure concept drawings in advance (concerning innovation or sustainability), no focus on EMAT (which is seen as hinge for shifting), too detailed specifications, higher costs upfront, contractors have to make a big investment in advance without guaranty, tools are not sufficient (just starting to work with SE for example) and the data challenge (to be able to measure and validate in advance, more data is needed) (Appendix A.1).
This culture shift demands for a professional procurement department that can deal with these elements (and focus on sustainable development and innovation) and can integrate different departments (look over the walls). Not all companies are yet convinced in the added value of innovative building models which limits competition. Guidelines, pilots and other sources for getting a better perspective are needed to convince the market. The traditional way of thinking also hampers the ideas of specifying functionally or using EMAT instead of lowest price.
When the culture shift has found a new balance a lot of constraints and components are solved. Concerning innovation the emphasis on these components should be on encouraging sustainable innovation.
Companies that lead the way and help the shifting process towards more innovative building models will probably benefit in the end. The culture shift did not start without a reason, it tries to lower total cost of failure, encourage innovation, and encourage forming of partnerships.

*No professional procurement department.*
The culture shift also shifts the importance of separate phases; it shifts the point of transferring the project from client to contractor to an earlier stage. The procurement department therefore gets more obligations and responsibilities than they used to have. Most aspects have already been discussed in the previous two paragraphs. Such a department has to invest in getting knowledge and experience on how to encourage contractors to design an object that meets criteria on sustainability, an important part of this specific topic is defining sustainable development and dealing with uncertainties in the beginning of a project. This department has to know the processes described and has to be able to convince their superior why some of the new approaches to encourage innovation are important. They have to become the knowledge hub between client, contractors and subcontractors for finding ‘sustainable’ solutions to the needs of the client.

*Lack of clear guidelines to encourage sustainability or innovation.*
Both client and contractor can learn more on innovation and on sustainability. Guidelines will create clarity and equality in how to deal with innovations and what barriers need to be overcome. At the moment 'Gunnen op waarde', 'oplossingsvrij specificeren' and 'leidraad aanbesteden' (CROW 2007, 2007b and RRB 2009) are seen as useful guidelines that try to encourage innovation. Guidelines how to deal with sustainability and sustainable procurement are 'Criteria AgentschapNL', 'Duurzaam Inkopen 2.0', 'Gunnen op duurzaamheid' and 'EU-lessen voor Duurzaam inkopen' (AgentschapNL 2010, Bouwend Nederland 2008, RRB 2008). These guidelines do not entirely answer the question how to deal with the subjectivity issues of sustainable development, or how to value it. Formulating clear policy as stated earlier is an important aspect which can be the start of specifying 'rules for the game', how the government will deal with innovation regarding sustainable development. A lack of knowledge and experience how to use these guidelines is an issue that should be taken into consideration carefully. The credo should be: "*just try it!*". Use pilot projects, learn from mistakes and from each other. See it as a goal to have the knowledge and experience and distinct yourself within the market.

The first four barriers are ranked, as explained with table 4; dealing with "No Policy" delivers most result. The other components of *process* specific innovation (table 3, page 45) are:

- *Limited competition;* On national level, competition can be limited by a few companies that have the ability to deal with specific projects (big projects, or projects with a specific expertise needed). Opening borders by the EU is a big step in increasing competition. It is assumed to be a matter of time until this competition increases.
- *Different points of view on definitions;* As Mr. van Amstel pointed out during the interview, municipalities should have a consistent approach on dealing with the sustainability issue. If one province has a different opinion on this topic than another province (one is specifically demanding solar energy and the other wind energy) it will limit possibilities for competition. The opinion should be the same: "both want solar"; or on a higher level: "supply energy from an inexhaustible source".
- *Hard to protect innovation (intellectual property);* One of the underlying problems here is the potential of an idea to formulate it as intellectual property. First a building process cannot be protected in such a way (it is too easy to make slight alterations to bypass the protected process). Second with the current procurement procedures it is not allowed to ask for a specific (intellectually protected) product, if there is not sufficient competition on the market (also see the interviews on this topic).
- *Client and contractor do not jointly involve in selection and integration of subcontractors;* Although suppliers and subcontractors typically perform 70–80% of the gross work done in construction projects they are often kept at arm's-length distance by contractors. Careful joint subcontractor selection by both client and contractor in collaboration is therefore important in order to increase subcontractors' involvement and integration, which in turn may have many positive effects on project performance. Due to their large part of the work load and the interdependence among construction activities, increased subcontractor integration may facilitate improved environmental performance (Eriksson & Westerberg, 2010).
- *Tools are not sufficient & The data challenge & Lack of competence in conducting LCC and interpreting its findings;* the last three points interact; several interviewees and authors (see appendix A and B) argued a tool is only a tool. It should always be used together with other methods. As explained in Chapter 2 sustainable development is a very broad term, and using it in a tool always means choosing what to implement and what to leave out of it: the data challenge. Some tools require quite a lot of details before it is able to give a score. Within the context of D&C it is not desired to ask for many details before a contract is awarded, to decrease transfer cost (also see 3.1). Using a tool that needs an extensive amount of designing is therefore not desirable.

## 5.2 Roadmap

The **main goal** of this thesis is to be able to encourage a contractor to build in a way that meets criteria on sustainability for the Operate and Maintenance phase of an object. To answer the **main question**, the steps a client should take during the concept and development phase within a D & C project to reach this goal have to be defined. As the basis of this Roadmap the xTRIZ tools and procedures (Figure 29, Appendix A.3) were used. The study and results of Chapters 1, 2 and 3 are added at several steps to guide the process towards a lifecycle oriented systems optimization encouraging innovation and 'sustainable' solutions. The result of the

workshop presented in Chapter 4 supports the steps proposed in the roadmap. Each step is described in the following 4 sections; 5.2.5 gives an overview of the steps taken and results obtained.

- **Ambition document**, similar to Chapter 1 and 2, a definition and ambition of several terms and goals needs to be formulated before analyzing the system.
- **Function Analysis**, the first step of improving systems functionality (Figure 29, Appendix A.3) which has been performed and evaluated during the workshop (chapter 4).
- **Root Conflict Analysis+**, a combination of section 2.2 used for formulating problems during the lifecycle and an xTRIZ procedure.
- **Solve Conflict or Contradiction**, the final steps of the xTRIZ procedure projected within the context and framework of barriers presented as result of chapter 3.

### 5.2.1 *Stating an ambition that defines the goals and definition regarding sustainability*

As it became clear during the interviews and literature review, a definition of 'sustainable building' varies between people, organisations and contexts. As a start, a proper ambition needs to be formulated what is meant with this term. For each specific project more detailed challenges (section 2.2, figure 6) should be set, a choice can be made between:

- Zero waste, Emissions & Energy Reduction, Regulatory Compliance;
- Resource Efficiency, Product Stewardship, Life-cycle analysis;
- Safety & Health, Local Environment, Global Climate Change.

The more aspects chosen, the less real effect can be expected if the budget does not change. The ambition should formulate the aspects and in what way it should be interpreted during the whole lifecycle (also see section 5.1.3). The process of formulating this document is also the moment the client needs to be informed about the consequences of the stated ambition, for the rest of the project. What the ambition means for formulating an Output specification or Award criteria. The client has to define the level of importance of the document, in case weighing of alternatives is needed.
The earlier such an ambition is formulated, the better. Considering a project, the document should be prepared preferably in the initiative stage or during the research or definition stage (Appendix A.3). This ambition should be based on policy of the organisation. If this policy is not formulated or vague, the ambition needs to be checked and accepted by authorized personnel. This acceptance is needed to be able to argue decisions made in a later stage (what is the demand of the client behind the client?).
**Result:** A document stating the ambition on sustainability of the project. An employee, or a small team, will be appointed to be responsible for achieving this objective. Incentives affecting the individual level have been found to facilitate improved environmental performance (Eriksson & Westerberg, 2010). He should have some expertise regarding the specific ambition, for example a waste-manager.
**Organization:** If a client demands or wishes to procure and build in a socially responsible manner, which has to be asked in the first meeting, following the roadmap can be started.

### *5.2.2 Use TRIZ's Function Analysis to recognize components of the system,*

The function analysis was part of the case study in chapter 4. It helps with building functional models of systems and identifying sets of interaction/interface problems. It is a new approach to analyze a system and distinguishes 'super systems' and 'subsystems' of a system and its interactions. It is possible to translate the ambition into super system components. It shows the effect of the ambition on the system and results in a first optimizing step of the project. It should be applied when an analysis of a system is needed and identify problems and challenges related to system's functioning. The problems and challenges are constructed from the context of the ambition.
For example, if the ambition is to reduce waste production during the operate, maintenance and disposal phase, the super systems 'waste production', 'operator', 'maintenance department' and 'disposal at end of life' can be added to see what components interact with these super systems, and why they interact.
**Result:** Two results should be expected from this analysis. The first result is that the system is analyzed and functions are defined within a broad context, it is a first step towards a functionally specified output specification. The second result is that components that interact with the components of the ambition are defined. These components should be better investigated during the next step.
**Organization:** A facilitator should run a team session to conduct a Function Analysis. The team should consist of members who understand different aspects of the problem (technical, business, etc.) and also involve lead users. Average time needed to build an FA diagram is 2-3 days. Not all team members are needed for the whole process.

*5.2.3 Use TRIZ's Root Conflict Analysis+ to identify specific problems.*

RCA+ helps with analyzing a problem and extracting all underlying contradictions and conflicts. It should be applied when all the underlying roots of a problem and all contributing factors have to be understood.
For this roadmap RCA+ is used to predict problems from the end of the life cycle, working backwards. The problem is a combination of the ambition from the first point, and a system component of the second point. Repeat this step by going from back to front through the phases of the lifecycle.

Table 5 illustrates an assumption (it is not validated so far) of an example how a result of an RCA+ can look like. If the ambition is to reduce waste production during the operate, maintenance and disposal phase the general questions of table 5 can be stated. First a selection should be made which specific question has to be analyzed. For example, if from step 5.1.2 the component ´operator´ interacts with most components compared to the other components, this component needs to be formulated as a problem first. The root conflict analysis will find contradictions that are at the basis of causing the formulated problem. The main question should now be, does the client want to try and solve this problem by his own, or does the market need to come up with an answer?
If it is desired that the problem is solved by the client, he can use the creative steps of TRIZ; the 40 inventive principles or the 76 inventive standards.

| Phase | Specific main problem |
|---|---|
| Disposal or recycle | 1. Facility causes too much waste at the end of its life.<br>• What causes waste?<br>o Design did not prevent waste<br>o Construction cannot be reused<br>o Elements cannot be reused<br>o Materials cannot be recycled – (upcycled)<br>• What causes facility to be at end of life?<br>o Facility is physically obsolete<br>o Facility is economically obsolete<br>o Facility is functionally obsolete<br>o Facility is technologically obsolete<br>o Facility is socially obsolete<br>o Facility is legally obsolete |
| Operate and Maintenance | 2. Facility causes too much waste during the operation.<br>• What causes too much waste?<br>o The operation process processes waste<br>o …<br>• What causes an operator to be needed?<br><br>3. Facility causes too much waste during maintenance.<br>• What causes too much waste?<br>o Frequency of maintenance<br>o Sort of maintenance<br>o Not designed to maintain without waste production<br>o Changed construction or elements cannot be reused<br>o Waste cannot be recycled.<br>o …<br>• What causes maintenance? |
| Realisation | 4. The realization of a specific component causes waste during the operate and maintenance phase.<br>• What causes too much waste? |

**Table 5: Possible Top Root Conflicts, an example how it could look like**

If it is desired that the problem is solved by the contractor, the problem can be formulated as a requirement in the output specification, or the contradiction can be formulated as an EMAT criterion. It is assumed that the

choice that is made can be argued in a similar way as a choice between other aspects, if it is part of an award criterion, a precondition or a requirement in the output specification.
As discussed in section 3.1.3 and appendix A.1.4, minimum requirements (demands and preconditions) and award criteria (wishes) are formulated. Together with the client it should be discussed if found contradictions are a precondition, a demand, or a wish.
**Result:** An RCA+ diagram, the format of such a diagram is the same as of Appendices A.1 to A.5. It reveals underlying contradictions and conflicts, specified to each part of the lifecycle taking into consideration one or more chosen components from the FA. The contradictions and conflicts found should be part of a discussion with the client. Decisions should be made who will solve the conflict and if it should be solved by the contractor, how it should be part of the procurement procedure to solve it (is it a demand, or a wish). The ambition stated will contribute to this decision process, as the ambition level is stated in this document.
**Organization:** A facilitator should run a team session to conduct an RCA+. The team should consist of members who understand different aspects of the problem (technical, business, etc.) and also involve lead users. Average time needed to build an RCA+ diagram is 2-4 hours. Sometimes, depending on the complexity it can take up to several days. Building the diagram is an iterative process; the final result may differ quite a lot from the first draft.

### *5.2.4 During the actual procurement procedure, keep in mind the stated barriers and try to work around them, deal with them.*

The results of the previous three steps are a well formulated ambition, concerning sustainability, an analysis of the function of the system and a Root Conflict Analysis+ of components of the system that negatively interact with the ambition, which resulted in specific requirements that need to be dealt with during the Design and Construction Phase. The result of the function analysis revealed what components of the design are affected by these requirements. It is now a matter of translating these results and proceed with the desired procurement process.
The context of this thesis is the D&C building model, so this is the ‘desired’ procurement process. As explained in section 3.1, D&C should not be a goal on itself but a result of an analysis what process should fit the specific project best. Within this context the project specific barriers need to be reviewed, and communicated how to deal with them. The three barriers mentioned first are part of the ‘most important’ barriers from table 4.

- *(1) Innovation is difficult to measure in advance;* This affects two important issues: value and measurement. A jury can be used to value specific subjective values concerning solutions that have a sustainable effect, but that cannot be valued monetarily.
  At the moment, within a D&C building model, measurement is an issue that is tried to be dealt with in a too early stage. It increases transfer costs and considering ‘sustainability’ aspects not a lot of effective measurement tools are available. A contractor should be awarded a contract based on competence, a global design and goals he declares to be able to reach. Instead of a very detailed design that makes it possible to use LCC or LCA tools. The interview with Mr. Schweitzer states an approach that tries to find the right balance between transfer cost and amount of details of the design. If there is no *need* for measurement anymore this aspect is not a barrier. Guidelines and policy can formulate rules how to deal with non-measurable sustainable innovations.
  Further details on this aspect can be found in the boxed text “the value of sustainable development” (page 38)
- *(2) Unclear benefits;* Not all innovations will be a success, innovation in general is one of the main drivers of a well functioning economy, and therefore, considering the construction industry, the government should be more focussed on encouraging innovation in this industry and overcome the problem of unclearness by looking at a bigger picture. Innovation concerning sustainable development will most of the times not show a clear result in the end, it is less easy to show the public, clients or superiors the results of the investments made. Awards or labels like LEED or BREEAM give a body to such invisible innovations.
  Another issue concerning unclear benefits is how the product is being marketed. Ottman et al. (2006) state green marketing must satisfy two objectives: *improved environmental quality* and *customer satisfaction*. Misjudging either or overemphasizing the former at the expense of the latter can be termed “green marketing myopia”. Evidence indicates that successful green products have avoided green marketing myopia by following three important principles: consumer value positioning, calibration of consumer knowledge, and the credibility of product claims (also see Appendix F)
- *(3) Specification is too detailed;* This component is an interesting contradiction of the system. A client wants to know the details and specifics of a project as early as possible. To give the market more

space to innovate they need to think more in results. Details should not matter when the result is optimal. A client should have more confidence in the contractors; this should be the main step to take during the selection process. It is not economically reasonable to ask contractors to invest a substantial percentage of the total fixture before the contractor is awarded the job. Not only from the clients' perspective, change is needed, also a contractor has to invest in tender process efficiency to try to lower their initial costs to do an offer.
It requires a professional procurement department that is able to formulate clearly the functions of the project and is able to manage and divide all new uncertainties and risks that are part of the culture shift.

- *Advantage of sustainable solution does not reach client*; Clearly formulate the advantages as a part of the Social Responsibility (also see interview with Ms Duineveld). Be aware of this aspect and try to reveal the advantages that do not reach the client.
- *No focus on EMAT;* EMAT should be used to encourage a contractor to find solutions for specific contradictions found in the third step of the roadmap. EMAT should at least weigh for 40% of the score and should exist of maximum 4 main criteria (PSIbouw/Verniewing Bouw, 2010).
- *Higher costs upfront;* it is expected that solutions that have a more optimal TCO or LCC results in a different division of funds needed to finance the project. Is the client aware of this? Is the clients' organization able to deal with this problem? When different departments deal with budgets concerning realization and maintenance, these departments need to work together during the procurement phase to organize the finances and regulation of the project concerning this. Step 2 of the roadmap is a right moment to arrange this.
- *No return on investment;* the contractor loses its innovation very easily to the competition due to procurement procedures. The client should be aware of this. The client can investigate his options before proceeding to an official procurement procedure, the contractor can sell open licenses (CROW, 2009) of his product or the client can make more use of the dialogue procedure. The key issue at this point is transparency and fairness towards the contractor.
- *Specific products are not integrated into LCC applications;* The use of specific applications that use a product database will never cover all products or all possibilities a product has. It creates a framework to fit a design into. Not all possible solutions will fit within such an exact model. An application needs to be used carefully, alternatives should always be a possibility and measuring in a different way than an exact model should also be possible.
- *No sufficient compensation for the contractor;* a proper balance must be made between compensation for the contractor and specification asked to fulfill the requirements of the procurement procedure. As was given as advice during the interviews (Ms. Duineveld), try to run through the procedure quickly. Out of a group, make a quick selection of only view contractors; compensate these contractors partially for their design efforts.

### *5.2.5 The result of the Roadmap*

The roadmap, illustrated in figure 20, is the graphical result of the steps that can be taken as described in the previous sub-sections. It will produce an ambition document, list of (sub-)systems negatively interacting with these ambitions, a list of contradictions & conflicts and a proposal which party (client or contractor) should solve these conflicts or contradictions. Table 3 on page 45 summarized all barriers. It is assumed that this roadmap will make a beginning of breaking these barriers.

- The Roadmap will complement the procurement departure in encouraging innovation in their processes, it will partly deal with the barrier that innovation is not measurable in advance. The FA and RCA+ will be a sufficient analysis of the system and root conflicts and therefore take apart this immeasurable innovation, so the department will better understand the problem.
- The Ambition document will state a clear policy, specific for this project, or preferably for several projects. It will overcome the barrier of different points of view on definitions as it is written down in an early phase. A decision can be made on dealing with higher costs upfront, or involve other departments in an early phase, to be able to get insight of the lifecycle of the construction. The contractor can get a better idea of the demand of the client, by reading this document.
- The result of the FA can reveal unclear benefits, as it will take apart the whole system, including super-systems. It is also a step towards a more functionally described specification, and therefore can be an addition to the culture shift.
- The result of RCA+ makes it possible to make clear what advantages will reach the client, and similar to the result of the FA it can reveal unclear benefits. It will uncover contradictions (a benefit against a negative effect) and so give insight in the benefit that might have been overlooked in the first place.

- What aspects of sustainability is part of the precondition, Output specification or EMAT can start a discussion of the need for EMAT-criteria, and might start a discussion in selecting sub-contractors together with the contractor, as some sub-contractors have specific technology to solve a contradiction.

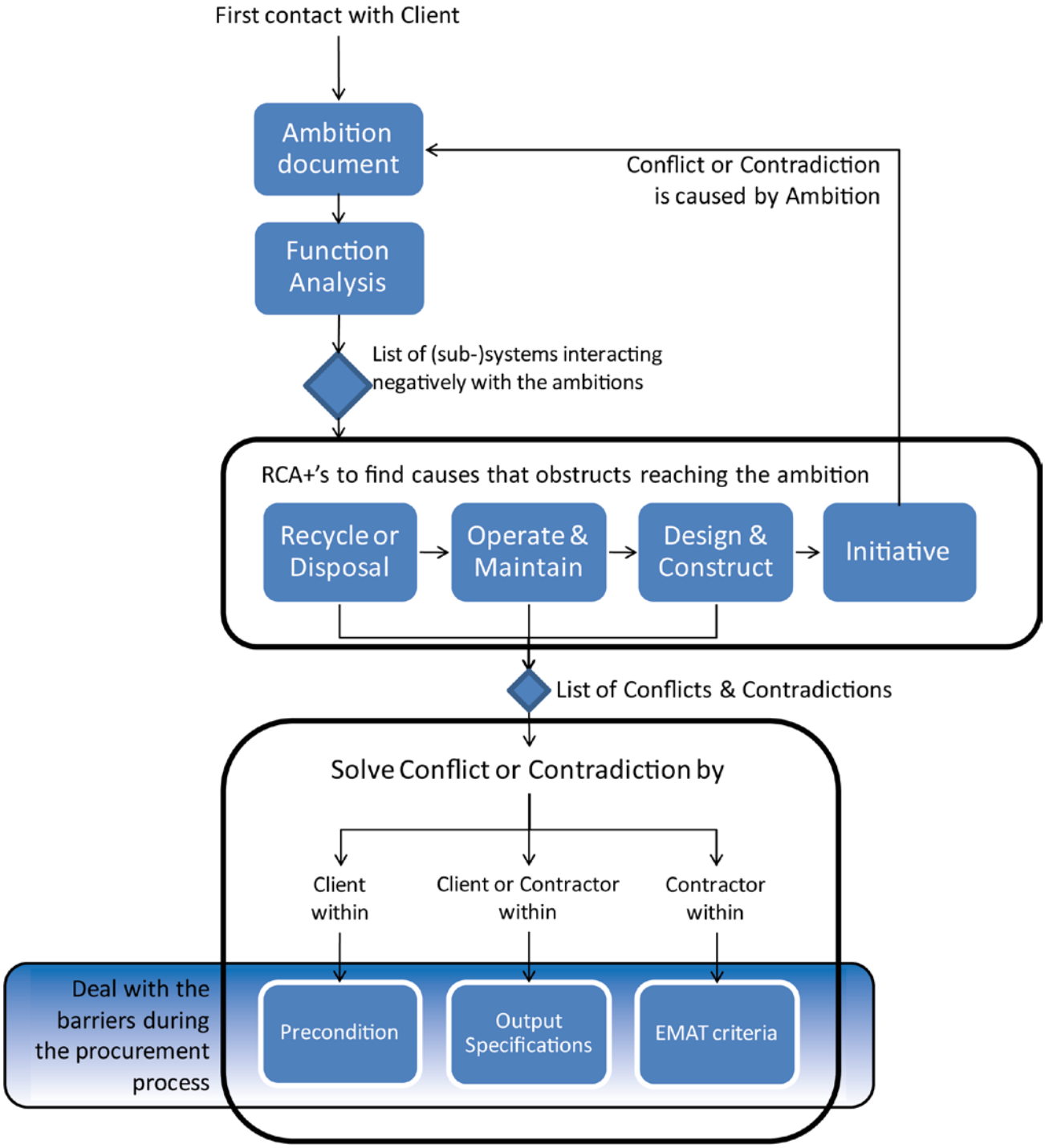



**Figure 20: Roadmap: Steps to take from first contact with client to designing tender documents.**

## 5.3 TRIZ in a procurement procedure

The Procurement Guidebook (Leidraad Aanbesteden, 2009) describes the procurement procedure as follows: a procurer first chooses a building model (Appendix A.1); then tunes his output specification to this model; decides which contract form fits best to these two choices and after that will start the procurement procedure (Appendix A.1). The choice of the procurement procedure is also affected by European law (Appendix A.1).

The thesis focuses on Design & Construct as a building model, which asks for a functionally specified demand within a UAVgc contract, as described in the context (section 1.5). TRIZ will first be implemented between choosing the building model and specifying the output specification. Are there any complications expected within this process to implement TRIZ?
In principle, if the client is not obliged to follow European Procurement Procedures, the client can choose with which party he wants to collaborate, and sign a contract; no specific restrictions of non-discrimination or transparency are applicable, except of 'normal' contract forming. In that case he can demand a contractor to use TRIZ, if no contractor is able to do so; the procurer has to reformulate his demand.
If the client is obliged to follow European procurement procedures, or is tied to other (organization specific) policy, will there be a problem to specify TRIZ as a methodology? In consultation with two colleagues no problems were found. TRIZ is 'freely' available for use; if a contractor has not the capabilities required he can outsource the request. It is assumed that principles for non-discrimination or proportionality are not applicable here. But is it advisable to specifically request the use of TRIZ? One of the barriers of 3.3.1 is output specifications are too detailed, specifically demanding TRIZ consolidates this barrier. The client has three options (also showed in figure 20) to demand TRIZ with a gradual scale from restricted choice of process to unrestricted choice:

- Precondition: the client can prescribe what steps the contractor has to take into account of his design process. It is possible to prescribe the process illustrated in (Appendix A.3 figure 29). The contractor has no other choice than to use TRIZ.
- Output specification: the client can partly require the use of TRIZ, or state contradictions to be solved by the contractor, or choose another intermediate approach.
- EMAT-criteria: the client can score the contractor for using a tool for systematic innovation, as a process criterion. A contractor can distinguish himself from the market.

It is assumed by formulating a Pilot project; the use of TRIZ can be specified, as it is a pilot European regulation are more flexible (Leidraad aanbesteden, 2009).
Formulating the contradictions is not part of this step and according to the Procurement Guidebook (Leidraad aanbesteden, 2009), formulating the output specification has no restrictions on how to describe the problem or system. It is assumed that the result of a FA or RCA+ can be described without problems in the tender documents, but demanding to solve them by using TRIZ is not advised directly. A contractor can be able to solve a contradiction without using TRIZ tools, but the result might not be the best or found in an efficient way. If a solution is the best depends on the competition, and can be valued accordingly by the client. The five main features from section 2.3.3 can be used to score the solutions. Not finding a solution fully efficiently is not a problem of the client; the contractor would be wise to invest in a tool that enables him to solve contradictions efficiently. The barrier "the culture shift is just starting" should not be underestimated; specifying to solve contradictions could be considered as a highly functional demand, which is one of the transitions that are being undertaken presently.

- It is expected that contractors will find it difficult to solve contradictions specified in an output specifications or an EMAT-criteria.

As a consulting company, Grontmij can assist a client or a contractor with using TRIZ. As it is a tool for systematic innovation it will find effectively and efficiently innovative solutions for client or contractor.

## 5.4 Conclusions to sub question 3, 4 and 5

3) Which methods exist to encourage a contractor to develop a sustainable object in a D&C project?

This chapter has quite a high level of "how-it-could-be" assumptions, based on the result of chapter 2, 3 and 4. The important conclusion is that 'sustainability' is not a *patch* that can be attached to a design somewhere in the middle of the process. It should start as early as possible and taken along during the whole project. One project fits as a small part within a higher leveled process of innovation (figure 18); this process should also be in order. Clear long-term policy encourages a contractor to develop innovative products or process in order to compete on the long run with their competitors. A professional procurement department is able to gain experience on the new challenges raised by the culture shift from traditional procurement to innovative

procurement. With this experience it is possible to formulate clear roadmaps how to encourage sustainability. The result presented in 5.2.5 is assumed to be a useful start in creating this roadmap.

4) What methods should be used at control points in the concept and development phase?
5) What recommendations can be given to apply TRIZ in the concept and development phase?

The literature review, interviews and workshop all contributed to the creation of the roadmap. The answers of sub question 4 and 5 are combined by following the roadmap proposed in section 5.2. Using Function Analysis and Root Conflict Analysis+ will define the function of a system and the causes of conflicts within the system, within the context of the stated 'sustainability ambition'. The first modules of the method of xTRIZ are then completed. If found contradictions should be solved by the client or by the contractor should be discussed, using the modules for problem solving (40 inventive principles, 76 inventive standards or ARIZ) is advised.
The use of TRIZ within the procurement phase is only tested during a short session (chapter 4). The positive comments of the participants and their answers to the inquiry were partly the base of the implementation of TRIZ modules to the roadmap as described in 5.2.5.

## 5.5 Chapter summary

The improvement of the process for innovation is a construction industry wide issue, which has to be dealt with on a national or international level. No clear policy is a major issue that hampers this process during the initial phases of a constructions life cycle. A professional procurement department that knows what to expect from the 'culture shift' and gains experience on procuring sustainable or innovative products or objects are seen as the first steps to be taken in dealing with the issue of providing a process for innovation.
Concerning a project specific demand for innovation or sustainability a roadmap is proposed. It starts by stating a clear ambition to define what is desired concerning the sustainability of the project. Using TRIZ in order to analyse the system and find conflicts and contradictions to this ambition and decide if a conflict or contradiction has to be solved. Finally stating who should be responsible to solve it. During the specific procurement procedure, several barriers need to be kept in mind. For example the understanding that not everything is measurable in an early stage of a building process, especially aspects of innovation or sustainability. Output specifications should never be too detailed in order to give a freedom in design for the contractor, who will be encouraged to find more optimal solutions to the project.
No practical conflicts were found for using the proposed roadmap. It might be too soon to demand contradictions to a contractor as he is not yet used to work with the current freedom in design. It is also not in line with demanding a functional output specification, to specify TRIZ as a tool that has to be used; the contractor should have the freedom to choose its own processes and tools. Grontmij can assist both client and contractor to use TRIZ during their processes.


# 6 Discussion

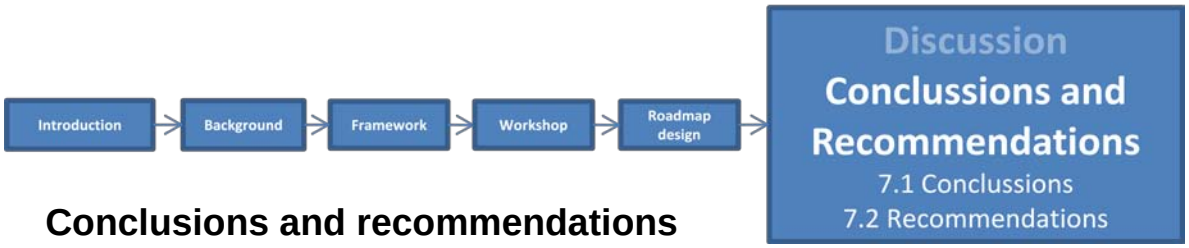
The results of this thesis have been presented in the previous chapter. This chapter presents a discussion on several aspects from the thesis.

Sustainable Procurement within the civil engineering industry is an emerging development; processes are just being set up (interview Mr. van Bruggen). The thesis contributes to this process by including an elaborated study on the definition of “sustainability” and making a connection to the “Evolution of Technology”, being able to state that innovation is the engine to enable a sustainable future. This approach to sustainability leads to a similar question within the procurement process: how to encourage innovation within the initial stages of the construction industry? By combining theory on innovation and sustainability within the initial stages of the lifecycle it became clear what barriers arises that blocks the development of it. TRIZ is presented as a tool to force innovation within a project. Revealing the barriers that discourages innovation within a project and as a process can pave the road for implementing these innovations.

The roadmap is a concept design; it has not been verified or validated among experts yet. The key steps of the roadmap are individual TRIZ tools; these tools have been used extensively in a wide range of industries and have proven its abilities to solve problems. As discussed in this thesis already a few researches have investigated the possibilities of using TRIZ in the construction industry, also with positive results (Mao, 2009). The choice of TRIZ to be used as a methodology and scoring it against three other methodologies (Systems Engineering, Value Engineering and Value Management) was not a fair balanced choice. During this thesis the certificate of Advanced TRIZ Practitioner was reached. The amount of information gathered on TRIZ was a lot more than on the other methodologies. As explained all methodologies can be used to include lifecycle thinking.
The use of TRIZ within the procurement phase is only tested during a short session (chapter 4). The positive comments of the participants and their answers to the inquiry were partly the base of the implementation of TRIZ modules to the roadmap as described in 5.2.5.

The definition of *Sustainability* presented in this thesis is based on a literature study. As explained in section 3.3, everyone has their own perspective on this definition, making this definition also subjective. Several interviewees, colleagues and students (who were met during the thesis) also included aspects as (social) safety, making profit and protecting the environment (as it is all part of the PPP thinking model) to sustainability. It can be discussed if material-use, energy-use, water-use, flexibility and waste-reduction are the *only* aspects of this term that need to be taken into account. The Brundtland committee stated the needs of the present should be met without compromising the ability of future generations to meet their own needs. According the definition in this thesis the focus should be on material-use, the other four aspects are derivatives (for example energy is generated from the materials oil or gas, water is a material, flexibility and waste management extends the life of a material). The growing economies (for example China and India) will put more pressure on the resources available. With that perspective and without any change future generations will have to deal with less water or a scarce of specific materials. Therefore the emphasis of the term sustainability in the construction industry should be on material-use (and so more specific, also energy, water, flexibility and waste).
The aspects that are included by others (safety, environment and profit) should be taken into account separately, but it should not be part of the term sustainability as if it should be a trade-off between it.

Systematic Innovation by Mann and Dekoninck (2003) and Souchkov (2010) show the Evolution of Technology, it provides insight in an extensive study on 2,5 million patents within several industries. The graphical illustration presented in figure 10 in section 2.3 shows reaching a higher degree of ideality will lead to a solution that uses less material and energy; and decreases dynamics and dimensions, in other words: it will lead to a more ‘sustainable’ solution. The interpretation of the term ‘innovation’ in this thesis is a very broad interpretation, which is not borne by all people who were spoken to during the course of this thesis. If this idea on innovation and sustainability cannot be explained to others and so will not be adapted to them, the urge to improve the process of innovation is lacking. It is a vulnerable aspect of this thesis which needs attention in further research and discussions.




# 7 Conclusions and recommendations

In this chapter first the main conclusions are presented that are drawn from the research as described in the previous chapters. The remainder of this chapter describes how these conclusions can contribute to developments in the construction industry in general and Grontmij in particular and recommendations for further research are provided.

## 7.1 Conclusions

The main question of this master thesis was*: What steps should the client take during the concept and development phase within a D & C project in the civil engineering sector, in order to encourage the contractor to develop an object that is sustainable in the operate and maintenance phase?*

This problem has been analyzed using the following five sub-questions: “What are the main steps taken by the client in the concept and development phase?”; “What are the main problems developing an object that is sustainable in the operate and maintenance phase?”; “Which methods exist to encourage a contractor to develop a sustainable object in a D&C project?”; “What methods should be used at control points in the concept and development phase?”; and “What recommendations can be given in the this phase?” Based on the answers to these sub-questions a practical set of steps that forms a Roadmap (chapter 5) has been developed and presented which Grontmij can use as a guideline to consult and support a client. In conclusion, the advantages associated by using this roadmap can be summarized by three major points which will now be provided:

1. Innovation is the engine that enables a sustainable future. In order to encourage innovation the client should focus on it as early as possible in the building lifecycle and to do so deal with the barriers for innovation that arise during the process.

In this thesis (section 3.1) it has been shown that with respect to the building lifecycle the ‘sustainability gain’ has to be obtained very early in the process. As an example the client has to decide what he wants and in what kind of collaboration he wishes to achieve it. If a client chooses a D&C model, and has a wish for an object that uses less energy, material or achieves another goal regarding sustainability, then they should focus on encouraging innovation. In order to accomplish this, the client has to become aware of the three pairs of main barriers presented in section 3.3 for sustainable procurement that can be distinguished, arising from the client, contractor and knowledge and experience.
Generally, a framework for encouraging innovation is not provided by the client. To remedy this, the client (public procurer) should formulate clear policy and form a professional procurement department which is able to give substance to the potential of innovative contracting (integrated contracts).

2. Concerning the initial stages of the building lifecycle, three issues need specific attention: specify functionally; compensate the contractors sufficiently for their efforts and be aware of the difficulties in valuing ‘sustainability’.

The first issue concerns the need for a functional specification. Presently, the culture shift of the construction industry is ‘just starting’, from traditional procurement towards innovative procurement. Therefore, experience is needed to understand the potential of these new cooperation forms and make full use of its potential to encourage innovative solutions. Traditionally specifying a demand gives only little design freedom to the contractor. The innovative procurement procedures give space to a more functionally specified demand. This new approach has major implications to the whole building process and is just starting to find its way through the industry.
The second issue involves the compensation for the contractor. It has been assumed that developing an object that is sustainable in the Operate and Maintenance phase acts the same as developing an innovative object. Such an object sometimes consists of an innovative or new idea or approach brought forward by a contractor, which needs to be legally protected. It is assumed that contractors are afraid their ideas will be lost without compensation in this process, due to cherry-picking and the concept of level of playing field. These current procedures do not encourage contractors to design innovative solutions.To counteract this problem,

during the procurement process; the intellectual property of the contractor needs to be protected against cherry picking and level of playing field, by making use of the dialogue procedure or open licences.
The third issue is the value of a 'sustainable' object. The contradiction on this issue is that the best solution will reduce use of materials or energy use, which means a reduction of (initial) costs for the client, developing such a solution will probably increase initial costs for the contractor. The client is not yet able to value this material or energy reduction sufficiently and so not able to award the contractor for their efforts on doing so.

3. As has been shown in chapter 5, the roadmap provides the client with a unique way to pave the road for a contractor to build an object that meets the criteria of sustainability during the Operate & Maintenance phase.

This roadmap tackles the natural problems associated with such a development task, which are:

- Creating the clients' awareness of the various aspects of sustainability in the project. In order to encourage a contractor to develop innovative products or processes a client has to formulate clear long-term policy. The policy defines future goals regarding sustainability, enabling a contractor to responds accordingly.
- Defining the function of a system and the causes of conflicts and contradictions within the system according these aspects of sustainability. In this thesis TRIZ has been introduced as a tool to design innovative solutions to specific problems resulting from such conflicts and contradictions, which is both effective and efficient. This methodology is characterized by its focus on reaching a higher *degree of ideality*. More specific, it aims to state and decrease harmful effects and costs and to increase useful effects.
- Dealing with the contradiction of the system through all tender documents. The roadmap shows at the final step, when a contradiction is found that needs to be solved, the client should internally discuss who needs to solve the contradiction. The client can solve it on its own, but can also formulate the stated contradiction as part of the Output specifications or EMAT-criteria and by doing so challenge the contractor to find a solution which can be a distinguishing factor for awarding the project.
- Breaking down barriers to encourage innovation within the procurement phase. Practically this means a professional procurement department needs to gain experience on the new challenges raised by the culture shift from traditional procurement to innovative procurement.

Using this roadmap a contractor is enabled by the client to use innovative solutions in order to meet the needs of the client that demand for a sustainable design in the O&M phase.

## 7.2 Contribution and Recommendations

The last section of this thesis will focus on the contribution to and recommendations for the industry and Grontmij in particular. It is based on the findings of this study and on personal experiences obtained during the course of the study.

### *7.2.1 Grontmij specific contributions and recommendations*

The business processes at Grontmij were not widely studied for this thesis, the study was conducted at Team Projects, and only the members of the team and a view other colleagues were approached for information regarding the subject of the thesis. For the team three contributions can be distinguished: better understanding of the definition of and starting a discussion on sustainability and sustainable procurement and the second contribution is the acquaintance with TRIZ and its tools as a methodology for systematic innovation. The third contribution is the design of the Roadmap. When the Roadmap is tested and has proven its potential, Grontmij can use it to support and consult their clients enabling them to encourage a contractor to build an object that meets specific sustainability criteria.
This leads to the recommendations towards Grontmij:
The first recommendation to Grontmij is **to use the Roadmap in a pilot project**. It can be tested and then adjusted to the needs of the company. Following the roadmap will give insight in Sustainable Procurement as a process, where sustainability is taken into consideration in the whole initial process stages.
As discussed in this thesis concerning sustainability, the emphasis should be on improving the process of innovation and adapting innovative solutions within a process. The concept that innovation is the engine that

will enable a sustainable future, and therefore be a specific part of the procurement process should be discussed amongst employees who have to deal with the initial phases of the building lifecycle.
The development of knowledge and experience on topics concerning sustainability have just started, internally quite a few departments are working on this topic. The second recommendation is **to initiate a platform to encourage knowledge transfer** on all projects of Grontmij dealing with sustainability. As it is a lifecycle approach, all departments need to know from each other what issues are being dealt with and if connecting each other's issues might lead to new innovative approaches on solutions that meet criteria on sustainability.
The final Grontmij specific recommendation is **to make use of the TRIZ tools**. TRIZ is a very effective and efficient methodology to solve specific problems, for optimizing of systems and creating "what's next". It can be used to analyze internal business processes (for example to encourage the process of innovation) or it can be used within project design, besides the proposed roadmap. The methodology for Systematic Innovation can probably be adapted to the current development of Systems Engineering in the industry, this also needs further research which can be conducted by Grontmij or in general.

### *7.2.2 Contributions to the construction industry and recommendations for further research*

As mentioned in section 1.5 the construction market seems to be willing to take its social responsibility to deal with challenges concerning global warming, depletion of raw materials, excessive energy use and other issues concerning sustainability. This thesis reveals the real challenges that have to be faced within a specific part of the building process, the procurement stage, to meet this market demand. With this result the company is able to consult their clients on relevant issues during the procurement stage. This thesis combines two topics, 'innovation' and 'sustainable development'. It shows the importance of the recent culture shift towards a more innovation stimulating environment when dealing with the current demand for solutions that are socially responsible. By making the link between these two topics, it became clear that barriers for innovation are also applicable to demanding solutions that meet criteria on sustainability, especially for the phases after realisation of a construction within D&C contracts.
Specifically for the procurement stage, the thesis showed that aspects concerning 'sustainability' should be part of a total approach, including the process and all tender documents a client needs to create in order to put the tender on the market.
For further research it is recommended to investigate the following issues:

- Every barrier mentioned in the RCA+ model needs to be broken. To start at the top further research can focus on developing policy that encourages innovation and sustainability within the procurement process. It can also focus on the culture shift and identify barriers within this process that obstruct the process of innovation.
- Further development of the proposed roadmap. Further incorporating TRIZ and test it on several projects.
- Do a study on integrating TRIZ within Systems Engineering as was proposed in section 3.2.4.
- Another proposal for a research topic is to design a Social Cost-Benefit Analysis for Sustainable Development. It should make it possible to measure the benefits of a 'sustainable' solution and support the ambition on sustainability as proposed in the roadmap. Such an analysis is performed in one of the earliest stages, and it is expected to contribute to a higher sustainability gain.
- During the interviews several interviewees mentioned the 7 tracks for the development of Sustainable Procurement in the Civil Engineering industry. The track "sustainable functional specification might be interesting to focus on, as it can find a solution to break the barrier of a "too detailed output specification".
- The different backgrounds and working fields of the interviewees revealed an interesting difference between the B&U and GWW sector (Housing and offices building, and civil engineering). As the European Procurement Procedures specify quite specifically how to select and award a contractor, due to law which a public procurer is obliged to follow, within a B&U project the client does not have to deal with these procedures. What kind of difference in effect does this cause on the framework and process of encouraging innovation? It seems that the B&U sector is more flexible and tolerates innovations more easily, but fails to create a competitive atmosphere where contractor can distinguish themselves, where in the GWW it is the other way around.
- An interesting contradiction is the balance between the need for a detailed design and the selection time for the contractors. A project developer mentioned that at the moment this balance is not found, contractors sometimes invest 20% of the total fixture into preliminary design costs, before they are awarded the job. What is fair?

- The last recommendation is to focus on the dialogue, several interviewees considered the dialogue to solve problems between client and contractor on how to deal with innovative solutions. Prevention of risk of cherry picking and level of playing can be the goal of this research.

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# Appendices

# A Theory

## A.1 The Procurement process

The reader “Design and Construct in Civil Engineering”, which is part of a course at the TU Delft, written by de Ridder and Noppen (2009) is used as a basis for explaining the essence of the procurement process. De Ridder was the promoter of Marco Dreschler, his PhD thesis “Fair competition - How to apply the ‘Economically Most Advantageous Tender’ (EMAT) award mechanism in the Dutch construction industry” (2009) was another important source for understanding the process. Also the “Leidraad Aanbesteden voor de bouw” (Procurement Handbook for the construction industry) by the Regieraad bouw (2009) is used for the following text.

### *A.1.1 Principles of collaboration*

Upon setting a *sales* agreement in its most simple form, there will be three characteristics to be considered: value, price and cost. Value minus Price is the Benefit for the demander, Price minus Cost is the Profit for the supplier. Usually it is the supplier who will not be satisfied, because he will have failed to create enough value for the costs he has incurred.
A collaboration agreement is more complicated than a sales agreement. The purpose of a collaboration agreement is: *The Contractor incurs costs in order to develop a concept, which has enough value for the Employer to justify him paying the price asked for it.* The nature of the collaboration takes place in between two extremes: either the employer carries out all the work, or he put it out to tender.
In civil engineering, collaboration centres on the development of a concept (building). The Contractor and the Employer both collaborate to achieve the same aim, with each working according to his own interests. The principal’s main interest is to create as high a level of ‘value’ as possible. The contractor’s main interest is to see to it that costs are as low as possible.
Two kinds of risk are constituted for each party, the risk in specifying the Employer’s demand and the production risk for the Contractor.

### *A.1.2 Elements of procurement*

**Tasks to be agreed upon**

One of the most important components of a collaboration agreement are the tasks to be agreed on. Drawing up a task description can be best carried out by considering the total lifetime of a civil engineering work. After all, in each stage of the structure’s lifetime tasks are contracted out. The choice of the form of the collaboration agreement concerns the distribution of the tasks that have to be carried out during the building process. The most important tasks are:

- Design of the building project (D= ‘Design’ or E=’Engineer’);
- Build the project (B=’Build’ or C=’Construct’);
- Project acquisition (F=’Finance’);
- Providing maintenance and management of the realized project (M=’Maintain’);
- Exploiting the realized project (O=’Operate’).

The more tasks a Contractor gets, the more freedom he should get to design solutions for the demand of the Employer. The formulation of the requirements is also an important element of the design-freedom of the Contractor.

**Systems of reimbursement**

The second component of the agreement is the system of reimbursement. A reimbursement system is nothing more than fixing a price for the task to be fulfilled. Two types of systems of re-imbursement are often used: ‘cost plus’ systems and ‘fixed price’ systems. When using a ‘cost plus’ system, the Employer reimburses all acceptable and reasonable costs of which the Contractor can demonstrate that he has incurred those expenses. Using a ‘fixed price’ system, the Contractor receives a fixed amount of money concerning the services rendered or product delivered.

**Distribution of risks**
The distribution of risks is always a difficult element of the contract, the best known general rule with respect to the distribution of risks is that a certain risk shall be borne by that party which is capable of both estimating and controlling that risk in the best possible way.

So a contract form is determined by means of a combination of certain tasks; but also by a certain reimbursement system, and including risk clauses. Standardized administrative conditions which can be used are DNR 2005; UAV 1989; UAV-TI 1992; UAVgc 2005; VGBouw Model Building Team agreement; Model DBFM-agreement RWS.

*A.1.3 Procurement procedures*
At this moment, the context of the procurement procedures is formed by Directive 2004/18/EC (European Parliament 2004). Articles 28-34 of the Directive define the procurement procedures. In article 28, the Directive states that contracting authorities shall apply their national procedures, adjusted for the purposes of the Directive. They shall award their public contracts by applying the *open* or *restricted procedure*. Only in specific cases and circumstances, contracting authorities may apply a *competitive dialogue*, *a negotiated procedure* or *other procedures*. (Dreschler, 2009)

**Open Procedure**
Article 2.1 ARW 2005: The open procurement procedure ("openbare procedure" in Dutch) is a procurement that is made known generally/publicly, and in which all suppliers are allowed to tender. Before the award of the contract, the procurer can arrange an electronic sale by auction, if precise specifications for the task are established. (Dreschler, 2009)

**Restricted Procedure**
Article 3.1 ARW 2005: The restricted procurement procedure ("niet-openbare procedure" or "procedure met voorafgaande selectie" in Dutch) is a procurement that is made public and wherein all suppliers are allowed to request to be invited. From these requests, the procurer selects and invites the most suitable suppliers to tender. Only the selected suppliers are allowed to tender. The procurer can limit the number of suppliers that will be invited to tender. This number needs to be large enough to ensure effective competition and needs to be at least three (in the case of a national procedure) or five (in the case of a European procedure), provided there are enough suitable candidates. (Dreschler, 2009)

**The competitive dialogue**
In article 29, the Directive states that the competitive dialogue may be applied in the case of particularly complex contracts. Curiously enough, the article does not provide any guideline for establishing the complexity of contracts. It does state that the most economically advantageous tender award mechanism shall be the sole basis of awarding the contract for the competitive dialogue procedure. (Dreschler, 2009)

**The negotiated procedure**
Article 30 describes the cases justifying use of the negotiated procedure *with* prior publication of a contract notice, article 31 *without*. Cases justifying the use of the negotiated procedure are summarised as follows: · Specifications cannot be drawn up with sufficient precision to permit open/restricted procedures (Dreschler, 2009);
- Research and development projects;
- Overall pricing is not possible due to nature of works or risks;
- Failure of open/restricted procedures.

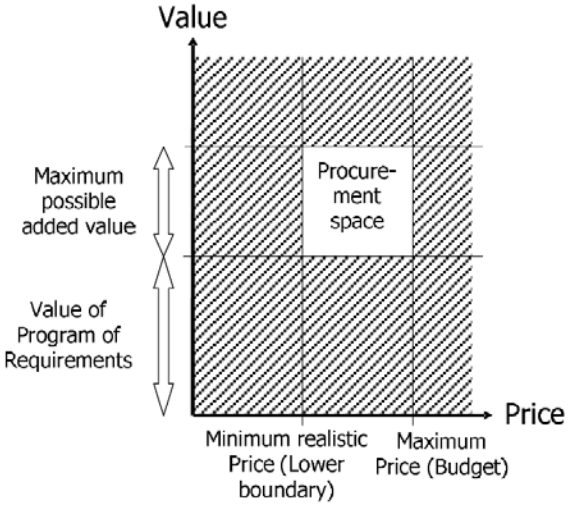
**Other procedures**
The Directive also distinguishes less mainstream procurement forms:
Article 32: Framework agreements;
Article 33: Dynamic purchasing systems;
Article 34: Public works contracts: particular rules on subsidised housing schemes;
Title III: Rules on public works concessions;
Title IV: Rules governing design contests.

The Dutch ARW also distinguishes the so-called “informal” procedure, which is not allowed for European projects. (Dreschler, 2009)

*A.1.4 Selection and award of contract*

For each form of collaboration the Employer/Client needs to find a partner. In principle this process consists of two sub-processes: selection, and the award of the contract. For all procedures, suppliers should first be checked on the *minimum standards*. Noncompliance to these standards will provide ground for exclusion. Besides checking on minimum standards, the restricted procedure, the competitive dialogue and negotiated procedures make use of *selection criteria* (to prove economic and financial standing of the suppliers) as well. The open procedure does not use selection criteria.

Article 44 states that requirements posed in the selection criteria must be related and proportionate to the subject matter of the contract. Furthermore they need to be “objective” (transparent), non-discriminatory and once they are published, they cannot be altered anymore.




There are several boundaries that put constraints on proposals that suppliers can make. The procurer has a certain budget and minimum requirements. To protect suppliers also a minimum price can be stated for which the project can be made. The amount of value added (on top of the minimum requirements) can also be limited. This results in the “procurement space” according to Dreschler (2009).

According to the Directive, procurers (Employer) have two possibilities for awarding contracts:

- Lowest price
- Economically Most Advantage Tender (EMAT, or MEAT or in Dutch: EMVI/EMVA). A special type of EMAT is the Design contest.

Besides price, which is the only criteria in ‘Lowest Price’, the EMAT also takes other criteria into account, for example, quality, technical merit, aesthetic and functional characteristics, environmental characteristics, running costs, cost-effectiveness, after-sales service and technical assistance, delivery date and delivery period or period of completion. It is possible to make some criteria fixed and other variable. When only the criteria ‘price’ is fixed and all other criteria are variable one speaks of a Design Contest.

This means the Employer (procurer) has three possible strategies for obtaining best value for money (Dreschler 2009):

| Award Strategy | Price | Value | Best Value for Money |
|---|---|---|---|
| Lowest Price | Variable | Fixed | Price minimization |
| Design Contest | Fixed | Variable | Value maximization |
| EMAT | Variable | Variable | Value Price optimisation |

*A.1.5 An example: the present procedure for a Design-Build, fixed price, contract*

De Ridder and Noppen (2009) give an example of a procedure for a Design-Build, fixed price, contract. The standard procedure for selection of tenderers consists roughly of the following steps:

1. Invitation to pre-qualify by means of e.g. advertising in relevant newspapers such as COBOUW;
2. Analysis of received pre-qualification data based on: company/joint-venture structure, experience, resources, financial position, general suitability etc. Normally ca. 6 tenderers (short list) will be selected for further application;
3. Submission of tender documents and receipt of tenders (formal offer). The selected contractors each tender on the basis of the Client’s project concept. This concept is worked out by the tenderer to such a level that he is able to offer a price including construction cost, site cost, general cost, profit and risk, and – if applicable – the capitalized maintenance cost.

4. Adjudication of all tenders. The client assesses the tenders in accordance with the evaluation criteria and raises further point requiring clarification, if any. He rejects non-conforming tenders and advises tenderers concerned. Because proposed design concepts are a fundamental part of the offer, both the assumptions and the anticipated performance shall be checked. Obviously the lowest price is still the most attractive, though not the only, governing criterion.
5. Declaration of intention. The assessment results in a ranking of tenderers in which the price-quality ratio of the various offers is the main criterion. The tenderer with the most favourable price-quality ratio receives a letter of intent for (planned) collaboration. This offers both parties the opportunity to settle any matters on which they disagree. Especially the required performance is an important issue.
6. Negotiation. By means of negotiation both parties have to come to an agreement. Main subject is of course an acceptable performance of the project concept. Another aspect is the cost-consequence in case of possible design variation.

Decision on contract award. After all items have been positively negotiated and tasks, responsibilities obligations, modes of payment, distribution of risks etc. have decided upon, the final offer can be accepted and the contract awarded.

### *A.1.6 Different forms of cooperation*

Figure 21 illustrates the building process according to CROW (2004), Bruggeman et al. (2008) and van Ree van Meel (2007). The figure shows who is responsible according different contracts forms for different phases. The CROW (2004) divides the contract forms in three different concepts:

- **Traditional cooperation concept** (Traditioneel samenwerkingsconcept)

This concept involves a contractual relationship with a separate responsibility for the design and implementation. These are defined in the 1989 UAV, RVOI and SR, where the client is responsible for the design and the contractor for the implementation. Contract forms: Regie (cost-plus contract), UAV/RAW (Traditional contract), Bouwteam (building team).

- **(Long) maintenance framework concept** ((Meerjaren)onderhoudsraamconcept)

In this cooperative venture there is a contractual relationship with a divided responsibility for design. The responsibility of the client for the design is limited to the principles and conditions laid down in a framework agreement. The contractor is responsible for the elaboration of these principles and conditions into concrete maintenance and the execution of the work. Contract form: Raamcontract (framework contract).

- **Integrated cooperation concept** (Geïntegreerd samenwerkingsconcept)

The integrated collaboration concept is based on a prior appointment. Responsibilities are distributed between client and contractor concerning the development of output specification to design of the structure. The contractor bears full responsibility for further realization. Contract forms Design & Construct, Turnkey. The point where responsibility for the project changes from client to contractor changes per contract form.

Also other forms of contracts are mentioned by Bruggeman et al. (2008). The Purchase/construction; a project developer buys land, develops property and sells it to a client (only domestic/office buildings). The DBFMO forms; the contractor becomes responsible for the phases Design, Build, Maintain and/or Finance and Operate. And the Alliance; contractor and client form an alliance and divide the profits together.

The figure shows that, in almost all contract forms, the client is responsible for the initial and program phase and partly the design phase. As noticed earlier, these three phases are most important considering sustainable purchasing.

The initial focus of the research will be the Design and Construct form of collaboration. The details of this form are described in section 3.1.

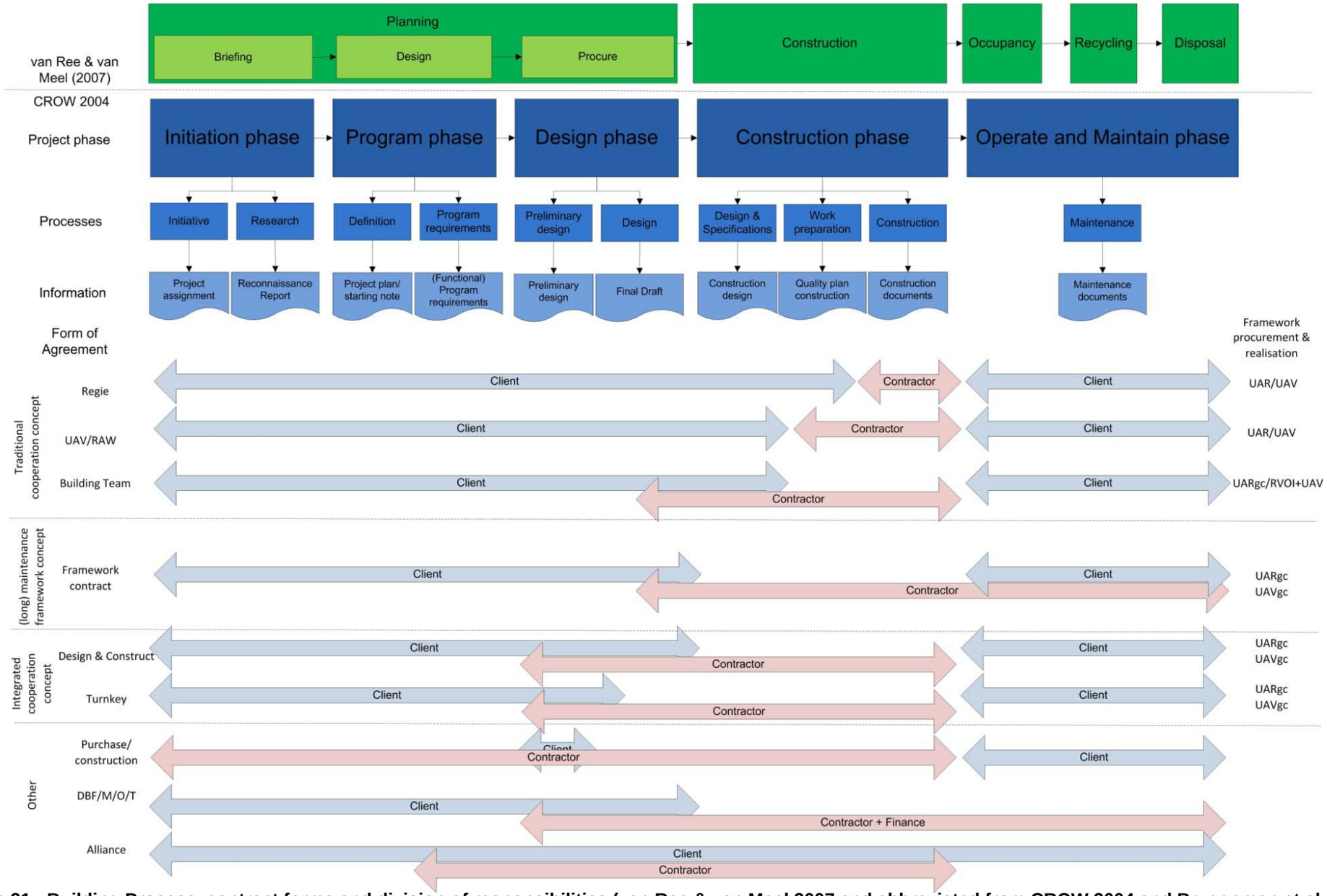



**Figure 21 : Building Process, contract forms and division of responsibilities (van Ree & van Meel 2007 and abbreviated from CROW 2004 and Bruggeman et al. 2008)**

## A.2 Methodologies study

### *A.2.1 Selecting a methodology to improve the process of sustainability and innovation*

To be able to select a methodology criteria have to be stated to score and compare. So far the thesis showed that to improve the process of sustainable development with a focus on the initial phases the following three criteria-aspects can be conducted:

- Life cycle integration (figure 7, section 2.2)
- Strong focus on innovation (sections 1.1 and 2.3);
- Focus on function optimization (figure 10, section 2.3);
- Applicable in initial phase (figure 12, section 3.1).

One other aspect should also be considered

- Current use/ knowledge in industry.

*Current use/ knowledge in industry* is stated as a criterion to see if there is already a connection to the level of knowledge in the industry. If a methodology is unknown so far, implementation of it can be less easy.

**Four methodologies**

*Systems Engineering*

Grontmij B.V. is doing several pilot projects using the theory of Systems Engineering (SE). The Stena Line project is one of these pilot projects. Therefore it makes sense to fit the possible design method into the theory of Systems Engineering. The theory of SE is shortly as follows:

Clients are increasingly focused on specifying the problem and buying products and services instead of dealing with designing solutions to these problems. Contractors are dealing more and more with the overall responsibility for the design and construction and come up with innovative ideas. Among others, this renewal calls for transparency and focus on clients. The principles, methods and techniques of Systems Engineering contribute to this perfectly (Leidraad SE, 2009).

According In ‘t Veld (2002) a system is, within a defined objective, a collection of interrelated distinct elements. A system is always a part of a larger whole. How the system is seen and defined depends on the interests and responsibilities of the viewer. This system is called the “System of Interest”. The larger whole is the System of Systems in which several “Systems of Interest” are located.
To give an example, a railway station is a system of interest and is part of a bigger mobility system. The railway station system is part of the rail transport system (which also includes the train system, energy system and traffic control system). The transport system is part of the mobility system which also includes air, water and road transport. Within the railway station system there are also smaller systems like catering systems and ticket booth systems. (Leidraad SE, 2009)

Starting a project within the Civil Engineering sector an analysis of opportunities and threats related to the client’s needs is made. The point of view of the client is the System of Interest. The client’s needs are the input for SE and defines the solution space. This solution space can be physical limitations, standards and directives and available time and budget. The client needs are process input and is managed within the System Engineering Process.

The definition of Systems Engineering Management used by the Department of Defence of the US in their book “Systems Engineering Fundamentals” (DoD, 2001) is*:*

> *“Systems engineering is an interdisciplinary engineering management process that evolves and verifies an integrated, life-cycle balanced set of system solutions that satisfy customer needs.”*

As illustrated by Figure 22, systems engineering management is accomplished by integrating three major activities:

- Development phasing that controls the design process and provides baselines that coordinate design efforts,

- A systems engineering process that provides a structure for solving design problems and tracking requirements flow through the design effort, and
- Life cycle integration that involves customers in the design process and ensures that the system developed is viable throughout its life.

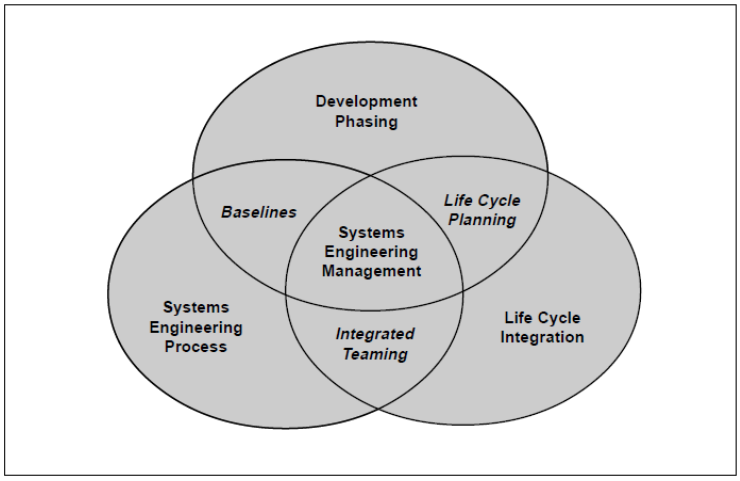



**Figure 22 Three Activities of Systems Engineering Management (DoD, 2001)**

The systems engineering process is a top-down comprehensive, iterative and recursive problem solving process, applied sequentially through all stages of development, that is used to:

- Transform needs and requirements into a set of system product and process descriptions (adding value and more detail with each level of development),
- Generate information for decision makers, and
- Provide input for the next level of development.

As illustrated by Figure 23, the fundamental systems engineering activities are Requirements Analysis, Functional Analysis and Allocation, and Design Synthesis—all balanced by techniques and tools collectively called System Analysis and Control. Systems engineering controls are used to track decisions and requirements, maintain technical baselines, manage interfaces, manage risks, track cost and schedule, track technical performance, verify requirements are met, and review/audit the progress. (DoD, 2001)

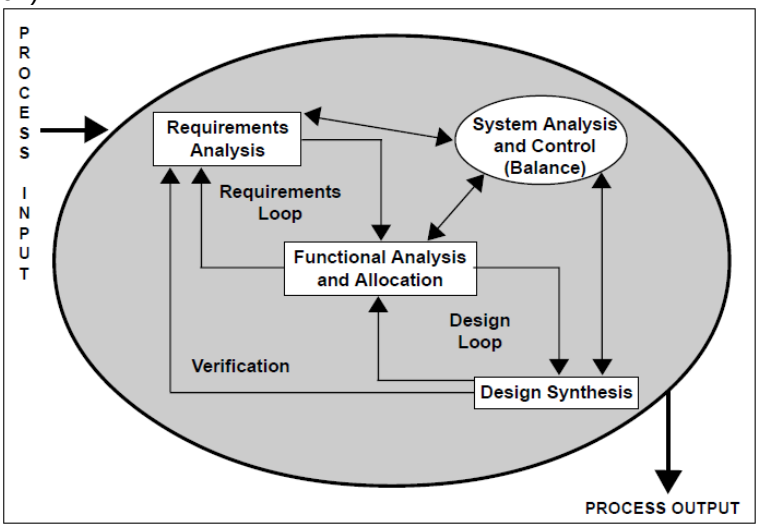



**Figure 23 Systems Engineering Process (DoD 2001)**

The systems engineering process is an iterative process and repeated several times during the life cycle. Figure 23 illustrates the development of a project. During the concept phase the input from the client will be processed to output specifications. These specifications are input for the development phase. The need of the client will become more specific resulting in several functional needs which will be input for following phases. The V-model shows the development and realization and the locations

(green oval forms) where SE process takes place. This V-model will be repeated when renewal of the object is needed. Similar steps will be taken to satisfy new client needs.

In figure 24 the purple dotted line illustrates the coupling point in a D&C contract. First the client will be responsible for a part of the development; he will define his needs (sometimes assisted by a consultancy agency). Then the client will transfer the responsibility of the final realization to the contractor. The contractor will be responsible for further development of the design and construction of the object. After completion of most part of the realization the contractor will transfer the responsibilities back to the client.

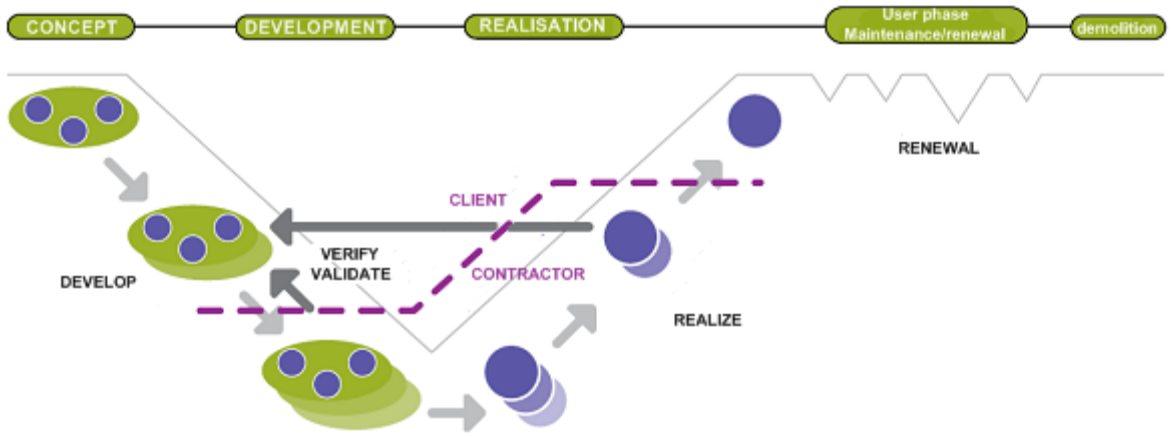



**Figure 24 Coupling point and V-Model of development and realization (Leidraad SE, 2009)**

Within the concept phase the requirements of the customer are analyzed. These requirements are the input for the rest of the process.
According DoD (2001) requirements analysis involves defining customer needs and objectives in the context of planned customer use, environments, and identified system characteristics to determine requirements for system functions. Prior analyses are reviewed and updated, refining mission and environment definitions to support system definition. Requirements analysis is conducted iteratively with functional analysis to optimize performance requirements for identified functions, and to verify that synthesized solutions can satisfy customer requirements. The purpose of Requirements Analysis is to:

- Refine customer objectives and requirements;
- Define initial performance objectives and refine them into requirements;
- Identify and define constraints that limit solutions; and
- Define functional and performance requirements based on customer provided measures of effectiveness.

In general, Requirements Analysis should result in a clear understanding of:

- Functions: What the system has to do,
- Performance: How well the functions have to be performed,
- Interfaces: Environment in which the system will perform, and
- Other requirements and constraints.

Systems Engineering is a more general process describing how clients needs eventually result in an output. Concerning (figure 6, section 2.2) of van Ree and van Meel (2007), SE will deal with the *sustainability challenge*.

*Value Methodologies*
In a short historical introduction in the article by Male et al. (2007) the broader use of the term Value Methodology is explained. The SAVE International (Society for the Advancement of Value Engineering) standard uses the term *value methodology*, highlighting that it includes the processes known as value analysis, value engineering, value management (VM), value control, value improvement and value assurance. VM with its origins in North American manufacturing has gone though a developmental process internationally with local contextualization in many countries. From a European context VM is seen as a style of management. Its goal is to reconcile differences in view

between stakeholders, and, internal and external customers as to what constitutes value. It does this through a structured, systematic, analytical functioned-oriented and managed process involving a representative, multidisciplinary team brought together in a participatory workshop situation. As a management style it has a wide application and can be applied to products, services, projects, programs of projects and administrative procedures.
The North American approach for manufacturing (Value Engineering, VE) and the European approach as a management style (Value Management, VM) are shortly reviewed as potential methodologies.

**Value Engineering**
According to Dell'Isola (1997) Value Engineering (VE) is a methodology that is known and accepted in the industrial sector. It is an organized process improving value and quality. The VE process identifies opportunities to remove unnecessary costs while assuring that quality, reliability, performance, and other critical factors will meet or exceed the customer's expectations. VE is a rigorous, systematic effort to improve the value and optimize the life cycle cost of a facility. VE generates these cost improvements without sacrificing needed performance levels.

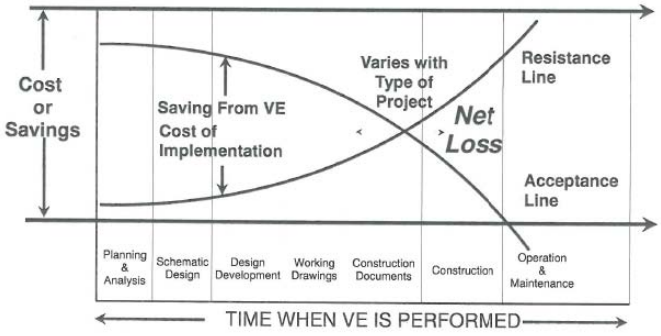



**Figure 25 Potential Savings from VE Applications (Dell'Isola, 1997)**

VE should be performed as early as possible – before commitment of funds, approval of systems, services or designs – to maximize results. Figure 25 illustrates the potential for savings.
VE is effective in many areas of the construction industry, and it can be utilized at different stages in the life of a building project. Applied with flexibility and creativity, VE is almost unlimited in its ability to indicate areas of potential savings that were not readily apparent.
Mao et al. (2009) state the creativity phase of VE relies to a great degree on a brainstorming process. A substantial amount of the time and effort of the VE team is spent on free thinking in order to create as many ideas as possible. However, most of these ideas will eventually be proven useless as they are irrelevant to the problems of the project. This, in a sense, indicates a kind of waste and inefficiency in the VE exercise. Also see Appendices A.2 and A.3 for more information on Value Engineering.

**Value Management**
According to Green (1994) Value Management (VM) is a structured process of dialogue and debate among a team of designers and decision makers during an intense short-term conference. The primary objective of value management is to develop a common understanding of the design problem, identify explicitly the design objectives, and synthesize a group consensus about the comparative merits of alternative courses of action. Value management makes no pretence about finding optimal answers; it is solely concerned with establishing a common decision framework around which participants can think and communicate.
He argues *"that traditional value engineering is only applicable to design problems which are well structured and easily defined. The approach is distinguished by the assumption that 'function' is an objective characteristic which remains constant over time. It is further assumed that all solutions offer the same level of performance, and that 'good value' is achieved by selecting the solution with the lowest lifecycle cost (...) Unfortunately, it is soft problems of this nature which invariably dominate during the early stages of building design. This is especially true for projects which are commissioned by multifaceted clients, where the requirements of several diverse interest groups need to be satisfied. In these circumstances, it becomes necessary to adopt a flexible version of value engineering which reflects the learning paradigm of soft systems thinking; such an approach has been defined as value management. (...) Value management is based on a way of thinking which is fundamentally different from that for value engineering. Of primary concern is the need to improve communication and establish a common perception of what is required."*

Male et al. (2007) state value management provides a structured, challenging, analytical and mediated process that permits value systems to merges to the benefit of the client. By bringing the right team together at the right time, value management focuses on value system evolution and resolution. Figure 26 below presents the value management process, including some important activities that take place during each of the phases.

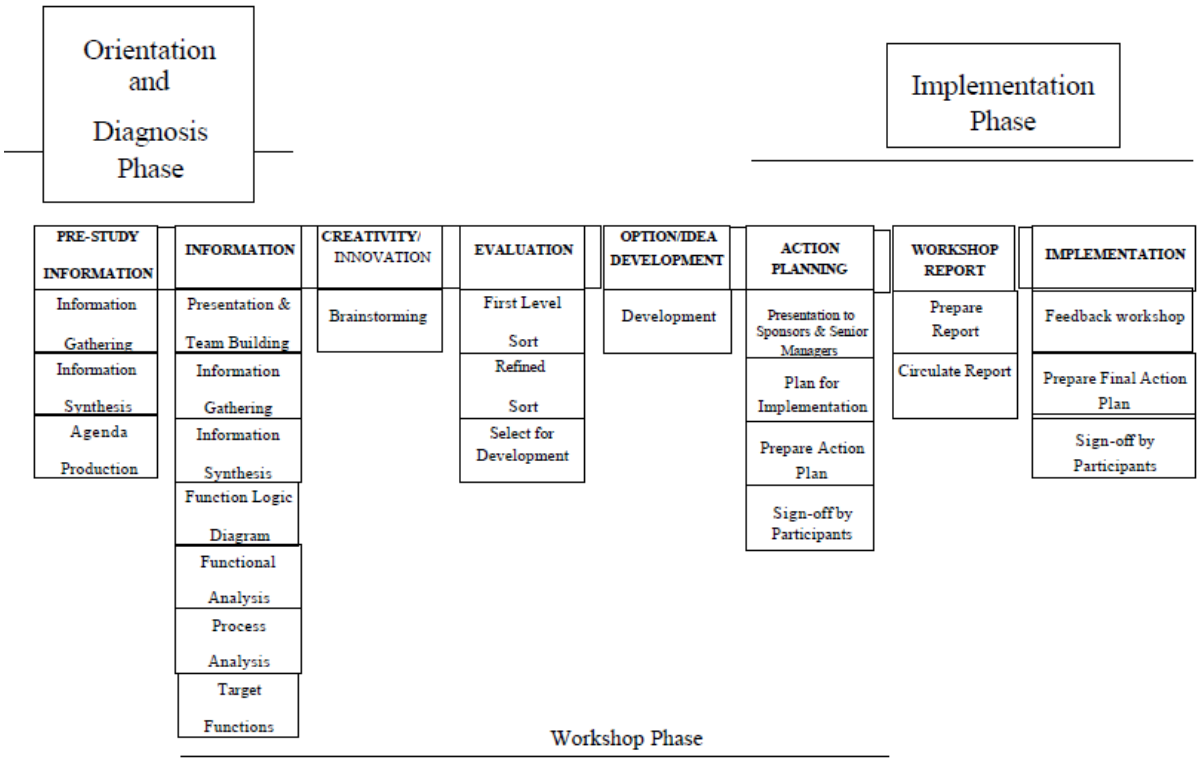



**Figure 26: The Value Management Process (Male, Kelly, Gronqvist and Graham, 2007)**

*TRIZ and xTRIZ*

TRIZ (pronounced TREEZ) is the Russian acronym for *Teoria Reshenia Izobretatelskih Zadatch*, the Theory of Solving Inventive Problems. This proven algorithmic approach to solving technical problems began in 1946 when the Russian engineer and scientist Genrikh Altshuller studied thousands of patents and noticed certain patterns. From these patterns he discovered that the evolution of a technical system is not a random process, but is governed by certain objective laws. These laws can be used to consciously develop a system along its path of technical evolution - by determining and implementing innovations. (www.TRIZ.org)

Abdalla et al. (2005) describe TRIZ as one of the more sustainable methodologies: TRIZ focuses on the use of “existing” resources and elimination of contradictions. This concept is at the core of sustainability and can be further strengthened by reducing the amounts of used resources and avoiding the introduction of new resources as much as possible. In TRIZ, the solution ideas are generated, usually, by identifying the Ideal Final Result (IFR).

In case we want to achieve a positive effect, IFR can be stated as “A function of a system is delivered while there is no system to deliver the function” (Souchkov, 2010). The evaluation of solution ideas in TRIZ is conducted by seeing whether the new solution gets the system closer towards ideality or the IFR (Abdalla et. al., 2005).

TRIZ is complex. It contains many techniques and knowledge bases. Learning full TRIZ takes considerable time. Currently TRIZ is available as a number of independent modules that can be learned and used independently (Souchkov, 2010).

From 1946 till now TRIZ has been evolving. Nowadays a lot of TRIZ tools trying to optimize the innovation process. This process can be divided into three phases: Ideation (initiative), Design and Implementation. TRIZ focuses on the Ideation phase, the front end of innovation. This ‘Fuzzy front-end’ is very poorly supported by scientific and systematic methods. The combination of techniques and data-bases used in this methodology fills the gap (Souchkov, 2010).

xTRIZ or Systematic Innovation developed by Souchkov (ICG T&C 2010) evolves classical TRIZ further by adding techniques and organizes processes of innovation.


**Figure 27: Generic TRIZ Process (Souchkov, 2010)**

*Scoring methodologies*

The sections started with stating five criteria to score the methodologies on applicability to improve sustainable development and innovation in the initial phases of the building process. Table 6 shows the results:

| | SE | VE | VM | TRIZ (xTRIZ) |
|---|---|---|---|---|
| Strong focus on innovation | o | o | o | ++ |
| Focus on function optimization | + | ++ | + | ++ |
| Applicable in initial phase | ++ | - | ++ | ++ |
| Current use/ knowledge in industry* | + | o | o | o |
| Life cycle integration | + | + | + | + |

**Table 6: Scoring methodologies. *the Guideline SE (Leidraad SE, 2009) and question 12 of the interviews (Appendix B) are used to score this criterion.**

### *A.2.2 Other methodologies*

Three other methodologies were also considered in the initial stage of this thesis, the research proposal. These methodologies did not focus on all phases of the lifecycle as can be concluded in the end.

#### *Concurrent Design*

Concurrent engineering (CE) is a production management philosophy that has received much attention in manufacturing, and to a lesser extent construction, over the past several decades. In order to achieve desired time-saving goals, concurrent engineering advocates concurrent, overlapped processes instead of sequential product and process design (Bogus et. al., 2005 referring Prasad, 1996). According Anumba et al. (1996) The D&C procurement method is similar in many respects to manufacturing sector processes. The solution-neutral specification will state the client requirements in terms of desired design attributes and will form the basis of tenders for the design and construction of the proposed facility.

Comparing the CE-method with the VE-method, CE emphasizes on efficiency during the construction phase. The Concurrent Design development takes place after the contractor is awarded the assignment, according van Ree and van Meel (2007) (see figure 6, section 2.2) this will deal with the *environmental challenge*, but will not deal with the sustainability challenge.

#### *Constructability*

Constructability has been defined as the optimum use of construction knowledge and experience in planning, design, procurement, and field operations to achieve overall project objectives. (Radtke 1993)

Radtke (1993) explains the process of constructability and the steps that should be taken during traditional building process:

*"Figure 28 presents the ideal relationship of the model process and phases in the facility delivery process (FDP). As shown, obtaining constructability capabilities and planning constructability milestones occur early in the FDP. As a practical matter, the earlier the first two milestones are completed, the sooner the third milestone **(implement constructability)** can occur. Milestones "Obtain Constructability Capabilities" and "Plan Constructability Program" can occur earlier than*

*shown in Fig. 18. With regard to "Event" 2 in Fig. 18, once the contracting strategy is selected, the source(s) of constructability can be determined: (1) Contract with constructor or construction manager; (2) in-house constructability knowledge; or (3) use constructability consultant. The "Pre-Detailed Design" in Fig. 184 includes: (1) Process design; (2) preliminary engineering; (3) conceptual design; (4) preschematic design; (5) schematic design; and (6) design development sub phases. The detailed design phase refers to actual design and development of construction plans and specifications.*

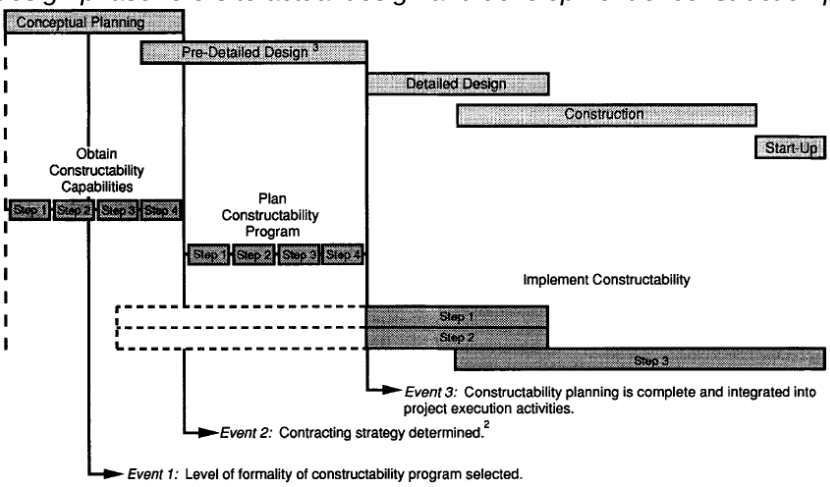



**Figure 28 Ideal Relationship of Milestones and Steps to Facility-Delivery Process (Radtke, 1993)**

*Three major events that influence constructability implementation are: (1) Determining the level of formality for the constructability program (milestone 1, step 2, activity 4); (2) selecting the project-contracting strategy (milestone 1, step 3); and (3) completing constructability planning (milestone 2). Once the project-contracting strategy is selected, the source(s) of constructability input can be determined. These sources include: (1) The constructor or construction manager; (2) in-house owner constructability knowledge; or (3) a constructability consultant. Step 3 (document lessons learned) in the implement constructability milestone is related to the corporate constructability program."*

According Arditi et al. (2002) the primary objective of VE is to reduce the total life-cycle cost of a facility; whereas, constructability focuses on the optimization of the construction process. VE is normally performed during the design phase of the delivery process. Constructability can be performed before VE, providing information so that VE may be more effective. VE and constructability can complement each other in achieving their goals.

Considering van Ree and van Meel (2007), constructability is performed as early as possible and it would therefore have opportunities to deal with the *sustainability challenge*, but according Arditi et al. it optimizes the construction process and does not consider the life cycle in the first place. Next to that, this theory is based on the traditional building process, whereas this research will be focused on the D&C process. Within this process it is assumed that the contractor will optimize design and construction because of the responsibilities the contractor has and the profit he wants to make.

*Integrated Logistics Support*

El Haram and Horner (2003) apply the principles of ILS to the development of cost effective maintenance strategies. A number of techniques have been developed and used in the defence, aviation and oil industries to select cost effective maintenance strategies. They include failure modes and effects analysis (FMEA), reliability centred maintenance (RCM), level of repair analysis (LORA), availability, reliability and maintainability analysis (ARM) and whole life costing (WLC) (El Haram and Horner refer to Blanchard, 1992). These techniques, collectively known as integrated logistics support (ILS), have the ability to influence project design characteristics and to provide a project at an affordable cost throughout its life cycle. It is an engineering and management tool that helps to ensure that the customer or the user will receive a project that will not only meet performance requirements such as durability, reliability, maintainability, quality and availability, but one that can be expeditiously and economically supported throughout its life cycle. The ultimate objectives of ILS are as:

- influence project design from the operation, maintenance and support point view;
- integrate the ILS elements;
- identify, develop and schedule the necessary support resources;
- achieve high operational availability levels at lowest life cycle cost;
- determine ILS elements and perform trade-offs amongst them;
- perform design trade-offs to optimize operation, maintenance, support and economic issues;
- measure the impact of alternative design solutions on life cycle costs.

This study focused on existing building stock, Integrated Logistics Support, in particular FMEA and RCM, provided a robust framework for identifying the most cost-effective and appropriate maintenance strategy for existing building stock. It allows rational choices to be made between Condition-Based Maintenance, Time- Based Maintenance, Reactive Maintenance, Re-design, and Failure Finding tasks.
The elements are already there and can be defined according to their characteristics. FMEA and RCM can be used in the briefing phase, but it will focus on a higher level (details are not yet designed). Mapping the failure modes and effects or centre maintenance and reliability during the briefing phase focusing on specific sustainable elements such as use of energy and material or production of waste should result in a more sustainable design.

ILS focuses on the operate and maintenance phase and can be started in every phase prior to the O&M phase. Due to level of detail the ILS will be on a sliding scale of effectiveness being less effective when applied in the very early stages of the building process, and more effective when details are forming. This contradicts the idea of freedom in design possibilities during the procurement of Design & Construct, were the Client should try to specify functions instead of a detailed design.

## A.3 Process and Procedures of xTRIZ

TRIZ can be used for problem solving and create what's next. A short summary of the procedures RCA+, Function Analysis and 40 Inventive Principles is stated below. It is strongly advised to follow an official course to fully understand using the procedures, for example a course of Valeri Souckov (Souchkov, 2010; www.xTRIZ.com). As figure 29 shows, it is only a part of the methodology.

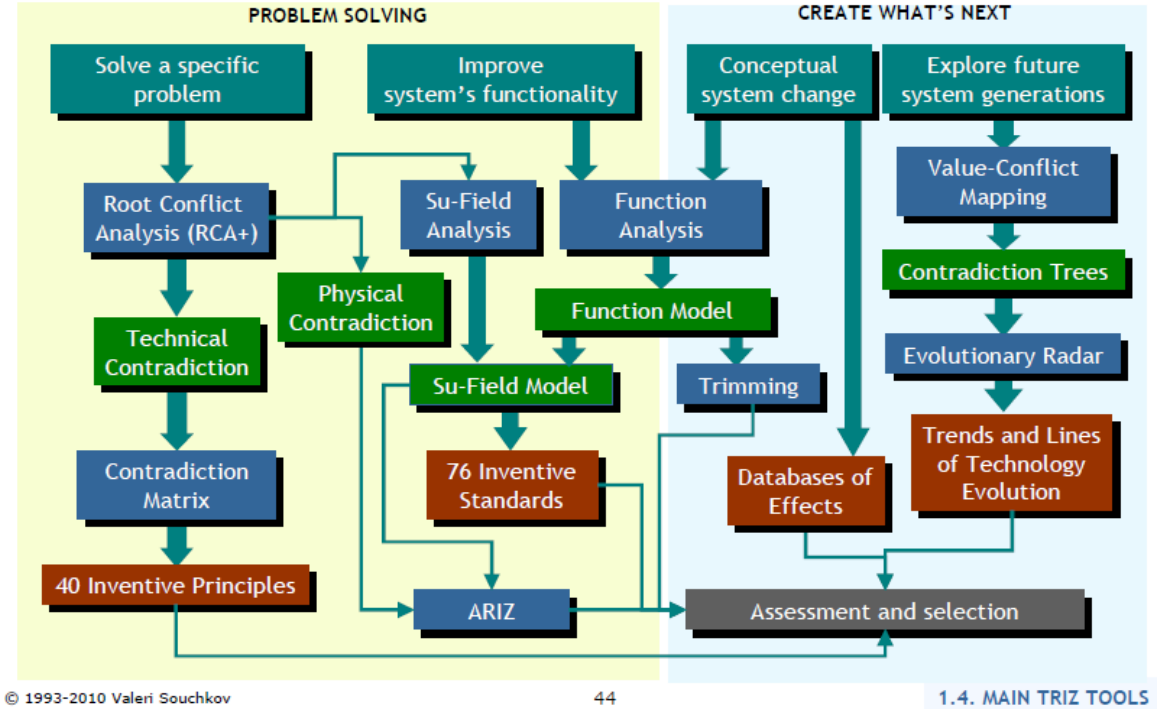



**Figure 29: Main TRIZ Tools (Souchkov, 2010)**

### *A.3.1 Procedure of RCA+*

Step 1: State the general negative effect of concern and start drawing the RCA+ diagram in a top-down manner.
Step 2: Ask the question "What causes this effect to occur?" to find all the causes of the negative effect.
Step 3: Check if the cause is the *only condition* which is enough to produce the negative effect.
Step 4: Ask for each cause if it also produces a positive effect.
Step 5: For each negative effect already present start again at step 2 and 3.
Step 6: Create a table of the revealed causes: Cause; Type of Cause; Positive effect and Negative effect.
Step 7: Select your problem
Step 8: Use TRIZ techniques to solve problem.

### *A.3.2 Procedure of FA*

Step 1: Define a component model of your system
Step 2: Complete a matrix of functional interactions (functions)
Step 3: Represent the results graphically.
Step 4: Compile a list of problems.
Step 5: Rank the list of problems with comparative ranking.
Step 6: Proceed to problem solving.

### *A.3.3 40 inventive principles*

Step 1: Select from RCA+ a technical contradiction you want to solve.
Step 2: Find in the Altshuller's Matrix (www.TRIZ40.com) a parameter that is closest to the negative and positive effect.
Step 3: Write down the principles from step 2.
Step 4: Repeat step 2 and 3 if there are more possible parameters.

Step 5: If from step 4 principles are the same from different results, use these principles first. Generate ideas based on the principles
Step 6: Write down ideas, first per principle it is also possible to combine principles.
Step 7: Select the best idea candidate from the list of ideas. Proceed to verification of the idea.

### *A.3.4 Enhancing Value Engineering Process by Incorporating Inventive Problem-Solving Techniques*

Mao et al. (2009) propose a modified VE session with TRIZ. To improve efficiency and effectiveness, the workshop session of VE is significantly modified by incorporating TRIZ tools and techniques, whereas the pre-workshop and post-workshop remain the same as in a conventional VE process. The modified workshop session consists of five phases: initial design, function trimming, interaction analysis, creativity and idealization, and evaluation. For detailed procedures of the modified workshop session please refer to figure 29. A lot of comparison can be found between figure 29 and 30.

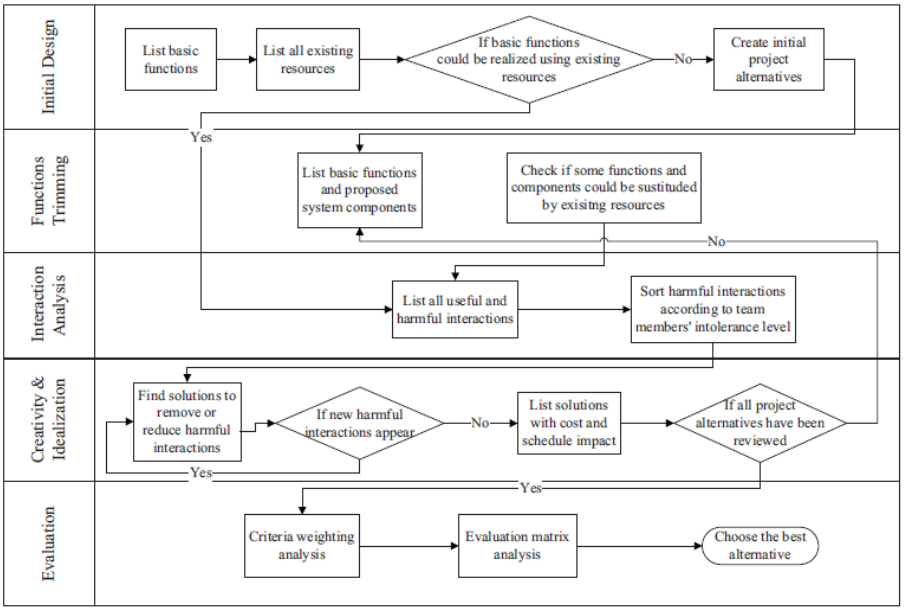



**Figure 30: Procedures of the modified VE workshop session (Mao et al., 2009)**

# B Interview reports

The interviews were all conducted in Dutch. Therefore the interview guideline is also in Dutch. Emans; taking interviews: theory, technique and training (2002) has been used as a bases for setting up this guideline and as a guideline for conducting interviews. Every interview starts with a small summary of the interview in English. Not all questions have been asked during every interview. This guideline contains all questions. The interview with Gerwin Schweitzer from RWS has been altered slightly to ask specific questions on DuboCalc.

---

Interviewleidraad

Met: (type naam van geïnterviewde)
Locatie: (naam instantie, naam stad)
Datum: (tijd, dag, jaar)

Aanwijzingen voor de interviewer

1) neem recorder mee, aantekeningenblok, pen, achtergrond info, output format
2) Controleren of de geluidsapparatuur werkt
3) Respondentienummer, datum en tijdstip noteren
4) Begin met jezelf voor te stellen
5) Geef een introductie van het interview (zie introductie)
6) Start daarna de geluidsopname en begin met het stellen van de vragen
    - Pas op dat je niet gaat sturen, geen mening laat doorschemeren en geen voorbeelden geeft
    - Geen vragen overslaan
    - Antwoorden ook in steekwoorden noteren
    - Samenvatten en doorvragen

Introductie (5 min)
Om te beginnen wil ik nog even het **doel van dit interview** uiteenzetten. Voor advies- en ingenieursbureau **Grontmij** in de Bilt, bij de afdeling waterbouw/ team projects/ expertgroep **inkoop- en contractmanagement** doe ik onderzoek naar **duurzaam inkopen in de GWW**. Uit het onderzoek moet naar voren komen hoe in het gehele proces van **Vraagspecificatie tot afronding van het contract**, binnen **D&C en UAVgc**, de **opdrachtnemer geprikkeld** kan worden duurzaamheid voor de laatste twee fases van het object (beheer- en onderhoud- en sloopfase) meegenomen kan worden. Binnen dit proces zijn er mijns inziens **verschillende elementen** die invloed hebben op een **duurzamer resultaat**. De **opdrachtgever** zal door zijn vraagspecificatie of selectie en gunningscriteria duurzaamheid kunnen uitvragen. De **opdrachtnemer** moet geprikkeld worden om in te gaan op deze vraag, hij zou zich kunnen onderscheiden op de markt of er zou een vorm van beloning moeten worden ingesteld voor het bereiken van duurzamere oplossingen. Tot slot is de **context** mijn onderzoek zich puur op het D&C bouwmodel, binnen een UAVgc contractvorm.
Met de resultaten van dit onderzoek wil Grontmij een **klant kunnen begeleiden** in zijn wens om een **duurzaam object te realiseren**, binnen dit gestelde kader.

Het interview zal naar verwachting **een uur** in beslag nemen. In dit interview zal ik u vragen stellen over **uw ervaring als rol van adviseur** binnen dit proces. Het is voor mij erg belangrijk om te weten hoe u als adviseur **de waarde van duurzaamheid bepaalt**. Wat voor **afwegingen** u maakt binnen het **opstellen** van de **vraagspecificatie** en eventuele **gunningscriteria**.
Heeft u er bezwaar tegen als ik u **bij naam noem** in mijn verslag, **of** wilt u liever dat ik het interview **anoniem** verwerk? Alles wat u bedenkt kan waardevol zijn, ik zal daarom als u daar geen bezwaar tegen hebt een **geluidsopname** van het interview maken, **zodat niets van wat u zegt verloren gaat**. Nadat ik het interview uitgewerkt heb zal ik het u **toesturen** zodat u er nog **commentaar** op kunt geven.

Heeft u **nog vragen** voordat we beginnen?

*> Schakel nu de geluidsopname in!(Naam geïnterviewde noemen!)*

Allereerst zou ik u willen vragen om u **voor te stellen**. (5 min)

1) Wat is uw functie?
2) Wat is uw expertise?
3) Met welke delen van de bouwcyclus heeft u te maken?
4) Heeft u ervaring met D&C projecten binnen UAVgc?

Dan zou ik graag willen weten wat **uw beeld is** ten aanzien van **Duurzaam Inkopen**. (10 min)

5) Wordt er binnen *uw organisatie/ door uzelf* een bepaalde definitie gehanteerd voor het begrip duurzaamheid in de bouw?
6) Heeft *uw organisatie /uw klanten* doelstellingen ten aanzien van Duurzaam inkopen?
7) Zo ja, Hoe worden deze doelstellingen meegenomen in het aanbestedingsproces?

(Ik zie het begrip duurzaamheid binnen mijn onderzoek als een vorm van product- of procesinnovatie die het gebruik van materiaal/energie/water minimaliseert en de flexibiliteit maximaliseert tijdens de beheer en onderhoudsfase en de hoeveelheid afval minimaliseert tijdens de sloopfase.)

Dan gaan we door naar de zaken waarmee de **opdrachtgever** een belangrijke rol speelt. De **Vraagspecificatie** en de **Selectie en Gunningcriteria**. (20min)

Met het oog op duurzaamheid kan er een afweging gemaakt worden of de beoogde **duurzaamheidaspecten** onder de minimum eisen of onder de selectie/gunningcriteria moeten vallen.

8) Hoe heeft u bepaalt of een eis binnen de VS(minimum eisen) danwel binnen de selectie/gunningscriteria werd opgenomen?
9) Ziet u beperkingen in het opstellen van minimumeisen mbt duurzaamheid?
10) Zo ja, hoe komt dat?
11) Heeft u ervaring met het toepassen van EMVI?
    a. Kunt u een voorbeeld geven van een project waar u dit hebt toegepast?
    b. Welke criteria werden hierin opgenomen?

Een methode die toegepast kan worden om te bepalen hoe en welke aspecten in een VS of EMVI terugkomen is **Value Management**. Een belangrijk punt hierin is om de **waarde te bepalen** van duurzaamheid, zoals we net besproken hebben.

12) Wordt deze methode gebruikt binnen *uw Advieswerk*? Hoe wordt het toegepast? Voorbeelden?

Binnen een VS of een EMVI worden de eisen al dan niet direct **omgezet in een waarde.**

13) Gebruikt u een methode om de waarde die in EMVI vertegenwoordigd wordt te bepalen?
    a. Welke dan? Of hoe ziet die er uit? Praktijkvoorbeelden?
14) Wat ziet u als waarde in duurzame criteria voor de beheer-, onderhoud- en sloopfase?
15) Hoe zou u die waarde willen laten vertegenwoordigen in het aanbestedingsproces?
16) Zou u gezien de vele aspecten die vanuit OG gestuurd kunnen worden binnen een EMVI, het criterium voor duurzaamheid in de O&M fase mee willen nemen in de EMVI?

Een ander aspect wat binnen VM van belang is is om na de conceptfase (voor de haalbaarheidsstudie) **alle belangrijke stakeholders** bij elkaar te brengen, actoren die beslissingen kunnen maken. (15 min)

17) Zou u als opdrachtgever samen met opdrachtnemer en onderaannemers in een vroeg stadium willen werken aan alternatieven?
    a. Hoe zou u dat willen vormgeven?
18) Welke nadelen ziet u met een dergelijke vroege samenwerking?
19) Welke voordelen ziet u met een dergelijke vroege samenwerking?

In mijn ogen is duurzaamheid een **vorm van innovatie**, danwel het proces danwel het toepassen van producten die niet eerder zijn toegepast om bepaalde duurzame aspecten te stimuleren. Met deze insteek zijn er volgens de literatuur enkele zaken die vanuit de OG gestuurd kunnen worden om innovatie de ruimte te geven:

a. Vroege transfer van OG naar ON
b. Veel Communicatie
c. De OG moet meer risico durven nemen en garanties te geven voor innovatie delen van het contract
d. Er moet voldoende tijd zijn voor de tenderfase
e. Er moeten zo min mogelijk limieten zijn voor de ON, in keuze van methodes en dergelijk

20) Kunt u kort per punt aangeven wat uw mening is over de toepassingsmogelijkheid van deze punten als OG?

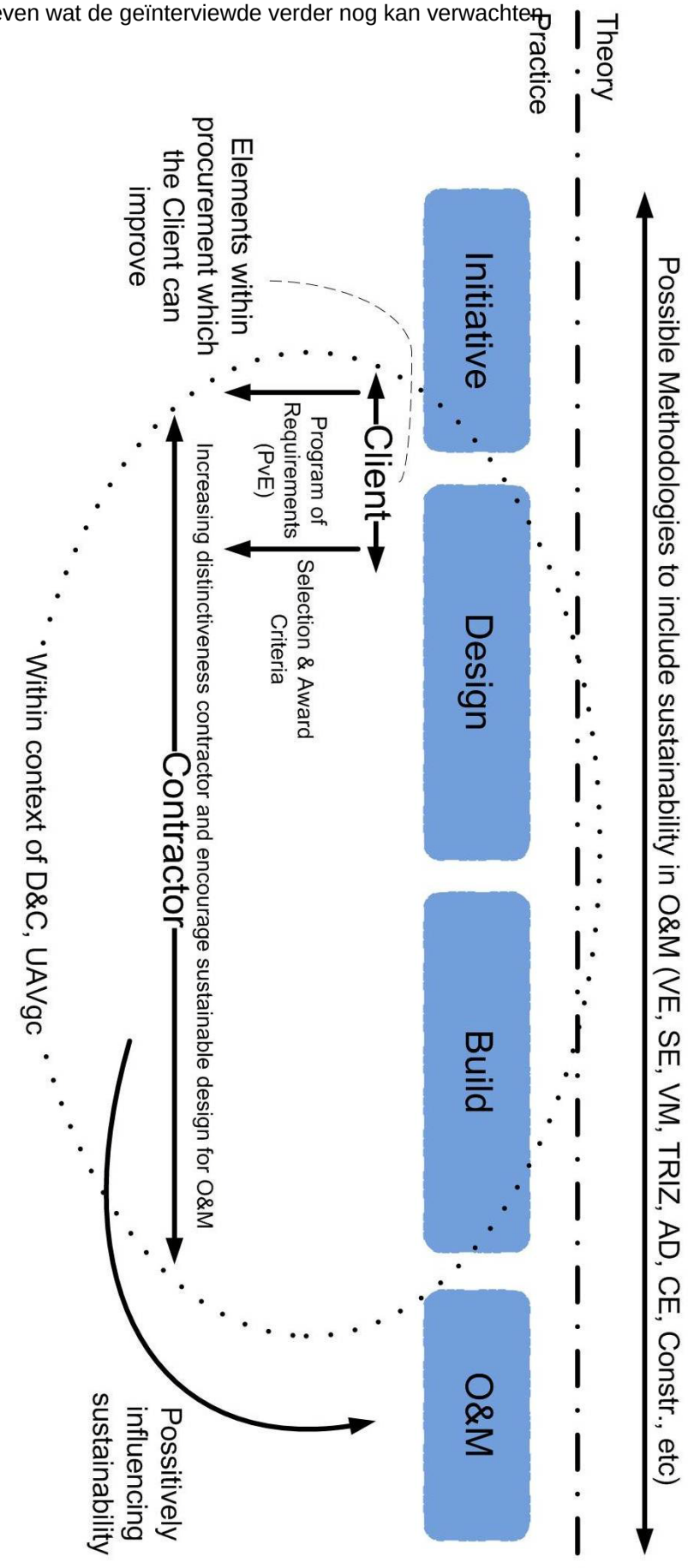
Voor een **ON lijkt er weinig motivatie** te zijn om met innovatieve ideeën te komen voor de OG. Impliciet hebben we het hier al over gehad. In de UAVgc en de regelgeving rondom aanbesteding zal het lastig zijn om nieuwe ideeën in te brengen, **door de beginselen van transparantie** zal informatie van ON snel uit kunnen lekken. **Level of playing field** en **cherry picking** zijn gevaren die op de loer liggen.

21) Bent u van mening deze ontwikkelingen een negatieve invloed hebben op innovatie in de bouw?
    a. Waarom?

Afsluiting (5 min)

- Nog een open vraag: nog iets te melden?
- Bedanken (geven doosje merci)
- Memoreren waarvoor het gediend heeft en

- Aangeven wat de geïnterviewde verder nog kan verwachten



### *B.1.1 Interview with Mr. Krombos, province of Overijssel*

Summary of interview
Name: mr. Krombos
Function: Contract advisor at the Province of Overijssel
Since 2000 mr. Krombos has been working with D&C and UAVgc contracts.

**Sustainability**
The province is using the definition of 'sustainability' from AgentschapNL. The criteria stated by AgentschapNL are used to score offers from different tenders. We do not ask for any extra criteria. Other policy objectives may be leading. For example sometimes we are asking for improvement on 'availability' and 'safety', not specifically sustainability. Indirectly, sustainability is taken into consideration too.

**Output specification and EMAT**
We are experienced in using EMAT (economically most advantageous tender). At the moment, we are starting to use a ratio of 60% quality and 40% price. If this is more oriented to price, price will be predominating the score. On average we state 7 to 10 criteria; we do not limit this amount. We also do not put emphasis on sustainable criteria. We always look at the goal of the project and we have to meet the criteria stated by AgentschapNL.
Since 2010, sustainability is a fixed criterion; tenders can score quite a bit on this criterion which will be translated into a substantial financial contribution.

**Value of Sustainability.**
We use the guideline of CROW: "Gunnen op Waarde" (Awarding for Value). This guideline is not always applicable. Not every criterion can be valued objectively. We use our personal knowledge and experience in cases where it is difficult to value certain criteria.

**Co-operation between Client and Contractor**
During the pre-contractual phase, we ask the market to come up with solutions and ideas to our problem. You have to take into consideration that these procedures have to be transparent etc. You should stay within the legal framework of procurement procedures. Some clients do not know the possibilities within this framework, there is more possible than they think there is.
We are changing our policy on acceptance of alternative offers. First we did not want alternatives, but to encourage innovation, we have consulted the market and concluded to change this policy. Nowadays we are accepting alternative offers.

**Innovation and D&C**
Steps that can be taken to encourage innovation within Design & Construct building models:
Early transfer Client to Contractor: I agree, you have to manoeuvre carefully within the legal framework, but there are possibilities to do so.
Better communication: Especially transparency. You have to state clear criteria, and be clear in clarifying the rejections to losing tender parties.
Client should take more risk: Depending on the size of the project, the client should take more risks. Worst that can happen is the judge declaring the process to be null and void.
More time is needed for the tender phase: It depends. My experience is that some big projects have a too short tender phase. But it depends what you are asking from the market.
No limits for contractors in choosing methods and design: depends on the sort of work you are asking.

The last 10 years I did not see any real innovation in the civil engineering sector.

**Other**
DBM seems to result in a qualitative better product compared to traditional building models.

**Interview dhr. Krombos**

Met: dhr. Krombos (Peter)
Locatie: Provinciehuis Overijssel, Zwolle
Datum: 9.00u 21 juni 2010

*(De nummering van vragen verloopt volgens een volledige vragenlijst, niet alle vragen uit die lijst zijn bij de interviews gesteld, onderwerpen die buiten de vragenlijst vielen en wel besproken zijn is in kaders geplaatst)*

*Allereerst zou ik u willen vragen om u voor te stellen.*

1) Wat is uw functie?

Bij de eenheid wegen en kanalen ben ik adviseur contracten, ik houd mij bezig met het afstellen van gunnings-, selectie- en EMVI-criteria.

2) Wat is uw expertise?

Mijn achtergrond is weg- en waterbouw en administratief opleiding, maar ik heb mijn leven lang al dit werk gedaan.

3) Met welke delen van de bouwcyclus heeft u te maken?

Nieuwe infrastructuur wordt niet zo veel meer aangelegd, dus de echte initiatieffase komt niet zo vaak meer voor. De meeste contracten zitten in de Design/Engineering (Design), vaak is het al heel ver uitgewerkt. De bouw (Construct), waar ook beheer en onderhoud (Operate and Maintain) soms aan gekoppeld is.

4) Hebt u ervaring met D&C projecten binnen UAVgc?

Ja, vanaf 2000 zijn wij hier al bezig met innovatieve contractvormen en die op de markt te brengen. De eerste was in 2000. Wij hebben een gereconstrueerd wegvak met meerjarig onderhoud op de markt gebracht met een dergelijk contract. Ook in de natte sfeer hebben wij vrij veel ervaring.

*Dan zou ik graag willen weten wat het beleid is van de provincie ten aanzien van Duurzaam Inkopen.*

5) Wordt er binnen de provincie een bepaalde definitie gehanteerd voor het begrip duurzaamheid in de bouw?

Nee, De provincie hanteert dezelfde definitie van AgentschapNL en gebruikt ook haar 45 criteria. Wij hebben geen aanvullend strenger beleid ten aanzien van duurzaamheid.

6) Heeft de provincie doelstellingen ten aanzien van Duurzaam inkopen?

De provincie volgt het rijksbeleid en de provincie wil 2010 alles 50% duurzaam inkopen. Het rijk heeft een doelstelling van 100%.

7) Zo ja, Hoe worden deze doelstellingen meegenomen in het aanbestedingsproces van de provincie?

Aan de hand van de criteria van AgentschapNL is er een lijst gemaakt, aanbiedende partijen vragen wij die lijst in te vullen. Naarmate de aanbieder meer van dit soort punten met ja kan beantwoorden en dat ook kan aantonen krijgt hij een bepaalde score en over het algemeen is dat een puntenscore die wij vertalen in geld die leidt tot een fictieve korting op de aanneemsom. Dit passen wij toe bij Engineering en Construct en bij Traditionele contractvormen.
Als wij praten over Beheer & Onderhoud moet je denken aan een jaarlijks of meerjaarlijks onderhoud aan de infrastructuur, dan valt in de Initiatieffase niet veel aan duurzaamheid te winnen. De grootste winst kun je maken bij nieuwe infrastructuur. Heel af en toe hebben wij dat nog, de meest recente was de omlegging rond Wesepe. Daar voegen wij dan in de EMVI duurzaamheid toe, waar aanbiedende partijen behoorlijk op kunnen scoren.

*Ik zie het begrip duurzaamheid binnen mijn onderzoek als een vorm van product- of procesinnovatie die het gebruik van materiaal/energie/water minimaliseert en de flexibiliteit maximaliseert tijdens de beheer en onderhoudsfase en de hoeveelheid afval minimaliseert tijdens de sloopfase.*

Op het minimaliseren van afval zijn we wel heel scherp, bijvoorbeeld bij het vervangen van een wegdek, daar komt materiaal vrij. We proberen dat vrijkomende materiaal zoveel mogelijk te hergebruiken.

*Tijdens het gesprek komt ook op enkele punten naar voren dat 'Duurzaamheid' of 'Innovatie' niet altijd de doelstelling is, maar dat het soms wel een resultaat is. Enkele citaten:*

"Voor asfaltconstructies of beton vragen wij een garantie van 12 jaar. Dat doen wij alleen omdat we dan minder op de weg terug hoeven te komen, dat heeft meer te maken met de bereikbaarheid en veiligheid dan met duurzaamheid. Door het stellen van die criteria impliciet neem je dan duurzaamheid mee, maar het is niet leidend voor ons. Andere beleidsdoelstellingen zijn daar leidend in."

"Bij ons spelen eisen ten aanzien van landschappelijke inpassing en esthetica een rol. Het is mijn ervaring dat wanneer je dat vraagt er ook innovatieve oplossingen uitkomen. Maargoed dan is onze insteek veel meer vanuit ruimtelijke kwaliteit, om dat op te krikken, met als bijwerking dat het meer innovatie met zich meebrengt."

*Dan gaan wij door naar de zaken waarmee de opdrachtgever een belangrijke rol speelt. De Vraagspecificatie en de Selectie en Gunningcriteria.*

*Op het oog van duurzaamheid kan er een afweging gemaakt worden of de beoogde duurzaamheidaspecten onder de minimum eisen of onder de selectie/gunningcriteria moeten vallen.*

8) Wordt er bij de provincie gebruik gemaakt van selectie/gunningscriteria?

Ja. (Zie ook vorige antwoorden)

9) Hoe hebt u bepaald of een eis binnen de VS(minimum eisen) dan wel binnen de selectie/gunningscriteria werd opgenomen?

De VS is een detaillering waar het werk aan moet voldoen. Bij de criteria komt meer aan de orde hoe een bedrijf daarin staat. Wat het beleid is van het bedrijf en wat ze kunnen waarmaken ten aanzien van duurzaamheid.

10) Ziet u beperkingen in het opstellen van minimumeisen met betrekking tot duurzaamheid?

Voor een aantal zaken is duurzaamheid lastig aantoonbaar te maken, als opdrachtgever kijken wij wel naar het aanbod. Neem de logistiek; kan je meewegen waar de productie is en hoe dat getransporteerd wordt? Momenteel is bij mij niet bekend dat bedrijven vroegtijdig investeren in materieel om op duurzaamheid te scoren.

12) Hebt u ervaring met het toepassen van EMVI?

Ja dit passen wij geregeld toe. De laatste aanbestedingen passen wij een verhouding toe van 60% kwaliteit, 40% prijs, zeker bij de contracten onder de UAVgc. Wil je niet in de situatie komen dat prijs alsnog de doorslag geeft, dan moet je die 60% vrij duidelijk vormgeven. Duurzaamheid heeft niet altijd de hoogste wegingsfactor bij ons, want vaak zijn bereikbaarheid, verkeersveiligheid en leefbaarheid aspecten die vrij zwaar wegen. Zo gauw je de verhoudingen anders maakt, zeg, 60% prijs 40% kwaliteit en daarin duurzaamheid verweven, dan wint waarschijnlijk de aanbieder met de laagste prijs, maar brengt hij waarschijnlijk niet zoveel duurzaamheid.

a. Kunt u een voorbeeld geven van een project waar u dit hebt toegepast?

De omlegging rond Wesepe.

b. Welke criteria werden hierin opgenomen?

Onder andere duurzaamheid.

U gaf al aan dat verschillende punten zijn die in de EMVI meegenomen kunnen worden. Beperkt u dat tot een bepaald aantal criteria?

Dat is afhankelijk van het project. Wij hebben geen minimum op voorhand, gemiddeld passen wij 7 tot 10 criteria waarop beoordeeld wordt toe. Het is niet zo dat wij bewust een keuze

maken tussen maar 4 of 5 criteria. Zeker niet dat we daar duurzaamheid het hoogste gewicht geven. Wij kijken steeds naar de doelstelling, wij moeten minimaal aan de eisen voldoen van het Agentschap en verder zijn we daar niet ambitieus in om dat op te krikken.

*Een methode die toegepast kan worden om te bepalen hoe en welke aspecten in een VS of EMVI terugkomen is Value Management. Een belangrijk punt hierin is om de waarde te bepalen van duurzaamheid, zoals wij net besproken hebben.*

13) Wordt deze methode gebruikt binnen de provincie? Hoe wordt het toegepast? Voorbeelden?

Nee.

*Binnen een VS of een EMVI worden de eisen al dan niet direct omgezet in een waarde.*

14) Gebruikt u een methode om de waarde die in EMVI vertegenwoordigd wordt te bepalen?

We proberen wel dingen op waarde te bepalen, CROW heeft daar ook een leidraad voor. Gunnen op waarde. Dat is de leidraad die wij hanteren, maar dat is niet altijd goed toe te passen.
Voor bereikbaarheid is er wel een methode waarmee de maatschappelijke winst te berekenen is. Hoe sneller een aannemer klaar is hoe minder overlast er is, dit kan als bonus/malus worden ingepast.

15) Wat ziet u als waarde in duurzame criteria?

Er zijn veel criteria die lastig in waarde om te rekenen zijn. Je vraagt je dan af wat het waard is als opdrachtgever. Je gebruikt dan je gevoel of ervaring, of percentages van de raming. Laten wij eerlijk zijn, uiteindelijk ook bij Bonus/malus, pak je wel de bonus, het is toch geld wat je uit moet keren, belastinggeld. Dan blijft dat steeds een afweging, van wat is mij dat dan waard, dat hij dat soort dingen doet.

17) Zou u gezien de vele aspecten die vanuit OG gestuurd kunnen worden binnen een EMVI, het criterium voor duurzaamheid in de O&M fase mee willen nemen in de EMVI?

Bij UAVgc contracten wel. Daarin nemen wij altijd duurzaamheid als item mee. Bij traditionele contracten gebruiken wij ook het scoringsmodel wat ik eerder liet zien afgeleid van AgentschapNL. Degene die het meeste duurzaamheid kan inbrengen krijgt de meeste korting. Daar kan je behoorlijk op scoren. Vanaf 1 januari 2010 is duurzaamheid een vast criterium bij ons.

*Een ander aspect wat binnen VM van belang is is om na de conceptfase (voor de haalbaarheidsstudie) alle belangrijke stakeholders bij elkaar te brengen, actoren die beslissingen kunnen maken.*

18) Zou u als opdrachtgever samen met opdrachtnemer en onderaannemers in een vroeg stadium willen werken aan alternatieven?

Als je maar binnen je wettelijke kaders blijft van het aanbestedingsbeleid, dan zijn er meer mogelijkheden, dan mensen over het algemeen denken.

a. Hoe zou u dat willen vormgeven?

In de precontractuele fase is best mogelijk om een heel open overleg te hebben met potentiële opdrachtnemers. De vragen die je als opdrachtgever hebt kan je daar neer leggen en de markt vragen hoe zij daar tegen aankijken. Dat wordt regelmatig toegepast en is zinvol om te doen.
Je moet voorzichtig zijn dat het objectief gebeurt, dat iedereen dezelfde informatie krijgt, dat soort dingen.

19) Welke nadelen ziet u met een dergelijke vroege samenwerking?

Men is heel terughoudend. In algemene rondes zal iemand met een goed idee dat daar nooit vertellen. Het moet in mijn optiek altijd volgen uit individuele gesprekken, waar je ook afspreekt dat het vertrouwelijk is, naar elkaar toe. Als de omgeving veilig genoeg is, dan krijg je wel dingen boven water.

a. Als iemand een goed idee heeft, is het dan vertrouwelijk, maar vervolgens mag u dan wel die aanbesteding vormgeven. Hoe past dat dan in het transparantiebeginsel?

Op dat moment heb je nog geen aanbestedingsprocedure gestart. Dus de informatie die je gekregen hebt zou je kunnen vertalen in criteria zodat de aannemer wel een kans krijgt. De criteria worden ook beschikbaar gesteld aan de anderen zonder dat het idee naar buiten komt. Juridisch gezien is dat heel lastig manoeuvreren.

b. Aanvaardt u dan ook alternatieve aanbiedingen?

Het is al jaren de lijn geweest om heel expliciet op te nemen dat wij geen alternatieve aanbiedingen aanvaarden. Daar gaan wij vanaf om innovatie te stimuleren. Het is moeilijk om de alternatieven te vergelijken, maar ze moeten in eerste instantie aan de vraagspecificatie voldoen. Je moet als OG ook durven om alternatieven te stimuleren. Dat gaan wij doen. Ik zie wel bij veel OG's terughoudendheid hierin. Dat hadden wij zelf ook, maar sinds kort hebben wij heel uitgebreid met de markt erover gediscussieerd, en gezegd dat wij dat gaan toestaan. Je moet die stap doen, ook al liggen er risico's. Je moet dingen op gang brengen.

*In mijn ogen is duurzaamheid een vorm van innovatie, danwel het proces danwel het toepassen van producten die niet eerder zijn toegepast om bepaalde duurzame aspecten te stimuleren. Met deze insteek zijn er volgens de literatuur enkele zaken die vanuit de OG gestuurd kunnen worden om innovatie de ruimte te geven:*

21) Kunt u kort per punt aangeven wat uw mening is over de toepassingsmogelijkheid van deze punten als OG?

a. Vroege transfer van OG naar ON

Daar ben ik het wel mee eens. Daar is heel veel winst te halen. Het is en blijft voorzichtig manoeuvreren, met het oog op aanbestedingswetgeving, maar er zijn wel mogelijkheden. Dat kan goed uitpakken.

b. Veel Communicatie

En transparant zijn. Je moet in alles wat je doet transparant zijn. De afwijzingen moet je goed kunnen beargumenteren, laat zien hoe het is gedaan. Laten zien wat je criteria zijn. Daar moet je volstrekt helder in zijn. Op het moment dat je dat doet, dan wordt het ook geaccepteerd.

c. De OG moet meer risico durven nemen en garanties te geven voor innovatie delen van het contract

Daar hikken ze wel tegen aan, op het moment dat je die ruimte geeft, loop je iets meer risico. Dat moet je durven nemen. Het ergste wat je kan overkomen is dat de hele aanbestedingsprocedure wordt afgeschoten door de rechter. Als je dat niet goed doet moet je dat opnieuw doen. Het is een kwestie van tijd. Je loopt misschien een keer een half jaar vertraging op, daar hangen wel kosten aan. Dat risico moet je afwegen. Het maakt wel wat uit of het om een groot of klein werk gaat.

d. Er moet voldoende tijd zijn voor de tenderfase

Dat is iets wat je altijd hoort. Maar dat is afhankelijk van wat je de markt vraagt. Je ziet over het algemeen bij hele grote projecten dat de tenderfase wel krap is. Daar ben ik het wel mee eens. In het begin moet je voldoende tijd nemen.

e. Er moeten zo min mogelijk limieten zijn voor de ON, in keuze van methodes en dergelijk

Keuzes van methodes ben ik wel mee eens, maar limieten is toch wel afhankelijk van het werk. Bij een groot werk zal toch de top 5 van Nederland het werk krijgen, het MKB zal dan als onderaannemer wellicht taken krijgen toebedeelt. Bij kleine werken proberen we de drempel zo laag mogelijk te stellen om het MKB ook een kans te geven het werk te winnen.

*Voor een ON lijkt er weinig motivatie te zijn om met innovatieve ideeën te komen voor de OG. Impliciet hebben wij het hier al over gehad. In de UAVgc en de regelgeving rondom aanbesteding zal het lastig zijn om nieuwe ideeën in te brengen, door de beginselen van transparantie zal informatie van ON snel uit kunnen lekken. Level of playing field en cherry picking zijn gevaren die op de loer liggen.*

22) Bent u van mening deze ontwikkelingen een negatieve invloed hebben op innovatie in de bouw?

Daar ben ik het mee eens. De GWW is redelijk traditioneel, als je naar de afgelopen 10 jaar kijkt, dan zijn er niet zo veel nieuwe producten ontwikkeld. Er is geen hele kwaliteitsslag gemaakt.

*Afsluiting*

- Nog iets toe te voegen?

Je ziet dat er bij DBM, waar bijvoorbeeld een onderhoudscontract van 15 jaar aan zit, er toch een kwalitatief beter product wordt afgeleverd dan bij de traditionele manier van uitvragen.

### *B.1.2 Interview with Mr. Steenbruggen, de Woonplaats*

Summary of interview
Name: mr. Steenbruggen
Function: Advisor on innovation and sustainability at housing corporation 'De Woonplaats'.
Expertise: Maintenance, we are investigating possibilities to implement 'lifecycle thinking'.
Four years ago, de Woonplaats, in co-operation with TNO, started 'result-oriented property maintenance', which describes the desired result instead of the desired process. This can be seen as a similar kind of process compared to D&C. It is based on the 'cradle to cradle' principle.

**Sustainability**
De Woonplaats uses a similar definition as stated by the Brundtland committee. It is stated in a Environment policy document. Aspects which are dealt with by this document are: water, energy, material-use, environment, sustainable behaviour of residents and sustainable business. Maintenance is mostly done in a traditional manner; what we ask is what we get. We are now asking for sustainable materials, sustainable paints and FSC-certified wood for example.

**Output specification and EMAT**
At the moment we only use selection criteria, we do not use award-criteria or EMAT. In the near future we probably have to apply award criteria also, but policy has not been formulated yet.

**Value of Sustainability.**
The municipality of Enschede (and others) and de Woonplaats do not have any policy on how to value sustainability yet.

**Co-operation between Client and Contractor**
Public procurement procedures are not applicable to this Housing cooperation. They are considering to alter their policy, and implementing similar rules and procedures as stated by the EU.
De Woonplaats is participating in *Pioneering*, a platform to stimulate innovation in the construction industry in Twente. The market has to be more pro-active, this asks for a culture shift. It is a new approach driven on customer demand.

**Innovation and D&C**
Steps that can be taken to encourage innovation within Design & Construct building models:
Early transfer Client to Contractor: In an early stage it should be clear what the client wants.
Better communication:
Client should take more risk: In the past we sometimes have shared costs on risks together with the contractor.
More time is needed for the tender phase: We do not have experience on this.
No limits for contractors in choosing methods and design: That is a common pitfall. You are used to dictate as a client, now you have to give space to contractor's ideas. We have to get used to that.

**Other**
This new way of thinking costs time and money. We are beginning to see the benefits for the maintenance stage. Learning by trying.

**Interview dhr. Steenbruggen**

Met: dhr. Steenbruggen (Dik Roetert)
Locatie: De Woonplaats, Enschede
Datum: 15.30u 21 juni 2010

*(de nummering van vragen verloopt volgens een volledige vragenlijst, niet alle vragen uit die lijst zijn bij de interviews gesteld, onderwerpen die buiten de vragenlijst vielen en wel besproken zijn is in kaders geplaatst)*

*Allereerst zou ik u willen vragen om u voor te stellen.*

1) Wat is uw functie?

Adviseur innovatie en duurzaamheid bij De Woonplaats binnen onze afdeling strategie en vastgoed. Beleidsadviseur op het gebied van duurzaamheid, daarnaast houd ik mij bezig met onderhoudsbeleid.

2) Wat is uw expertise?

Technische bouwkunde en technische bedrijfskunde. En altijd vanuit de onderhoudshoek gezeten bij de Woonplaats. De laatste jaren wat breder in de nieuwbouw. Innovatieve oplossingen, bouwconcepten en het bouwproces. Daarom ben ik bezig met Systems Engineering en DBM constructies. Om zo te kijken welke ambities De Woonplaats heeft of het de goede oplossing is.

3) Met welke delen van de bouwcyclus heeft u te maken?

Vanuit mijn ervaring zit ik in het onderhoud. Maar we gaan nu kijken hoe we de hele levenscyclus aan elkaar kunnen knopen, verschillende afdelingen hebben hun eigen doelen. De projectmanager wil zo goedkoop mogelijke stichtingskosten en de onderhoudsafdeling wil zo goedkoop mogelijk onderhoud. We doen nu pilot projecten om te kijken of het aan elkaar geknoopt kan worden. We hebben dit jaar ook het Total Cost of Ownership principe binnengehaald, maar dat past nog niet in onze administratieve processen.

4) Heeft u ervaring met D&C projecten binnen UAVgc?

De Woonplaats werkt vooral nog binnen een traditioneel model.
We zijn 4 jaar terug begonnen met resultaatgericht vastgoed onderhoud, samen met TNO. Daarin beschrijven we resultaten: ‘het moet er zo en zo uitzien’, de markt komt maar met oplossingen en wij kijken welke oplossing het beste is.

*Dan zou ik graag willen weten wat het beleid is van de wooncorporatie ten aanzien van Duurzaam Inkopen.*

5) Wordt er binnen De Woonplaats een bepaalde definitie gehanteerd voor het begrip duurzaamheid in de bouw?

Ja, deze staat beschreven in het milieubeleidsplan. Het is soortgelijk aan de Brundtland definitie.

6) Heeft De Woonplaats doelstellingen ten aanzien van Duurzaam inkopen?

Er is een milieubeleidsplan wat daar richting aan geeft. Er zijn een aantal punten waar naar gekeken wordt, energie, materiaal, water, milieu, duurzaamgedrag bewoners en de eigen bedrijfsvoering van De Woonplaats. Materialisering is de laatste jaren een thema, we kijken naar alle stromen die met het materiaal te maken heeft. Waar het vandaan komt en hoe het gemaakt wordt.
Het implementatieplan geeft invulling aan Duurzaam Inkopen. We doen met een aantal bedrijven een traject voor MVO. Zelf zijn er ook al wat zaken als het rijden van een bedrijfsauto met A label, werken met FSC-hout en bepaalde soorten verf.

7) Zo ja, Hoe worden deze doelstellingen meegenomen in het aanbestedingsproces van *de Woonplaats*?

We werken in het onderhoud vooral nog traditioneel. Als je kijkt naar ons nieuwbouw, naar materialen, dan gebruiken wij een materialenvoorkeurslijst. Bedrijven maken wat wij vragen, ze komen dus zelf niet met alternatieven die wellicht duurzamer zijn dan dat wat omschreven is. In de Pilot stappen wij daar dus vanaf, wij specificeren vrij functioneel en de markt komt maar met oplossingen. De markt moet ons zien te overtuigen. Nu komen we op het punt van hoe het gemeten kan worden. Met TNO

zijn we nu een leidraad aan het opzetten, op basis van C2C. Zolang dat er niet is werken we met GPR gebouwen.

*Ik zie het begrip duurzaamheid binnen mijn onderzoek als een vorm van product- of procesinnovatie die het gebruik van materiaal/energie/water minimaliseert en de flexibiliteit maximaliseert tijdens de beheer en onderhoudsfase en de hoeveelheid afval minimaliseert tijdens de sloopfase.*

*Dan gaan we door naar de zaken waarmee de opdrachtgever een belangrijke rol speelt. De Vraagspecificatie en de Selectie en Gunningcriteria.*

*Met het oog op duurzaamheid kan er een afweging gemaakt worden of de beoogde duurzaamheidaspecten onder de minimum eisen of onder de selectie/gunningcriteria moeten vallen.*

8) Wordt er bij De Woonplaats gebruik gemaakt van selectie/gunningscriteria?

Wel van selectiecriteria, maar gunningscriteria nog niet. Selectie wordt steeds belangrijker, we kijken dan naar een bedrijf en de duurzaamheidsambitites die het bedrijf heeft.

12) Heeft u ervaring met het toepassen van EMVI?

Ik heb er veel over gelezen maar er is geen beleid. Ik denk dat het die kant wel op moet. Als je kijkt naar renovatie en prijs, en als je naar duurzaamheid kijkt, of bouwsnelheid voor minder overlast, dan moet dat gewaardeerd worden. Of een bepaald bedrag afhalen van de prijs.

*Kort werd een voorbeeld gegeven dat De Woonplaats werkt met scenario's hier ben ik kort op doorgegaan.*

Wat moet ik me bij scenario's voorstellen?

Scenarios in onderhoud zijn verschillende maatregelen om te komen tot een resultaat. Bijv. Ik kies een duur materiaal, zodat ik later in de 25 jaar (daar praten we tegenwoordig over) dat kan terugverdienen. Een ander scenario is dat je niet voor een duur materiaal kiest, maar vaker onderhoud moet plegen tussentijds.

Valt het onder oplossingsvrij specificeren?

Ja daar komt het op neer, we gaan nu vanuit een functiebenadering. De functie moet aanwezig zijn en de markt komt met oplossingen. Dat is toch 180graden andersom, op dit moment gaan we zelf de oplossingen in bestekken omschrijven, je moet het zo en zo doen. En de bedrijven doen inspanning om het te maken, waardoor er geen creatieve oplossingen zijn. Je ziet nu een heel ander bedrijf, ze denken mee, komen met oplossingen.

*Een methode die toegepast kan worden om te bepalen hoe en welke aspecten in een VS of EMVI terugkomen is Value Management. Een belangrijk punt hierin is om de waarde te bepalen van duurzaamheid, zoals we net besproken hebben.*

13) Wordt deze methode gebruikt binnen *de Woonplaats*? Hoe wordt het toegepast? Voorbeelden?

Deze methode wordt niet gebruikt.

*Binnen een VS of een EMVI worden de eisen al dan niet direct omgezet in een waarde.*

Uit het interview komt naar voren dat er vanuit gemeente en woningcorporatie nog beleid moet worden gemaakt ten aanzien van het waarderen van duurzaamheid. Dit beleid is er nu nog niet.

Er is kort ingegaan op de bezigheden als innovatief beleidsadviseur. Er wordt kort aangestipt dat de Woonplaats, door onder andere betrokken te zijn in Pioneering een onderdeel van innovatie platform Twente, ruimte wil geven aan de markt om met innovatieve oplossingen te komen. Als de opdrachtgever het niet vraagt, dan wordt het niet aangeboden. Binnen traditioneel aanbesteden is het moeilijk om deze innovatieve ambities na te streven, vandaar dat er gekeken wordt naar andere vormen. We werken meer vraaggestuurd, kijken wat de klant wil.
De markt moet proactief met de oplossing komen, en daar zijn we in de woningbouw nog niet aan gewend. De markt moet met dingen komen en vragen stellen, dat is een hele andere, nieuwe, aanpak.

*In mijn ogen is duurzaamheid een vorm van innovatie, danwel het proces danwel het toepassen van producten die niet eerder zijn toegepast om bepaalde duurzame aspecten te stimuleren. Met deze insteek zijn er volgens de literatuur enkele zaken die vanuit de OG gestuurd kunnen worden om innovatie de ruimte te geven:*

21) Kunt u kort per punt aangeven wat uw mening is over de toepassingsmogelijkheid van deze punten als OG?

a. Vroege transfer van OG naar ON

Ja, daar ben ik het wel mee eens. Dat zien we nu ook, de VS moet helder zijn, wat wil je nu precies. Met onze resultaat gericht onderhoud traject, met planmatig onderhoud, moet je heel helder hebben wat je wilt als OG. Als dat niet helder is dan komt de markt niet met goede oplossingen. Je moet je budgetten meegeven, dat zijn we ook niet gewend. Je vraagt aan de markt, en die moeten aangeven of het kan of niet. Je moet in een vroeg stadium helder hebben van, wat wil je nou precies.

b. Veel Communicatie

*(Als het gaat om informatieverstrekking naar kandidaten)* Voor de pilot hebben we het ook naast het beleid gelegd of het aansluit. Daar lijken nog wel conflicten op te treden die we moeten aanpassen voor een volgende keer.

c. De OG moet meer risico durven nemen en garanties te geven voor innovatie delen van het contract

Die afspraken maken we wel, je kunt alles bij de ON neerleggen. Risico kost geld. OG verlangt van ON wel garanties, maar andersom kan het ook. Wij hebben nog geen garanties gegeven om het verlies te delen met ON. Voor risico's hebben we dat wel eens meebetaald.

d. Er moet voldoende tijd zijn voor de tenderfase

De ervaring dat er meerdere partijen meedoen hebben we nog niet. Consortium is geselecteerd op kennis en kunde en verder niet.

e. Er moeten zo min mogelijk limieten zijn voor de ON, in keuze van methodes en dergelijk

Denk ik wel, dat klopt, dat is de valkuil die in het traject zit. Je kijkt snel in de traditionele rol, je moet ruimte geven, en dat is continue een spanningsveld, we zijn gewend om alles te dicteren. En nu is het van: 'kom maar op'.

*Voor een ON lijkt er weinig motivatie te zijn om met innovatieve ideeën te komen voor de OG. Impliciet hebben we het hier al over gehad. In de UAVgc en de regelgeving rondom aanbesteding zal het lastig zijn om nieuwe ideeën in te brengen, door de beginselen van transparantie zal informatie van ON snel uit kunnen lekken. Level of playing field en cherry picking zijn gevaren die op de loer liggen.*

22) Bent u van mening deze ontwikkelingen een negatieve invloed hebben op innovatie in de bouw?

Daar hebben we nog geen ervaring mee. Ik kan het me wel voorstellen. Alles wat bij De Woonplaats ontwikkeld wordt is 'openbaar', dat mag iedereen gebruiken.

Afsluiting

- Nog een open vraag: nog iets te melden?

Het is aardig nieuwe materie. We zitten op dit moment met de vraag of we er echt mee door gaan. We gaan in ieder geval door voor het onderhoud. Er komt veel bij kijken, veel kennis en kunde. Het kost veel energie en tijd. We zien bij het onderhoud dat het steeds beter gaat, als je het een paar keer gedaan hebt zie je de voordelen in.

### *B.1.3 Interview with Mr. van Amstel, Megaborn*

Summary of interview
Name: Mr. van Amstel
Function: Director of Megaborn, participator of Sustainable Purchasing at NLingenieurs and member of Systems Engineering and Sustainable Purchasing working group at CROW.

**Sustainability**
The definition I use is: 'PPP-minded design'. PPP-minded means that for every stage of the process you are aware of your needs and demands, and you are aware how you have weighed and compared these needs and demands. Systems Engineering is the ideal tool to do this.
Material-use is a derivative of 'energy'. Material-use can be linked to the principle of competition, so you are including or excluding specific parties. The *Central Team* stated that material-use should follow from a functional specification. The considerations that have to be made are dependent on the lifecycle of the product. LCA as a calculating model is not considered to be the best option. Formulating key performance indicators is what it should be about.

**Output specification and EMAT**
Primarily 'sustainability' should be implemented into the output specification. The award criteria should be a stimulant for the contractor to align his point of view with the client's.

**Value of Sustainability.**
We have to define the main parameters of value. For example, we should not look at use of steel when comparing alternative offers; we should look at energy use, because energy use is the one of the Main Parameters of Value.
Municipalities have to formulate policy describing their Main Parameters of Value. They should have a mission and a vision on sustainability; preferably a consistent policy, vision and mission with other municipalities. This policy will be the basis for making considerations and decisions for the creation of an output specification.

**Co-operation between Client and Contractor**
In an early stage of the process you would like to be able to form your vision on the project you are starting. You need other people to be able to form this vision. Your own knowledge is needed to select those other people. Concerning the form of co-operation the project is decisive. You can not say: I will use D&C to develop this project; it should be: this particular project asks for D&C. Another project might be solved in an optimal way using traditional methods.

**Innovation and D&C**
Licenses should be used more to protect innovations developed by contractors. Investments in developing innovations should be increased.

**Other**
A central team (Doorontwikkeling van Duurzaam Inkopen in de GWW) stated 7 tracks for sustainable procurement: Exploring sustainable aspects, Goalformulation, Innovation, functional specification, instruments, validating and verifying, and a exploratory study.
Clients are not asked what their considerations were during the initial phase of the project. Engineers just work with what they get. By this, they are missing the essence of the vision of the client.
Clients are not able to formulate their demands in a clear and proper way. They are stating what they *don't* want, instead of what they want.

**Interview dhr. van Amstel**

Met: dhr. van Amstel (Niels)
Locatie: Megaborn, Waardenburg
Datum: 10.30u 24 juni 2010

*(de nummering van vragen verloopt volgens een volledige vragenlijst, niet alle vragen uit die lijst zijn bij de interviews gesteld, onderwerpen die buiten de vragenlijst vielen en wel besproken zijn is in kaders geplaatst)*

*Allereerst zou ik u willen vragen om u voor te stellen.*

1) Wat is uw functie?

Ik ben regiomanager van Megaborn, dit is een adviesbureau op het gebied van verkeer infra en mobiliteit. De missie is dat iedereen veilig en vlot thuiskomt en hoe we dat (maatschappelijk) verantwoord kunnen verzorgen. In dat kader zijn we ook bezig met maatschappelijk verantwoord ondernemen, duurzaam inkopen en allerlei maatschappelijke ontwikkelingen.

2) Wat is uw expertise?

Ik heb Civiele Bedrijfskunde gestudeerd in Delft. Momenteel ben ik erg actief binnen NLingenieurs, voorheen bij BouwendNederland en daarvoor werkte ik voor KWS. Bij KWS hield ik mij onder andere bezig met Duurzaam Inkopen in projecten. Bij BouwendNederland heb ik gekeken naar de relatie tussen OG en ON. Daar stond de vraag centraal hoe de wensen van de OG het beste door de ON gerealiseerd kan worden. In dat kader ben ik ook druk bezig geweest met Duurzaam Inkopen en dan op zowel projectniveau als organisatieniveau. Ik heb ook gekeken hoe de B&U en GWW beter kan samenspelen. Zo was ik daar voorzitter van verschillende werkgroepen, en heb zo bijvoorbeeld met CROW gekeken hoe duurzaamheidseisen concreet gemaakt kunnen worden en gemeten kunnen worden. Samen met anderen heb ik meegewerkt aan publicaties over het vormgeven van duurzaamheid in contracten en organisaties.
Ik was betrokken bij Nationaal Pakket 1, Duurzaam Inkopen in de GWW. Trekker geweest van Nationaal Pakket 2, daar hebben we ons gericht op functioneel specificeren. Ik heb gekeken hoe dat programma eruit moest zien, hoe dat gearrangeerd kon worden. Vervolgens ben ik voorzitter geweest van nationaal pakket 3.
Sinds twee jaar ben ik directeur van Megaborn, ik ben zo naadloos overgegaan van BouwendNederland naar NLingenieurs. Bij NLingenieurs ben ik trekker Duurzaam Inkopen. Ik ben nu ook lid van de werkgroep Systems Engineering Duurzaam Inkopen met Johan Hekker.
Namens NLingenieurs zit ik ook in het Centraal Team Doorontwikkeling Duurzaam Inkopen GWW van VROM/RWS/Agentschap NL. Daar ben ik onder meer trekker van spoor 5, ontwikkeling functionele specificaties SE.

4) Heeft u ervaring met D&C projecten binnen UAVgc?

Ja.

Voor het interview begon werd nog kort aangegeven dat er in de GWW met name Engineering & Construct projecten zijn, die ‘onterecht’ het label D&C meekrijgen. Tijdens het interview werd nog een vergelijking gemaakt dat binnen een organisatie (overheid) eigenlijk altijd sprake is van D&C, omdat een hoger geplaatste ambtenaar vrij functioneel zijn vraag uitvraagt aan een collega, en er zo eigenlijk al een D&C constructie ontstaat (maar dan zonder de ingewikkelde contracten en regelgeving).

7 sporen van doorontwikkeling Duurzaam Inkopen voor de GWW:

Er zijn 7 sporen[1]:

1. **Verkenning Duurzaamheidaspecten in de GWW**
2. **Doelen ambities, speerpunten**
3. **Innovatie**
4. **Functionele specificaties duurzaamheid**
5. **Instrumenten (DuboCalc, Greencalc, CO2prestatieladder e.d.)**
6. **Meetbaarheid en monitoring**

   Er zijn 4 monitor punten:
   - a hoe duurzaamheid is het project;
   - b hoe duurzaam is het geworden;
   - c hoe wordt duurzaam ingekocht;
   - d hoe duurzaam zijn mensen.
7. **Verkenning en planstudie**

Eroverheen komt nog een soort saus van een community of practice. Daarin zitten mensen met ervaring, daarvan ben ik de moderator. Vragen die daar spelen zijn: Hoe ga je het dan vormgeven? Wat betekent dat? Hoe regel en richt je de financiering in, over de jaren heen? Wat zijn de ervaringen die je hebt gehad? Wat betekenen de richtlijnen voor de gebruiker? Hoe moet je dat inrichten? Het zal sterk gaan over hoe functionele eisen te organiseren. Dat is meer een organisatievraagstuk dan inhoudvraagstuk.

*Dan zou ik graag willen weten wat uw beeld is ten aanzien van Duurzaam Inkopen.*

5) Wordt er binnen *uw bedrijf/ door uzelf* een bepaalde definitie gehanteerd voor het begrip duurzaamheid in de bouw?

Ja. ‘Bewust en omgevingsgericht’ ontwerpen op basis van PPP. Bewust betekent dan dat je in elke fase van het project bewust bent van de eisen die je wilt stellen of de behoeftes die je hebt en dat je daar ook bewust afwegingen in maakt.
Daarvoor gebruiken wij Systems Engineering. Dat is de gewenste tool, omdat het de impliciete processen die bij veel partijen aanwezig zijn, expliciet maakt. De tool geeft aan waar er gaten zijn waar beslissingen en keuzes over gemaakt moeten worden. In de GWW hebben we nadrukkelijk te maken met de politieke component. Onze insteek van SE is destijds mede geweest om politici handvaten te geven om al in een zeer vroeg stadium belangen in beeld te brengen en afgewogen keuzes te kunnen maken en dit op tijd te doen.

*Ik zie het begrip duurzaamheid binnen mijn onderzoek als een vorm van product- of procesinnovatie die het gebruik van materiaal/energie/water minimaliseert en de flexibiliteit maximaliseert tijdens de beheer en onderhoudsfase en de hoeveelheid afval minimaliseert tijdens de sloopfase.*

Materiaalgebruik is een afgeleide van energie, emissie en gebruik van natuurlijke grondstoffen. Materiaalgebruik wordt nu eigenlijk naar de achtergrond gezet, omdat materiaalgebruik gekoppeld kan worden aan het concurrentiebeginsel. Waar je partijen gaat benadelen of bevoordelen ten faveure van een bepaald materiaal. In het centraal team hebben we gezegd dat materiaal gebruik wel volgt uit de functionele omschrijving. De afwegingen die gemaakt worden zullen afhankelijk moeten zijn van de cyclus. Misschien volgt daar wel uit dat tropisch hardhout beter is dan fsc, of beton beter dan asfalt…

Gisteren las ik dat een LCC niet per definitie een goed resultaat geeft voor de LCA.

[1] http://www.senternovem.nl/duurzaaminkopen/gww/doorontwikkeling/index.asp

LCA is geen zinnig beslisinstrument. Het geeft alleen een richting of indicatie. Ik heb twee jaar gewerkt in een projectgroep die zich richtte op het proberen uit te rekenen wat de milieuimpact van een asfaltweg was. Uiteindelijk hebben we gezegd: “Dat is leuk en aardig maar hier komen we niet uit”. Verschillende groepen hebben verschillende opvattingen over wat wel en niet mee te nemen in een LCA en hoe het met elkaar in relatie zou staan. Er is altijd discussie over bepaalde coëfficiënten en relatiefactoren. Er ontstaan gaten op de punten waar die waardes moeten worden toegekend.
Ervaring van velen met betrekking tot LCA is dat je weet wat de output moet zijn, dus je ook weet wat de input moet zijn van een LCA, je kunt een LCA erg sturen, toevallig komen ze allemaal erg mooi uit. En als dat niet zo is kun je factoren anders inschatten. LCA is daarom als berekeningsmethode met waarheidsgehalte niet de beste optie. Hoe reken je het dan uit? Dat is lastig, je kunt beter gewoon eerst is teruggaan naar je topbehoeften, dat formuleren en dan zien wat je wilt hebben.

*Dan gaan we door naar de zaken waarmee de opdrachtgever een belangrijke rol speelt. De Vraagspecificatie en de Selectie en Gunningcriteria.*

*Met het oog op duurzaamheid kan er een afweging gemaakt worden of de beoogde duurzaamheidaspecten onder de minimum eisen of onder de selectie/gunningcriteria moeten vallen.*

8) Hoe heeft u bepaald of een eis binnen de VS(minimum eisen) danwel binnen de selectie/gunningscriteria werd opgenomen?

In principe primair in de VS. De basis is de VS, geen *goede* VS maar een VS. Een VS dekt niet alles af. Je kunt, indachtig de communicatieprincipes, maar 30-50% van je behoeftes vastleggen in de vraagspecificatie en iedereen leest het altijd anders. Iedereen heeft een ander perspectief bij een bepaald woord. Er zijn verschillende filters waarmee je kijkt. Vanuit welk veld je ook kijkt, dan moet je onderkennen dat je zelf een bepaald filter hebt. Dat kun je op elkaar afstemmen, dat betekent wel dat je dus naast schriftelijke overdracht ook de dialoog moet voeren. De VS is niet het enige middel om schriftelijk de gewenste richting en belangen aan te geven. Er moet dus ook iets meer zijn, daarvoor heb je gunningcriteria. Daaruit moet naar voren komen wat de OG werkelijk belangrijk vindt. Het belangrijke is dan voor de gunningcriteria dat de ON bewust is dat het beeld wat hij heeft niet hetzelfde is als het beeld wat de OG heeft. Hij moet bewust zijn dat hij daar naar moet vragen, dat hij goed op lijn zit en dat vervolgens goed doorvertaald.
Daarnaast heb je nog een schil “faciliteren/organiseren” dat is de schil die om VS en selectie/gunning heen hangt om te zorgen dat jij uiteindelijk een VS maakt die zo goed mogelijk aansluit bij de wensen van je organisatie, de maatschappelijke behoefte en er vervolgens zorgt voor vertaling van VS naar het te realiseren project. Zonder goede organisatie en communicatie zal er altijd ruis zijn, hoe goed de VS en de gunningcriteria ook zijn verwoord.

*Een methode die toegepast kan worden om te bepalen hoe en welke aspecten in een VS of EMVI terugkomen is Value Management. Een belangrijk punt hierin is om de waarde te bepalen van duurzaamheid, zoals we net besproken hebben.*

12) Wordt deze methode gebruikt binnen *uw Advieswerk*? Hoe wordt het toegepast? Voorbeelden?

Nee.
Ik ken het begrip van Prorail, die gebruiken dat, bepaalde waardetoedeling. Ik weet ook van een project van TNO dat 8 of 9 jaar geleden is ontwikkeld. Daar werden bij de ontwikkeling van een wijk ongeveer 20 waardes geformuleerd, door middel van software konden gebruikers zien wat de verhoudingen waren tussen deze waardes. Wat gebeurt er bijvoorbeeld met de onderhoudskosten als de realisatiekosten laag worden gehouden. Zo kan er goed bijgestuurd worden tijdens het proces.

Realiseer je dat bij de GWW de verhouding realisatie/onderhoud ongeveer 50/50 is. Bij de B&U zitten de meeste kosten in de arbeid die verricht wordt, dan kan je stellen dat 90% arbeid/ 5% realisatie en 5% onderhoud de verspreiding is van de kosten. Wat is dan de waarde van het gebouw? Stel dat een iets hogere energierekening een veel hogere omzet oplevert (vanwege het fijne werkklimaat), wat is dan de waarde van energie?

*Binnen een VS of een EMVI worden de eisen al dan niet direct omgezet in een waarde.*

13) Gebruikt u een methode om de waarde die in EMVI vertegenwoordigd wordt te bepalen?
    a. Welke dan? Of hoe ziet die er uit? Praktijkvoorbeelden?
14) Wat ziet u als waarde in duurzame criteria voor de beheer-, onderhoud- en sloopfase?
15) Hoe zou u die waarde willen laten vertegenwoordigen in het aanbestedingsproces?
16) Zou u gezien de vele aspecten die vanuit OG gestuurd kunnen worden binnen een EMVI, het criterium voor duurzaamheid in de O&M fase mee willen nemen in de EMVI?

Er wordt geen specifieke methode gebruikt. We gaan nu kijken naar emissie, we zitten in het centraal team te zoeken van wat zijn de kernwaarden waarop je het gaat sturen. Wat zijn de waarden van emissie en energieverbruik, hoe ga je daarmee om? Dat zijn zaken waar beter aan te rekenen valt. In de zin van het project kan je uitrekenen wat het aan energie gaat kosten. Je gaat bijvoorbeeld niet kijken naar het staalverbruik tussen twee alternatieven, dat is appels met peren vergelijken. Is de kernwaarde minder staalverbruik? Nee, eigenlijk wil je minder energie, dat is de kernwaarde. En dat kun je soms beter op andere manieren bereiken dan door minder staalgebruik.

Als we het hebben over de waarde van duurzaamheid, dan moet een gemeente een ambitie hebben waarin de kernwaarden zijn geformuleerd. De gemeente moet een visie formuleren over duurzaamheid. Het liefst consistent met de visie en ambitie van andere gemeentes, zodat de markt daar breed op kan anticiperen. Vanuit dat beeld (die horizon) kan vervolgens een VS worden opgebouwd.
Neem uit jouw definitie ‘flexibiliteit’, flexibiliteit is niet het hogere doel, daar zit nog iets achter. Flexibiliteit is geen systeemniveau, energie is meer een systeemniveau. Zo moet er dus voor energie een ambitie en visie worden opgesteld.

Hoe vaak start een project echt nog bij de initiële fase terecht?
In het begin is al heel veel helder als je met het goede abstractieniveau werkt. Materialen is in feite een soort suboptimale realisatie binnen een eenmaal gekozen concept. Het is geen hoofddoelstelling. Dus daar moet je niet op gaan sturen.
Traditioneel stellen ingenieurs geen vragen van hoe het proces tot dan toe is verlopen, het deel waar zij niet bij betrokken waren. Uit de diverse onderzoeken die ik met oa. Risnet heb verricht blijkt dat zelden iemand vragen stelt over wat ervoor is gebeurd. Dat wordt vaak aangenomen als een gegeven. We constateren in de sector dat ingenieurs ook vragen moeten stellen hoe de initiatieffase tot stand is gekomen. Wat is de (onbenoemde) behoefte die daar achter zit? Het is deels bedoeld om te achterhalen hoe de VS is opgebouwd, wat er gemist is, en deels om zich af te vragen wat de visie is ten opzichte van zaken. De meeste mensen weten niet wat ze daar aan kunnen bijdragen dus doen ze dat niet.
Wij hebben geconstateerd in de commissie ‘infrastructuur en bouwproces’ dat de mensen die nu worden opgeleid op de HBO en WO niet toegerust zijn voor deze maatschappij, die duurzaam wil inkopen. Ze moeten leren vragen te stellen, kritisch te zijn en door te vragen. Want van hen wordt verwacht dat ze kritische vragen stellen aan een OG met de vraag wat voor hem belangrijk is en wat zijn beeld erbij is.

Is het een kwestie van durf om functioneel te specificeren?
Het lijkt haast of een opdrachtgever een cursus Nederlands moeten hebben. Ze moeten formuleren wat ze willen, en niet formuleren wat ze niet willen. Of heel omslachtig in ingewikkelde lange zinnen formuleren wat ze wel en niet willen.

*Een ander aspect wat binnen VM van belang is is om na de conceptfase (voor de haalbaarheidsstudie) alle belangrijke stakeholders bij elkaar te brengen, actoren die beslissingen kunnen maken.*

17) Zou u als opdrachtgever samen met opdrachtnemer en onderaannemers in een vroeg stadium willen werken aan alternatieven?
    a. Hoe zou u dat willen vormgeven?
18) Welke nadelen ziet u met een dergelijke vroege samenwerking?
19) Welke voordelen ziet u met een dergelijke vroege samenwerking?

Ik zeg niet dat ON en OG zo snel mogelijk met elkaar in contact moeten komen. Het zal mooi zijn als je zo snel mogelijk de mensen erbij betrekt die veel kennis hebben over de invulling van jouw wensbeeld en met hen de communicatie en dialoog over de belangen en beelden voert. Andere mensen moeten je helpen om in beeld te brengen wat je niet weet. Een mens weet van 80% van de benodigde kennis niet, dat hij het niet weet, van 10% weet hij dat hij het niet weet. Van 10% weet hij het wel, waarvan je 5% zeker weet. Voor die 90% heb je communicatie en spiegelen met andere mensen nodig. Moet je dan snel naar de markt toe? Dat kan, afhankelijk van het project. Er zit veel meer omheen, hoe zit het met integriteit, aanbestedingsregels. Je eigen kennis en kunde moet vooral dienen om anderen op goede gronde te kunnen selecteren. En proberen dat zo objectief mogelijk te doen. Je moet een goede afweging maken bij de selectie.
Als je met SE werkt ben je op een gegeven moment zover qua uitwerking van belangen, behoeftes, beelden en afwegingen/keuzes dat je met voldoende vertrouwen en goede integriteit de overstap kan maken naar de andere partij. Dat is afhankelijk van de complexiteit van het project, de organisatie, de eigen kennis en kunde.

*In mijn ogen is duurzaamheid een vorm van innovatie, danwel het proces danwel het toepassen van producten die niet eerder zijn toegepast om bepaalde duurzame aspecten te stimuleren. Met deze insteek zijn er volgens de literatuur enkele zaken die vanuit de OG gestuurd kunnen worden om innovatie de ruimte te geven:*

    a. Vroege transfer van OG naar ON

De vraag moet in feite bepalend zijn voor wanneer je een andere partij inschakelt. Niet dat mensen zeggen van: “ik ga D&C doen”. Sommige vragen vragen dat je traditioneel aanbesteed. Heel veel projecten hadden traditioneel moeten worden aanbesteed en andere juist weer DC.

*Voor een ON lijkt er weinig motivatie te zijn om met innovatieve ideeën te komen voor de OG. Impliciet hebben we het hier al over gehad. In de UAVgc en de regelgeving rondom aanbesteding zal het lastig zijn om nieuwe ideeën in te brengen, door de beginselen van transparantie zal informatie van ON snel uit kunnen lekken. Level of playing field en cherry picking zijn gevaren die op de loer liggen.*

21) Bent u van mening deze ontwikkelingen een negatieve invloed hebben op innovatie in de bouw?
    a. Waarom?

Intellectueel eigendom, werken met licenties. Er wordt te weinig geld besteed aan de ontwikkelkosten. Dat heeft ook te maken met het moment van bevragen van de markt. Een Prijsvraag is niks, er moet wel een project achter hangen.

*Afsluiting*

### *B.1.4 Interview with Mr. van Bruggen, CROW*

Summary of interview
Name: Mr. van Bruggen
Function: Project manager Procurement and Contracts at CROW.

**Sustainability**
CROW does not use a specific definition. I think that finding a optimal balance between the 3 P's should be the goal of sustainability. The central team "Doorontwikkeling van Duurzaam Inkopen in de GWW" (further development of sustainable procurement in the civil engineering sector) decided that we will not search for a definition, because it is impossible considering all different points of view. CROW has no goals concerning sustainability, it is a neutral foundation that does what the sector is asking for.

**Output specification and EMAT**
EMAT can be seen as hinge between traditional and innovative building models. Using EMAT will encourage the use of D&C models. Clients have to think of what they really want; they should encourage contractors to offer sustainable solutions. Clients should not specify exactly what they want; but transfer responsibilities en possibilities to contractors. The more work a single person gets to do, the more responsibility he feels to achieve a good result. Contractors should have a personal affinity with sustainability and they should get a financial incentive.
Try to specify only 2 or 3 EMAT criteria. In advance you have to think carefully on how to measure these criteria, it takes a lot of communication and you have to be open.

**Value of Sustainability.**
CROW prefers to use the report "Gunnen op Waarde". Learn how to use it, before you use it, it is not a 'magic wand' for solutions. We are used to translate our values into euros. In case of sustainability it is difficult to make this translation, because most values are subjective. To be able to give a value to these subjective parameters of sustainability you should use a jury, an expert group that compares alternatives.

**Co-operation between Client and Contractor**
It depends on the sort of project. Sometimes you just have to do the job, in simple projects. Not all projects have to be done within innovative building models, finding a good balance between using a traditional and an innovative model is what it is all about.

**Innovation and D&C**
The concept of using "Open Licences" is not supported by all parties yet. I think it is a matter of trust. A

**Other**
A tension can be found between functional specification and integration into the public environment. The integration into public environment will result in specific demands. All small projects have to form one big liveable city. What it is all about is that the client should know what he wants, and that the contractor knows what he wants. The allocation of tasks is changing. We used to sit on top of things, now we have to let go.

**Interview dhr. van Bruggen**

Met: dhr. van Bruggen (Paul)
Locatie: CROW, Ede
Datum: 9.00u 25 juni 2010

*(De nummering van vragen verloopt volgens een volledige vragenlijst, niet alle vragen uit die lijst zijn bij de interviews gesteld, onderwerpen die buiten de vragenlijst vielen en wel besproken zijn is in kaders geplaatst)*

*Allereerst zou ik u willen vragen om u voor te stellen*.

1) Wat is uw functie?

Ik ben projectmanager Aanbesteden & Contracteren. Ik houd mij bezig met duurzaam inkopen en aanbesteden. Ik begeleid de leidraad aanbesteden en de online tool DSS, die daarbij hoort. Ik werk ook aan de aanbestedingskalender en ik begeleid het platform geïntegreerd contracteren. Ik ben geen specialist op het gebied van contracteren. Dat doet een andere programmamanager. Het is opgedeeld in Aanbesteden & Contracteren, ik doe het deel 'Aanbesteden'.

2) Wat is uw expertise?

Mijn achtergrond is Civiele Techniek, ik ben Beton en Staal constructeur geweest. Ik ben 6 jaar beton- en staalconstructeur geweest. Vervolgens heb ik bij verschillende gemeentes gewerkt, van Didam, Bunnik, Harderwijk en Apeldoorn. Daarna ben ik drie jaar hoofd grondbedrijf en publiek private samenwerking geweest bij de Dienst Landelijk Gebied.

3) Met welke delen van de bouwcyclus heeft u te maken?

Met name de aanbesteding. Ik doe sinds kort het project netwerkorganisatie.

4) Hebt u ervaring met D&C projecten binnen UAVgc?

Ik heb er zelf geen specialistische kennis van geïntegreerde contracten. Ik heb wel iets soortgelijks gedaan in Apeldoorn destijds bij de gemeente, maar dat was meer PPS. Ik zit wel in het platform geïntegreerd contracteren, waar bijvoorbeeld prof. Dorée van de Universiteit Twente ook in zit.

*Dan zou ik graag willen weten wat uw beeld is ten aanzien van Duurzaam Inkopen.*

5) Wordt er binnen *uw organisatie/ door uzelf* een bepaalde definitie gehanteerd voor het begrip duurzaamheid in de bouw?

Nee, er is geen officiële definitie. Zelf zie ik het als het vinden van een optimum tussen de 3 P's. Ik zit ook in een centraal team voor de Doorontwikkeling van Duurzaam Inkopen in de GWW (net als dhr van Amstel). Daar hebben we gezegd ook niet naar een definitie te gaan zoeken, omdat we daar niet uitkomen.
Momenteel ligt de focus erg op de P van Planet, met name een milieuvriendelijke bedrijfsvoering en materialisering. We zoeken naar een manier om de sector te kunnen verleiden. Voor welk thema is de meeste behoefte, voortgang en draagvlak voor te vinden? Dat lijkt dan te komen op energie, water en CO2 uitstoot. Dat zijn items waar we de komende jaren echt mee doorgaan. Er zijn nog een paar andere thema's, maar als we het allemaal willen gaan doen in de GWW, dan schiet het niet op. Dan krijg je oeverloze discussies over iets wat eigenlijk nauwelijks invloed heeft uiteindelijk.

6) Heeft *uw organisatie* doelstellingen ten aanzien van Duurzaam inkopen?

Nee, dat heeft te maken met de positie van CROW. CROW is een neutrale stichting die gepositioneerd is tussen OG, ON en ingenieursbureaus. Wij doen dat waar de sector behoefte aan heeft en hebben niet een specifieke doelstelling voor onszelf. De enige doelstelling is het ondersteunen van de sector.

7) Hoe worden deze doelstellingen ten aanzien van het bereiken van een duurzame bouw meegenomen in het aanbestedingsproces?

Dat is iets wat nu speelt. Verschillende grote opdrachtgevers vinden de vastgestelde criteria van AgentschapNL voor de GWW echt het minimum niveau voor de GWW. We worden er niet echt warm

van. We willen een doorontwikkeling van Duurzaam Inkopen in de GWW realiseren. Daar zijn we nu mee bezig met een aantal sporen (zie ook interview van Amstel). Zo hopen we in de sector met draagvlak van allemaal OG's in de sector tot een systeem te komen om duurzaam te bouwen.

*Dan gaan we door naar de zaken waarmee de opdrachtgever een belangrijke rol speelt. De Vraagspecificatie en de Selectie en Gunningcriteria.*

*Met het oog op duurzaamheid kan er een afweging gemaakt worden of de beoogde duurzaamheidaspecten onder de minimum eisen of onder de selectie/gunningcriteria moeten vallen.*

8) Hoe bepaalt een opdrachtgever of een eis binnen de VS(minimum eisen) danwel binnen de selectie/gunningscriteria wordt opgenomen?

Voor de selectie kijk je of een bedrijf iets heeft met de vraag die je stelt, met de gunning kan je nog eens extra stimuleren om met duurzame oplossingen te komen. Daar is EMVI dan belangrijk, je zou met incentives kunnen komen.
Het is belangrijk dat OG echt nadenkt van wat zij belangrijk vinden in een project, of dat duurzaamheid is. Hoe zij de ondernemingen willen stimuleren om daar ook met duurzame voorstellen te komen. Dan moet je niet alles gaan voorschrijven, maar dan moet je de verantwoording en ook de mogelijkheid geven aan ON om met duurzame oplossingen te komen.

9) Ziet u beperkingen in het opstellen van minimumeisen mbt duurzaamheid?

Wat je in de markt ziet is een soort vrees voor een aantal componenten. Je ziet een soort vrees om geïntegreerd te contracteren. Dat is ook afhankelijk van welke OG's, RWS raakt er steeds meer aan gewend. Bij decentrale overheden zie je dat nog nauwelijks. Daar zie je nog veel RAW contracten. Ook met RAW contracten kun je duurzaamheid bevorderen. Maar als je het echt hebt over het hele traject, beheer onderhoud en sloop, dan kan ik me voorstellen dat je de markt beter kunt stimuleren als je het op het hele traject doet. Dan kijk je meer naar D&C, DBM of DBMO.

*Dus u zegt de M variant moet er altijd bij zitten?*

Algemeen gezegd: Hoe kleiner je de verantwoordelijkheid legt bij een bepaalde speler in de bouw, hoe minder hij zijn creativiteit zal aanboren. Hoe breder je iemand inzet, hoe meer hij wordt geprikkeld om mee te denken over creatieve en levenscyclus oplossingen.

*Heeft dat te maken met dat iemand betrokken moet zijn?*

Een combinatie, je moet persoonlijk gebonden zijn en een financiële prikkel hebben.

10) Hebt u ervaring met het toepassen van EMVI?
    a. Kunt u een voorbeeld geven van een project waar u dit hebt toegepast?
    b. Welke criteria werden hierin opgenomen?

Nee, we doen geen projecten bij CROW.
EMVI is bij het platform GC als meest belangrijke punt gepakt om GC te kunnen stimuleren en te verbeteren. Volgens mij zou het een boost geven als je mensen kunt verleiden om toch meer te gunnen op waarde of EMVI. Dus in mijn ogen is het misschien wel het belangrijkste scharnierpunt om van traditioneel naar GC over te kunnen gaan.

*Een methode die toegepast kan worden om te bepalen hoe en welke aspecten in een VS of EMVI terugkomen is Value Management. Een belangrijk punt hierin is om de waarde te bepalen van duurzaamheid, zoals we net besproken hebben.*

11) Wordt deze methode gebruikt binnen *uw Advieswerk*? Hoe wordt het toegepast? Voorbeelden?

Ik ken de methodiek wel, maar ben geen specialist.

Met het centrale team zijn we op zoek om voor elke fase in de bouw te bepalen hoe duurzaam iets is. Ook in het kader van functioneel specificeren. Dat staat allemaal in de kinderschoenen. Momenteel gebruiken we bijvoorbeeld voor de duurzaamheid van de bedrijfsvoering de $CO_2$Ladder, voor de materialisering kan DuboCalc worden ingezet. Er zijn nog een aantal andere tools, maar deze twee gebruiken we momenteel.

*Binnen een VS of een EMVI worden de eisen al dan niet direct omgezet in een waarde.*

12) Gebruikt u een methode om de waarde die in EMVI vertegenwoordigd wordt te bepalen?

Wij zijn voorstander van 'Gunnen op Waarde'. Je moet er wel kennis van hebben om het te kunnen toepassen, zie het niet als toverstokje.

13) Wat ziet u als waarde in duurzame criteria voor de beheer-, onderhoud- en sloopfase?

In jouw studie is het erg belangrijk om beheer, onderhoud en sloop daarin mee te nemen. Dan moet je dat op de een of andere manier handen en voeten geven in je EMVI criteria.

14) Hoe zou u die waarde willen laten vertegenwoordigen in het aanbestedingsproces? (vraag is omgevormd naar welke problemen er zijn om duurzaamheid uit te vragen in het aanbestedingsproces)

De aanbesteding moet voldoen aan verschillende juridische eisen, zoals transparantie en non-discriminatie. Dat maakt het lastig manoeuvreren.
Het tweede wat speelt zijn de verschillende budgetten/afdelingen binnen de organisatie van de OG. Het budget voor de realisatie is niet dezelfde als die van beheer en onderhoud. Als verantwoordelijke voor realisatie niet meetbaar kan maken dat bij een hogere investering de kosten voor beheer en onderhoud afneemt, dan zal hij dat budget niet krijgen van die afdeling. Daarnaast is er ook wel wantrouwen tussen die twee afdelingen, want misschien gebruik je het budget niet voor dat wat je voorgesteld had.

*Het is lastig om sommige waardes echt in Euro's uit te drukken.*

Waarde moet zoveel mogelijk objectief en meetbaar gemaakt worden. Neem landschappelijke inpassing, dat een waarde die moeilijk te meten is. Bij aanbesteden moet het toch objectief meetbaar gemaakt worden. Maar in dit geval is het dan subjectief. Je kunt dan met juryleden werken, maar dat is iets waar we aan moeten wennen. Van oudsher waren we gewend het allemaal monetair te doen. Zo is de RAW ontstaan. Als het allemaal om geld gaat, moeten we die kwaliteit heel goed beschrijven. Soms ontkom je niet aan subjectiviteit.

15) Zou u gezien de vele aspecten die vanuit OG gestuurd kunnen worden binnen een EMVI, het criterium voor duurzaamheid in de O&M fase mee willen nemen in de EMVI?

De eerste keer dat je leest dat minstens 40% van de gunningswaarde kwaliteit moet zijn en niet prijs, dan is dat even wennen. Je moet echter niet heel veel aspecten willen omschrijven waarop gescoord kan worden. Kies er twee of drie. Als ik iemand vraag om 100 aspecten mee te nemen, dan zal het te ingewikkeld worden, dan krijg je een standaard oplossing. Maar richt je je specifiek op twee of drie aspecten, dan kan je verwachten dat dat wel goed wordt meegenomen.
Het blijft wel dat het goed meetbaar moet zijn, en daar moet je van te voren heel goed over nadenken. Dat vergt veel communicatie en je moet je kwetsbaar opstellen. Het is leuk, maar niet altijd makkelijk.

*Een ander aspect wat binnen VM van belang is is om na de conceptfase (voor de haalbaarheidsstudie) alle belangrijke stakeholders bij elkaar te brengen, actoren die beslissingen kunnen maken.*

16) Zou u als opdrachtgever samen met opdrachtnemer en onderaannemers in een vroeg stadium willen werken aan alternatieven?

Dat zou bij een project moeten kunnen. Het heeft weinig nut bij simpele opdrachten. Je moet dus ook weer niet gaan overdrijven. Soms moet je met de voeten in de klei, er moet gewoon iets gebeuren. Niet alles moet geïntegreerd gedaan worden. Je moet daar een leuk evenwicht in vinden, daar komt het op neer.

*Voor een ON lijkt er weinig motivatie te zijn om met innovatieve ideeën te komen voor de OG. Impliciet hebben we het hier al over gehad. In de UAVgc en de regelgeving rondom aanbesteding zal het lastig zijn om nieuwe ideeën in te brengen, door de beginselen van transparantie zal informatie van ON snel uit kunnen lekken. Level of playing field en cherry picking zijn gevaren die op de loer liggen.*

20) Bent u van mening deze ontwikkelingen een negatieve invloed hebben op innovatie in de bouw?

Voor de open licentie is nog niet bij iedereen evenveel draagvlak. Ik denk dat het te maken heeft met vertrouwen. Maar ook hoeveel waarde we eraan hechten.

*Afsluiting*

- Nog een open vraag: nog iets te melden?

Je onderzoek is vrij breed, erg interessant, je kunt het breed houden, of een punt eruit halen en daar dieper op ingaan.

Over functioneel specificeren:
Er is een spanningsveld tussen functioneel specificeren en het inpassen in een groter geheel, in een concrete openbare ruimte. Daaruit volgen namelijk wel specifieke eisen. Als je allemaal kleine projecten functioneel gaat specificeren raakt het geheel van die projecten versnipperd. Alle kleine projecten moet wel weer een leefbare gemeente opleveren. Het is geen doel op zich om geïntegreerd te gaan contracteren. RAW is ook een prima middel.
Waar het om gaat is om duidelijk te krijgen wat de overtuiging is van de OG en de overtuiging van de ON wat ze moeten doen. Het komt toch altijd aan op hele goede samenwerking. De verdeling van taken blijft altijd een onderwerp. Die verdeling verandert. Het is een andere manier van denken. We moeten dingen loslaten, terwijl we vroeger er bovenop moesten zitten.

### *B.1.5 Interview with Ms. Duineveld, BouwendNederland*

Summary of interview
Name: Ms. Duineveld
Function: policy officer economics and association matters at BouwendNederland.

**Sustainability**

BouwendNederland is using a definition for sustainability but I have not got it by hand.
The concept ‘Sustainability’ is abstract. It can be compared to abstract concepts as ‘Communication’ or ‘Flow’. Sustainability has to be defined in guidelines. When these guidelines are clear and acknowledged by the market it is possible to use it. These guidelines are not the truth, but we are able to work with it, we know what to expect. The government should make clear policy how they are going to deal with sustainability; then the market is able to cope with it.
Sustainability is about making a cycle from initiative to demolition. It depends on personal value what to measure within this cycle, energy or waste for example.

**Output specification and EMAT**

A demand has to be proportional to the desired result. Asking for FSC wood while no wood is used in a project does not make sense. Sustainability is already present in most specifications or EMAT, it is part of other demands. If a client is asking for ‘reliability’ then ‘sustainability’ is also taken into consideration. For the aspects of sustainability that are missing a ‘total package’ has to be asked for specifically in award criteria focussing on $CO_2$ or waste reduction.

**Value of Sustainability.**

We are supporting CROW’s “Gunnen op Waarde”. This guideline should be the rules of the game. The industry is not yet familiar with applying this approach.

**Co-operation between Client and Contractor**

As a client you have to know on what to focus on. This makes it possible to focus on specific contractors, suppliers. Contractors have to enter into partnerships to optimize their supply chain. D&C encourages the forming of partnerships. Forming these partnerships eliminates a lot of initial work, like cost calculations, in partnerships you have made arrangements already. Suppliers will get closer to the client and be able to better understand their demands.
Clients in the other way have to define a clear policy, so the partnerships know where to focus on and what to develop. Already some partnerships have taken advantage of supply chain management and produced new products together.

**Innovation and D&C**

Client and contractors should be starting a dialogue sooner. The client has to reduce the amount of competitors as soon as possible. At the moment jurisdiction is missing on how to deal with dialogues; this will change over time.
If it is difficult to manage a risk client and contractor should deal with this risk together. A bottleneck occurs when new techniques are never tried in real time, within an existing project.
Time in a tender phase does not influence innovation. For innovation a lot more time is needed.
A good question will result in a good answer. If a client is not able to state a good question he should state what he specifically wants.

**Other**

For a company it has to be clear what is asked, and how to score on it. At the moment companies are not working on sustainability, because they are not asked to do it, or they are not paid for doing it.
Another important remark is: companies are already doing a lot of sustainable development, they just do not know it. Maybe they have to alter little things to be even more sustainable.

**Interview mv. Duineveld**

Met: mv. Duineveld (Marieke)
Locatie: BouwendNederland, Zoetermeer
Datum: 10.00u 28 juni 2010

*(de nummering van vragen verloopt volgens een volledige vragenlijst, niet alle vragen uit die lijst zijn bij de interviews gesteld, onderwerpen die buiten de vragenlijst vielen en wel besproken zijn is in kaders geplaatst)*

*Allereerst zou ik u willen vragen om u voor te stellen.*

1) Wat is uw functie?

Ik ben beleidsmedewerker economische- en verenigingszaken. Ik houd mij bezig met belangenbehartiging en ondersteuning van bedrijven. Ik werk nu 5 jaar bij BouwendNederland, met name richting decentrale overheid en het laatste jaar specifiek op RWS en prorail. Ik ben nu betrokken bij het centrale team van de doorontwikkeling Duurzaam Inkopen voor de GWW. Hoe ga je duurzaamheid nu toepassen in de projecten, met name binnen Geïntegreerde Contracten? We zijn een intermediair tussen bedrijven en (semi)-overheidsinstanties.

2) Wat is uw expertise?

Ik ben afgestudeerd aan de universiteit van Wageningen. Binnen Bouwend Nederland met name betrokken bij projecten omtrent vernieuwend aanbesteden.

3) Met welke delen van de bouwcyclus heeft u te maken?

Ik werk vooral in het voortraject, de tenderfase, op het moment dat de 'concurrentiefase' ingaat stappen wij eruit. Als branchevereniging hebben wij daar niets te zoeken. Wij hebben een blik voor de langere termijn, waarin we proberen de rollen van de markt en de overheid beter te kunnen vormgeven. De veranderingen waar wij nu zitten, van heel erg RAW, naar meer openheid van de markt, moet meer vormgegeven worden. Ook vanuit juridisch oogpunt bekeken. Met als menselijke factor de vraag hoe je het beste kunt samenwerken, zonder meteen in juridische aspecten te belanden.

4) Heeft u ervaring met D&C projecten binnen UAVgc?

Nee, wij houden ons bezig met de fases ervoor en erna. Je ziet na de gunning uitdagingen ontstaan tussen de markt en de overheid. En dan heb ik het over langere trajecten, we doen niets projectspecifiek. Wij houden bijvoorbeeld wel de ontwikkelingen bij van de $CO_2$ ladder van ProRail, om vervolgens sector breed (het marktcollectief) te vragen hoe dat ervaren wordt. Dat is de intermediaire rol die wij hebben.

Bij D&C en UAVgc is de projectbeheersing lastig. ON moet aantoonbaar maken wat er is gedaan. De OG wil best ruimte geven, maar wil wel weten wat er gebeurt. Vooraf moet er veel meer op papier gezet worden door de ON wat hij gaat doen en hoe. De OG zegt de markt vrij te willen laten, maar wil er continue bovenop zitten. De ON geeft aan dat hij het wel kan, maar moet dat vervolgens aantonen in procesbegeleiding. Dit is anders dan werken met het RAW, waarin alles letterlijk op papier staat. Daar zit wel een slag in taak en verantwoordelijkheid.

*Dan zou ik graag willen weten wat uw beeld is ten aanzien van Duurzaam Inkopen.*

5) Wordt er binnen *BouwendNederland* een bepaalde definitie gehanteerd voor het begrip duurzaamheid in de bouw?

BouwendNederland hanteert een definitie, maar deze heb ik even niet bij de hand.

6) Heeft *BouwendNederland* doelstellingen ten aanzien van Duurzaam inkopen?

(Vraag is niet letterlijk zo gesteld, antwoord komt uit de vorige vraag)

Ik denk dat het begrip duurzaamheid te vergelijken is met een begrip als 'communicatie', dat is ook abstract. Een ander voorbeeld is doorstroming. Waar het dan om gaat is dat je richtlijnen met elkaar afspreekt. Zodra iedereen weet hoe die richtlijnen eruit zien kan er mee gewerkt worden, dan weet

men hoe het aangeboden moet worden en hoe de markt er op in kan spelen. Of die richtlijnen nu de waarheid is, dat denk ik niet, maar je kunt er mee verder. Die uitdaging ligt er nu ook voor duurzaamheid.

Duurzaamheid is ook business, onderscheidend vermogen van een bedrijf. We moeten gewoon zien dat het een onderdeel is van de markt. Als er vraag naar is of je kunt vraag creëren, dan valt er geld te verdienen.

*Ik zie het begrip duurzaamheid binnen mijn onderzoek als een vorm van product- of procesinnovatie die het gebruik van materiaal/energie/water minimaliseert en de flexibiliteit maximaliseert tijdens de beheer en onderhoudsfase en de hoeveelheid afval minimaliseert tijdens de sloopfase.*

Eigenlijk kijk je naar de cirkel die je met elkaar maakt, van initiatief tot sloop. Hoe het binnen die cirkel eruit ziet is persoonsafhankelijk, of het nu om energie gaat of afval.
Binnen D&C contracten is het van belang dat een OG beleid maakt voor meerdere jaren. Je geeft dan een signaal aan de markt waarop ze kunnen gaan scoren in de toekomst. In de uitvraag moet ook heel duidelijk naar voren komen dat er gescoord kan gaan worden op duurzaamheid. Je moet wel beleid of richtlijnen maken waarin je aangeeft welk aspect van duurzaamheid belangrijk gevonden wordt, er zijn te veel aspecten mogelijk, dus je moet kiezen. Prorail doet dat bijvoorbeeld op het aspect $CO_2$, RWS op materialen.

*Dan gaan we door naar de zaken waarmee de opdrachtgever een belangrijke rol speelt. De Vraagspecificatie en de Selectie en Gunningcriteria.*

*Met het oog op duurzaamheid kan er een afweging gemaakt worden of de beoogde duurzaamheidaspecten onder de minimum eisen of onder de selectie/gunningcriteria moeten vallen.*

8) Hoe hebt u bepaald of een eis binnen de VS(minimum eisen) danwel binnen de selectie/gunningscriteria werd opgenomen?
9) Ziet u beperkingen in het opstellen van minimumeisen mbt duurzaamheid?

De gestelde eisen moeten wel proportioneel zijn. Men zoekt naar vaste items, die misschien helemaal niet relevant zijn voor het project, zoals FSC hout vragen, terwijl er geen hout in het project voorkomt. Of ISO 14001, zonder te weten wat je daar eigenlijk mee verwacht te bereiken. Dat klinkt dan interessant en duurzaam.

10) Hoe komt dat? Heeft dat met meetbaarheid te maken?

Misschien. Wat ik me afvraag is of duurzaamheid niet al veel meegenomen wordt in projecten, zonder dat dat specifiek zo genoemd wordt. Als je bijvoorbeeld in je plan ‘minimale verkeersbewegingen’ meeneemt, zit daar al een vorm van duurzaamheid in. Zo valt een groot deel van duurzaamheid misschien al onder bekende aspecten, en moet je misschien nog een beetje aandacht vragen voor afval of $CO_2$ beperking. Zo maak je er meer een *total package* van, dan dat je 5% duurzaamheid los eraan koppelt.

11) Heeft u ervaring met het toepassen van EMVI?

> Later toegevoegd ter informatie: Vanuit BNL zijn wij niet betrokken bij EMVI aanbestedingen. Wij houden ons wel bezig met samenwerking met bedrijven, overheden en kennisinstituten met de richtlijnen mbt toepassen van EMVI.

Wil je zorgen dat bedrijven investeren in hun aanbieding, dan moet je daar ook echt wel wat tegenoverstellen. Die fictieve korting. Stel je neemt een verdeling van 20/15/5 voor drie verschillende aspecten, en het aspect duurzaamheid is 5%, is dat dan voldoende gewicht om de markt te triggeren? Dat hangt helemaal af van de vraag hoeveel tijd erin gestoken moet worden om dat goed in het plan te verwerken.

Ik denk dat je duurzaamheid aan de andere aspecten moet koppelen. Om zo een groter aandeel duurzaamheid te krijgen. Je kunt denken aan een databank of richtlijnen. Neem bijvoorbeeld het aspect doorstroming, daar zit duurzaamheid in, dan kan je dat goed verwerken. We moeten meer in onze vingers krijgen dat we naar het totale ontwerp kijken, niet naar 3 of 4 losse aspecten. In het totale ontwerp moet duurzaamheid verweven zijn. Als je dan nog iets mist dan moet dat in de gunning terugkomen, dan moet daar iemand zich op kunnen onderscheiden.

*Een methode die toegepast kan worden om te bepalen hoe en welke aspecten in een VS of EMVI terugkomen is Value Management. Een belangrijk punt hierin is om de waarde te bepalen van duurzaamheid, zoals we net besproken hebben*.

12) Wordt deze methode gebruikt binnen *uw Advieswerk*? Hoe wordt het toegepast? Voorbeelden?

Het is wel bekend bij BouwendNederland, maar we zijn er niet actief mee bezig. We houden ons nu vooral bezig met Systems Engineering. Value Management kan van pas komen bij grote gebiedsgerichte projecten waarbij bestuurlijke keuze nog gemaakt moeten worden.

*Binnen een VS of een EMVI worden de eisen al dan niet direct omgezet in een waarde.*

13) Gebruikt u een methode om de waarde die in EMVI vertegenwoordigd wordt te bepalen?
    a. Welke dan?

Wij steunen de CROW aanpak, ‘gunnen op waarde’. Dat moeten de spelregels zijn binnen de sector. Tijdens presentaties die ik geef, waar deze methode ook even kort genoemd wordt, valt het mij op dat niet iedereen weet hoe het werkt. De systematiek is vrij simpel, maar ze hebben veelal het ‘rekensommetje’ nooit gezien. Je ziet wel dat EMVI meer gebruikt wordt bij het Rijk, maar bij de decentrale overheid lijkt het soms zelfs achteruit te gaan. RAW wordt nog veel toegepast en vinden het moeilijk om begrippen zoals duurzaamheid daarin toe te passen.

*Een ander aspect wat binnen VM van belang is is om na de conceptfase (voor de haalbaarheidsstudie) alle belangrijke stakeholders bij elkaar te brengen, actoren die beslissingen kunnen maken.*

17) Zou u als opdrachtgever samen met opdrachtnemer en onderaannemers in een vroeg stadium willen werken aan alternatieven?
    a. Hoe zou u dat willen vormgeven?

Als je een aanbesteding publiceert dan is het vrij kort tijd om de markt erbij te betrekken. Van te voren moet je bepalen waarop je gaat focussen. Dan heb je een trigger dat je weet op welke leveranciers je moet richten. Daarnaast speelt ketensamenwerking een belangrijke rol. Men zoekt veel meer partnerships met bepaalde partijen op, niet meer in van die hokjes waar we nu inzitten. Ook D&C versterkt de vorming van partnerships.

18) Welke nadelen ziet u met een dergelijke vroege samenwerking?

Wat je nu ziet is dat er niet heel efficiënt wordt gewerkt. Veel gaat ad hoc. Zo zie je bijvoorbeeld dat bij een aanbesteding dezelfde leveranciers terugkomen bij verschillende aanbieders. Er komt ook veel rekenwerk bij kijken. Als je van te voren afspraken maakt over samenwerking, dan scheelt dat veel werk in het zoeken naar geschikte partners per project. Zo kunnen leveranciers ook veel dichter bij de hoofdaannemer en opdrachtgever komen.
Vanuit de OG moet er dan ook een duidelijk beeld geschept worden wat zij gaan doen de komende tijd, zodat de markt daarop kan inspelen, en met echt onderscheidende aanbiedingen kunnen komen. Je ziet nog weinig ketensamenwerking in de sector, maar de bedrijven die er mee bezig zijn hebben daar hun voordeel mee gedaan. Die hebben samen met partners producten ontwikkeld.

*In mijn ogen is duurzaamheid een vorm van innovatie, danwel het proces danwel het toepassen van producten die niet eerder zijn toegepast om bepaalde duurzame aspecten te stimuleren. Met deze insteek zijn er volgens de literatuur enkele zaken die vanuit de OG gestuurd kunnen worden om innovatie de ruimte te geven:*

20) Kunt u kort per punt aangeven wat uw mening is over de toepassingsmogelijkheid van deze punten als OG?

    a. Vroege transfer van OG naar ON

Je moet denk ik vroeg de dialoog aangaan. Hoe eerder de bouw erbij betrokken is, hoe meer de bouwbedrijven zijn kennis in kan brengen, in de initiatieffase. Hoe eerder hoe beter, maar begrijp ook dat het soms gewoon lastig is. Ja kunt veel meer de dialoog aangaan, maar je moet ook eerder trechteren, sneller bedrijven laten afvallen in het proces. Zodat opdrachtnemers kunnen investeren in de tijd die ze besteden aan een aanbesteding.
Momenteel is er nog angst voor juridische geschillen, maar daar is ook nog veel onwetendheid, er is wel ruimte binnen de aanbesteding voor een dialoog.

    c. De OG moet meer risico durven nemen en garanties te geven voor innovatie delen van het contract

Je moet vooral kijken naar beheersbaarheid, wie kan wat beheersen. Wie het kan beheersen moet de garantie geven en de verantwoordelijkheid nemen. Maar er zijn aspecten die moeilijk beheersbaar zijn, door welke partij ook, dat moet met ervaring steeds meer helder worden.
Je ziet nu dat nieuwe technieken niet worden geaccepteerd, dat is een bottleneck voor innovatie. Als je het nergens mag proberen dan ga je nooit ervaring op doen. Er is wel ontwikkeling te zien waarbij beide partijen dan een deel van het risico op zich nemen.

    d. Er moet voldoende tijd zijn voor de tenderfase

Als het om innovatie gaat dan heeft deze tijd daar geen invloed op. Innovatieve producten moeten al op de plank liggen om in te passen, als die nog bedacht moeten worden tijdens de tenderfase dan ben je te laat.

    e. Er moeten zo min mogelijk limieten zijn voor de ON, in keuze van methodes en dergelijk

Bij een goede vraag krijg je een goed antwoord. Als je geen goede vraag kunt stellen, stel hem dan maar niet. Stel dan maar gewoon wat je wilt hebben. We noemen het niet meer oplossingsvrij specificeren. Oplossingsvrij is eigenlijk niet te doen, want geen oplossing is zomaar vrij, je krijgt een hoop zaken mee waar dingen gedaan moeten worden. Je moet dan wel heel goed kunnen aangeven wat je dan wil. Zonder dat je dan weer te beperkend bent. De komende jaren zijn wij nog wel bezig met de vraag hoe functioneel te specificeren, met D&C en duurzaamheid, hoe stel je nou de vraag aan de markt?

*Voor een ON lijkt er weinig motivatie te zijn om met innovatieve ideeën te komen voor de OG. Impliciet hebben we het hier al over gehad. In de UAVgc en de regelgeving rondom aanbesteding zal het lastig zijn om nieuwe ideeën in te brengen, door de beginselen van transparantie zal informatie van ON snel uit kunnen lekken. Level of playing field en cherry picking zijn gevaren die op de loer liggen.*

21) Bent u van mening deze ontwikkelingen een negatieve invloed hebben op innovatie in de bouw?
    a. Waarom?

Waar het om gaat is de relatie die ON heeft met OG, hoeverre ON zijn idee kwijt kan en hoe OG daar mee omgaat. Binnen de dialoog zou je dit kunnen vormgeven.
Binnen een bedrijf is het belangrijkste dat er een heldere vraag ligt en het moet helder zijn dat je daar op kan scoren. Bij ProRail zie je dat de $CO_2$ ladder een fictieve korting kan geven van 10%, dat is een heel sterke financiële trigger. Dan willen bedrijven er wel tijd in steken, maar we hebben nog een hele weg te gaan.

Afsluiting

- Nog een open vraag: nog iets te melden?

De opdrachtgevers besteden nog steeds niet duurzaam aan. We moeten goed onthouden wat het doel is met duurzaamheid, duurzaam inkopen an sich, waarom je het doet. De criteria van AgentschapNL of de $CO_2$ ladder is niet het doel, dat is een middel. Uit de markt zien we dat er veel duurzaam mogelijk is. We komen bij de aanbesteding er niet aan toe, omdat het niet gevraagd wordt en omdat het niet betaald wordt. We proberen daar ruimte voor te scheppen, maar het zit in het aanbesteden. De overheid moet met de markt nadenken over oplossingen. Met Maatschappelijk Verantwoord Ondernemen hebben we een soortgelijke discussie. Men heeft vaak niet door dat ze al duurzaam bezig zijn. Bedrijven moeten bewust zijn wat ze al wel doen en wat nog niet, en dan daar op inspringen.

### *B.1.6 Interview with Mr. Schweitzer, Rijkswaterstaat*

Summary of interview
Name: Mr. Schweitzer
Function: Developer of DuboCalc at Rijkswaterstaat

**Sustainability**
Rijkswaterstaat considers landscaping, environmental burden of material production and efficient energy-use as three main pillars of sustainability.
DuboCalc does not prefer the use of specific materials. The total environmental load of material-use and energy-use has to be taken into account of a design to be able to choose a material.

**Output specification and EMAT**
Rijkswaterstaat developed a protocol in which it stated that sustainability can be described in three forms of demand in a procurement process: within a award criterion, a performance demand or a process demand. We aim at using award criteria, but the other two are not excluded.
The biggest restriction of demanding sustainability is financial budget.

RWS tries to specify as functional as possible. Contractors are offering a design with corresponding price and MKI (Environmental Cost Indicator). The contractor has to prove if his MKI is reasonably feasible. But we do not check it in detail. In the end if the contractor does not live up to his promise he will be fined. We are using system oriented contract management to verify and validate the contractors work concerning this MKI, during the whole process.

**Value of Sustainability.**
Calculations from DuboCalc result in a MKI. It is a score, for example 100MKI. The lower the score the better design. Cost calculators estimate the amount of work that is needed to score better. For example, to alter a design to score 75 instead of 100 it will cost one million. Then RWS will offer 1.6 million to encourage a contractor to come up with a good solution.
DuboCalc uses shadow pricing as method to translate several environmental effects into Euros.

**Innovation and D&C**
If a client specifies his demands very technically, a contractor is not able to do what he is good at. You should always award a contractor for innovation. The bigger the assignment, the better the contractor can integrate his business model into the work.
During the tender phase innovation has to be developed already. No tender phase will be long enough to develop an innovation.
Restrictions and guidelines are always necessary. Finding a balance between setting restrictions or not is the real question.
The intellectual property of a contractor should be protected. RWS has made some arrangements on this in the past.

**DuboCalc specific**
DuboCalc is a Lifecycle assessment tool with a focus on material-use in the civil engineering sector. In relation to the other five interviews this interview was more oriented towards to possibilities and development of DuboCalc.
The application makes it possible to give a view about the sustainable performance of a specific design. It allows to compare alternative designs on the criterion ‘sustainability’. The tool gives an overview of several key performance indicators for the design, build, operate, maintenance and disposal stages of a construction.
It is possible to implement new materials into DuboCalc. It has has to apply to some conditions, the material should be available to the market and it should be included in the National Environment Database.
DuboCalc connects to the new procurement formats. It balances low tender costs on one side and high amount of detail on the other side.

**Interview dhr Schweitzer**

Met: dhr. Schweitzer (Gerwin)
Locatie: Rijkswaterstaat, Utrecht
Datum: 13.00u 28 juni 2010

*(de nummering van vragen verloopt volgens een volledige vragenlijst, niet alle vragen uit die lijst zijn bij de interviews gesteld)*

*Allereerst zou ik u willen vragen om u voor te stellen.*

1) Wat is uw functie?

Ik ben werkzaam bij de afdeling Waterbouw en Milieu, dienst infrastructuur bij RWS. Ik houd mij bezig met de ontwikkeling van DuBoCalc. Dit programma hebben we de afgelopen 2 jaar geschikt gemaakt voor Duurzaam Inkopen. Daarnaast ben ik ook programmamanager Kennis en Vernieuwing.

2) Wat is uw expertise?

Milieukunde

3) Met welke delen van de bouwcyclus heeft u te maken?

Ik werk aan de ontwikkeling van DuboCalc, dat is in feite een Levenscyclus Analyse model. Daar kijk ik naar alle fases van de bouwcyclus.

4) Kunt u kort weergeven wat DuboCalc doet, wat het doel ervan is?

Het is vooral een inkooptool. Dit model moet geschikt zijn om op het moment van inkopen een oordeel te kunnen geven over de duurzaamheidprestaties die aangeboden of verlangd wordt.
DuboCalc is vergelijkbaar met het kostencalculatie model. In plaats van dat het de kosten (euro's) in beeld brengt, brengt het de milieukosten in beeld. Op hoofdlijnen stuurt het model op materiaalkeuze, materiaalhoeveelheid en het energiegebruik in de gebruiksfase. Van invloed is de beheer- en onderhoudcyclus en de milieuprestatie van het produceren van het materiaal. Daar waar de transportafstand dominant is voor de milieubelasting hebben we ook de transportafstand in beeld gebracht. Dit is bijvoorbeeld het geval bij grond transport. Grond wordt niet geproduceerd, enkel opgegraven getransporteerd en toegepast. In een aantal gevallen kan je ook het onderhoudscenario, of de levensduur van het materiaal aanpassen. Zo kan je de milieuprestatie optimaliseren. Voor het berekenen van scenario's en de levensduur hebben we voor sommige gevallen ook modellen, waaraan de aannemer zich moet houden. De resultaten van die modellen zouden dan als geldige reden kunnen worden aangedragen om defaultwaardes in de software van DuboCalc aan te passen, als het gaat om onderhoud of levensduur.

Het model DuboCalc richt zich op de milieuprestatie van materialen en energiegebruik gedurende de levensduur. DuboCalc is een aanvulling op beslisinformatie die er al is. De MER brengt al enkele aspecten in beeld en weegt deze, DuboCalc vult dan informatie aan.

*Dan zou ik graag willen weten wat uw beeld is ten aanzien van Duurzaam Inkopen.*

6) Heeft *RWS* doelstellingen ten aanzien van Duurzaam inkopen?

RWS heeft binnen duurzaam inkopen doelstellingen voor duurzame energie, duurzaam materiaalgebruik, duurzame productiemethoden en ruimtelijke kwaliteit van infrastructuur.

*Ik zie het begrip duurzaamheid binnen mijn onderzoek als een vorm van product- of procesinnovatie die het gebruik van materiaal/energie/water minimaliseert en de flexibiliteit maximaliseert tijdens de beheer en onderhoudsfase en de hoeveelheid afval minimaliseert tijdens de sloopfase.*

DuboCalc heeft geen voorkeur voor het gebruik van een bepaald materiaal. Als je kijkt naar minimaliseren van gebruik van materiaal dan ga je voorbij aan het feit dat je door een andere materiaalkeuze te maken, je duurzamer bezig kunt zijn. Een materiaal wat in eerste instantie niet

duurzaam lijkt te zijn, doordat het bijvoorbeeld milieuonvriendelijk is, kan wel eens het meest duurzame alternatief zijn, binnen alle mogelijk opties.
$CO_2$ heeft op het moment de politieke aandacht. Maar er is meer dan $CO_2$. DuboCalc kijkt alleen naar een hele lijst met milieueffecten. Het geeft een breder beeld van de milieubelasting van materialen en energiegebruik.

*Dan gaan we door naar de zaken waarmee de opdrachtgever een belangrijke rol speelt. De Vraagspecificatie en de Selectie en Gunningcriteria.*

*Met het oog op duurzaamheid kan er een afweging gemaakt worden of de beoogde duurzaamheidaspecten onder de minimum eisen of onder de selectie/gunningcriteria moeten vallen.*

In een protocol hebben we in beeld gebracht wat er kan. Er kan op drie plekken in de inkoop duurzaamheid gevraagd worden. Als gunningcriterium, als prestatie-eis en als proceseis. De prestatie-eis is de meest harde, vervolgens de gunning- en daarna de proceseis. RWS richt zich met name op het gunningcriterium. Maar de andere 2 zijn niet uitgesloten.

7) Ziet u beperkingen in het opstellen van minimumeisen met betrekking tot duurzaamheid?
8) Zo ja, hoe komt dat?

- Budget. Hoe hoger het ambitieniveau hoe groter de kans dat de kosten stijgen en dat moet uiteindelijk wel betaalbaar zijn.

Uit literatuur en andere interviews komt naar voren dat binnen de afdelingstructuur van een overheidsorgaan het lastig is in te spelen op de mogelijkheden voor een beter ontworpen levenscyclus, omdat het budget van realisatie en het budget van beheer en onderhoud door verschillende afdelingen wordt beheerd. Herkent u dat probleem en welke oplossingen zijn er?

- De verdeling van de budgetten over verschillende potjes voor aanleg en beheer en onderhoud. Dat probleem los je op door DBFM toe te passen. Maatregelen die extra geld kosten maar zichzelf terugverdienen kunnen zo makkelijker gerealiseerd worden.
Bij D&C contracten moet je als OG waarborgen dat wat je krijgt ook voldoende presteert in de fase na aanleg. Het moet technisch goed zijn en het moet qua duurzaamheid acceptabel zijn. Dat bereik je door prestatie-eisen mee te geven.

*Rijkswaterstaat is zoals ik het lees in een ver stadium van de ontwikkeling van DuboCalc, een tool die de gunning van duurzame inschrijvingen beter meetbaar zal maken.*

*Een methode die toegepast kan worden om te bepalen hoe en welke aspecten in een VS of EMVI terugkomen is Value Management. Een belangrijk punt hierin is om de waarde te bepalen van duurzaamheid, zoals we net besproken hebben.*

10) Is deze methode naar voren gekomen binnen uw organisatie? Hoe wordt het toegepast?

Bij RWS kijken we hoeveel we over hebben voor verschillende aspecten. Zo worden dan bijvoorbeeld duurzaamheid en veiligheid met elkaar vergeleken, hoe belangrijk vind je het ene ten opzichte van het andere. In het geval van veiligheid hebben we nu gezegd dat dat altijd een eis is, en geen gunningscriterium. Je moet duurzaamheid in de gunningscriteria wel een waarde meegeven wil het echt iets doen, 2% van de raming is dan bijvoorbeeld te weinig.
Je maakt een berekening op basis van de kostenraming, dat geeft ook zicht op wat er technisch haalbaar is en wat redelijk lijkt. De inschrijver kijkt ook wat hij durft aan te bieden, waar hij de risico's nog van kan beheersen.

Uit DuboCalc komt een waarde, de Milieu Kosten Indicator (MKI). Wij stellen bijvoorbeeld het referentieontwerp op MKI van 100. Dat is dan het minimum binnen de gunningscriteria. Vervolgens optimaliseren we dat referentieontwerp, wat dan bijvoorbeeld een score geeft van 75. Hiertussen zit

een bandbreedte van scores en waardes. De MKI geeft een indicatie van de milieukosten, dit wil niet zeggen dat je dat 1 op 1 overneemt. Je kunt ook de waarde bepalen door te kijken hoeveel extra geïnvesteerd moet worden om die waarde van 75 te halen. Misschien heeft de ON daar een miljoen voor nodig. Om voor een echte prikkel te zorgen stel je dan bijvoorbeeld de waarde op 1,6 miljoen. Zodat de ON echt zijn best gaat doen die score van 75 te halen. Het is dan de uitdaging van de kostenramers om te bepalen wat precies die waarde is (het bepalen van 1,6 miljoen). Die moeten een indicatie geven van wat de kosten zijn voor de gevraagde/gewenste innovatie.

*Binnen een VS of een EMVI worden de eisen al dan niet direct omgezet in een waarde.*

11) Hoe is in het programma DuboCalc deze waarde berekend, bedacht?

Je kunt je voorstellen dat er verschillende milieueffecten zijn die je niet meteen bij elkaar op kunt tellen. DuboCalc berekent de schaduwprijzen van verschillende milieueffecten, en die schaduwprijzen kan je wel makkelijk bij elkaar optellen. Zo wordt alles omgerekend naar Euro's en vervolgens bij elkaar opgeteld.

12) Gebruikt u een methode om de waarde die in EMVI vertegenwoordigd wordt te bepalen?
    a. En dan met name de meer subjectieve waardes?

We proberen dit dus vooral te doen door gebruik te maken van de schaduwprijsmethode en door de daadwerkelijke kosten in te schatten van duurzaamheidmaatregelen.

13) Wat ziet u als waarde in duurzame criteria voor de beheer-, onderhoud- en sloopfase?

In feite wordt niet anders beoordeeld dan milieubelasting in de bouwfase. Of je de emissies nu hebt als gevolg van de bouwfase of tijdens onderhoud, maakt voor de uiteindelijke uitkomst niet uit.

(stuk interview dat niet meteen onder een van de vragen valt).
We kijken dus naar de totale levenscyclus in onze beoordeling. De mate van milieubelasting van de bouwfase wordt opgeteld bij de belasting van de beheer- en onderhoudsfase. Zo kan het zijn dat de bouw minder duurzaam verloopt, maar dat het beheer en onderhoud heel duurzaam kan verlopen.

Het streven is de uitvraag zo oplossingsvrij mogelijk te doen. De inschrijver komt terug met een prijs en een MKI waarde. Hoe hij die MKI waarde gaat realiseren maakt ons op het moment van inschrijving niet uit, hij moet aantonen dat de MKI redelijkerwijs te halen is. Zo kan de inschrijver gaandeweg het proces misschien voor een alternatief ontwerp kiezen, zolang hij maar aan die MKI waarde blijft voldoen. Wij controleren aan de hand van systeemgerichte contractbeheersing of de inschrijver aan de eisen voldoet. Dit doe je tijdens het hele proces.

*Een ander aspect wat binnen VM van belang is is om na de conceptfase (voor de haalbaarheidsstudie) alle belangrijke stakeholders bij elkaar te brengen, actoren die beslissingen kunnen maken.*

Rijkswaterstaat heeft eigenlijk twee momenten als het gaat om contact met stakeholders. Het eerste moment is de '*Vraag Specificatie',* de opdracht die RWS meekrijgt om te realiseren. Dan gaat het om wensen die vanuit de omgeving komen. Vervolgens wordt de uitvraag gedefinieerd. Daaruit volgt een dialoog met de markt en kan er gekeken worden of dat wat gevraagd is haalbaar is, en of de lat hoger danwel lager gelegd moet worden.

*In mijn ogen is duurzaamheid een vorm van innovatie, danwel het proces danwel het toepassen van producten die niet eerder zijn toegepast om bepaalde duurzame aspecten te stimuleren. Met deze insteek zijn er volgens de literatuur enkele zaken die vanuit de OG gestuurd kunnen worden om innovatie de ruimte te geven:*

17) Kunt u kort per punt aangeven wat uw mening is over de toepassingsmogelijkheid van deze punten als OG?

    a. Vroege transfer van OG naar ON

Wanneer een marktpartij vroeg betrokken wordt in het proces kan hij zijn specialisme het beste inpassen. Hoe meer er door de OG voorgekauwd is, hoe minder goed de markt nog zijn 'kunstje' kan toepassen.
Als het gaat om innovatie moet je altijd de markt belonen, het gaat niet vanzelf. Hoe groter de opdracht gemaakt wordt die de ON mag uitvoeren, hoe efficiënter hij het proces kan invullen. Of een vroege transfer daadwerkelijk leidt tot meer innovaties weet ik niet.

    b. Veel Communicatie

Dat is nooit verkeerd.

    c. De OG moet meer risico durven nemen en garanties te geven voor innovatie delen van het contract

Dit is niet mijn vakgebied, maar mijn mening is dat een ON zijn product moet zien te verkopen. Als hij met een innovatief product op de markt wil komen, moet hij dat zelf goed hebben uitgewerkt. Als er door ON geen garanties gegeven kunnen worden kan er met pilots gewerkt worden waarin kan worden aangetoond dat het product voldoet.

    d. Er moet voldoende tijd zijn voor de tenderfase

Er moet voldoende tijd zijn om je innovatie projectspecifiek te maken. De innovatie zelf moet al wel klaar liggen, daar is geen enkele tenderfase lang genoeg voor.

    e. Er moeten zo min mogelijk limieten zijn voor de ON, in keuze van methodes en dergelijk

Dat proberen we altijd wel. Je moet wel randvoorwaarden geven waarbinnen gewerkt wordt. Een belangrijke afweging die gemaakt moet worden is: hoeveel normen en richtlijnen geef je mee?

*Voor een ON lijkt er weinig motivatie te zijn om met innovatieve ideeën te komen voor de OG. Impliciet hebben we het hier al over gehad. In de UAVgc en de regelgeving rondom aanbesteding zal het lastig zijn om nieuwe ideeën in te brengen, door de beginselen van transparantie zal informatie van ON snel uit kunnen lekken. Level of playing field en cherry picking zijn gevaren die op de loer liggen.*

18) Bent u van mening deze ontwikkelingen een negatieve invloed hebben op innovatie in de bouw?
    a. Hoe wordt het idee van de ON beschermd?

Daar wordt wel over nagedacht Daar zijn afspraken over gemaakt. Om innovatie te stimuleren moet het intellectueel eigendom beschermd zijn. Daar heeft de ON veel tijd en moeite in gestopt en moet dat zien terug te verdienen in een aantal projecten.

Afsluiting

- Nog een open vraag: nog iets te melden?
-

*Er zijn nog enkele vragen specifiek over DuboCalc besproken:*

19) In DuboCalc zitten een aantal materialen. En onderhoudscenario's (alleen default). Stel dat je met een innovatief idee komt, is dat dan in te voeren?

Ja, dat kan. De aanbieder moet de milieuprestatie van het innovatieve materiaal laten berekenen en vervolgens laten toetsen. Het daadwerkelijke proces zal door de Stichting Bouwkwaliteit nog moeten worden vastgesteld. Na het doorlopen van het proces kan de data worden opgenomen in de nationale milieudatabase. Als het daar in staat kan het worden opgenomen in de DuboCalc bibliotheek.

20) Stel dat je een bepaalde milieuwaarde vraagt waardoor alleen een bepaald product van die leverancier eruit komt. Kan dat?

Nee, je moet wel een redelijk uitvraag doen die concurrentie niet uitsluit.

21) Zou een leverancier graag zijn product voor zichzelf houden, komt hij dan wel in aanmerking voor DuboCalc? Dus je kunt een eigen product hebben in DuboCalc.

Als er voor één product verschillende leveranciers zijn dan nemen we voor de milieuprestatie een branche gemiddelde op. Wanneer er slechts één leverancier is dan kan je een eigen product hebben in DuboCalc.

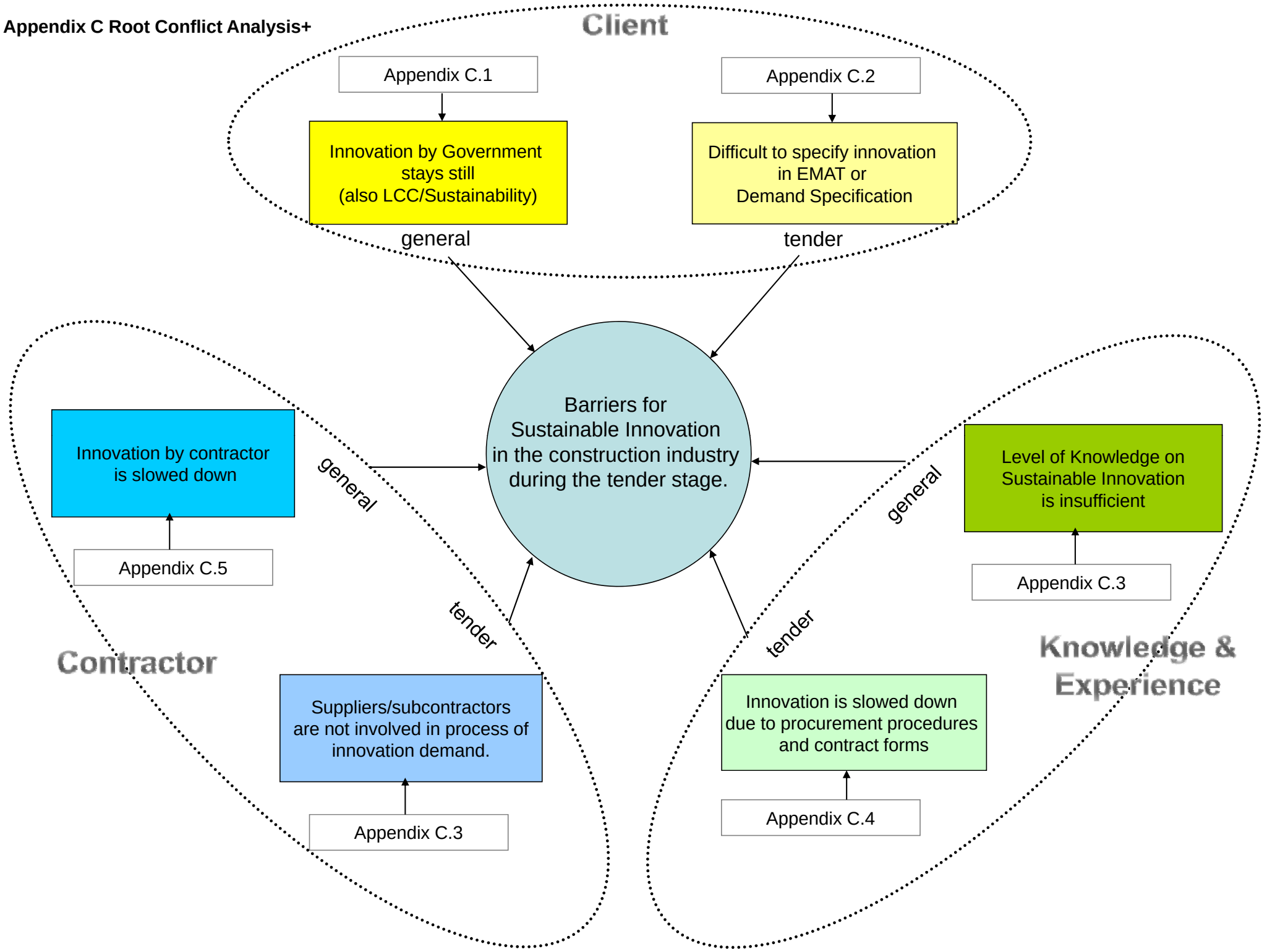
22) Wordt er in DuboCalc ook iets met flexibiliteit gedaan?

Niet echt. Er zijn default waardes voor afvalverwerking na sloop, waaronder recycling en verbranden van afval, maar echt volledig hergebruik van een object komt momenteel niet voor omdat dit in de praktijk een uitzondering is.

Openvraag/opmerking

DuboCalc sluit aan op de nieuwe manier van aanbesteden. We gaan dat binnenkort vaker in de praktijk zien. Bij de ontwikkeling van DuboCalc is een afweging gemaakt tussen het laag houden van de kosten van de tenderfase en het detailniveau van de projectspecifieke milieuberekening.

**Appendix C Root Conflict Analysis+**



# RCA+ legend

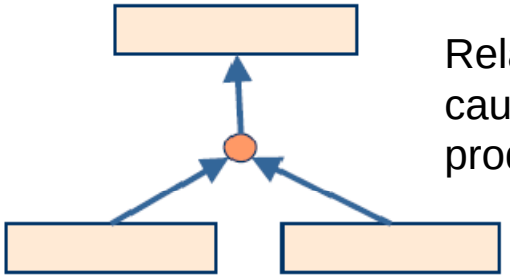
Positive Effect

Factual cause/ effect

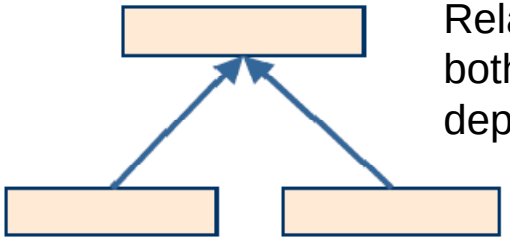
Assumptive cause/ effect

Non-changeable cause

Contradiction cause



Relationship “And”: all causes must be present to produce negative effect.



Relationship “Or”: both causes do not depend on each other

Sources (number in corner):


1) Life Cycle Costing in Sustainable Public Procurement: A Question of Value, International Institute for Sustainable Development (IISD) December 2009

2) RRBouw-Rapport 134: EU-lessen voor Duurzaam Inkopen. 2008 (EU lessons for sustainable procurement)

3) Handboek Oplossingsvrij Specificeren (CROW) (Guideline Specification without stating solutions)

4) Gunnen op duurzaamheid, Bouwend Nederland, 2008 (Awarding Sustainability)

5) Dobberen tussen concurrentie en co-development, oratie prof. Dorée 2001 (Floating between competition and co-development)

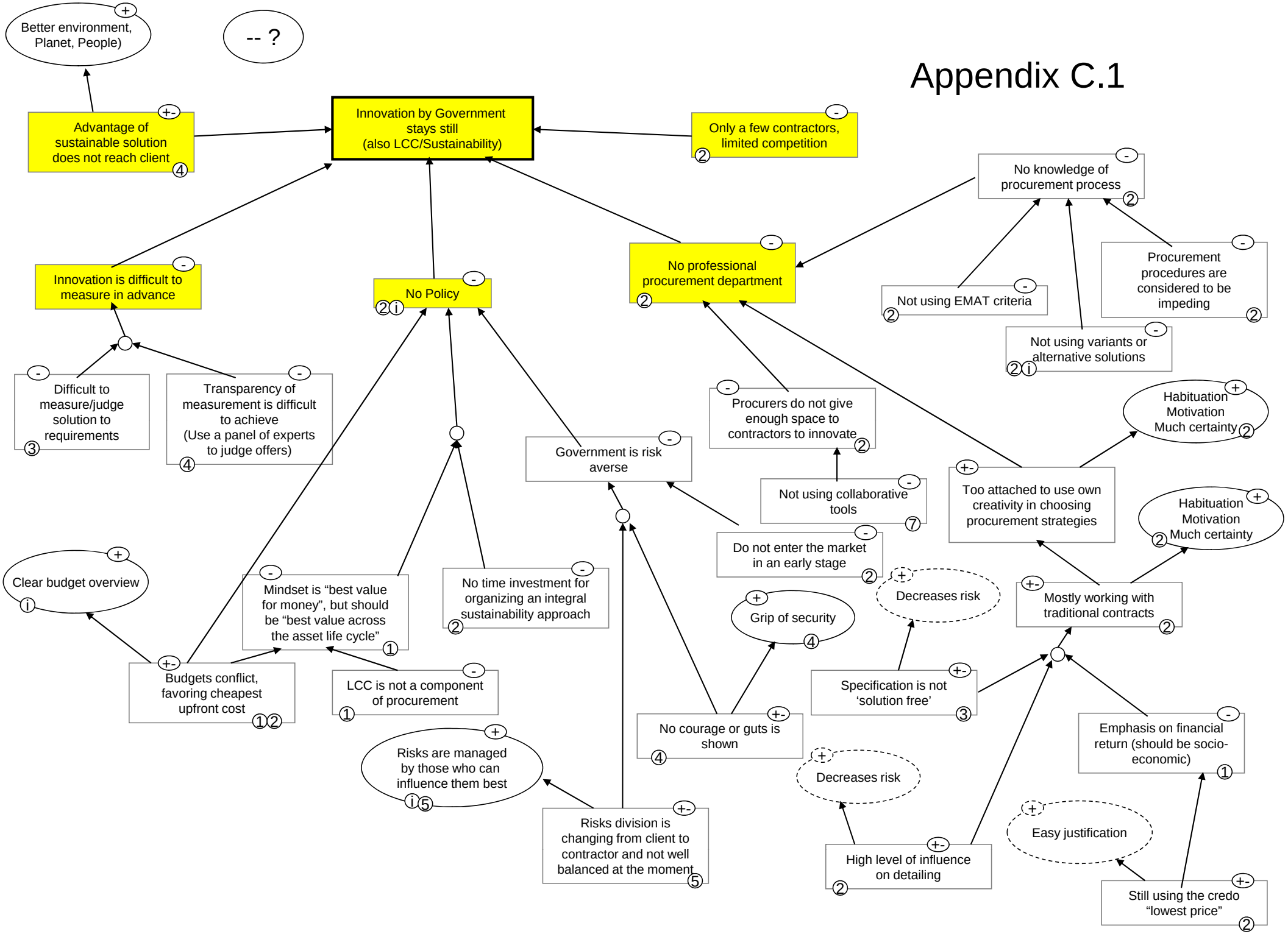
6) Eisenhardt KM. Agency theory: an assessment and review. Acad Manage Rev 1989;14(1):57–74.

7) Erikson, P.E. and Westerberg, M. Effects of cooperative procurement procedures on construction project performance: A conceptual framework. Int. Jrnl. of Project Management 2010; article in press.

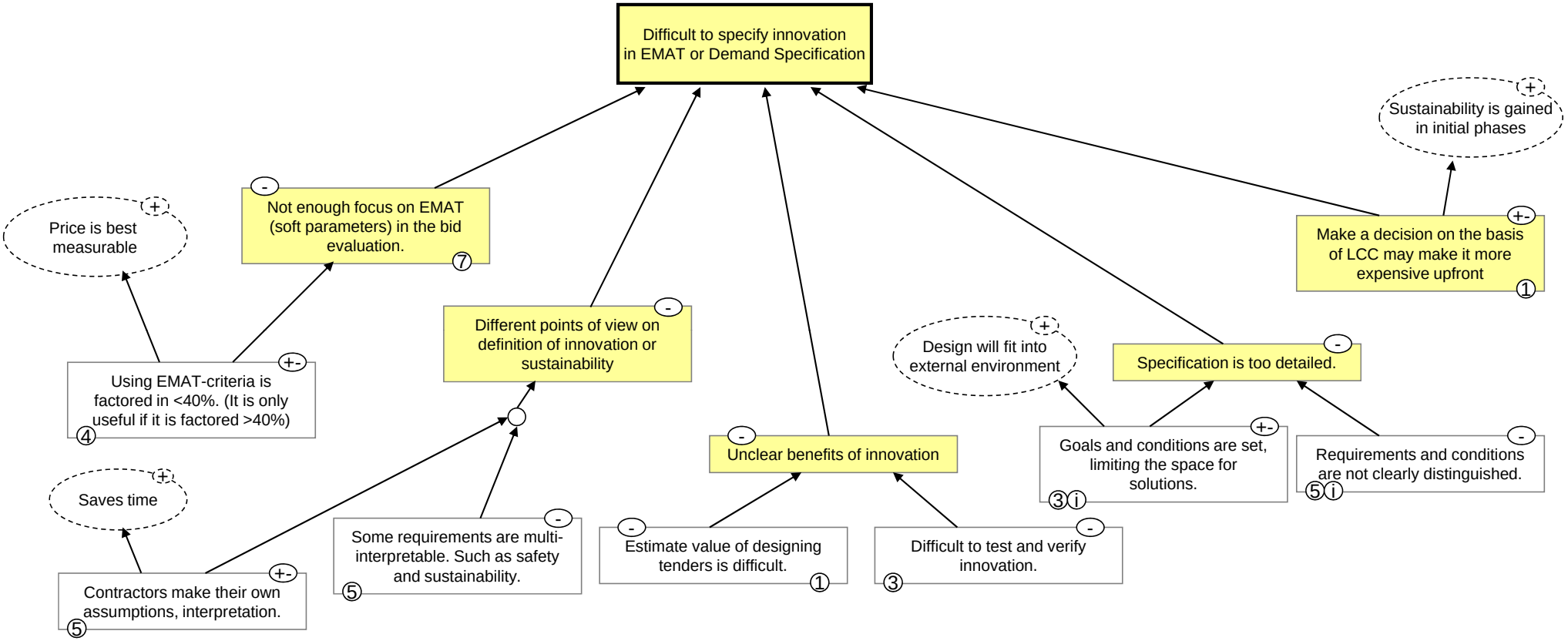
8) Schmidt & Corvers, 2009. Innovatie en aanbesteden.

i) Information abstracted from interviews (see appendix B)

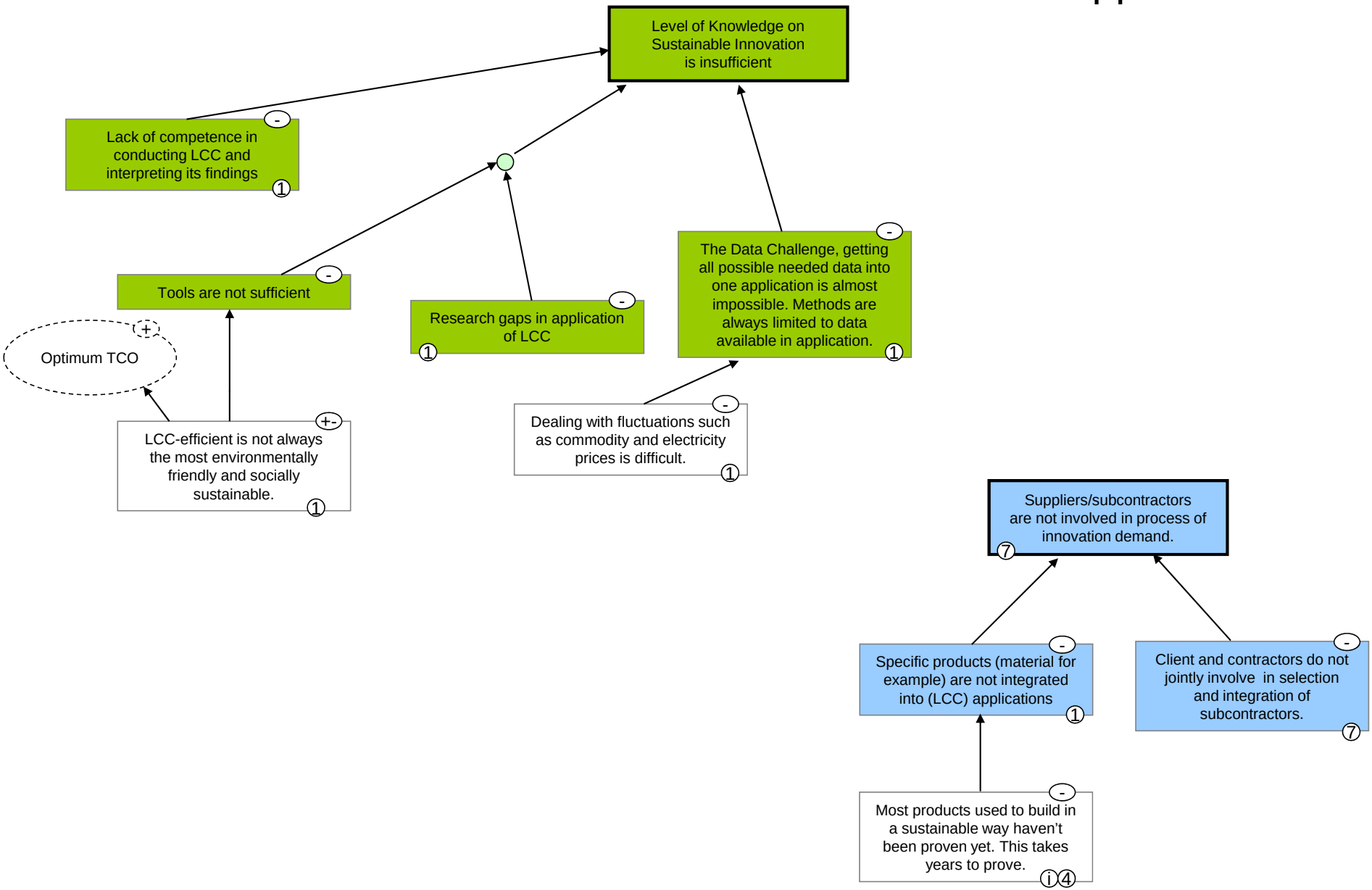
# Appendix C.1


Better environment, Planet, People)
-- ?
Innovation by Government stays still (also LCC/Sustainability)
Advantage of sustainable solution does not reach client
Only a few contractors, limited competition
Innovation is difficult to measure in advance
No Policy
No professional procurement department
No knowledge of procurement process
Not using EMAT criteria
Procurement procedures are considered to be impeding
Not using variants or alternative solutions
Difficult to measure/judge solution to requirements
Transparency of measurement is difficult to achieve (Use a panel of experts to judge offers)
Procurers do not give enough space to contractors to innovate
Habituation Motivation Much certainty
Government is risk averse
Not using collaborative tools
Too attached to use own creativity in choosing procurement strategies
Habituation Motivation Much certainty
Clear budget overview
Mindset is “best value for money”, but should be “best value across the asset life cycle”
No time investment for organizing an integral sustainability approach
Do not enter the market in an early stage
Decreases risk
Grip of security
Mostly working with traditional contracts
Budgets conflict, favoring cheapest upfront cost
LCC is not a component of procurement
Specification is not ‘solution free’
Emphasis on financial return (should be socio-economic)
Risks are managed by those who can influence them best
No courage or guts is shown
Decreases risk
Easy justification
Risks division is changing from client to contractor and not well balanced at the moment
High level of influence on detailing
Still using the credo “lowest price”

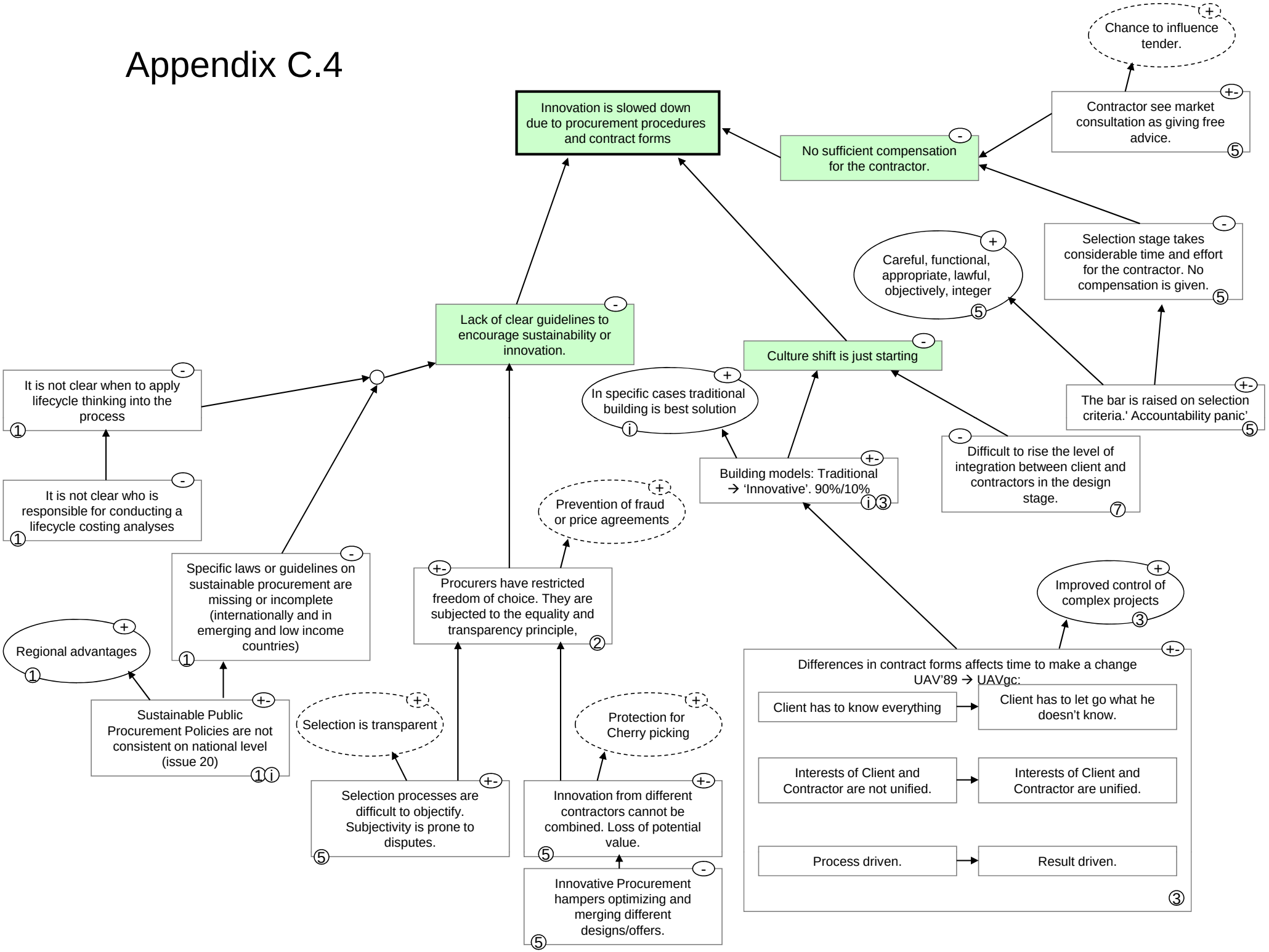
# Appendix C.2


Difficult to specify innovation in EMAT or Demand Specification
Sustainability is gained in initial phases
+
Price is best measurable
+
Not enough focus on EMAT (soft parameters) in the bid evaluation.
-
7
Make a decision on the basis of LCC may make it more expensive upfront
+-
1
Different points of view on definition of innovation or sustainability
-
Design will fit into external environment
+
Specification is too detailed.
-
Using EMAT-criteria is factored in <40%. (It is only useful if it is factored >40%)
+-
4
Unclear benefits of innovation
-
Goals and conditions are set, limiting the space for solutions.
+-
3 i
Requirements and conditions are not clearly distinguished.
-
5 i
Saves time
+
Some requirements are multi-interpretable. Such as safety and sustainability.
-
5
Estimate value of designing tenders is difficult.
-
1
Difficult to test and verify innovation.
-
3
Contractors make their own assumptions, interpretation.
+-
5

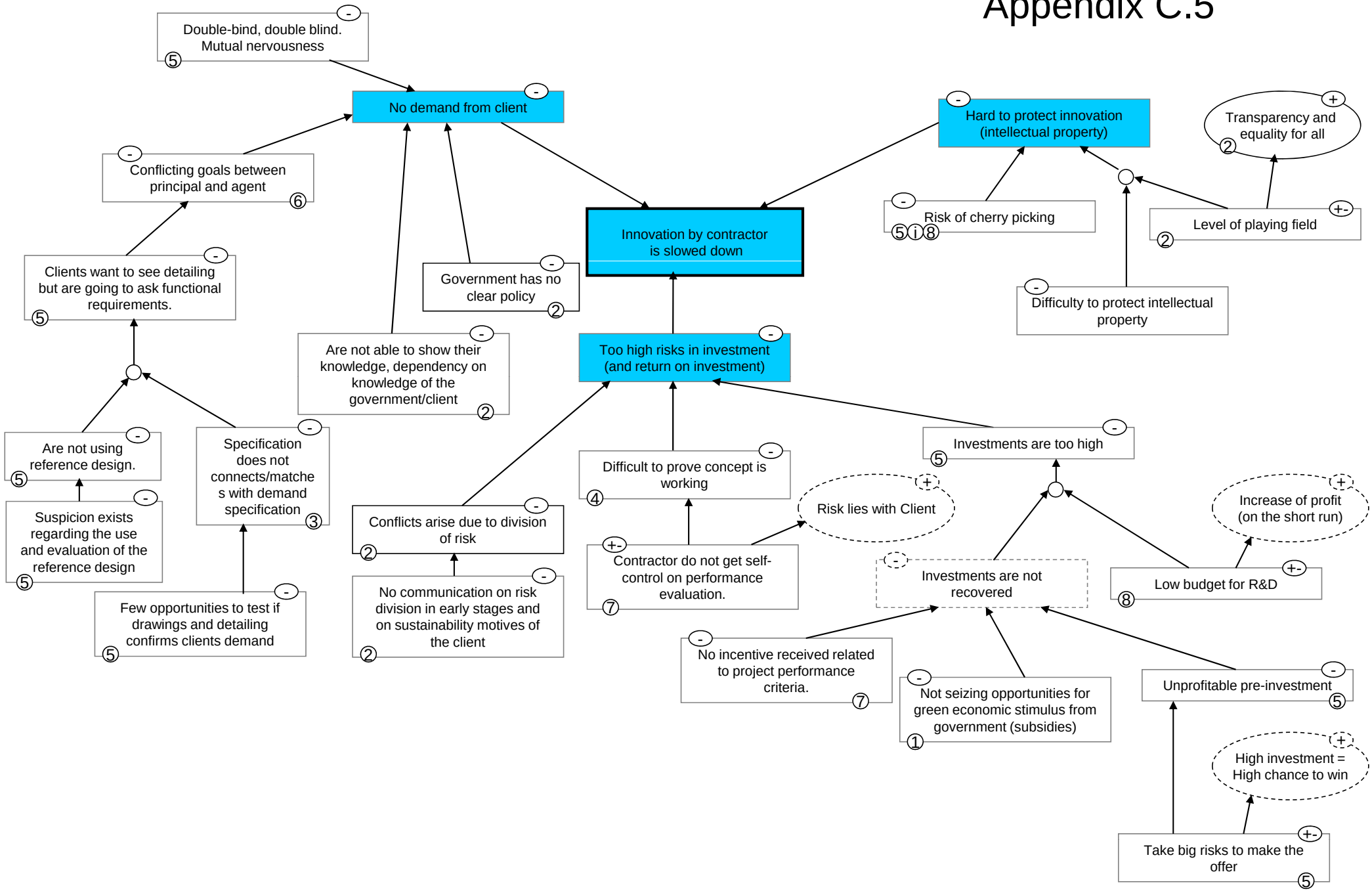
# Appendix C.3


Level of Knowledge on Sustainable Innovation is insufficient
Lack of competence in conducting LCC and interpreting its findings
-
1
Tools are not sufficient
-
Optimum TCO
+
LCC-efficient is not always the most environmentally friendly and socially sustainable.
+-
1
Research gaps in application of LCC
-
1
The Data Challenge, getting all possible needed data into one application is almost impossible. Methods are always limited to data available in application.
-
1
Dealing with fluctuations such as commodity and electricity prices is difficult.
-
1
Suppliers/subcontractors are not involved in process of innovation demand.
7
Specific products (material for example) are not integrated into (LCC) applications
-
1
Client and contractors do not jointly involve in selection and integration of subcontractors.
-
7
Most products used to build in a sustainable way haven't been proven yet. This takes years to prove.
-
i
4

# Appendix C.4


Innovation is slowed down due to procurement procedures and contract forms
Chance to influence tender.
Contractor see market consultation as giving free advice.
No sufficient compensation for the contractor.
Selection stage takes considerable time and effort for the contractor. No compensation is given.
Careful, functional, appropriate, lawful, objectively, integer
Lack of clear guidelines to encourage sustainability or innovation.
Culture shift is just starting
It is not clear when to apply lifecycle thinking into the process
In specific cases traditional building is best solution
The bar is raised on selection criteria.' Accountability panic'
Difficult to rise the level of integration between client and contractors in the design stage.
Building models: Traditional → 'Innovative'. 90%/10%
It is not clear who is responsible for conducting a lifecycle costing analyses
Prevention of fraud or price agreements
Specific laws or guidelines on sustainable procurement are missing or incomplete (internationally and in emerging and low income countries)
Procurers have restricted freedom of choice. They are subjected to the equality and transparency principle,
Improved control of complex projects
Regional advantages
Differences in contract forms affects time to make a change
UAV'89 → UAVgc:
Client has to know everything
Client has to let go what he doesn't know.
Sustainable Public Procurement Policies are not consistent on national level (issue 20)
Selection is transparent
Protection for Cherry picking
Interests of Client and Contractor are not unified.
Interests of Client and Contractor are unified.
Selection processes are difficult to objectify. Subjectivity is prone to disputes.
Innovation from different contractors cannot be combined. Loss of potential value.
Process driven.
Result driven.
Innovative Procurement hampers optimizing and merging different designs/offers.

# Appendix C.5


Innovation by contractor is slowed down
No demand from client
Double-bind, double blind. Mutual nervousness ⑤
Conflicting goals between principal and agent ⑥
Clients want to see detailing but are going to ask functional requirements. ⑤
Are not using reference design. ⑤
Suspicion exists regarding the use and evaluation of the reference design ⑤
Specification does not connects/matches with demand specification ③
Few opportunities to test if drawings and detailing confirms clients demand ⑤
Government has no clear policy ②
Are not able to show their knowledge, dependency on knowledge of the government/client ②
Too high risks in investment (and return on investment)
Conflicts arise due to division of risk ②
No communication on risk division in early stages and on sustainability motives of the client ②
Difficult to prove concept is working ④
Contractor do not get self-control on performance evaluation. ⑦
Risk lies with Client
Investments are too high ⑤
Investments are not recovered
No incentive received related to project performance criteria. ⑦
Not seizing opportunities for green economic stimulus from government (subsidies) ①
Hard to protect innovation (intellectual property)
Risk of cherry picking ⑤ i ⑧
Difficulty to protect intellectual property
Transparency and equality for all ②
Level of playing field ②
Increase of profit (on the short run)
Low budget for R&D ⑧
Unprofitable pre-investment ⑤
High investment = High chance to win
Take big risks to make the offer ⑤

# D 21 Components interacting in a Function Analysis

| From | | To 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| **Innovation demand by Government stays still.** | 1 Advantage of sustainable solution does not reach client. | | Client does not know what he gets | No incentive to formulate policy | | |
| | 2 Innovation is difficult to measure in advance. | Result may not reach client. | | Subjectivity is no firm basis for forming policy | | |
| | 3 No Policy | | Policy has to be made how to deal with subjectivity | | No Policy means no attention for | |
| | 4 No professional procurement department. | | Experts are needed to define what to measure objectively and what to measure subjectively | doesn't formulate policy | | |
| | 5 Limited competition. | | | | | |
| **Difficult to specify innovation in EMAT or Demand Specification.** | 6 No focus on EMAT | | | | | |
| | 7 Different points of view on definitions. | unclear definition of advantages | increases problem | Hampers creation of clear policy | importance of need for department can be discussed | |
| | 8 Unclear benefits of innovation. | If you don't know what it does, you can't see the advantages | is part of | Hampers creation of clear policy | | |
| | 9 Specification is too detailed. | Increases insight | | | | |
| | 10 Higher costs upfront. | | | | Should encourage forming a department | |
| **Innovation is slowed down by contractor.** | 11 No demand from client. | | | | | |
| | 12 No return on investment. | | | | | |
| | 13 Hard to protect innovation (intellectual property) | | | | | |
| **Suppliers/subcontractors are not involved in process of innovation demand.** | 14 Specific products are not integrated into LCC applications. | | Causes difficulty in comparision | | | |
| | 15 Client and contractor do not jointly involve in selection and integration of subcontractors. | | | | | |
| **Level of knowledge on Sustainable Innovation is insufficient.** | 16 Lack of competence in conducting LCC and interpreting its findings. | Advantages are not well formed during LCC conduction | Increases difficulty to | No competence means no good policy formulation | Should stimulate the need for | |
| | 17 Tools are not sufficient. | Tool do not show all advantages | Increases difficulty to | | difficult to become an expert with insufficient tools | |
| | 18 The data challenge | Diffuses to see advantages | No data available to measure | | | |
| **Innovation is slowed down due to procurement procedures and contract forms.** | 19 Lack of clear guidelines to encourage sustainability or innovation. | | Rules to play the game have to be developed | No guidelines to base policy on | | |
| | 20 Culture shift is just starting. | | | Pilots are the basis for new policy | A new demand for professional procurement | Not all companies are adjusted to innovative procurement |
| | 21 No sufficient compensation for the contractor. | | | | | |

| From ↗ To | | | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|
| **Innovation demand by Government stays still.** | 1 | Advantage of sustainable solution does not reach client. | | | feeds | | |
| | 2 | Innovation is difficult to measure in advance. | Objectivity is preferred, instead of subjective jury reports. To score EMAT | | Feeds | increases need too detailed drawings | |
| | 3 | No Policy | Policy should stimulate use of EMATcriteria during tenderstage | Policy does not mention 'umbrella' definition of sustainablitiy (AgentschapNLcriteria) | no policy that formulates how to deal with uncertainties of innovations | Policy should encourage 'oplossingvrij specificeren' | No policy (division of deparments 'Realisation' and Operate&Maintain makes it difficult to spend more on realisation costs |
| | 4 | No professional procurement department. | Not able to formulate EMATcriteria | Different definitions are used at different departments | | No know how on OvS | |
| | 5 | Limited competition. | | | | | |
| **Difficult to specify innovation in EMAT or Demand Specification.** | 6 | No focus on EMAT | | | | No EMAT means no Distinctive market, means less variation | |
| | 7 | Different points of view on definitions. | | | | | |
| | 8 | Unclear benefits of innovation. | | increases | | to get more grip on innovation, more detailed drawings are needed | |
| | 9 | Specification is too detailed. | hampers effectiveness of EMAT | decreases | | | Costs can be estimated better |
| | 10 | Higher costs upfront. | | | | | |
| **Innovation is slowed down by contractor.** | 11 | No demand from client. | Innovation Demand is not integrated into EMATcriteria | | | client demand is too detailed | |
| | 12 | No return on investment. | | | Investing in tests for project specific innovations are not recovered | | |
| | 13 | Hard to protect innovation (intellectual property) | | | | | |
| **Suppliers/subcontractors are not involved in process of innovation demand.** | 14 | Specific products are not integrated into LCC applications. | | | | | |
| | 15 | Client and contractor do not jointly involve in selection and integration of subcontractors. | | | | | integrated supply chains increase initial costs (temporarily) |
| **Level of knowledge on Sustainable Innovation is insufficient.** | 16 | Lack of competence in conducting LCC and interpreting its findings. | | Different interpretations of results | | | LCC can cause higher costs upfront, but lower costs on total |
| | 17 | Tools are not sufficient. | | | | | |
| | 18 | The data challenge | | | | | |
| **Innovation is slowed down due to procurement procedures and contract forms.** | 19 | Lack of clear guidelines to encourage sustainability or innovation. | Gunnen op Duurzaamheid', is just a start | Guidelines could formulate definitions | | Handboek Oplossingsvrij specificeren from detailed specification to functional specification | |
| | 20 | Culture shift is just starting. | Only 5% instead of 40 to 60% | | | | LifeCycle thinking can motivate higher initial costs |
| | 21 | No sufficient compensation for the contractor. | compensation can be build in EMAT | | | | |

| From ⇗ To | | | 11 | 12 | 13 |
|---|---|---|---|---|---|
| **Innovation demand by Government stays still.** | 1 | Advantage of sustainable solution does not reach client. | | | |
| | 2 | Innovation is difficult to measure in advance. | | | |
| | 3 | No Policy | No Policy means no firm basis for demand decreases demand for innovation (because a skill and expertise are needed to formulate such demands) | | Cherry Picking/Level of Playing field |
| | 4 | No professional procurement department. | | | No expirience in helping to protect contractors innovation |
| | 5 | Limited competition. | | | |
| **Difficult to specify innovation in EMAT or Demand Specification.** | 6 | No focus on EMAT | | increases | |
| | 7 | Different points of view on definitions. | | | |
| | 8 | Unclear benefits of innovation. | increases | Increases | |
| | 9 | Specification is too detailed. | | | |
| | 10 | Higher costs upfront. | | Contractors have to make high costs upfront to make a chance to win the tender | |
| **Innovation is slowed down by contractor.** | 11 | No demand from client. | | No Demand, no market | |
| | 12 | No return on investment. | | | |
| | 13 | Hard to protect innovation (intellectual property) | | Innovation is common knowledge before positive ROI is reached for inventor | |
| **Suppliers/subcontractors are not involved in process of innovation demand.** | 14 | Specific products are not integrated into LCC applications. | | | |
| | 15 | Client and contractor do not jointly involve in selection and integration of subcontractors. | client doesnt know what market can offer | | |
| **Level of knowledge on Sustainable Innovation is insufficient.** | 16 | Lack of competence in conducting LCC and interpreting its findings. | | | |
| | 17 | Tools are not sufficient. | | | |
| | 18 | The data challenge | | | |
| **Innovation is slowed down due to procurement procedures and contract forms.** | 19 | Lack of clear guidelines to encourage sustainability or innovation. | | | |
| | 20 | Culture shift is just starting. | | | |
| | 21 | No sufficient compensation for the contractor. | | Direct related to | No incentive to sell innovation |

| From ⇗ To | | | 14 | 15 |
|---|---|---|---|---|
| **Innovation demand by Government stays still.** | 1 | Advantage of sustainable solution does not reach client. | | |
| | 2 | Innovation is difficult to measure in advance. | | |
| | 3 | No Policy | | no justification for |
| | 4 | No professional procurement department. | | Not clear what possibiliteits there are |
| | 5 | Limited competition. | Products from a specific supplier are not implemented due to non-discrimiation principle | |
| **Difficult to specify innovation in EMAT or Demand Specification.** | 6 | No focus on EMAT | | |
| | 7 | Different points of view on definitions. | | |
| | 8 | Unclear benefits of innovation. | | |
| | 9 | Specification is too detailed. | | |
| | 10 | Higher costs upfront. | | |
| **Innovation is slowed down by contractor.** | 11 | No demand from client. | | If you don't know it, you don't get it. |
| | 12 | No return on investment. | | |
| | 13 | Hard to protect innovation (intellectual property) | Innovation can be lost after implementing into application | Contractor and subcontractor do not want to share knowledge up front |
| **Suppliers/subcontractors are not involved in process of innovation demand.** | 14 | Specific products are not integrated into LCC applications. | | |
| | 15 | Client and contractor do not jointly involve in selection and integration of subcontractors. | | |
| **Level of knowledge on Sustainable Innovation is insufficient.** | 16 | Lack of competence in conducting LCC and interpreting its findings. | | |
| | 17 | Tools are not sufficient. | Limits amount of possible products | |
| | 18 | The data challenge | Products are difficult to compare | |
| **Innovation is slowed down due to procurement procedures and contract forms.** | 19 | Lack of clear guidelines to encourage sustainability or innovation. | | |
| | 20 | Culture shift is just starting. | | Culture shift demands more integration between different expertises |
| | 21 | No sufficient compensation for the contractor. | | |

| From ⇗ To | | | 16 | 17 | 18 |
|---|---|---|---|---|---|
| **Innovation demand by Government stays still.** | 1 | Advantage of sustainable solution does not reach client. | No incentive to conduct lcc | | |
| | 2 | Innovation is difficult to measure in advance. | | Increases that | |
| | 3 | No Policy | No Policy No Need for Lcc | | |
| | 4 | No professional procurement department. | No obligation to learn | | |
| | 5 | Limited competition. | | | |
| **Difficult to specify innovation in EMAT or Demand Specification.** | 6 | No focus on EMAT | | | |
| | 7 | Different points of view on definitions. | | | makes challenge more difficult, every point of view can change data interpretation. |
| | 8 | Unclear benefits of innovation. | | | |
| | 9 | Specification is too detailed. | | | |
| | 10 | Higher costs upfront. | | | |
| **Innovation is slowed down by contractor.** | 11 | No demand from client. | | | |
| | 12 | No return on investment. | | | |
| | 13 | Hard to protect innovation (intellectual property) | | | |
| **Suppliers/subcontractors are not involved in process of innovation demand.** | 14 | Specific products are not integrated into LCC applications. | | Increases that | Difficult to choose which products are implemented into database |
| | 15 | Client and contractor do not jointly involve in selection and integration of subcontractors. | | | |
| **Level of knowledge on Sustainable Innovation is insufficient.** | 16 | Lack of competence in conducting LCC and interpreting its findings. | | Decreases effectiveness of tool | |
| | 17 | Tools are not sufficient. | makes it difficult to interpret findings | | Tools are unable to overcome datachallenge |
| | 18 | The data challenge | | makes | |
| **Innovation is slowed down due to procurement procedures and contract forms.** | 19 | Lack of clear guidelines to encourage sustainability or innovation. | Guidelines are needed to create competence | | |
| | 20 | Culture shift is just starting. | | | |
| | 21 | No sufficient compensation for the contractor. | | | |

| From ⇗ To | | | 19 | 20 | 21 |
|---|---|---|---|---|---|
| **Innovation demand by Government stays still.** | 1 | Advantage of sustainable solution does not reach client. | Delays forming guidelines | | Client cannot ccompensate contractor for it. |
| | 2 | Innovation is difficult to measure in advance. | | No culture asks for objective measurement and scoring of tenders | If it is not measurable it is difficult to put a value/price to it. |
| | 3 | No Policy | No orders are given to create guidelines | No clear policy on dealing with innovative procurement procedures (Leidraad Aanbesteden) | Policy should state amount of compensation. |
| | 4 | No professional procurement department. | Nobody is responsible to create | Professionals have to deal with procurement procedures | This department should find a good balance between costs and effort. |
| | 5 | Limited competition. | | | |
| **Difficult to specify innovation in EMAT or Demand Specification.** | 6 | No focus on EMAT | | EMAT is a the most important hinge for cultureshift | EMAT can increase amount of compensation |
| | 7 | Different points of view on definitions. | No clear goals for forming guidelines | Slows down | |
| | 8 | Unclear benefits of innovation. | No incentive | Slows down | Decreases |
| | 9 | Specification is too detailed. | | Will be eliminated by | Contractor has to spend less time in design can increase budget for tenderstage |
| | 10 | Higher costs upfront. | | Will increase due to | |
| **Innovation is slowed down by contractor.** | 11 | No demand from client. | | | |
| | 12 | No return on investment. | | Contractors have to deal with risks more than they used to do. | |
| | 13 | Hard to protect innovation (intellectual property) | | | this increase the amount of compensation needed per project |
| **Suppliers/subcontractors are not involved in process of innovation demand.** | 14 | Specific products are not integrated into LCC applications. | | | |
| | 15 | Client and contractor do not jointly involve in selection and integration of subcontractors. | | is needed for | |
| **Level of knowledge on Sustainable Innovation is insufficient.** | 16 | Lack of competence in conducting LCC and interpreting its findings. | Nobody knows how to | | |
| | 17 | Tools are not sufficient. | No trust in effectiveness of guideline | Delays culture shift | |
| | 18 | The data challenge | Too much data to choose from for guideline | Delays culture shift | |
| **Innovation is slowed down due to procurement procedures and contract forms.** | 19 | Lack of clear guidelines to encourage sustainability or innovation. | | | |
| | 20 | Culture shift is just starting. | no firm basis | | |
| | 21 | No sufficient compensation for the contractor. | | | |

# E Workshop

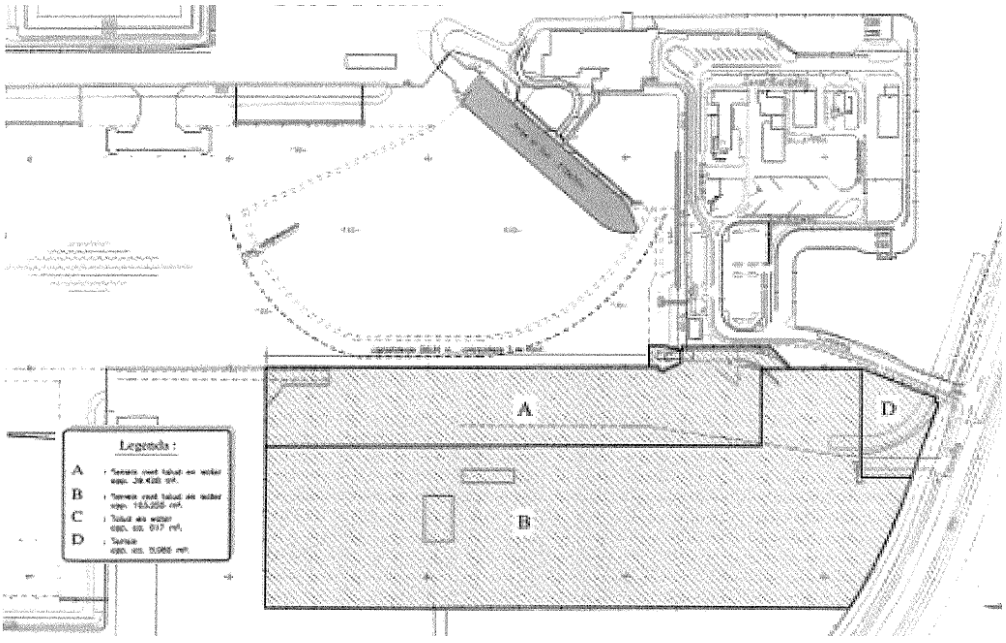
**Workshop TRIZ 6 september 2010**
**door Mees Beeker**
Workshopleider: Mees Beeker
Deelnemers: Ron Cuppers, Martijn van den Elzen, Stephan Laaper, Sander Dekker, Harm Janssen, Iris van Beuzekom, Pieter de Jager en Peter Floor.
Uitgenodigd, maar om diverse redenen niet aanwezig: Hans Bruinsma, Ruud Raaijmakers en Karel Veenvliet.

Agenda:

- 12.00u Introductie TRIZ en Workshop
- 12.30u Functie Analyse
- 13:15u Koffie
- 13.30u 40 Principles of 76 Inventive Standards
- 14.30u Afronding en evaluatie
- 15.00u Weer aan het werk…

De Case:

- Een kade in de haven van Rotterdam is aan vervanging toe.
- De verhuurder wil zo optimale Total Cost of Ownership en zo duurzaam mogelijke levenscyclus.
- De huurder zal voor de komende 50 jaar de kade weer gaan huren.
- De huurder wil capaciteit uitbreiden van 1 naar 2 schepen.
- De schepen zijn van het type RoRo, Roll-on Roll-of.
- De huurder wil op de kade opslagruimte hebben.
- De lengte van de kade is te kort om twee schepen in een rechte lijn achter elkaar te laten aanmeren.
- Een concurrerende rederij (de Buren) moet niet gehinderd worden op water of land.



**Function Analysis**

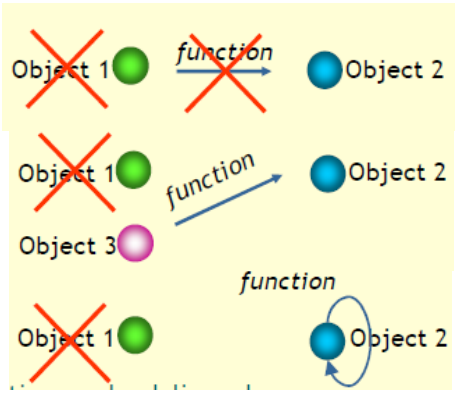
1) Omschrijf de componenten van het system (Schrijf deze op een geel blaadje)
2) Omschrijf de belangrijkste componenten van het super-systeem (op paars)
3) Omschrijf wat het product/ de producten zijn van het systeem (op roze)
4) Identificeer alle Nuttige, Schadelijke, Onvoldoende, Slecht beheersbare en Overdadige interacties in het model. Het is mogelijk ook **potentiële** problemen in te voegen.
5) Welke problemen beïnvloeden de hoofdfunctie het meest? Rangschik deze van veel naar weinig.

*Afhankelijk van het resultaat van de afgelopen 5 vragen gaan we door met de volgende stappen:*

**Trimming**

Is het mogelijk om een component volledig te verwijderen uit het diagram, en de positieve functies die het heeft onder te brengen onder andere componenten? (Proces van Trimming)

6) Dit kan op 3 manieren
   a. Een component kan verwijderd worden omdat de functie overbodig is.
   b. Een component kan verwijderd worden als een andere component zijn nuttige functies overneemt.
   c. Een component kan verwijderd worden wanneer een andere component de functie zelf kan gaan vervullen.




**76 Inventive Standards**

En/of (als het probleem als Su-field omschreven kan worden)

7) Selecteer twee problemen uit vraag 5, een probleem met een Slecht Beheersbare interactie en een probleem met een Schadelijke interactie
8) Pas de inventive standards toe van de groepen 1-1, 2-1 t/m 2-4 voor het eerste probleem
9) Pas de inventive standards toe van de groepen 1,2, 2-1 – 2-4 voor het tweede probleem

**40 Inventive Principles**

En/of (als het probleem als technische tegenstelling geformuleerd kan worden)

10) Vertaal de technische parameters van de tegenstelling naar algemene parameters uit de lijst. Als er meer mogelijkheden zijn, neem je die mee, als de tijd dat toelaat.
11) Vind de bijbehorende inventive principles uit de matrix
12) Gebruik de eerste 5 gevonden inventive principles om nieuwe oplossingen te bedenken. Zoveel als mogelijk.

**Evaluatie gevonden oplossingen**

13) Waardeer de oplossingen aan de hand van de volgende criteria:

| Oplossing: | 1 | 2 | 3 | 4 | N |
|---|---|---|---|---|---|
| Behaald 100% van het gewenste resultaat | | | | | |
| Win-win-win (PPP) oplossing | | | | | |
| 'Kost' (bijna) niets om te implementeren | | | | | |
| Geen schadelijke bijeffecten | | | | | |
| Geeft extra voordelen | | | | | |
| Totaal score | | | | | |

**Evaluatie Workshop**

| | Evaluatie TRIZ workshop | Helemaal mee eens | Deels mee eens | Deels mee oneens | Helemaal mee oneens | | Geen mening |
|---|---|---|---|---|---|---|---|
| 1 | Het zojuist doorlopen proces van TRIZ is een goede aanvulling op de huidige methode om een Vraagspecificatie te formuleren. | | | | | | |
| 2 | Deze methode stelt de klant in staat om de functie van zijn project te definieëren. | | | | | | |
| 3 | De klant krijgt beter inzicht in de functie en kan zo beter functioneel (oplossingsvrij) specificeren. | | | | | | |
| 4 | Met TRIZ ben ik beter in staat functioneel te specificeren. | | | | | | |
| | | | | | | | |
| 5 | TRIZ kan toegepast worden in de initiatief fase. | | | | | | |
| 6 | TRIZ kan toegepast worden in de ontwerp fase. | | | | | | |
| 7 | TRIZ kan toegepast worden in de realisatie fase. | | | | | | |
| 8 | TRIZ kan toegepast worden in de beheer en onderhoud fase. | | | | | | |
| 9 | TRIZ kan toegepast worden in de recycle en sloop fase. | | | | | | |
| | | | | | | | |
| 10 | Het in beeld brengen van tegenstellingen (contradictions) geeft een nieuwe kijk op het vraagstuk. | | | | | | |
| 11 | Met TRIZ kan ik de klant laten inzien wat er allemaal bij komt kijken als we het hebben over duurzaam inkopen. | | | | | | |
| 12 | TRIZ is een goede aanvulling op de methode van Systems Engineering. | | | | | | |
| 13 | TRIZ is een goede aanvulling op de methode van Value Engineering. | | | | | | |
| 14 | Na de functie analyse moet een *opdrachtnemer* de creatieve TRIZ stappen zetten om tot een oplossing te komen. | | | | | | |
| 15 | De TRIZ methodes zijn voor elk ontwerpproces voor Grontmij van toegevoegde waarde. | | | | | | |
| 16 | De methode zal op fundamentele wijze kunnen bijdragen aan een duurzame oplossing. | | | | | | |

Overige opmerkingen:

Graag invullen, als er tijdens de workshop geen tijd meer voor was, dan graag deze week invullen en even bij mij langsbrengen.

## E.1 Results Inquary Workshop

7 participants scored the inquary.

| | Evaluation TRIZ methodology | Fully agree | Partially agree | Partially disagree | Fully disagree | No opinion |
|---|---|---|---|---|---|---|
| 1 | The methodology of TRIZ is a good addition to the current process to formulate an Output specification. | 4 | 3 | | | |
| 2 | TRIZ helps the client to define the function of his project. | 2 | 5 | | | |
| 3 | De client gets a better insight of the function and with this he can better specify functionally. | 4 | 3 | | | |
| 4 | TRIZ makes me able to better specify functionally. | 2 | 5 | | | |
| | | | | | | |
| 5 | TRIZ can be applied during the initial stage. | 6 | 1 | | | |
| 6 | TRIZ can be applied during the design stage | 6 | 1 | | | |
| 7 | TRIZ can be applied during the construction stage. | 2 | 3 | 2 | | |
| 8 | TRIZ can be applied during the operate and maintain stage. | 2 | 5 | | | |
| 9 | TRIZ can be applied during the recycle or disposal stage. | 4 | 3 | | | |
| | | | | | | |
| 10 | Mapping contradiction adds a new view to the problem. | 6 | 1 | | | |
| 11 | TRIZ makes it possible to show the client what sustainable procurement entails. | 1 | 6 | | | |
| 12 | TRIZ is a good addition to the method of Systems Engineering. | 5 | 2 | | | |
| 13 | TRIZ is a good addition to the method of Value Engineering. | 2 | 3 | | | 2 |
| 14 | After Function Analysis, the *contractor* has to use TRIZ to come up with a solution. | 2 | 3 | 1 | | 1 |
| 15 | TRIZ is an added value to all design processes at Grontmij. | 3 | 3 | 1 | | |
| 16 | The methodology can fundamentally contribute to a sustainable solution. | 3 | 4 | | | |

Other remarks:
1: The right problem definition is still very important.
2: This inquiry is based on the limited experience with the methodology I just learned.

**Figure 31: Workshop TRIZ at Grontmij**


Whiteboard = System (Harbor expansion)
Purple post-it= super system
Yellow post-it=subsystem
Pink post-it=product
Red line= harmful effect
Black line= useful effect
(Product interactions are described next to it, lines would get quite messy)

**Figure 32: Result Function Analysis Workshop Try-out with students**

# F Marketing green products

It should not be forgotten that the concept also has to be sold to a client/contractor. This appendix will shortly review the paper by Ottman, Stafford en Hartman (2006) on green marketing.

Green marketing must satisfy two objectives: *improved environmental quality* and *customer satisfaction*. Misjudging either or overemphasizing the former at the expense of the latter can be termed "green marketing myopia." Research indicates that many green products have failed because of green marketing myopia—marketers' myopic focus on their products' "greenness" over the broader expectations of consumers or other market players (such as regulators or activists). According Ottman et al. (2006) evidence indicates that successful green products have avoided green marketing myopia by following three important principles: consumer value positioning, calibration of consumer knowledge, and the credibility of product claims.

**Consumer Value Positioning**

- Design environmental products to perform as well as (or better than) alternatives.
- Promote and deliver the consumer-desired value of environmental products and target relevant consumer market segments (such as market health benefits among health-conscious consumers).
- Broaden mainstream appeal by bundling (or adding) consumer-desired value into environmental products (such as fixed pricing for subscribers of renewable energy).

**Calibration of Consumer Knowledge**

- Educate consumers with marketing messages that connect environmental product attributes with desired consumer value (for example, "pesticide-free produce is healthier"; "energy-efficiency saves money"; or "solar power is convenient").
- Frame environmental product attributes as "solutions" for consumer needs (for example, rechargeable batteries offer longer performance").
- Create engaging and educational Internet sites about environmental products' desired consumer value.

**Credibility of Product Claims**

- Employ environmental product and consumer benefit claims that are specific, meaningful, unpretentious, and qualified (that is, compared with comparable alternatives or likely usage scenarios).
- Procure product endorsements or eco-certifications from trustworthy third parties, and educate consumers about the meaning behind those endorsements and eco-certifications. Encourage consumer evangelism via consumers' social and Internet communication networks with compelling, interesting, and/or entertaining information about environmental products.
- This short review on marketing green products shows that not only technical requirements of a sustainable building should be taken into consideration but also customer satisfaction to which the product is sold to.

# G Uitgebreide Nederlandse samenvatting

Artikel: Doorbreken van barrieres voor innovatie met Design en Construct contracten.
Richting een stappenplan voor Duurzaam Inkopen.

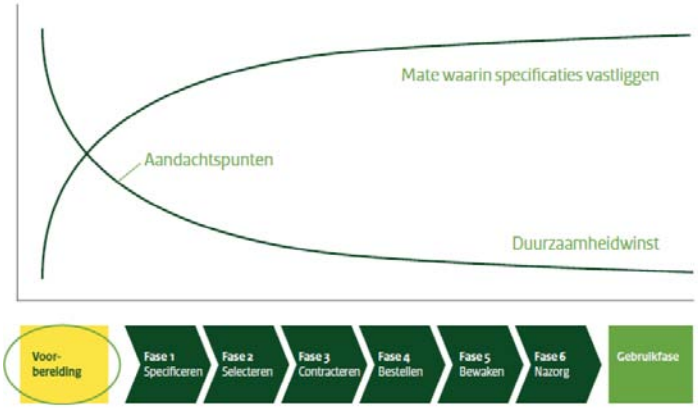
**Innovatie is de motor voor het totstandbrengen van een duurzame toekomst (Mann en Dekoninck, 2003; Souchkov, 2010. Dat is de rode draad die beschreven wordt in de afstudeerscriptie waar dit artikel uit voortkomt: het behandelt innovatie binnen de Grond- Weg- en Waterbouw. De nadruk wordt gelegd op een specifiek doel: Het prikkelen van de opdrachtnemer om duurzaam te bouwen voor de beheer- en onderhoudsfase van de levenscyclus van het object, binnen een Design & Construct overeenkomst. In de scriptie wordt gesteld dat op de lange termijn innovatie zal leiden tot oplossingen die het verbruik van energie en materialen verminderen en omvang en complexiteit verminderen voor een specifiek probleem. Er wordt beschreven wat de barrières zijn die tot standkoming van innovatie beperken binnen de eerste fases van de levenscyclus van het gebouwde object en TRIZ wordt aangedragen als methodologie om innovatieve processen te ondersteunen tijdens deze fase. De scriptie belicht het belang van het prikkelen van innovatie door overheidsinstanties en andere opdrachtgevers tijdens de aanbestedingsfase, om hen in staat te stellen de bouwindustrie te veranderen naar een meer maatschappelijk verantwoorde industrie. Het onderzoek is uitgevoerd bij Grontmij B.V. in de Bilt onder het Team Projects bij inkoop- en contractmanagement.**

## Onderzoek

Ter onderbouwing van het resultaat is er een theoretische analyse uitgevoerd, het resultaat van een literatuurstudie (inclusief informatie verworven tijdens een twee weken durende summer course TRIZ) over de termen Duurzaamheid en Innovatie die inzicht geeft in het gebruikte perspectief op duurzaam inkopen. Ondersteund door deze literatuurstudie en interviews met experts, geeft de analyse het bedrijfsproces weer, belicht deze de barrières voor het gestelde probleem en introduceert TRIZ als methodologie. Een workshop ‘TRIZ’ is georganiseerd om het potentieel van de methodologie te valideren als toevoeging aan het huidige proces. Met deze resultaten is een conceptueel stappenplan ontworpen en gepresenteerd.

## Duurzaam Inkopen

De Nederlandse overheid koopt jaarlijks voor ongeveer €50 miljard in. Een aanzienlijk aandeel van de totale markt, hieronder valt ook het inkopen van constructies uit de GWW. De overheid wil de markt prikkelen maatschappelijke verantwoordelijkheid te nemen en geeft hierin zelf het goede voorbeeld, zij wil in 2015 100% duurzaam inkopen.
AgentschapNL ondersteunt deze ontwikkeling door het schrijven van richtlijnen voor Duurzaam Inkopen. De algemene mening over deze richtlijnen is dat het enkel een begin is van wat er nodig is om daadwerkelijk ‘duurzaam’ in te kopen.
Wanneer gekeken wordt naar het behalen van een hoge mate van “Duurzaamheidswinst” tijdens de gehele levenscyclus, moet dit punt zo vroeg mogelijk worden meegenomen. (Figuur 1).




**Figuur 1: Duurzaamheidswinst wordt met name bereikt in het vroegste stadium van de levenscyclus**

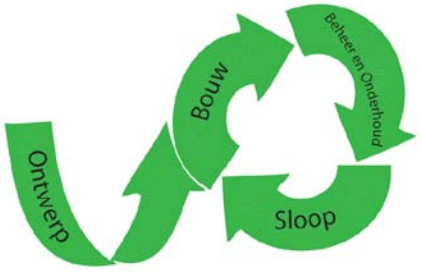
## Opdrachtnemer prikkelen duurzaam te bouwen

Grontmij is een internationaal ontwerp-, advies- en managementbureau. Zij levert adviezen en ingenieursdiensten met betrekking tot de stedelijke en natuurlijke leefomgeving, mobiliteit, schoon water en energie. Zij plant en realiseert duurzame en haalbare oplossingen. Bij verschillende projecten

wil Grontmij haar steentje bijdragen in een duurzame toekomst. Uit de praktijk kwam het volgende probleem naar voren. Binnen een Design & Construct contract (waar het ontwerp en de realisatie bij één partij of consortium is ondergebracht) wordt deze partij niet geprikkeld duurzaam te bouwen voor de fases na Realisatie, de Beheer en Onderhoudfase en de Sloopfase. Hieruit volgt de hoofdvraag: *Hoe kan de Opdrachtgever een Opdrachtnemer prikkelen duurzaam te bouwen voor de beheer en onderhoudsfase binnen een Design & Construct contract, in de GWW?* Uit het onderzoek komt naar voren dat Duurzaamheid en Innovatie een sterke koppeling kennen. Door het inkoopproces in te richten op een manier dat innovaties gestimuleerd worden, zal dit op de lange termijn duurzame oplossingen opleveren. Uit de praktijk blijkt dat tijdens het inkoopproces nog veel barrières voor innovatie bestaan. Een proces waarmee innovatie wel aantrekkelijk wordt, is vormgegeven in een Stappenplan. De basis van dit stappenplan is het proces van TRIZ. De koppeling tussen innovatie en duurzaamheid, de barrières, de TRIZ methodiek en het resultaat het stappenplan, zullen hieronder achtereenvolgens aan de orde komen.

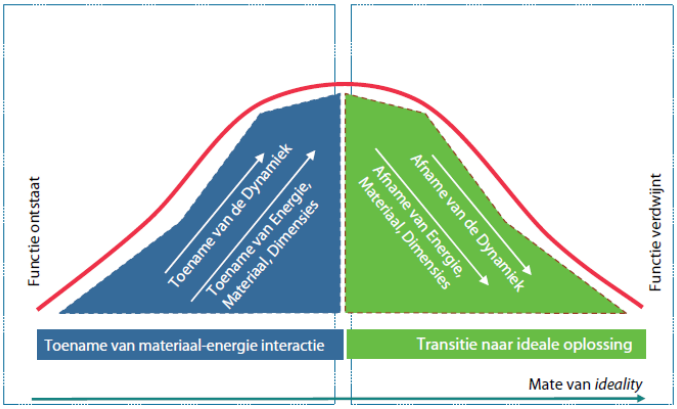
## Innovatie en duurzaamheid

Wanneer in de literatuur gezocht wordt naar een definitie van het begrip duurzaamheid dan wordt geen eenduidig antwoord gevonden. Het begrip kan op dusdanig veel mogelijke wijzen geïnterpreteerd worden dat een definitie altijd subjectief is. Twee bekende benaderingen zijn die van de commissie Brundtland en Elkington. Brundtland stelt dat duurzaamheid is wanneer aan de behoeftes van de huidige generatie wordt voldaan, zonder volgende generaties te benadelen om te voldoen aan hun behoeftes. Elkington presenteerde de bekende triple bottomline theorie, beter bekend onder het vinden van de juiste balans tussen People, Planet en Profit. Een constructie doorloopt een bepaalde levenscyclus (grofweg: initiatief, ontwerp, bouw, gebruik en onderhoud en sloop), wanneer de benadering van Brundtland hierop toegepast wordt kan gesteld worden dat dit bouwproces op zo'n manier ingericht moet worden, dat dit over honderden jaren nog steeds kan. Dat komt dicht in de buurt van nog een derde bekende benadering: Cradle2Cradle, afval is voedsel. Door de laatste fase (sloop, zie Figuur 2) van de bouw als eerste te bekijken in de initiatieffase, ontstaat een beeld van de afvalproductie die men graag zou willen zien te voorkomen.




**Figuur 2 Levenscyclus van een gebouw.**

De ladder van Delft laat zien hoe dit het beste kan (Figuur 3). Bovenaan de ladder staat preventie. Gesteld kan worden dat door slim te ontwerpen, of het maken van een slimme analyse, voorkomen kan worden dat een systeem gebouwd hoeft te worden. Aangenomen wordt dat iets niet doen het meest duurzaam is.
Dergelijk slimme ontwerpen vragen meestal om een bepaalde mate van innovatie. Een innovatie is een nieuw idee, dat succesvol geïmplementeerd is en waarvan de waarde erkend wordt door een bepaalde markt. Innovaties kunnen meetbaar gemaakt worden door positieve effecten, negatieve effecten en kosten in kaart te brengen, deze maat wordt ook de "Degree of Ideality" genoemd. Uit studies blijkt (Souchkov2010, Mann & Dekoninck 2003), dat technologische ontwikkeling evolueert langs deze schaal van Ideality (figuur 3). De hoogst haalbare graad van Ideality kan als volgt worden omschreven: "De functie van een systeem wordt geleverd zonder dat het systeem aanwezig is (Souchokov, 2010)." Kijkend naar de Ladder van Delft, zien we dat de hoogste trede een soortgelijk resultaat verlangt, een systeem is niet nodig, doordat de functie op een andere manier wordt vervuld. Daarmee is de koppeling gemaakt dat Innovatie, op de lange termijn, duurzamere oplossingen meebrengt. Kijkend naar materiaal- en energiegebruik, flexibiliteit en omvang.




1) Preventie
2) Hergebruik
3)recycling
4)Verbranding

**Figuur 3: Technologische Evolutie en de Ladder van Delft (Souchkov 2010 en Durmisevic, 2006).**

## Barrières voor Innovatie binnen het inkoopproces

Twee onderwerpen, ‘innovatie’ en ‘duurzame ontwikkeling’ zijn zo aan elkaar gekoppeld. Het toont het belang aan van de recente cultuurverandering richting een meer innovatie stimulerende omgeving die omgaat met de huidige vraag voor maatschappelijk verantwoorde oplossingen. Door deze koppeling te maken wordt duidelijk dat barrières voor innovatie ook toepasbaar zijn op de vraag naar oplossingen die voldoen aan duurzaamheidscriteria met de nadruk op de fases na realisatie van een object binnen design en construct contracten.

**Figuur 4: Doorbreken van Barrières voor Duurzame Innovatie**

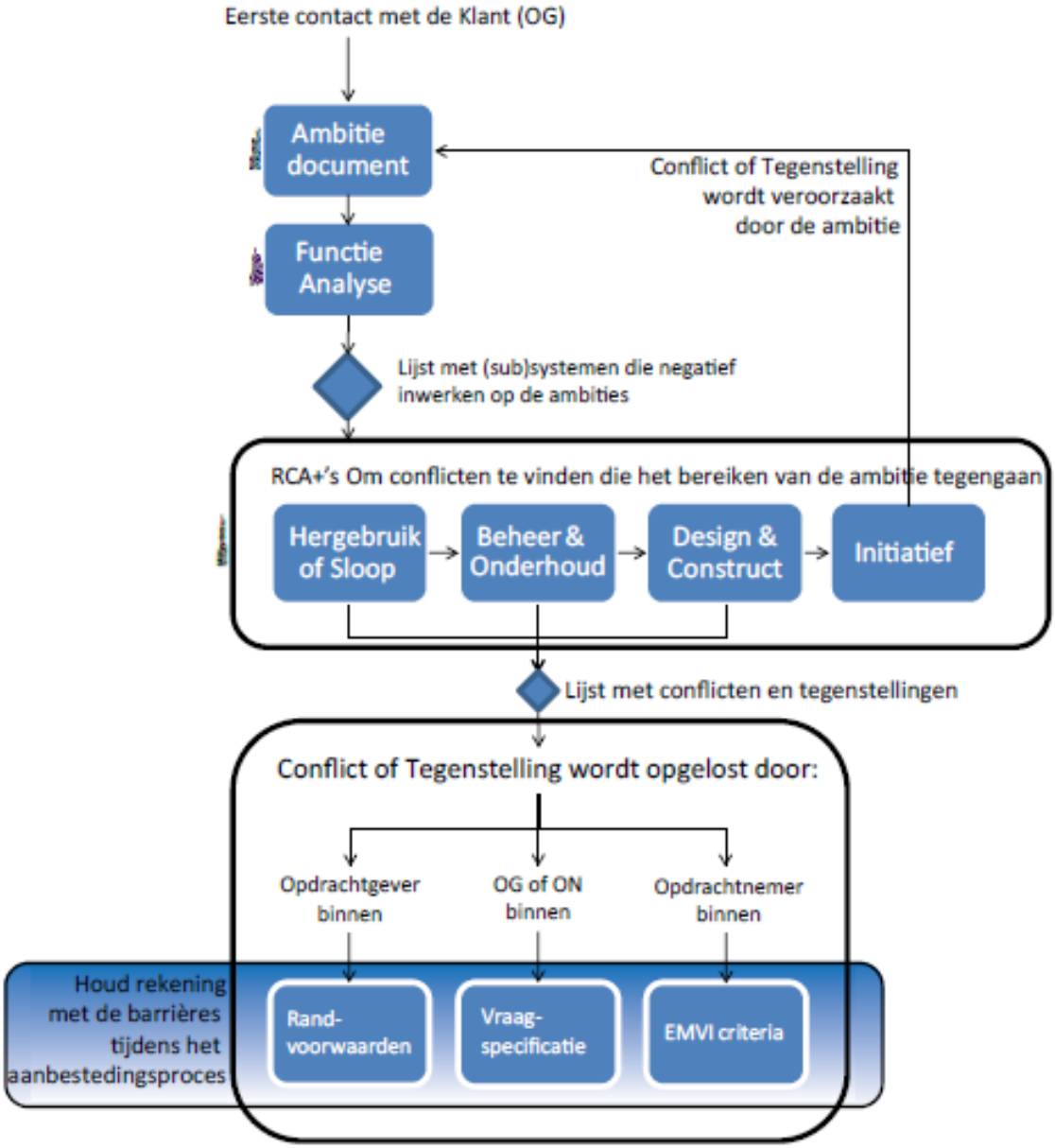
Het het onderzoek blijkt dat de barrières ontstaan uit drie richtingen, vanuit de opdrachtgever, de opdrachtnemer en de ‘algemene kennis en kunde’ (kennis en kunde is niet partij-specifiek, maar kan ook afkomstig zijn van bijvoorbeeld kennisinstituten of belangenorganisatie). Als voorbeeld worden er enkele barrières nader toegelicht. Vanuit de opdrachtgever mist met name eenduidig en duidelijk beleid wat als raamwerk kan dienen voor het prikkelen van de totstandkoming van innovaties, beleid over het bepalen van waarde van Duurzame oplossingen en functioneler specificeren zijn punten die extra aandacht verdienen. Innovaties in de bouwindustrie kunnen moeilijk beschermd worden, ook is het niet altijd zeker of de investeringen terugverdiend worden in één project en of voldoende wordt gecompenseerd voor inspanningen. Dit vormt een grote barrière vanuit de opdrachtnemer. Zoals zojuist beschreven is de definitie van ‘Duurzaamheid’ behoorlijk subjectief, tools die geschreven worden om dit te meten zijn dit ook, en sluiten daarmee ‘nieuwe’ ideeën uit, omdat deze hierbinnen niet gemeten worden. Dit is een barrière die uit de ‘kennis en kunde’ voortkomt.
Wanneer er gekeken wordt naar het inkoopproces, laten de resultaten van de scriptie zien dat aspecten die te maken hebben met ‘duurzaamheid’ een onderdeel moeten zijn van een totale benadering, met inbegrip van de processen van alle aanbestedingsdocumenten die een opdrachtgever moet maken om een uitvraag op de markt te kunnen zetten.

## TRIZ

TRIZ is in dit onderzoek geïntroduceerd als tool om effectief en efficient innovatieve oplossingen te ontwerpen voor specifieke problemen. Het wordt gesteld dat TRIZ een belangrijke rol kan spelen om ervoor te zorgen dat People, Planet en Profit niet alleen kunnen samengaan maar ook kunnen gedijen in een duurzame toekomst. De methodologie richt zich op het behalen van een hogere graad van *Ideality*, het vermindert de schadelijke effecten en de kosten en verhoogt de bruikbare effecten. Systematische Innovatie is gebasseerd op 1500 man-jaren van onderzoek in de dynamiek van de evolutie van systemen. Dit onderzoek betrekt 2 miljoen innovaties en analyses van technische en bedrijfssystemen over alle velden van de wetenschap. Deze bijdrage aan de kennisindustrie is beter bekend onder het acroniem TRIZ. TRIZ is een Russisch acroniem en staat voor *Teoria Reshenia Izobretatelskih Zadatch*, de theorie voor het oplossen van innovatieve problemen. Het is ontstaan in 1946 uit studies van Genrikh Altshuller die bij het bestuderen van duizenden patenten een bepaald patroon ontdekte. Hij ontdekte dat ‘innovatieve’ vindingen worden beheersd door enkele objectieve wetten. Door gebruik te maken van deze wetten kan er systematisch gezocht worden naar innovatieve oplossingen voor problemen (Mann & Dekoninck, 2003; Abdlalla et al., 2005; Souchkov 2010 and TRIZ.org, 2010).

## Resultaat: het stappenplan

Als eindresultaat is een praktische set van stappen ontwikkeld, die samen een Stappenplan vormen, gepresenteerd in figuur 5.




**Figuur 5: het Stappenplan.**
Stap 1: Het formuleren van een Ambitie document. Dit document omschrijft de ambities van de opdrachtgever als het gaat om duurzaamheid. De opdrachtgever krijgt tijdens het formuleren ook inzichten in verschillende barrières en kan daarvoor vooraf spelregels omschrijven hoe daar mee om te gaan.
Stap 2: Gebruik de Functie Analyse van TRIZ om de componenten van het gewenste systeem te definiëren. Allereerst levert dit een heldere uiteenzetting van de gewenste functies van het systeem. Ten tweede komen ook verschillende tegenstellingen (conflicten) aan het licht die ontstaan tussen twee sub-systemen.
Stap 3: Herken specifieke problemen door gebruik te maken van Root Conflict Analyse+. Door de levenscyclus van de bouw van achter naar voren weer te geven, kan de opdrachtgever de ambitie en het systeem per fase van de levenscyclus analyseren en kijken welke problemen er ontstaan. Door dit van achter naar voren te doen wordt het gemakkelijker 'de cirkel rond te maken'. Uit deze analyse zullen diverse problemen boven tafel komen, of deze problemen opgelost moeten worden door de OG of de ON staat dan ter discussie.
Stap 4: Tijdens het aanbestedingsproces zijn er nog altijd enkele barrières die overwonnen moeten worden om zo innovatie optimaal te stimuleren tijdens het proces.
Het stappenplan voegt een extra proces toe tussen de initiatiefase en de aanbestedingsprocedure. Door het stappenplan te volgen krijgt Duurzaam Inkopen een "totale benadering" en wordt "duurzaamheid" niet slechts toegevoegd op een later, specifiek, punt in het proces.

Kortom, de voordelen die aan dit stappenplan gekoppeld kunnen worden kunnen worden samengevat in drie hoofdpunten:

- Innovatie is de motor voor het totstandbrengen van een duurzame toekomst. Om innovatie te stimuleren moet een opdrachtgever zich zo vroeg mogelijk in het proces van de bouwlevenscyclus hierop richten en om dit te doen moet de opdrachtgever weten om te gaan met de barrières voor innovatie die voorkomen tijdens dit proces.
- Lettend op de initiele fases van de levenscyclus van een object, verdienen drie punten extra aandacht: Specificeer functioneel, compenseer de opdrachtnemer voldoende voor zijn inspanningen en wees ervan bewust dat het moeilijk is de waarde van 'duurzaamheid' te bepalen.
- Het gepresenteerde stappenplan biedt de opdrachtgever een unieke mogelijkheid om de weg vrij te maken voor de opdrachtnemer om een object te bouwen dat voldoet aan de criteria voor duurzaamheid voor de beheer- en onderhoudsfase.

Het wordt aanbevolen dat Grontmij dit stappenplan gebruikt om klanten te adviseren en ondersteunen om hen in staat te stellen de opdrachtnemer te prikkelen om een object te bouwen dat voldoet aan de criteria voor duurzaamheid voor de beheer- en onderhoudsfase.
Nader onderzoek is nodig om te reageren op de huidige ontwikkelingen in de markt rondom het opzetten van de methodologie van Systems Engineering in de industrie en het integreren van de methode van TRIZ hierin. De verwachting is dat Systematische Innovatie (TRIZ) kan worden ingepast in dit proces en een positieve bijdrage kan leveren aan de benadering.

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Dit artikel is een samenvatting van het afstudeeronderzoek van Mees Beeker, ter afronding van de Masteropleiding CEM. Er wordt slechts naar enkele bronnen verwezen. In de scriptie is een uitgebreidere referentielijst te vinden.