Unobstructed Constructed

Developing a supporting tool for municipalities to stimulate the implementation of smart solutions in construction logistics in civil structure projects.

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"If I had an hour to solve a problem I would spend 55 minutes thinking about the problem and 5 minutes thinking about the solutions"

Albert Einstein

Preface

This graduation process has resulted in much more than solely a research into the possibilities of keeping cities liveable and accessible during the execution of engineering projects. It has also provided me a great learning experience in which I was able to have a look behind the scenes of processes that take place within municipalities and market stakeholders. Besides this, the graduation process also contributed to my confidence in writing and conducting researches. In the first years of studying I could have never expected to be able to write and conduct this thesis on my own!

One of the things I enjoyed most during this graduation process were the 26 interview/ focus group sessions that I conducted in order to obtain all sorts of information. It struck me that every person I asked to join the research was willing and enthusiastic to participate. Thank you all for your contribution! Without you this theses report would have been mostly empty. Another exciting aspect of the graduation process was being part of the department Purchasing and Advise of the Engineering company of the municipality of Amsterdam. For me, it really felt included in this department as I was able to join all meetings and site activities. It can therefor be said that without the willingness of the Engineering company of the municipality of Amsterdam, this thesis would have never been established. Hence, I would like to thank the Engineering company of the municipality of Amsterdam and in particular the department Purchase & Advise for granting me the opportunity to conduct this research and design.

In addition, I would like to thank the members of the graduation committee because also without them this graduation project would not have been possible. Marcel Hertogh, I would like to thank you for being the chair of my graduation committee and for your clear guidance and well considered and critical questions during the official meetings. Marcel Ludema, I really appreciate all the time you have invested in the construction of this thesis. At each two weekly meeting, you provided me new insights with which I could move ahead. I also really value the trust you expressed in me during the official meetings. Leon, thank you for your contribution in giving me confidence in writing. Your phrase about taxis in New York has definitely contributed to the writing process. Furthermore, I would like to thank my daily supervisor Sarah. Sarah, I could not have a more suitable daily supervisor than you. On many levels we share the same working method and this allowed me to conduct this thesis in my own style of working. Besides this, I would like to thank you for always being available to have a chat and for your constructive feedback. Although she did not participate in the graduation committee, I want to express my gratitude to Sandra who has an enormous amount patience and was willing to change the official meetings many times.

Last, I owe much gratitude to all the people that helped me with the execution of this research and design thesis. These people include my parents, who supported me mentally, substantively and financially, my little sister, who did all spell checking during the writing process, and my boyfriend, who helped me out with the layout of the report.

Eke Hoekstra, January 2018

Samenvatting

Op dit moment is er een wereldwijde urbanisatietrend gaande. In Nederland wordt verwacht dat de bevolking van de vier grootste steden met 15% zal zijn toegenomen in het jaar 2030. Deze vier steden zullen in dat jaar een derde van de algehele Nederlandse bevolking huisvesten (Centraal Bureau voor de Statistiek & Planbureau voor de Leefomgeving, 2016). De groei van de stedelijke populaties zal ertoe leiden dat steden zich steeds verder zullen gaan ontwikkelen en dat zal daarop weer leiden tot een grote toename van het aantal bouwwerkzaamheden in stedelijke gebieden. Door de verandering van het bouwen in greenfield gebieden naar brownfield gebieden zullen steeds meer mensen hinder ervaren van de overlast die gepaard gaat met het toenemende aantal bouwwerkzaamheden. De overlast betreft, de uitstoot van fijn stoffen en de vermindering van de leefbaarheid en bereikbaarheid van steden tijdens bouwwerkzaamheden. Om ervoor te zorgen dat de zojuist genoemde overlast wordt verminderd, zijn er slimme oplossingen in bouwlogistiek ontwikkeld. Deze oplossingen betreffen de acties die gemeentes, aannemers, leverancier en andere stakeholders kunnen ondernemen en leiden, onder andere tot het verminderen van het aantal transportritten van en naar bouwplaatsen.

Voor gemeenten is het van belang dat haalbare, effectieve en efficiënte oplossingen in bouwlogistiek verder worden ontwikkeld en op een grotere schaal worden ingezet. Dit kan gemeenten immers helpen de door hen gestelde duurzaamheidsambities te halen en bij te dragen aan een verhoging van de leefbaarheid en bereikbaarheid van steden tijdens de uitvoer van bouwwerkzaamheden. Echter, gemeenten hebben op dit moment onvoldoende idee over de wijze waarop zij marktpartijen kunnen stimuleren tot het toepassen van bouwlogistieke oplossingen. Om gehoor te geven aan deze tekortkoming, is het doel van deze thesis dat er een begeleidende tool wordt ontwikkeld die gemeenten in staat stelt marktpartijen aan te zetten tot het gebruiken van bouwlogistieke oplossingen in uit te voeren projecten.

Door de vele rollen die gemeentes kunnen innemen (opdrachtgever, vergunningverlener, coördinator en grondeigenaar), de verschillende typen projecten die zij uitvoeren en de vele contractvormen waarmee zij te maken krijgen, is het doel van deze tool nader gespecificeerd. Het ontwerpdoel is als volgt: ‘Het ontwikkelen van een begeleidende tool, die gemeentelijke medewerkers die werken aan UAV-GC (Uniforme Administratieve Voorwaarde – Geïntegreerde Contracten) aanbestede civiele projecten, in staat stelt marktpartijen te stimuleren tot het toepassen van bouwlogistieke oplossingen in uit te voeren projecten’.

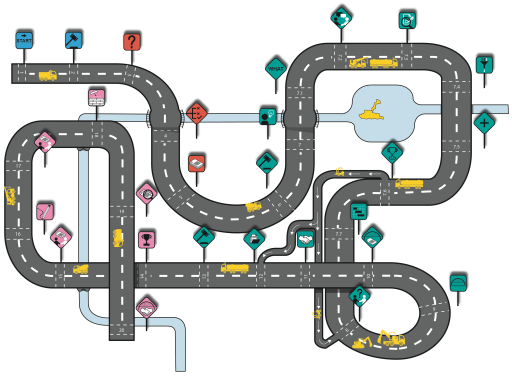
Om invulling te geven aan het gestelde ontwerpdoel zijn eerst ontwerpeisen opgesteld. Om die te kunnen opstellen is onder meer onderzoek gedaan naar drie verschillende aspecten. Als eerste, naar de inzetbare gemeentelijke instrumenten om de toepassing van bouwlogistieke oplossingen te stimuleren, ten tweede, naar de processtappen in UAV-GC aanbestede civiele projecten, en ten derde, naar de specificaties van de inzetbare instrumenten. De inzetbare instrumenten zijn gevonden door onderzoek te doen naar zeven ter zake doende onderwerpen: een literatuurstudie naar slimme oplossingen in bouwlogistiek, de vaststelling of een oplossing door een marktpartij of door de gemeente kan worden geïmplementeerd, de invloed van gemeenten op de implementatie van slimme oplossingen door marktpartijen, het toepassingsniveau van de oplossingen in civiele projecten, het achterhalen van specifieke marktpartijen, de obstakels en stimulansen die marktpartijen tegenkomen en tenslotte hoe gemeenten hierop kunnen inspelen.

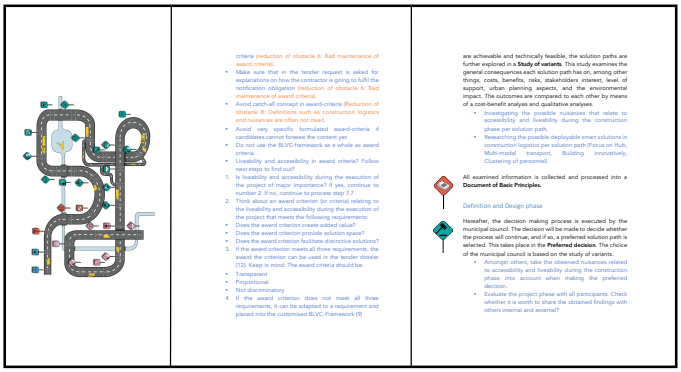
Dit heeft geleid tot zes instrumenten die ingezet kunnen worden: Inkoop, Communicatie, Materiaalbureau, Contractmanagement, BLVC en een Coördinatieafdeling binnen gemeenten.

Het tweede onderzoek heeft geresulteerd in een stroomdiagram van UAV-GC-processen dat is opgedeeld in vier fases met daarin 23 processtappen. Het derde onderzoek heeft geresulteerd in een lijst met positieve bijdragen en bijdragen van obstructieve aard, die voorkomen per instrument en gerelateerd zijn aan het stimuleren van slimme oplossingen in bouwlogistiek.

Naast de ontwerpeisen die te maken hebben met de drie onderzoeksaspecten zijn ook andere eisen geformuleerd. Deze eisen zijn verkregen uit de scope en het doel van de thesis en uit interviews met de toekomstige gebruikers van de begeleidende tool. Alle eisen samen zijn gebruikt als het startpunt van het ontwerp van de tool. Het ontwerp is vervolgens tot stand gekomen in een iteratief proces.

De laatste versie van de tool kan worden gezien als een Project Roadmap (zie figuren). De Project Roadmap is gepresenteerd als een boekje op A5 formaat. Dit boekje is hoofdzakelijk opgedeeld in twee delen: een afbeelding en een beschrijving van de Roadmap. De verkeersborden die te zien zijn op de afbeelding bevatting iconen die de processtappen van het UAV-GC-proces representeren. De verkeersborden kunnen ruitvormig of vierkant zijn en vertegenwoordigen de respectievelijk acties die kunnen worden ondernomen om bouw gerelateerde hinder in steden te verminderen en acties die alleen informatie bevatten over de UAV-GC processtappen.





Ten slotte wordt geconcludeerd dat de ontworpen tool voldoet aan alle gestelde ontwerpeisen. Daarnaast reageert de Project Roadmap op het gestelde ontwerpdoel. Dit betekent dat de ontwikkelde tool geschikt is voor alle gemeenten die marktpartijen willen stimuleren om bouwlogistieke oplossingen toe te passen in uit te voeren projecten. Aanbevolen wordt de Project Roadmap aan te passen aan voortschrijdend inzicht in gemeentelijke instrumenten en bouwlogistieke oplossingen voor de binnenstedelijke omgeving.

Summary

Nowadays, a worldwide urbanisation trend can be observed. In the Netherlands, it is expected that the population of the four largest cities will be increased with an average of 15% in 2030. In total, these four big cities will accommodate a third of the Dutch population in 2030 (Centraal Bureau voor de Statistiek & Planbureau voor de Leefomgeving, 2016). The growth of urban populations will generate a need to further develop cities, which will lead to a significant increase in construction work in cities. Because of the change from building in greenfield areas to brownfield areas, more people will experience the accompanying nuisances the increase of construction work brings. The accompanied nuisances relate to emissions and the reductions of the liveability and accessibility of cities during the execution of construction projects. To ensure the reduction of nuisances caused by construction tasks are reduced, a number of smart solutions in construction logistics have been developed. These solutions relate to the actions municipalities, contractors, wholesalers, and several other stakeholders can take. The smart solutions, among other things, provide concepts related to reductions of the amount of traffic.

It is in the municipalities' interest that feasible, effective and efficient solutions in construction logistics are further developed and applied on a larger scale, as this will help them to achieve their stated sustainable ambitions and increase the liveability and accessibility of urban confined areas during the construction phase of projects. However, on an operational level, municipalities do not sufficiently know how to stimulate the implementation of smart solutions in construction logistics in order to minimise nuisances caused by the construction sector. In order to respond to this shortcoming, the objective of this thesis is to provide a supporting tool to enable Dutch municipalities to stimulate market stakeholders to implement smart solutions in construction logistics in their projects.

Because of the many different roles municipalities can play (client, licensor, coordinator, and owner of ground), the various types of projects municipalities conduct and the diversity in contract types is the Design Statement more specified than the objective of this thesis. The Design Statement can be read as follows: 'Developing a tool that will give support to employees of municipalities working on the realisation of UAV-GC (Uniforme Administratieve Voorwaarden - Geïntegreerde Contractvormen) procured civil works, helping them to stimulate market stakeholders to implement smart solutions in construction logistics into projects.'

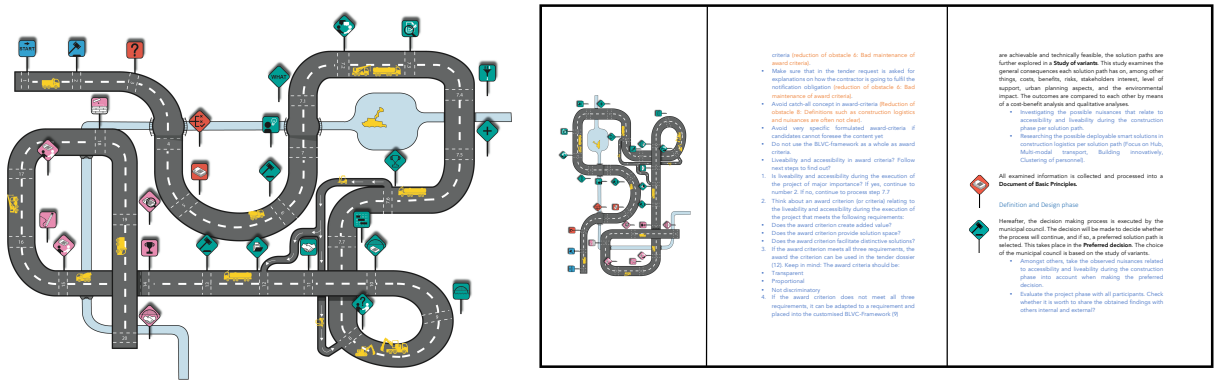
In order to respond to the Design Statement, a design of a supporting tool is developed. Prior to this, a number of Design Requirements that the design must satisfy are articulated. This requires, among other things, conducting research focusing on three aspects, being firstly, municipalities their deployable instruments to stimulate smart solutions in construction logistics, secondly, the process steps in municipalities its procured UAV-GC civil works projects and thirdly, the specifications of the deployable instruments. Through researching seven different subjects, namely a literature study on smart solutions in construction logistics, the smart solutions in construction logistics that are implementable by market stakeholders or by municipalities, the influence that municipalities have on the implementation of smart solution that can be implemented by market stakeholders, the level of applicability of smart solutions when implemented in civil projects, the specific related market stakeholders, obstacles and incentives that market stakeholders face and actions that municipalities can take, the deployable instruments

were found. These instruments are: Procurement, Communication, Material agency, Contract management, BLVC, and Coordination department.

The second research focus has resulted in a flow chart of the UAV-GC process that is divided in four phases and contains 23 process steps. From the third research focus, a list of contributors and obstructers that occur per instrument relating to the stimulation of smart solutions in construction logistics was developed.

In addition to the Design Requirements that relate to the three research aspects, are also other Design Requirements formulated. They are derived from the scope, objective, and interview sessions with future users. The requirements are used as a starting point in the design phase of the tool for which different iterative design steps are taken.

The final version of the tool represents a Project Roadmap (see figures). It is presented as a small booklet printed in A5 size. The booklet is primarily made out of two parts, being a graphic and an explanation text. The icons displayed on the traffic signs represent the actions that take place during each intersection. The traffic signs are shaped in two different forms, being a diamond and square, representing respectively actions that can be taken in order to reduce construction related nuisances and actions that only consist of process step explanations.



Finally, it has been decided that the created tool satisfies all mandatory requirements. Furthermore, the Project Roadmap responds to the stated Design Statement and ensures that all Dutch municipalities obtain guidance on how to stimulate market stakeholders to implement smart solutions in construction logistics in UAV-GC procured civil structure projects. It is recommended to keep supplementing the Project Roadmap with the latest information concerning municipalities its deployable instruments and smart solution in construction logistics in urban confined areas.

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Abbreviations

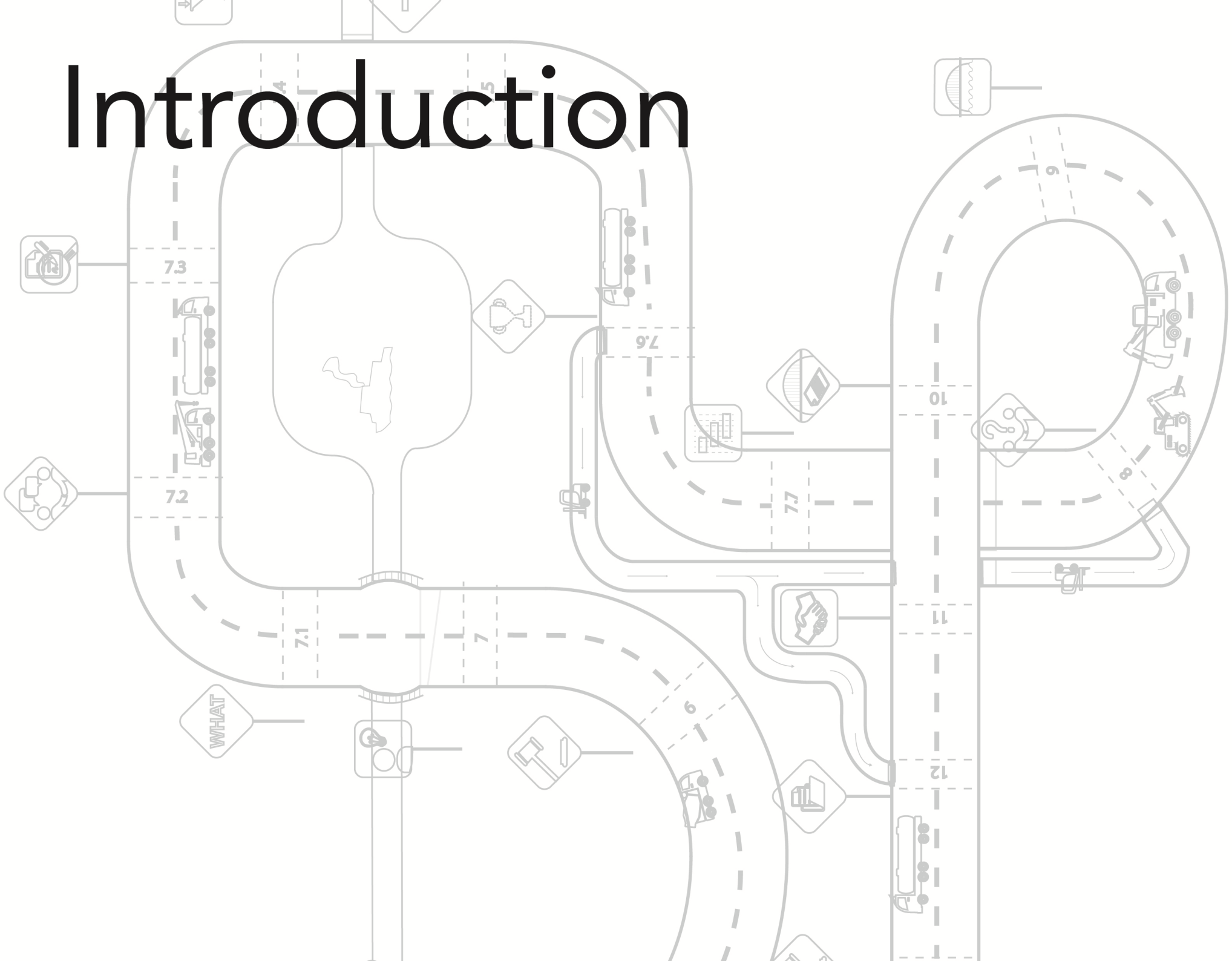
CO2	Carbon dioxide
NOx	Nitrogen oxide
GWW	Grond, Water & Weg
UAV-GC	Uniforme Administratieve Voorwaarden - Geïntegreerde Contractvormen
UAV	Uniforme Administratieve Voorwaarden
EMVI	Economisch Meest Voordelige Inschrijving
BLVC	Bereikbaarheid, Leefbaarheid, Veiligheid & Communicatie
WIOR	Werken In de Openbare Ruimte
PBI	Plan- en Besluitvormingsproces Infrastructuur
RAW	Rationalisatie en Automatisering Grond-, Water- en Wegenbouw
CRS	Costumer Requirements Specifications
SRS	System Requirements Specifications
DBFMO	Design, Build, Finance, Maintain & Operate
DBFM	Design, Build, Finance & Maintain
DBM	Design, Build & Maintain
DC	Design & Construct
EC	Engineer & Construct
FTL	Full Truck Loads
LTL	Less than Truck Loads

Glossary

In this thesis, the following words should be read as follows:

Smart solution	–	Clever and intelligent solution
Obstacle/ Obstruction	–	Something that hinders progress
Incentive/ Contributor	–	Something that encourages progress
Instrument	–	A mean that can be deployed by municipalities
Action	–	An activity that can be performed by municipalities

Introduction



1. Introduction

This chapter contains five different sections. In the first section an introduction is given of the main topic. The second section focusses on the problem analysis in which the problem explanation and problem statement are explained. Thirdly, the objective is stated after which in the fourth section the scope is formulated. Finally, in the fifth part the structure of the thesis report in explained.

1.1 Topic

Urbanisation and city changes
According to the United Nations (2016), in 2016 54.5% of the world population was living in urban areas, and this number will increase to 60% in 2030. This means that after this period of 14 years, one out of three people worldwide will live in a city with a population of at least half a million inhabitants (United Nations, 2016).

In the Netherlands the same urbanisation trend can be observed. It is expected that in the period in between 2017 to 2030 the population of the four largest Dutch cities (Amsterdam, Rotterdam, Den Haag and Utrecht) will increase with an average of 15%. In total, these four large cities will accommodate a third of the Dutch population in 2030 (Centraal Bureau voor de Statistiek & Planbureau voor de Leefomgeving, 2016).

The images below show this increase of population for each individual Dutch city. From these pictures it becomes clear that Utrecht and Amsterdam are taking the lead in this growth.

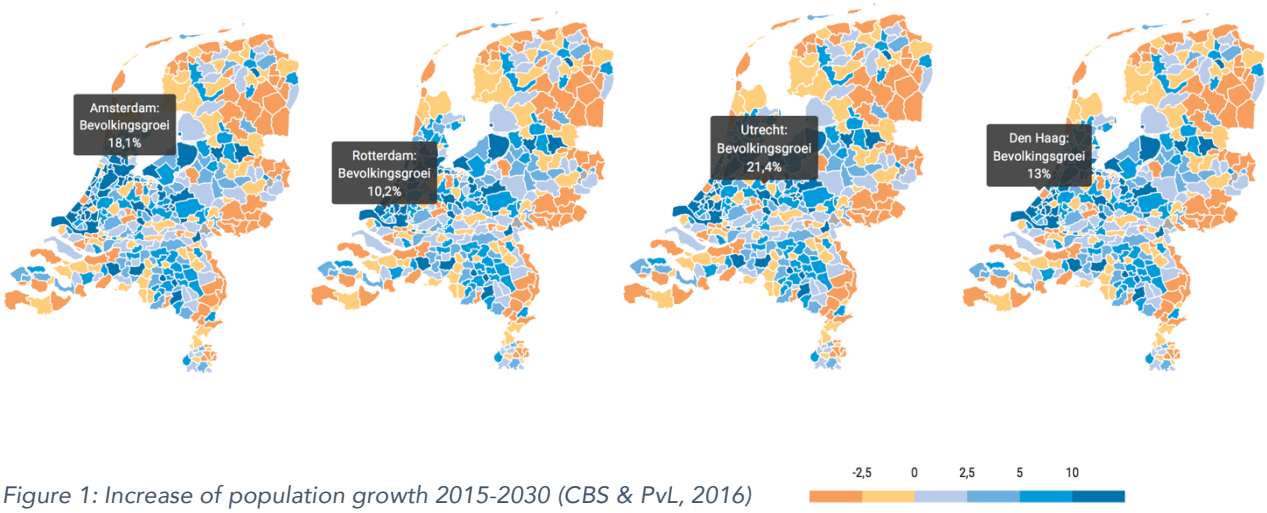


Figure 1: Increase of population growth 2015-2030 (CBS & PvL, 2016)

Since the 1990s a housing development shift has taken place, moving from greenfield areas to brownfield areas. A target was set by the Dutch government to make sure that 25 to 40 per cent of the then to be build houses were build within the existing built-up area (depending

on the region) (Adams & Watkins, 2008). Recent research shows that almost all regions have achieved this goal (Segeren, Kronberger, & Buitelaar, 2008).

Increase of construction task

The growth of urban population will, among other things, generate a need to further develop cities and to restore urban centres, to accommodate the new inhabitants and to satisfy their demands. Consequently, this will lead to a significant increase in construction work in cities. Currently in the Netherlands, around 50% of the total building revenue takes place in larger cities. Expected is an increase to 80% in the coming decennia (Roberts, Sykes, & Granger, 2016).

In Dutch urban areas, an increase in transport movements related to the construction industry can already be observed. Nowadays, three to five out of ten trucks on the road have a building site as destination, and 30% of all transported weight is linked to the construction industry (Klerks et al., 2012). This boils down to 200.000 delivery vans and 20.000 trucks a day (van Amstel & Postulart, 2017)

Nuisances

Hence this increase in construction work and the change from greenfield developments to brownfield developments, more people will experience the accompanying nuisances this increase of traffic movements causes (Quak et al., 2011). The nuisances caused by a rise in traffic movements consist of air pollution, noise pollution, reduction of road safety, city accessibility, and an increase of CO2 emissions (van Amstel & Postulart, 2017).

Smart Solutions in construction logistics

Several experimental projects have been carried out to test whether smart construction logistical solutions contribute to a decrease of these nuisances. Smart solutions in construction logistics include intelligent solutions like for example the use of a Hub and Multi-modal transport.

According to Van Merriënboer and Ludema (2016), who developed and tested smart building logistical concepts, it is possible to save 35% of CO2 emissions and to decrease 45% traffic movements through the implementation of smart solutions in construction logistics. Tests conducted by Dijkmans et al., (2014) also show a decrease of nuisances when implementing smart solution in construction logistics. The outcome of their tests shows a 40% to 60% reduction in traffic movements and a 30% to 50% reduction of emissions, especially NOx.

1.2 Problem Analysis

1.2.1 Problem explanation

Due to the increase in urban populations in the coming years, large cities are forced to construct new houses, associated facilities, and infrastructures. Cities, like for example Amsterdam, expect an increase of the city population of 53.000 inhabitants until 2030 (Centraal Bureau voor de Statistiek & Planbureau voor de Leefomgeving, 2016) and respond to this growth by building 60.000 new houses in order to meet this demand (Rooijers, 2016).

As was mentioned before, the increase of population will, by generating an enormous demand for construction projects, create many additional nuisances like air pollution, noise pollution, CO2 emissions, and accessibility problems. This increase in nuisances contradicts with the ambitions municipalities state in their agendas relating to sustainability, accessibility and liveability. In these agendas, strong statements are made about reductions in emissions and traffic amounts. In order to be able to achieve the stated ambitions, municipalities have to undertake action against the main causes of these nuisances, of which the supply and removal of materials, equipment, and personnel in the construction industry is part. Besides this, also traffic related to the sectors catering industry, retail, waste, and facility purchasing can be considered as contributors to the observed nuisances (Gemeente Amsterdam, 2016)

To, amongst other things, ensure the reduction of nuisances caused by construction tasks are reduced, a number of smart solutions in construction logistics have been developed. These smart solutions relate to the actions municipalities, contractors, wholesalers, and several other stakeholders can take. According to Ludema and Vries (2015), it is quite complicated for market stakeholders to implement these smart solutions for a number of reasons. One of the reasons they give is that market stakeholders in the construction sector are often participating in the same tender procedure, and are usually judged on the lowest price. This focus on the lowest price is not advantageous for the inclusion of smart solutions. Another reason is the acceptance of changes during the building process. This leads to the creation of buffers in stocks and execution times. An additional factor is the recent economic crisis that withholds contractors to invest in innovation on a large scale, as contractors have been occupied with financially surviving (Battes & Rolvink Couzy, 2015). It is in the municipalities interest that smart solutions in construction logistics are further developed and applied on a larger scale, as this will help them to achieve their stated ambitions concerning sustainability, liveability, and accessibility. In order to make this happen, municipalities want to stimulate market stakeholders to implement smart solutions in construction logistics. However, municipalities have no clear idea of the obstacles and incentives that market stakeholders, such as contractors and wholesalers, are facing when (not) implementing smart solutions in construction logistics. Besides this, it I s also not clear which smart solutions and instruments municipalities themselves can deploy, and at what moment they should implement these instruments.

When researching literature, strategic and tactical information on what municipalities can do to reduce nuisances caused by the construction sector can be found (Allen, Browne, & Holguin-Veras, 2010; Muñuzuri, Larrañeta, Onieva, & Cortés, 2005; SUGAR, 2011). However, hardly any information is available on how municipalities can translate this strategic and tactical information into an operational approach.

1.2.2 Problem statement

Summarizing the problem explanation above, the following Problem Statement can be drawn:

'On an operational level, municipalities do not sufficiently know how to stimulate the implementation of smart solutions in construction logistics in order to minimise nuisances caused by the construction sector.'

1.3 Objective

On a meta level, the objective of this project is on the one hand to strive for achievement of the sustainable goals that are set by municipalities, and on the other hand to increase the liveability and accessibility of urban confined areas during the construction phase. Therefore, the nuisances caused by the transportation of materials, equipment, and people related to the construction industry have to be minimalized. In order to fulfil this meta objective, an other objective is formulated that aims to develop a supporting tool that will enable Dutch municipalities to support market stakeholders and themselves to implement smart solutions in construction logistics.

1.4 Scope

1.4.1 Setting

This thesis is conducted and created within the department Procurement & Advise of the engineering company of the municipality of Amsterdam. All municipality related interview and focus group sessions took place within this department. That this research is based in Amsterdam does not mean that the outcome of this thesis is solely applicable for this specific municipality. This is due to the many generic aspects Dutch municipalities have in their processes and their deployable instruments. The outcome of this thesis can even contribute to municipalities outside of the Netherlands as, also there, many similarities in processes and instruments with other municipalities occur. However, the names of certain instruments and process steps are most likely to be different from each other.

1.4.2 Scoping

In order to make the objective of this thesis more manageable, there is, in consultation with the TU Delft and the municipality of Amsterdam, chosen to narrow down the focus of this thesis. This is necessary because of the many different roles municipalities can play, the various types of projects that they carry out, and the existing differences in administrative

conditions. Below, the scoping decisions are explained and are divided in five aspects, being role, sector, administrative conditions, purpose & location, and type of projects.

Role
Within construction projects, Dutch municipalities can operate in four distinct roles, being the main client, licensor, coordinator, and the owner of ground. It is chosen to focus on all four roles in order to gain most insight into the execution of construction projects processes, seen from the municipality's perspective.

Sector
Within the construction industry, three different types of construction sectors can be observed, namely utility, dwelling, and infrastructure sectors. The type of sector that will be treated in this research will be infrastructure sector. It has been chosen to eliminate the type 'dwelling' because municipalities themselves do not act as main clients in dwelling projects as this is left to housing corporations. The choice between the utility and infrastructure sectors is based on the numbers that were found in the 2015, 2016, and 2017 overviews of the amount spent on purchasing construction works by the municipality of Amsterdam. In those years it emerges that the percentage of the total money spent by the municipality and the number of utility projects is much lower than the percentage of the total money spent and the number of infrastructure projects (civil structures + pavements) as can be seen in Table 1 (Gemeente Amsterdam, 2017a, 2017b). Therefore, it is chosen to focus solely on infrastructure projects, as the much higher amount of infrastructure projects (in which a municipality is client) possibly contributes more to the reduction of nuisances than the amount of utility projects does.

Table 1: Percentage and amount spent on construction works (Gemeente Amsterdam, 2017a, 2017b)

2017				**2016**				**2015**			
Utility		Infrastructure		Utility		Infrastructure		Utility		Infrastructure	
12.8%	17	67.1%	86	15.8%	17	52.7%	111	5%	7	68%	105

As mentioned above, within the infrastructure sector a distinction is made between civil structure projects and pavements projects. Within this thesis, the focus will be solely on civil structure projects as it is expected that larger reductions in nuisances can be gained in this type of projects. This has to do with the different amounts of FTL (Full Truck Loads) and LTL (Less than Truck Loads) in both project types.

Administrative condition
The GWW-sector (Ground, Water & Roads) has two administrative conditions: UAV and UAV-GC (Uniforme Administratieve Voorwaarden & Uniforme Administratieve Voorwaarden - Geïntegreerde Contractvormen). The UAV is characterised by only procuring the execution phase of construction projects. This means that the other tasks are conducted by the client's own organisation or another organisation. The condition UAV is also called 'traditional type of contract'. UAV-GC procured projects, also called 'integrated type of contract', are characterised by the fact that the contracting party has more tasks and responsibilities. This

administrative condition allows different forms of organisation structures such as Design & Construct, Engineer & Construct, and Design Build & Maintain (PIANOo Expertisecentrum Aanbesteden, 2017a, 2017b).

Table 2: Administrative conditions (Gemeente Amsterdam, 2017a, 2017b)

2017				**2016**				**2015**			
UAV		UAV-GC		UAV		UAV-GC		UAV		UAV-GC	
36.6%	146	50.0%	26	49.9%	196	30.7%	20	83%	195	17%	13

In Table 2 is outlined which percentage of all executed construction projects by the municipality of Amsterdam are executed with the UAV and UAV-GC administrative conditions. It is clearly visible that the percentage of UAV procured projects is reducing in a quick pace, from 83% in 2015 to 49.9% in 2016 to 36.6% in 2017. This reduction of UAV procured projects results in a rapid growth of the UAV-GC procured projects, from 17% in 2015, to 30.7 % in 2016 to 50% in 2017. According to knowledge platform CROW (2017), is it expected that this growth will continue in the future and therefore in this thesis it is chosen to focus on the UAV-GC procured projects.

Location & Purpose

As already explained in the Topic and Problem analysis (Section 1.1 & 1.2), this research and design focuses on municipalities that have to deal with large building tasks which are located in urban confined areas.

Type of project

The type of construction projects that remain when taking all previous four aspects (role, sector, administrative conditions, and location & purpose) into account, are mostly UAV-GC procured civil structure projects such as car and bicycle parking garages, bridges, quay walls, tunnels, aqueducts, and viaducts. Below, four examples (Figure 2-5) of civil structure projects that fulfil the above mentioned scoping requirements are exposed.

Figure 2: Bicycle parking garage Beursplein Amsterdam (CRUX, 2017)

Figure 3: Restoration of Quay walls Bemuurde Weerd, Utrecht (Kleybruggen, 2017)

Figure 4: Market square + bicycle parking garage Nieuwe Markt Groningen (Gemeente Groningen, 2017)

Figure 5: Parking garage Boerenwetering, Amsterdam (AT5, 2017)

1.4.3 Scope Outline

Summarising the above mentioned scope, this thesis will focus on:

- projects in which municipalities act as the main **client** and also fulfil the role of a **licensor**, **coordinator,** and **owner of ground**.
- **civil structure projects** that are executed by municipalities.
- projects that are **UAV-GC** procured.
- municipalities that have to deal with **large building tasks** that are located in **urban confined areas**.
- the realisation of **civil structure projects** in the **GWW sector,** such as parking garages, aqueducts, viaduct, bridges, and quay walls.
- the **operational level** of the execution of civil structure projects, which can be useful for **employees of municipalities** who operate on this level (such as a purchasing advisor, project manager, risk manager, environmental manager, technical manager and contract manager).

1.5 Design Statement

In order to respond to the objective, in respect with the scope of this thesis, a Design Statement is formulated. The Design Statement is as follows:

'Developing a tool that will give support to employees of municipalities working on the realisation of UAV-GC procured civil works, helping them to stimulate market stakeholders to implement smart solutions in construction logistics into projects.'

1.6 Structure of Report

This report consists of ten chapters that are divided according to Figure 6.

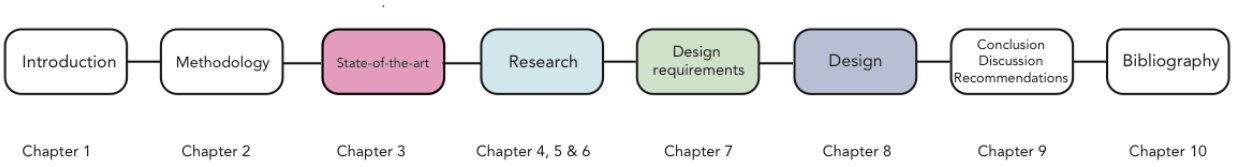


Figure 6: Structure of report (own figure)

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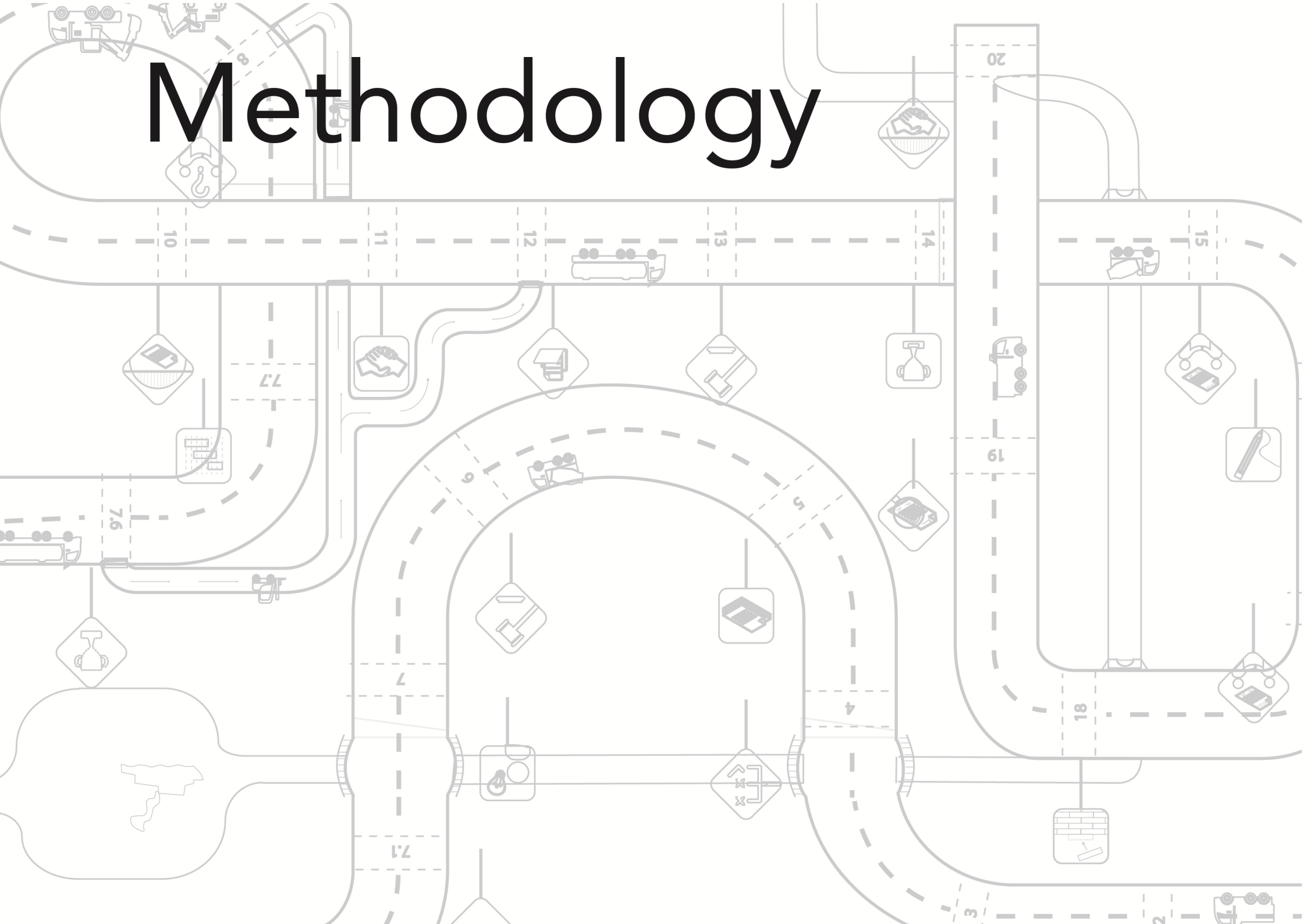
Methodology



2. Methodology

The objective of this Chapter is to present the way in which the Research & Design Methodology of this thesis is executed. In order to do this, first the general Research and Design methodology is described (Section 2.1), after which in Section 2.2 the Design method is explained. Finally, in Section 2.3, the four different Research methods are explained.

2.1 Research & Design

This Section is divided in three parts, being Design set up (Subsection 2.1.1), Research Questions (Subsection 2.1.2), and Research & Design set-up (Subsection 2.1.3).

2.1.1 Design set-up

Figure 7 roughly shows the main structure of the design process. The main structure is divided in five parts that are strongly related to each other. The relations are visualised by means of the arrows pointed in certain directions. When following the arrows, the main structure can be understood.

In order to response to the **Design Statement**: 'Developing a tool that will give support to employees of municipalities working on the realisation of UAV-GC procured civil structure projects, helping them to stimulate market stakeholders to implement smart solutions in construction logistics into projects', a **Design** of a tool needs to be created. Only, before a design can be developed, **Design Requirements** that the design must satisfy have to be articulated. However, without having any information on the topic, these design requirements cannot be set yet. Hence, a **Research** into the topic has been conducted for which a **State-of-the-art** literature study is used.

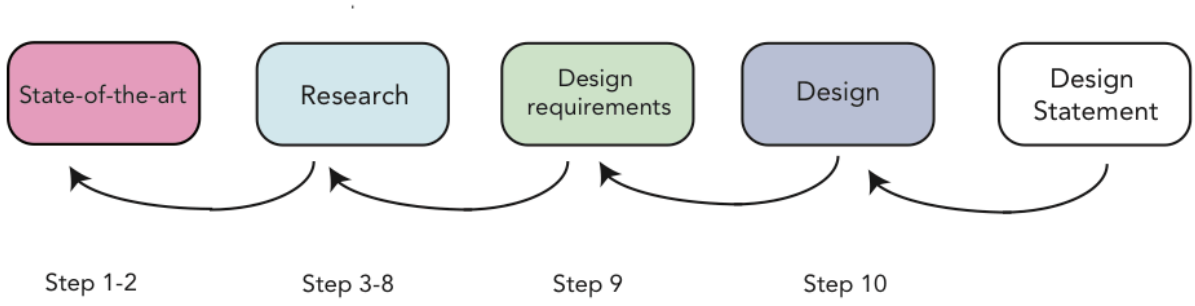


Figure 7: Main structure of design process (own figure)

2.1.2 Research Questions

The research part of the methodology consists of three main questions, of which the first question includes three sub-research questions. All questions can be found on the next page.

Q1 - Which set of instruments can Dutch municipalities deploy to positively stimulate the implementation of smart solutions in construction logistics in urban confined areas?

- *Q 1.1A: What level of influence do municipalities have on the application of smart solutions that are implementable by market stakeholders?*
- *Q1.1B: To what extent are the smart solutions that are implementable by market stakeholders applicable for civil structure projects?*

- *Q1.2: Which market stakeholders have a strong relation to the implementation of the most suitable smart solutions in construction logistics?*

- *Q1.3 Which obstacles inhibit and which incentives stimulate stakeholders to implement smart solutions in construction logistics?*

Q2. How does the process of municipalities' UAV-GC procured civil structure projects look like from the start (initiation phase) to the end (realisation phase)?

Q3. In which way can instruments obtained in Q1 stimulate the implementation of smart solutions in construction logistics in municipalities' own executed UAV-GC procured civil structure projects?

2.1.3 Research & Design set-up

The research part of this thesis has an explorative character, as the focus of the research initially starts broad and slowly narrows down during the investigation. According Saunders (2011), three fundamental ways of conducting explorative research can be designated, being: conducting a search in literature, interviewing experts, and performing focus group interviews. In this thesis, all three methods of conducting an explorative research are applied. The advantages that come forth when conducting explorative research are the flexibility and adaptability towards changes in the research direction it provides. However, this specific advantage is only provided if the research executer is willing to make these changes according to the availability of new data and insights (Saunders, 2011). In order to avoid changes as much as possible, a clear goal has been formulated. This goal relates to the specified Design Statement, which has been formulated previously (Section 1.5).

Figure 8, displayed on next page, shows the four main parts in which this thesis is structured (State-of-the-art (pink), Research (blue), Design Requirements (green) and Design (purple)). Besides that, it shows the ten steps that have to be taken in order to respond to the Design Statement. Furthermore, the figure shows the division in steps focussing on gaining knowledge (steps on the left side of figure) and steps focussing on the creation of the design of the tool (steps on the right side of figure). Figure 8 can also be seen as the more detailed and chronological presented version of Figure 7. The colours in Figure 8 correspond to the used colours in Figure 6 and 7. In Figure 8, the green and pink colours indicate the way in which the information of each step is obtained, and show respectively field research and literature study. The graphic is structured from top to bottom and the relation between the

blocks are visualised by the arrows drawn in between them. Each block consists of one or more steps that are presented through the yellow/white cubes.

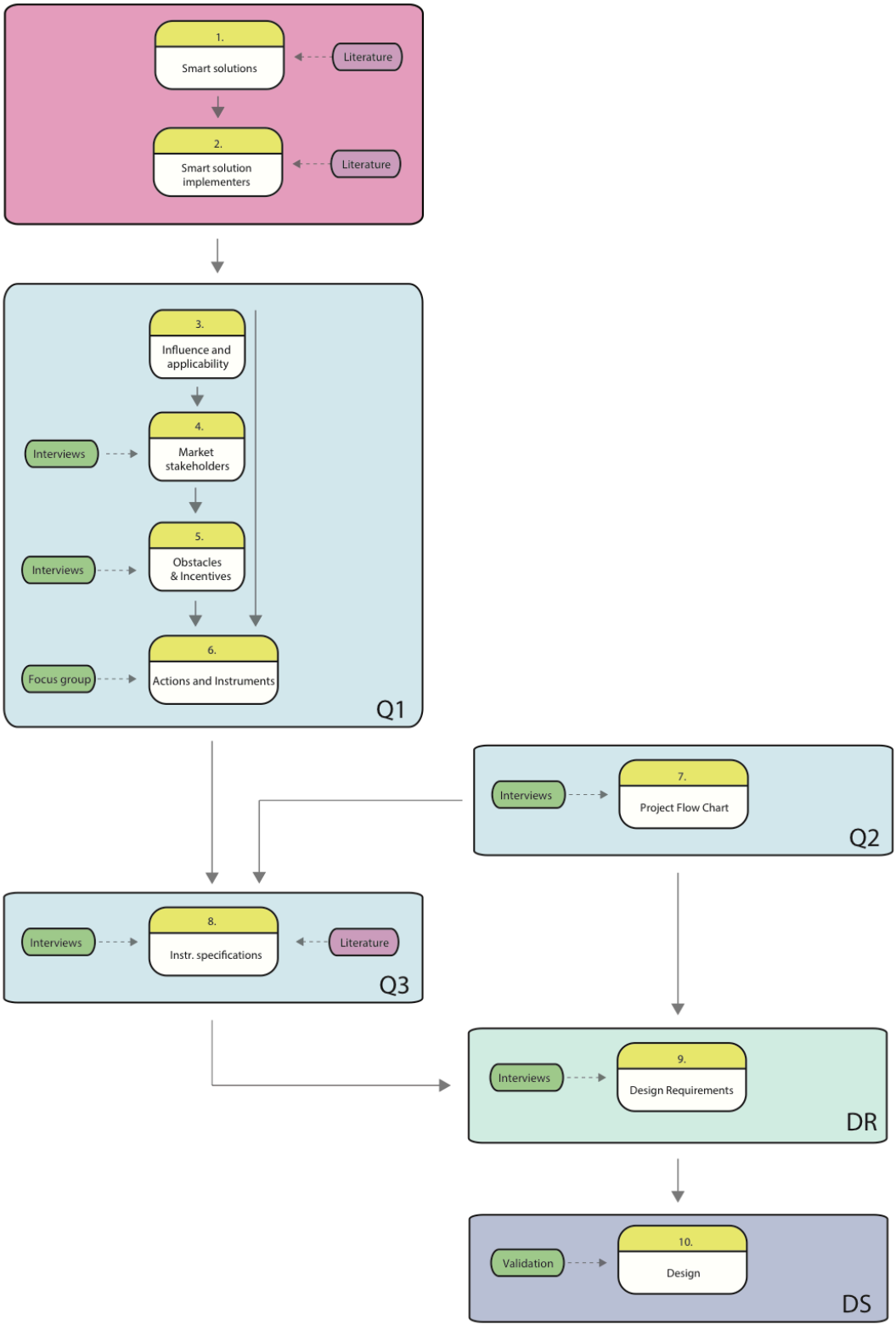


Figure 8: Detailed chronological methodology diagram (own figure)

The first (pink) block represents the conducted State-of-the-art literature study. First a research is conducted on **Smart solutions in construction logistics (1**). Subsequently, an analysis is conducted on the **Smart solution implementers (2)** in order to find out if municipalities or market stakeholders implement certain smart solutions.

Subsequently, the first research section (Q1) starts with the search for instruments that can be deployed by Dutch municipalities to positively stimulate the implementation of smart solutions in construction logistics. In order to find these instruments, four steps are taken. In the first step, insight is gained into the **Influence (3)** that municipalities have on the implementation of smart solutions, and the **applicability (3)** of the smart solutions in civil structure projects. Secondly, by means of interviews, knowledge is obtained on **Market stakeholders (4)**. In addition, there is looked at the level of influence Market stakeholders have on the implementation of smart solutions. In the third step, the observed **Obstacles and Incentives (5)** that market parties face when implementing smart solutions in construction logistics are collected through the conduction of interviews. Subsequently, in step four, these obstacles and incentives are translated into **Actions and Instruments (6)**. All obtained actions and instruments are acquired during a focus group.

In the second section (Q2), a research is conducted on what the **Project Flowchart (7)** of municipalities' UAV-GC procured infrastructure-construction projects looks like from start (Initiation phase) to end (Realisation phase). In order to obtain information about this, literature and interview sessions have been employed.

In the last research section (Q3), an investigation is done using the outcomes of both the first and the second research part. By interviewing professionals that work with the selected instruments, the **Instrument Specifications (8)** are determined.

On the basis of the obtained flow chart and instruments specifications, the **Design Requirements (9)** will be formulated (DR). Besides the input requirements, which contain the obtained research results, requirements will be set that relate to functional, non-functional, appearance, usability, and desirable aspects. The requirements relating to appearance and usability are acquired during interview sessions. However, the requirements relating to functional and non-functional are extracted from the problem statement, objective, and scope of this thesis.

With the established Design Requirements, the **Design (10)** process of the development of the tool can be started (DS). Iterative process steps have to be taken in order to come to the first version of the tool. Its future users will validate this version of the tool, and the results will be used for the development of a second version of the supporting tool. After this, a potential user validates the new revised tool focusing mainly on the generic applicability of the tool. Subsequently, the obtained information will be processed and translated into different alternatives in which the tool can be shaped. Thereafter, the most suitable design option is further developed.

2.2 Design method

In order to respond to the design task of this thesis, a slightly adapted version of 'The Basic Design Cycle' invented by Roozenburg and Eekels (1995) is deployed. The Basic Design cycle is known for its applicability for all sorts of design problems. For this reason, The Basic Design Cycle is considered the most fundamental model of designing as according Roozenburg and Eekels (1995) all solved design problems have gone through the model at least once. The Basic Design Cycle model is characterised by five different process steps, in which a trial and error process, knowledge related to the problem, and solutions are spirally increasing. The five different process steps consist of the Analysis phase, Synthesis phase, Stimulation phase, Evaluation phase, and the Decision phase (Roozenburg and Eekels, 1995).

In Figure 9, the slightly adjusted basic design cycle is displayed. In the figure it can be seen that the simulation phase is named validation phase. This is because no real simulation of the design has taken place during the design process. Below, the iterative design process is explained. It should be remembered that the design process is executed iteratively (Figure 9).

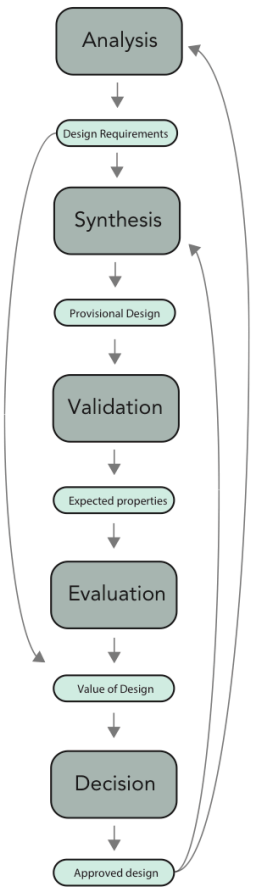


Figure 9: Adjusted Basic Life Cycle (own figure)

Analysis
In the first phase, research is conducted into smart solutions in construction logistics, Instruments, UAV-GC process, and instruments specifications in order to construct the Design Requirements (Chapters 3,4,5 and 6).

Synthesis
In the second phase, the provisional design is generated in which separate obtained information components are merged into a whole (Section 8.1).

Validation
In the third phase is by means of two validation sessions the provisional design validated. The sessions focused on getting insight in the substance and generic extent of the provisional design (Section 8.1).

Evaluation
In the fourth phase, it is tested to what extent the design satisfies all stated Design requirements. Besides this, a user-test is conducted in order to find how future users view the design of the supporting tool (Section 8.3).

Decision
In the fifth phase, the design is approved and the final design is proposed (Booklet called 'Project Roadmap – Unobstructed Constructed').

2.3 Research methods

In this thesis, various qualitative research methods are used individually and in combination with each other. The research methods consist of semi-structured interview sessions, a focus group, literature studies, and an already specified analysis technique. The manners in which the methods are used are explained below.

Semi-structured interviews
In research steps 4,5,7,8 and 9, semi structured interview sessions were held. According to Drever (1995), this method of interviewing is a flexible technique suited for small scale researches. When conducting a semi-structured interview, the interviewer draws up an interview format before the interview takes place. The format consists of the subject to be discovered and the associate corresponding questions. During the interview session, the detailed structure of the conversation is left to be worked out. This ensures that the interviewee has a fair degree of freedom in the information he or she provides (Drever, 1995).

Focus Group
During this research, in step 6, a focus group was deployed to gain expertise on certain aspects. Focus groups are a form of group interviews that concentrate on the communication between participants to make sure data is generated. In focus groups the explicit interaction between participants is part of the method (Kitzinger, 1995). A focus group generally involves 4-12 people and provides qualitative data resulting from a focussed discussion. When conducting a focus group, it is important to listen well and to pay attention to all participants, be open to hear what the participants have to say, and to be non-judgemental. Furthermore, it is crucial to create a comfortable environment for participants to share information and to be careful with the information they provide (Krueger & Casey, 2000).

Literature study
In this theses, in depth literature studies are conducted to obtain substantiate knowledge on certain aspects. The in depth studies are conducted in research steps 1, 2, and 8.

Analysis Technique
In step 4, a specific analysis technique is used during the execution of the research. This technique is called the Stakeholder-issue-interrelationship diagram (Bryson (2004), as cited in Bryant (2002). This diagram on the one hand makes clear which stakeholders share an interest in several issues, and on the other hand shows how stakeholders relate to each other when looking at the relations the stakeholders have with the issues. In this thesis, the Stakeholder-issue-interrelationship diagram is used in a slightly different way. In the diagram, it is indicated to what extent the stakeholders have influence on the issues. This is specified by means of the categories Large influence (++), Some influence (+), and No influence (-).

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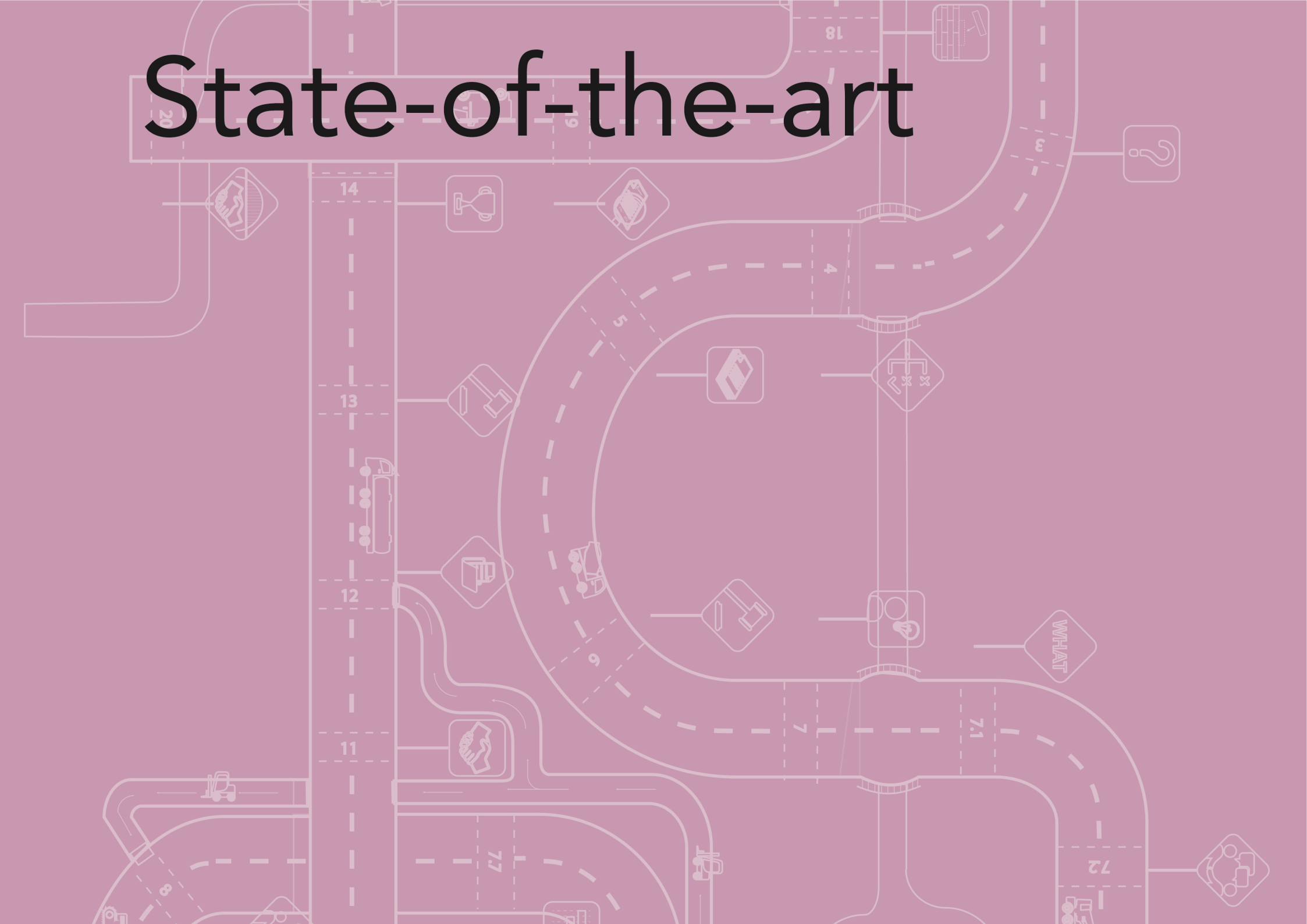
State-of-the-art



3. State-of-the-art

In order to search for instruments that can be deployed by municipalities to stimulate smart solutions (Chapter 4), it is necessary to first understand what smart solutions in construction actually are and which smart solutions exist. For these two reasons, a literature study on the smart solutions in construction logistics is provided.

In Section 3.1, an overview is provided of the smart solutions that were found in literature. Hereinafter, in Section 3.2 there is looked at the two different types of smart solution implementers (market stakeholders and municipalities).

3.1 Smart solutions in construction logistics

When searching in literature for smart solutions in construction logistics, not much scientifically proven information seems to exist. However, three articles that focus on smart solutions in construction logistics were found. The first research focuses on solutions obtained through analysing projects in the city of Amsterdam (Quak et al., 2011). The second source uses all the obtained test results and information related to smart solutions in construction logistics in the Netherlands (Platform Logistiek in de Bouw, n.d.). And in the last research, the focus lays on the challenges and potentials for construction logistic in urban areas (Anand, Haji, Gouderjaan, & van Amstel, 2016).

In total, twelve different smart solutions can be distracted from the three previous mentioned sources. The twelve solutions include smart solutions in construction logistics that can be both implemented by municipalities and market stakeholders (for example contractors, wholesaler and designers). It is noticeable that all twelve smart solutions in construction logistics find their origin in the utility sector. This ensures that the smart solutions are also described from the utility sector's perspective in literature as well as in the upcoming description of the smart solutions. To ensure that the smart solutions fit within the scope of this thesis, in Section 4.1 it will be tested to what extent the smart solutions are applicability for civil structure projects.

On the next pages, the twelve different obtained smart solutions in construction logistics are explained. The descriptions contain different logistic specific terminologies that are shortly explained in Table 3.

Table 3: Explanation of logistic specific terminologies (Quak et al., 2011)

Terminology	Explanation
Full Truck Loads (FTL)	During shipment of materials, trucks are fully loaded. In the construction sector Full Truck Loads often appear when for example sand, stones, and concrete need to be transported.
Less than Truck Load (LTL)	During shipment of materials, trucks are not fully loaded. In the construction sector Less than Truck Load appear when materials that cannot be easily stacked or materials that have truck deviating sizes need to be transported. Examples are window frames, long beams and columns, and installation materials.

Time-critical loads	In the construction industry time critical loads contain materials that need to be at the project location at a specific time. An example of a Time-critical load material can be for example concrete.
Non-Time- Critical loads	In the construction industry Non-time critical loads contain materials that do not need to be at the project location at a specific time, such as piles, sand-lime brick and other masonry units.

Preferred network

A preferred network is characterised by municipalities that enforce suppliers and transporters to make use of prescribed routes to and from building sites. Municipalities can, among other things, enforce preferred networks by signposting/placing traffic signs and by properly executing enforcement policy. A Preferred network can be deployed for both Full Truck Loads (FTL) & Less than Truck Load (LTL), time-critical & non time-critical deliveries, and infrastructure & utility projects (Quak et al., 2011). Selecting preferred routes can increase road safety and improve traffic flows in confined areas (Platform logistiek in de Bouw, n.d.).

HUB

A construction logistic hub can be used as an assembly point in which manufacturers, wholesalers/suppliers, transporters, and contractors deliver enormous quantities of products and materials. The products and materials will be bundled for each separate project and brought in smaller, fully loaded (electric) cars to the project site. This makes it possible to drive with fewer cars to the project site and to deliver goods just in time (lean), resulting in more accessible cities and improvement of air quality (Anand, Haji, Gouderjaan, & van Amstel, 2016). Hubs are often situated at city borders or outside cities where they separate traffic from in and outside cities (Platform Logistiek in de Bouw, n.d.). At the city border, hubs can be situated at a project specific location facilitated by a contractor, or on a permanent location (called LOP-logistiek ontkoppelingspunt) facilitated by municipalities. A boundary condition of a HUB is that it does not optimally work for FTL. Especially not for time-critical FTL filled with for example sand as, in this example, the hub only serves as an unnecessary extra transfer point (Quak et al., 2011).

Multi-modal transport

Multi-modal or synchromodal transport contains various ways of transporting goods. In construction logistics, this usually means transport on roads and over water. Often are building sites situated close to waterways, which makes this mode of transporting attractive to execute construction logistics in the Netherlands. When executing Multi-modal transport, contractors, manufacturers, wholesalers/suppliers, transporters, and shipping companies are obliged to cooperate. Transport over water reduces traffic movement across roads, nuisances, and emissions of toxic gasses. To make transport over water financially interesting, the construction logistics of several building project should be combined (Platform Logistiek in de Bouw, n.d; Anand, Haji, Gouderjaan, & van Amstel, 2016). A Disadvantage of the usage of multi-modal transport is the necessity of the presence of a transhipment point close to the construction site. Besides this, multi-modal transport is most suitable for non-time-critical FTL (Quak et al., 2011). In Figure 10 & 11 examples are showed on how multi-modal transport can be deployed.

Figure 10: Transportation over water (De gezonde stad, n.d.)

Figure 11: Transport over water (De laatste METER, 2017)

Distribution network

This solution focusses on the coordination of trucks that travel from and to the project location. Suppliers and building sites are connected to each other, as suppliers deliver their goods from a location that is nearest to the building site. This solution has a number of practical disadvantages, like for example the difference in products, qualities, services and costs suppliers offer, and the difficulty of developing a calculation tool (Quak et al., 2011).

Building innovatively

Smart building requires design professionals to think about construction logistics in an early stage of the building process. By means of prefabbing or other future methods, like for example 3D-printing, a reduction in the amount of freight traffic can be achieved. Instead of first bringing all materials to the project site after which a specific part is created on site, in the case of prefabbing there has been chosen to do this outside of the city. When the project part is ready, it is carried to the project location and all prefab parts are assembled. Besides a reduction in freight traffic, also the amount of labour that enters the city will decrease when using smart building techniques like prefabbing (Quak et al., 2011). The 3D printing technique has not yet been developed to the extend that it can be implemented on a large scale (Anand, Haji, Gouderjaan, & van Amstel, 2016). Hence, currently, several small-scale projects are being executed in which the 3D printing technique is deployed. This includes for example a concrete bicycle bridge in Eindhoven (See Figure 12 on next page) and a stainless steel bridge in Amsterdam (See Figure 13 on next page).

Finishing container, Mobile container and Combination-container

A finishing container is mainly used by a contractor/wholesaler to bundle construction materials prior to the finishing phase. All products will be collected at different working places to make sure that all construction products are available at the construction site. This to enable on the one hand a higher productivity by reducing the lost time spent on searching for materials, and on the other hand a reduction in material damage as the materials are properly stored. A reduction of the total finishing phase time also contributes to an increase of productivity (Platform Logistiek in de Bouw, n.d.)

Besides a finishing container are also other types of containers considered smart solutions in construction logistics. This includes mobile containers and combination-containers. Mobile containers are drivable cabinets in which materials and equipment are stored for contracting parties that work on the construction site. Every morning the mobile container is filled with new materials that the contractor will use that day. The searching time for materials and equipment will be reduced when using the mobile container, which can lead to an increase of the productivity of the employees. The combination-container solution enables combining waste and new supplies in one single delivery (Quak et al., 2011).

Figure 12: 3D printed concrete bicycle bridge (NOS, 2017)

Figure 13: 3D printed stainless steel bridge (3dprimeur, 2015)

Clustering of personnel transport

Clustering of personnel will reduce the amount of traffic caused by the contractor its employees that have to travel to go to work. The clustering can be executed in various ways, such as carpooling, where the employees collectively drive to the project location. Another option is parking at a Park & Ride at the border of a city, and from that point continuing the travel by taking the metro, tram, or bus to the project site (Platform Logistiek in de Bouw, n.d.). This option can also be executed by letting a shuttle bus commute between the Park & Ride and the project location (Quak et al., 2011).

Building ticket

This instrument is introduced to plan and regulate transport movements in order to develop a better logistic overview and to clarify delivery times for suppliers. This ensures that fewer suppliers have to wait to unload their materials, which often results in suppliers that are forced to drive around the city while waiting. Often, this solution is used in combination with the building logistic hub and a transport coordinator (Platform Logistiek in de Bouw, n.d.).

Logistic team

This smart solution focusses on the deployment of logistic teams that directly bring building materials to the correct workplace in construction projects. Preferable, this does not take place during working hours, in order to be able to continue the building process without interruptions. Better management and the taking over of workload will minimalize waiting hours. It can also be beneficial to higher a logistic transport coordinator that solely regulates

and manages all transport movements to and from the building site. This is to improve the tuning between building sites and wholesalers. This is supposed to lead to a higher productivity (Platform Logistiek in de Bouw, n.d.)

Award criteria
Governmental institutions are obliged to procure projects above a given cost price. For a long time, the assessment criteria were solely judged on the cost price. Since the introduction of the Procurement law 2012, governmental institutions are also obliged to introduce other award criteria such as performance level and life cycle costing criteria. It is possible to also implement award criteria concerning how the contracting party is going to deal with building logistic. By awarding these criteria, governmental institutions can stimulate the execution of best practises in building logistics (Platform Logistiek in de Bouw, n.d.)

Integrated information facilities
To be able to provide solid project schedules, necessary is the ability of a good ICT program that combines all schedules of all stakeholders. The Building Information Model (BIM) is an example of an integrated information facility (Platform Logistiek in de Bouw, n.d; Anand, Haji, Gouderjaan, van Amstel, 2016)

3.2 Smart solution implementers

The objective of this section is to find out which smart solutions in construction logistics are implementable by market stakeholders and which ones by municipalities. Namely, by knowing which smart solutions market stakeholders can implement, insight is given into the smart solutions that municipalities wish to stimulate to reduce nuisances related to accessibility and liveability of urban confined areas. In addition, the obtained smart solutions that can be implemented by municipalities give insight into the possible actions municipalities can take in order to reduce nuisances related to accessibility and liveability.

This section is divided as follows: In Subsection 3.2.1 an analysis is conducted of the two different smart solutions implementers, being market stakeholders and municipalities. Subsequently, in Subsection 3.2.2 conclusions are drawn.

3.2.1 Analysis of smart solution implementers
The division between smart solutions that are implementable by market stakeholders and municipalities is made on the basis of literature that is used in order to establish the description of the eleven smart solutions in Section 3.1.

In this subsection all the obtained smart solutions are listed and classified into two groups. When it is assumed that all twelve obtained smart solutions are scientifically proven to work, the following two solution categories (following page) can be set:

1. The solution is implementable by market stakeholders. When the market stakeholders are able to implement the solution, the nuisances related to emissions, accessibility, and/or liveability will be reduced.
2. The solution is implementable by municipalities. When municipalities are able to implement the solution, the nuisances related to emissions, accessibility, and/or liveability will be reduced.

In the following Table 4, the classification of all solutions into the two categories is outlined. In the first column the smart solutions are displayed. The second column shows the solution category in which the smart solution belongs. In the third column a substantive explanation is given of the choices made related to the categories in which the smart solution belongs. In the last column the source(s) from which the substantive explanation is distracted is displayed.

Table 4: Division of smart solution implementers

Smart solution	Category	Substantive explanation	Source
Preferred Network	2	Municipalities can require suppliers and transporters to make use of prescribed routes to and from building sites.	(Quak et al., 2011). (Platform Logistiek in de Bouw, n.d).
Hub	1 & 2	Hubs can be situated on a project specific location facilitated by contractor and on a permanent location (called LOP-logistiek ontkoppelpunt) facilitated by municipalities.	(Quak et al., 2011). (Platform Logistiek in de Bouw, n.d). (Anand, Haji, Gouderjaan, & van Amstel, 2016).
Multi-modal transport	1	Multi-modal transport is executed by market parties (transportation on roads and over water).	(Quak et al., 2011). (Platform Logistiek in de Bouw, n.d). (Anand, Haji, Gouderjaan, & van Amstel, 2016).
Distribution network	2	Municipalities have a coordinating role when implementing a distribution network.	(Quak et al., 2011).
Building innovatively	1	Market parties, such as design professionals, can execute innovative building projects.	(Quak et al., 2011). (Anand, Haji, Gouderjaan, & van Amstel, 2016).
Mobile/ Combination/ Finishing container	1	All three container options can be used within contracting companies their organisations.	(Quak et al., 2011). (Platform Logistiek in de Bouw, n.d)
Clustering of personnel transport	1	Contracting parties can execute this solution by introducing a shuttle bus or enforcing employees to make use of public transportation.	(Quak et al., 2011). (Platform Logistiek in de Bouw, n.d)
Building ticket	1	Contracting parties can make use of a building ticket to get a better logistic overview and to clarify delivery times for the supplier.	(Platform Logistiek in de Bouw, n.d)
Logistic Team	1	Contracting parties can choose to assign a logistic employee or transport coordinator to work on the building site.	(Quak et al., 2011). (Platform Logistiek in de Bouw, n.d)
Award criteria	2	Governmental institutions are obliged to procure projects above a given cost price by means of award criteria.	(Platform Logistiek in de Bouw, n.d)

Integrated information facilities	1	Integrated information facilities, such as Building Integrated Model (BIM), can be deployed by market stakeholders to gain a good insight into the stakeholders their schedules.	(Platform Logistiek in de Bouw, n.d). (Anand, Haji, Gouderjaan, & van Amstel, 2016).

3.2.2 Conclusion of smart solution implementers

When looking at Table 4 it becomes visible which smart solutions in construction logistics are implementable by market stakeholders and which ones by municipalities. The following conclusion from Table 4 can be drawn.

In total, eight out of eleven smart solutions can be implemented by market stakeholders. However, four out of eleven belong to municipalities. The difference in numbers is caused by the Hub smart solution that can be implemented by both market stakeholders and municipalities. For market stakeholders and municipalities, the Hub can be applied in various ways. Namely, when market parties make use of the Hub solution, the Hub location is often project specific and initiated by the main contractor. All project related suppliers are enforced to bring their supplies to the Hub, after which the materials are brought to the building site on demand. However, when municipalities implement the Hub solution, the location of the Hub is permanent. In this case, municipalities enforce all construction related stakeholders to deliver construction materials towards the Hub, after which the materials are brought to the building site on demand.

In Table 4, It is visible that the eight smart solutions that can be implemented by market stakeholders are the Hub, Multi-modal transport, Building innovatively, Mobile/ Combination/ Finishing container, Clustering of personnel transport, Building ticket, Logistic Team, and Integrated information facilities. It should be realised when reading these eight smart solutions that this list of solutions displays the smart solutions that municipalities wish to stimulate in order to reduce nuisances related to accessibility and liveability. The list of eight solutions will be made use of in the following Sections 4.1 and 4.2.

Furthermore, Table 4 displays the four obtained smart solution that can be implemented by municipalities. This category includes preferred network, Hub, distribution network, and award criteria. The smart solutions display the actions municipalities themselves can take in order to reduce nuisances related to accessibility and liveability. In Section 4.4, these four smart solutions will be used.

Research

4. Instruments

This chapter primarily focuses on answering Research Question 1: 'Which set of instruments can Dutch municipalities deploy to positively stimulate the implementation of smart solutions in construction logistics in urban confined areas?'. In order to respond to the Research Question, three Sub-Research questions are stated. These questions will be answered one at the time in Section 4.1-4.3. The answer to the main question will be provided in Section 4.4.

Goal of Research Chapter 4
The aim of this Chapter is to provide information for the input- and functional Design Requirements that can be found in Chapter 7. The input relates, among other things, to the instruments that municipalities can deploy in order to stimulate the in Section 3.1 mentioned smart solutions. In addition, this Chapter also focuses on obtaining insight in the following aspects:

- The smart solutions in construction logistics in which municipalities have the most influence on the implementation by market stakeholders.
- The smart solutions in construction logistics that are most applicable for civil structure projects.
- The smart solutions on which municipalities primarily should focus when stimulation of smart solutions in construction logistics is required.
- The market parties on which municipalities should focus when stimulation of smart solutions in construction logistics is required.
- The obstacles and incentives that market stakeholders face when implementing smart solutions in construction logistics.
- The actions that municipalities can take in order to stimulate the implementation of smart solutions in construction logistics in projects.

All obtained insights will be used as input during the development of the supporting tool.

Structure of Research Chapter 4
Using Figure 14 (next page), a description of the structure of Chapter 4 will be given.

The instruments that are needed to answer Research Question 1 will be obtained in two different ways, as visible in the figure (orange and yellow). On one side, the instruments are derived from smart solutions that are implementable by market stakeholders (orange). On the other side are the instruments derived from smart solutions that are implementable by municipalities (yellow).

Both categories of smart solution implementers (orange and yellow) were obtained in Section 3.2. Based on these results, both sets of smart solutions follow a different route to ultimately result in a list of instruments.

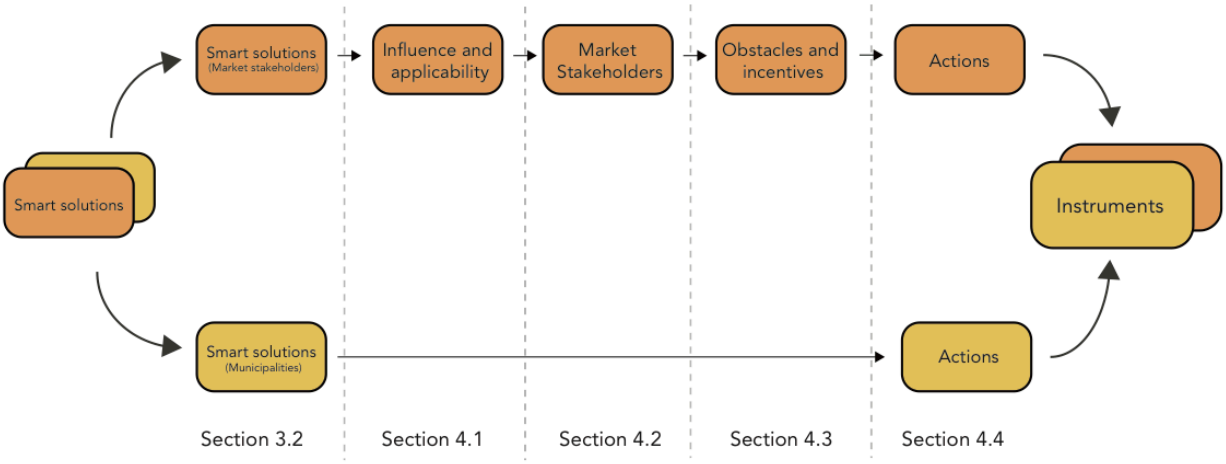


Figure 14: Structure of Chapter 4 (own figure)

Orange route – Smart solutions implementable by Market stakeholders
After the division of the smart solutions in Section 3.2, the solutions are tested to see to what extent they are applicable for civil structures projects and to define the level of influence municipalities have on the implementation (Section 4.1). The outcome of this test determines the relevance for this project to further investigate how municipalities can stimulate the smart solutions. After, in Section 4.2, a research is conducted on the market stakeholders that are involved during the implementation of the above-mentioned most suitable smart solutions. This research is conducted to both gain insight into the level of influence market stakeholders have and into the inter-relations between market stakeholders. In addition, this research is also carried out in order to investigate which specific market stakeholders should be interviewed for the following next step. This step consists of a research into the obstacles and incentives market stakeholders are facing when (not) implementing smart solutions in construction logistics (Section 4.3). As the final step, the obtained obstacles and incentives are used to gain insight into the actions that municipalities can take and the instruments municipalities can deploy (Section 4.4).

Red route – Smart solutions implementable by Municipalities
The in Section 3.2 acquired list of smart solutions that are implementable by municipalities is used in Section 4.4 to provide information on the actions municipalities can take. Subsequently, the actions are used to gain insight into the instruments that municipalities can deploy.

4.1 Influence on smart solutions and applicability of smart solutions

The aim of this section is to answer Sub-Research Question 1.1A: 'What level of influence do municipalities have on the application of smart solutions that are implementable by market stakeholders' and Sub-Research Question 1.1B: 'To what extent are the smart solutions that are implementable by market stakeholders applicable for civil structure projects'. Both answers to the Sub-Questions determine the relevance for this project to further investigate how municipalities can stimulate the smart solutions. Namely, as soon as municipalities have hardly any possibility to stimulate a specific smart solution to be implemented, it is not efficient to continue searching for instruments that stimulate implementation. In addition, if the smart solutions do not contribute to any reduction in nuisances when implemented in civil structure projects, it is also not efficient to continue searching for instruments that stimulate implementation.

The execution of both analyses are conducted by the researcher itself as little knowledge about the level of influence that municipalities have on the implementation of smart solutions and the applicability of the smart solutions in civil structure projects is outlined in literature or known by experts. The lack of knowledge related to the influence of municipalities is possibly linked to the interface between smart solutions and municipalities on which this topic lies. The possible cause that relates to the non-available expertise on the applicability of the smart solution in civil structure projects is that the smart solutions does not find their origin in the infrastructure sector and are not tested yet when applied in civil structure projects.

In order to make sure that the substantiation of the choices made in the analyses are as best as possible is made use of knowledge obtained trough all carried out interview sessions, the performed focus group and the read literature. By means of the continuous increasing learning process throughout the whole research progress, both analyses are constantly adjusted to the latest information available.

Section 4.1 is divided into three Subsections. First, in Subsection 4.1.1 the analysis concerning the level of influence of municipalities is displayed. Subsequently, in Subsection 4.1.2, the analysis of the applicability of the smart solutions for civil structure projects is showed. Finally, in Subsection 4.1.3 conclusions are drawn and an answer is given to both Sub-Research Questions Q1.1A and Q1.1B.

4.1.1 Level of influence of municipalities

The in Section 3.2 derived eight smart solutions that are implementable by market stakeholders, are used in this Subsection. Besides this, the explanation of these eight smart solutions in Section 3.1 are also utilised.

Analysis of level of influence

In this paragraph the analysis concerning the level of influence that municipalities have on the application of smart solutions that are implementable by market stakeholders is made. The analysis can be found in Table 5. During the execution of the analysis, the scope of this project

has been taken into account. For this analysis specific, this implies that the municipality acts as the main client, licensor, coordinator, and the owner of ground.

In Table 5, the first column displays the smart solutions that are implementable by market stakeholders. The second column shows the level of influence municipalities have on the application of the smart solutions in the first column. The level of influence is identified with a ++, +, +/-, and -. Lastly, the third column provides a substantive explanation of the choices made related to the level of influence.

In the second column of Table 5, an A ++ can be read as 'Municipalities have a large influence on the implementation of the smart solution', a + as 'Municipalities have influence on the implementation of the smart solution' a +/- as 'Municipalities have little influence on the implementation of the smart solution' and – as 'Municipalities have no influence on the implementation of the smart solution'. This ranking can be translated in a more quantitative approach being: A ++ is given when municipalities possibly can make use of two or more means to stimulate market stakeholders to implement certain solutions. A + is given when municipalities can make use of one mean to stimulate market stakeholders to implement certain solutions. A +/- is given when in case of municipalities deploy an indirect incentive, market stakeholders are triggered to implement certain solutions.

Table 5: Analysis of level of influence that municipalities have on the implementation of smart solutions by market stakeholders.

Smart solutions that are implementable by market stakeholders	**Level of influence of municipalities**	**Substantive explanation**
Hub	++	Municipalities can enforce and stimulate market stakeholders to make use of a HUB solution in the tendering phase.
Multi-modal transport	++	Municipalities can enforce and stimulate market stakeholders to make use of waterways to deliver materials to building sites. The influence municipalities have takes place during the tendering phase.
Building innovatively	+	Municipalities can stimulate market stakeholders to focus on the design of innovative building such as prefab or 3D techniques.
Mobile/ Combination/ Finishing container	+/-	Mobile container – The mobile container can be seen as an internal process optimiser within contractors its organisations. Municipalities' influence on the application of this smart solution is almost impossible. Combination container – Municipalities can possibly say something about the disposal of waste, what can indirectly lead to the implementation of the combination container. Finishing container – The finishing container is part of the HUB solution and cannot be solely stimulated by municipalities.
Clustering of personnel transport	++	Municipalities can enforce and stimulate market stakeholders to minimise the amount of personnel transport.

Building ticket	+/-	It is hard for municipalities to directly stimulate or enforce the usage of a building ticket. A possible option to stimulate contractors to make use of this solution is enforcing contactors to register all transportation to and from the building site. This can indirectly lead to the usage of a building ticket.
Logistic Team	+/-	It is hard for municipalities to directly stimulate or enforce the appointment of a logistic team. A possible option to stimulate market stakeholders to appoint a logistic team is to focus on the efficiency of the construction project. This can indirectly lead to the appointing of a logistic employees and or transport coordinators.
Integrated information facilities	+/-	Municipalities can possibly enforce market stakeholders to make use of integrated information facilities in projects that are procured by municipalities. However, the Integrated information facilities are not developed to such an extent that they can be deployed by contractors and other market stakeholders.

4.1.2 Applicability for civil works

The in Section 3.2 derived eight smart solutions that are implementable by market stakeholders, are used in this Subsection. Besides this, the explanations of these eight smart solutions in Section 3.1 are also utilised.

Analysis of applicability for civil works

In this paragraph the analysis concerning the extent in which the smart solutions are applicable for civil structure projects is made. This is important because of the origin of the smart solution lies in a different sector (utility) than the infrastructure sector. It can be the case that a solution implemented in utility projects reduces the amount of nuisances drastically while this is not the case when implementing the solution in civil structure projects.

Due to the lack of executed research on the applicability of smart solutions in civil structure projects it is hard to directly say anything about the level of applicability of smart solutions in civil structure projects. However, what can be said about the level of applicability is what difference in reduction of nuisances is expected when implementing the smart solution in civil structure projects in comparison with the implementation in utility projects.

The comparative analysis of the applicability can be found in Table 6. The first column displays the smart solutions that are implementable by market stakeholders. The second column shows the extent in which the smart solutions that are implementable by market stakeholder are applicable for civil structure projects in comparison with utility projects. The comparative level of influence is identified with a ++, +, +/-, and -. Finally, the third column provides a substantive explanation of the choices made related to level of applicability provided in column two.

In the second column of Table 6, a ++ can be read as 'When implementing this solution in a civil structure project, a larger reduction of nuisances related to accessibility and liveability is

expected than when the solution is implemented in a utility project', a + as 'When implementing this solution in a civil structure project, the same reduction of nuisances related to accessibility and liveability is expected as when the solution is implemented in a utility project', a +/- as 'When implementing this solution in a civil structure project, less reduction of nuisances related to accessibility and liveability is expected than when the solution is implemented in a utility project', and – as 'When implementing this solution in a civil structure project, no reduction of nuisances related to accessibility and liveability is expected'.

It should be kept in min that the +/- level of applicability only displays that it is expected that the smart solution makes sure a *less* reduction in nuisances is expected. This does not automatically mean *no* or *little* reductions are expected. Besides this, when reading Table 6, it should be considered that the executed projects in both utility and infrastructure sectors are roughly of the same size and therefore comparable to each other.

Table 6: Analysis of the extent in which the smart solutions are applicable for civil structure projects

Smart solutions that are implementable by market stakeholders	**Applicability for civil structures projects (comparison)**	**Substantive explanation**
Hub	+/-	When implementing a 'HUB' in civil projects, a smaller reduction of nuisances is expected. This is because of the larger numbers of FTL to and from the building sites in civil projects. These FTL for example contain concrete, asphalt and sand. For projects that do consist of a very little finishing phase (Projects as for example the construction of aqueducts and viaducts), the usage of a HUB can be even unnecessary since almost all trucks are FTL. In contrast, for civil projects that consist of a large finishing phase (projects such as bicycle and car garages) the HUB can be very beneficial and the reduction of nuisances can be significant when implementing the solution.
Multi-modal transport	++	When implementing 'multi-modal transport' in civil projects, a larger reduction of nuisance is expected. This has, among others, to do with the type of materials that needs to be delivered. When executing civil projects, often large batches of sand, stones and concrete need to be transported. These types of materials are very suitable for transportation by boat. Besides this are also the quantities that need to be transported of such a large size that transportation by boat becomes financially more attractive.
Building innovatively	+	When implementing 'innovative building' in civil projects, the same amount of reductions in nuisances is expected. When applying prefab and 3D printing techniques in both the utility and infrastructure sector, large profits can be gained relating to reductions in the amount of transport that is needed.
Mobile/ Combination/ Finishing container	+/-	When implementing a 'mobile, combination or finishing container' in a civil project, a smaller reduction of nuisances is expected. In case of all three containers this has to do with the smaller share a finishing phase has in civil projects. For this reason, less reduction is expected as all three containers work optimally in this phase of construction projects.

Clustering of personnel transport	+	When implementing 'clustering of personnel' in civil projects, the same amount of reductions in nuisances are expected. When obliging all employees to make use of public transportation or a shuttle bus the same reduction can be gained in both sectors.
Building ticket	+/-	When implementing a 'building ticket' in a civil project, less reduction of nuisances is expected. This has to do with the lower amount of different supplier that bring materials to the building site.
Logistic Team	+/-	When implementing a 'logistic team' in a civil project, less reduction of nuisances is expected. This has to do with the less profits that can be gained related to process optimisation on the building site. The reason for this is on the one hand, the smaller amount of sub-contractors working on the building site, and on the other hand, the smaller amount of different suppliers that bring materials to the construction site.
Integrated information facilities	+/-	When implementing 'Integrated Information facilities' in a civil project, less reduction of nuisances is expected. This has to do with the fewer profits that can be gained related to process optimisation on the building site. The reason for this is on the one hand, the smaller amount of sub-contractors working on the building site, and on the other hand, the smaller amount of different suppliers that bring materials to the construction site.

4.1.3 Conclusion of level of influence and applicability for civil works projects.

When looking at Table 5 and 6, an answer to Sub-Research Question 1.1A: 'What level of influence do municipalities have on the application of smart solutions that are implementable by market stakeholders' and Sub-Research Question 1.1B: 'To what extent are the smart solutions that are implementable by market stakeholders applicable for civil structure projects' can be given. The following conclusion from Table 5 and 6 can be drawn.

In Table 5, is can be seen that municipalities have on four out of eight smart solutions influence on the implementation of the smart solutions. The smart solutions on which a municipality has a large influence are the Hub, Multi-modal transport, and Clustering of personnel. The solution on which a municipality has a more average influence is the building innovatively solution. On the other four solutions (Mobile/ combination/ Finishing container, Building ticket, Logistic team, and Integrated Information Facilities) municipalities only have little influence on the implementation.

When looking at Table 6, it can be concluded that in five out of eight cases, the implementation of a certain solution in a civil works project provides less reduction of nuisances related to accessibility and liveability than when the same solution would be implemented in a utility project. This observation might sound strange. However, this result does not come out of the blue since the origin of the smart solutions does not lie in the infrastructure sector, but within the utility sector. Besides this finding, Table 6 also displays two cases in which the same or larger reductions in nuisances are expected when implementing the solution in civil structure projects. A larger reduction is expected in the case of the Multimodal transport solution. This has to do with the differences between infrastructure and utility projects, concerning the type of ordered materials, the way is which the materials can be transported, and the quantities in which the materials are transported.

Table 7: Level of influence/ applicability for civil projects

Smart solutions that are implementable by market stakeholders	Level of influence of municipalities	Applicability for civil structures (comparison utility projects)
Hub	++	+/-
Multi-modal transport	++	++
Building innovatively	+	+
Mobile/ Combination/ Finishing container	+/-	+/-
Clustering of personnel transport	++	+
Building ticket	+/-	+/-
Logistic Team	+/-	+/-
Integrated information facilities	+/-	+/-

Table 7 displays, the outcomes of both Table 5 and 6. In Table 7 it can be observed that in four cases municipalities both have an influence on the implementation of the solutions and are applicable in civil structure projects. This includes the Hub (++,+/-), Multimodal transport (++,++), Building innovatively (+,+) and Clustering of personnel transport (++,+). It might sound strange that the Hub solution is part of this list as it scores only a +/- on applicability for civil structures. Even so, the +/- only indicates that in comparison with a utility project with roughly the same size as a civil structure project, a lesser reduction in nuisances related to accessibility and liveability is expected. This does not mean *no* or *little* reductions are expected.

In the end, in can be concluded that in this project the focus should be on further investigating the possibilities on how to stimulate the 'Hub', 'Multi-modal transport', 'Building innovatively', and 'Clustering of personnel transport' solutions. From now on, in this report these four smart solutions will be named the most suitable smart solutions in construction logistics in civil projects to be stimulate by municipalities.

Furthermore, the recommendation to stimulate the previous mentioned four smart solutions will be incorporated in the functional Design Requirements in Chapter 7.

4.2 Market stakeholders

The goal of this Section is to give an answer to Sub-Research Question Q1.2: 'Which market stakeholders have a strong relation to the implementation of the most suitable smart solutions in construction logistics?'. It is important to obtain this information since insight in the level of influence that market stakeholders have, is needed to find out which market stakeholders should be stimulated by municipalities in order to reduce nuisances. At this moment, only little knowledge on this topic is available in literature. This information is incorporated in the description of the eleven smart solutions in Section 3.1.

In order to provide an answer to this question, first, in Subsection 4.2.1 an overview of the market stakeholders that are mentioned in Section 3.1 is displayed. After this, three interview sessions with professionals, during which the overview of stakeholders has been be discussed and complemented where necessary, are conducted. Subsequently, in Subsection 4.2.2, the obtained stakeholder list will be analysed according a Stakeholder-Issue Interrelation Diagram described in Bryson (2004) as cited in (Bryant, 2002). Thereafter, observations relating to the Stakeholder-Issue Interrelation Diagram are distracted (Subsection 4.2.3). This in order to find out which stakeholders have a strong relation to the implementation of the most suitable smart solutions and on which market stakeholders municipalities should focus when stimulation of smart solutions in construction logistics is required (Subsection 4.2.4).

4.2.1 Interviews sessions

In this Subsection, there is firstly looked at the different market stakeholders that are mentioned in Section 3.1. This has been done in preparation of the interviews that are held in the last stage of this Subsection.

Mentioned market stakeholders

In Table 8, the overview of the mentioned market stakeholders is provided. From the table it can be seen that six market stakeholders are mentioned. Besides this, it can also be seen that the contractor is mentioned the most and relates to the implementation of three out of four most suitable smart solutions in construction logistics.

Table 8: Mentioned market stakeholders in Section 3.1

Stakeholders	HUB	Multi-modal transport	Building innovatively	Clustering of personnel transport
Contractor	X	X		X
Transporter	X	X		
Wholesaler	X	X		
Manufacturer	X	X		
Shipping company		X		
Designer (Structural engineer/ Architect)			X	

This little insight into the market stakeholders that relate to the implementation of the smart solutions will be used in the following paragraph.

Interview sessions

To gain more knowledge about the market stakeholders that are related to the implementation of the most suitable solutions, three interview sessions are held. The interview sessions are held with three professionals with different relations to construction logistics. The list of interviewees is shown in Table 9. This table displays which person is interviewed, what the interviewee its job description is and for what organisation the interviewee works. In Appendix A.1 a fuller description of the interviewees is provided. This list contains a description of all persons that have participated in this project. The three interview sessions lasted for about 60 minutes and have been recorded.

Table 9: Interviewees – Market stakeholders

Interviewee	Job description	Organisation
	Researcher	Amsterdam University of Applied Sciences
	City district director	Municipality of Amsterdam
	Traffic and transport engineer	Municipality of Amsterdam - IB

The three conducted interviews are of a semi-structured nature. However, all three interviews are conducted with a slightly different interview guide. The first semi-structured interview guide consists of, among other things, the market stakeholders obtained in Table 8. This guide can be found in Appendix B.1. After conducting the first interview session, the market stakeholders' list in the interview guide is adjusted in accordance to the obtained conclusions. Subsequently, this adjusted interview guide will be used as new interview guide for the second interview session. This will be repeated until the third interview session has been finished.

In total, fourteen market stakeholders were mentioned in relation to the implementation of the suitable smart solutions as can be seen below:

- Contractor
- Sub-contractor
- Freelancer
- Wholesaler
- Producer/Manufacturer
- Transport company
- Waste processor
- Shipping company
- Recycling company
- Logistic company
- IT company
- Designer (Structural engineer/Architect)
- Advisor (Engineering)
- Research company

When comparing this list of market stakeholders with the market stakeholders derived in Table 8, eight newly involved parties can be observed. These new stakeholders are Sub-contractor, Freelancer, Waste processor, Recycling company, Logistic company, IT company, Advisor, and Research company.

In Table 10, a short description of the role that all fourteen market stakeholders fulfil in civil structure projects is displayed.

Table 10: Explanation role of market stakeholders

Market stakeholders	Explanation role
Contractor	The main executing stakeholder which bids in civil structure tenders (Besides, a contractor can also be a supplier of certain materials).
Sub-contractor	Contracting party that works for the main contractor. Often specialised contractors.
Freelancer	Freelance worker. Hired to work for the contractor or subcontractor.
Wholesaler	The supplying stakeholder of materials.
Producer/ Manufacturer	Producer of materials. Often only ordering in large batches is possible.
Transport company	Transport company that works for producers/ manufactures, wholesalers or contractors.
Waste processor	The party that collects and threats waste.
Shipping company	The stakeholder that enables transport over water. Works for producers/ manufactures, wholesalers or contractors.
Recycling company	Party that recycles waste.
Logistic company	The stakeholder which facilitates the logistic processing of projects. Acts often as an advising party for the contractor.
IT company	Facilitator of IT programs related to the construction sector.
Designer	The stakeholder which designs civil structures (architect and structural engineer). Bids in collaboration with the contractor in UAV-GC tenders.
Advisor	The stakeholder that advises stakeholders on engineering topics.
Research company	Parties such as universities that conduct research on construction logistics.

4.2.2 Stakeholder-Issue Interrelation Diagram

This Subsection utilises the fourteen market stakeholders that are obtained in the previous Subsection.

In this Subsection, an analysis of the level of influence that market stakeholders have on the implementation of the most suitable solutions is conducted. This is done to gain insight into the market stakeholders that municipalities can stimulate best to implement smart solutions in construction logistics. In addition, knowledge is gained on the inter-relations between market stakeholders and smart solutions. This information can provide views on which market stakeholders are recommendable to stimulate for particular smart solutions.

The execution of the analyses concerning the level of influence that market stakeholders have is conducted by the researcher itself as only little knowledge about the topic is described in literature or known by experts. In order to make sure that the substantiation of the choices made in the analysis are as best as possible is made use of knowledge obtained trough all carried out interview sessions, the performed focus group and the read literature. By means of the continuous increasing learning process throughout the whole research progress, the analysis is constantly adjusted to the latest information available.

The level of influence and insight in the interrelations is outlined by means of the Stakeholder-Issue Interrelation Diagram explained by Bryson (2004) as cited in (Bryant, 2002). For this purpose, first an indication of the level of influence the market stakeholders have on the implementation of the smart solutions is required. Hereinafter, the Stakeholder-Issue Interrelation Diagram can be developed after which conclusions relating to the interrelations between stakeholders can be drawn.

In order to give an indication of the level of influence the market stakeholders have on the implementation of the smart solutions, four tables are constructed. The four tables can be found in Appendix B.2. The tables consist of substantive explanations of the choices made concerning the level of influence.

Subsequently, in Table 11, the outcomes of al four tables in Appendix B.2 are combined. In Table 11, the first column displays the market stakeholders. Column two to five show the extent in which the market stakeholders have influence on the implementation of the four smart solutions.

The level of influence is identified with a ++, +, and -. In the table, a ++ can be read as 'this stakeholder does have a large influence on the implementation of the smart solution', a + as 'this stakeholder does have some influence on the implementation of the smart solution', and – as 'this stakeholder does not have any influence on the implementation of the smart solution'.

Table 11: Level of influence market stakeholders have on the implementation of the suitable smart solutions

Market stakeholder	**Level of influence on implementation**			
	Hub	Multimodal transport	Building innovatively	Clustering of personnel
Contractor	++	++	++	++
Sub-Contractor	+	+	+	+
Freelancer	-	-	+	-
Wholesaler	+	++	+	-
Producer/ Manufacturer	+	+	-	-
Transport company	+	+	-	-
Waste processor	-	-	-	-
Shipping company	-	++	-	-
Recycling company	-	-	-	-
Logistic company	++	+	-	+
IT company	++	-	+	-
Designer	-	-	++	-
Advisor	+	+	+	+
Research company	-	-	-	-

By means of the obtained information related to the level of influence market stakeholders have, the Stakeholder-Issue Interrelation Diagram can be constructed. The diagram can be seen in Figure 15 and can be read as follows:

- A thick black arrow corresponds to a large influence (++) the relevant market stakeholder has on the implementation of the smart solution in which the direction of the arrow points.
- A thin grey arrow corresponds to some influence (+) the relevant market stakeholder has on the implementation of the smart solution in which the direction of the arrow points.

- The words typed in red are the four most suitable smart solutions in construction logistics in civil structure projects (Hub, Multi-modal transport, Building innovatively and Clustering of personnel).
- The words typed in black are the fourteen obtained market stakeholders.

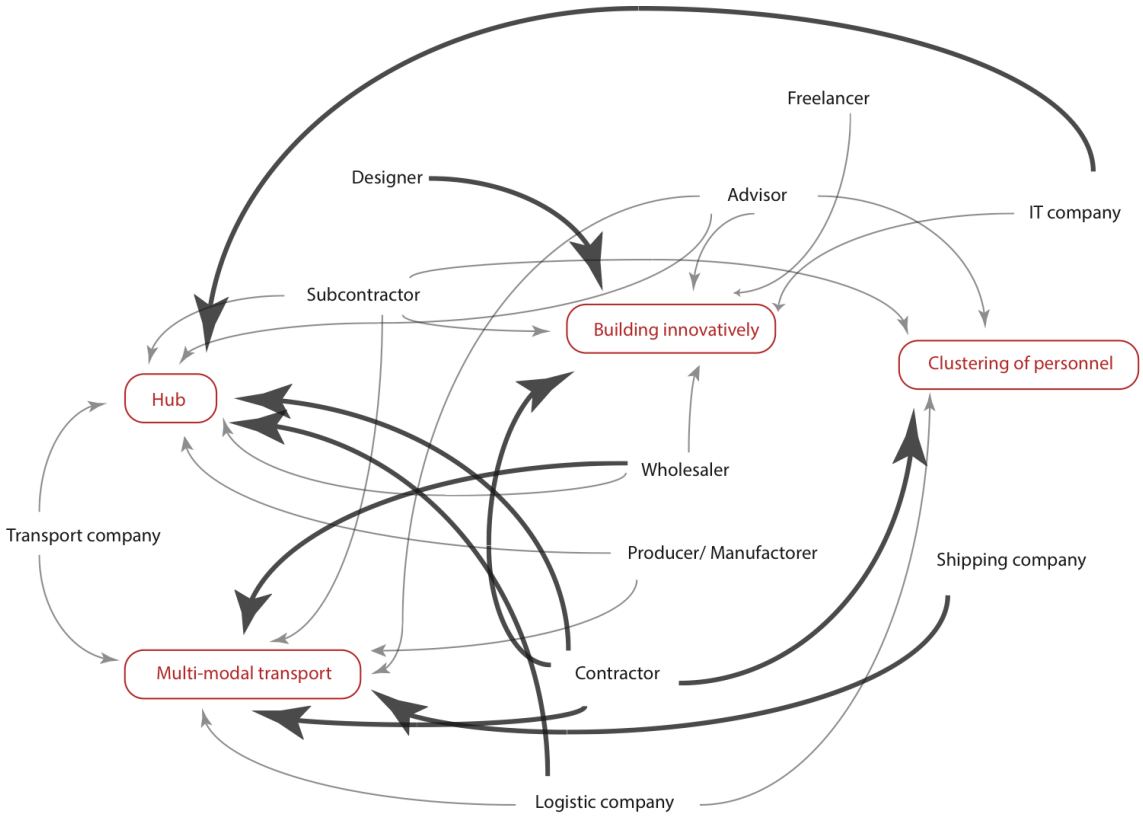


Figure 15: Stakeholder-Issue Interrelation Diagram (Bryson (2004) as cited in (Bryant, 2002)) (own figure)

4.2.3 Observations Stakeholder-Issue Interrelation Diagram

The following observations relating to the level of influence that market stakeholders have on the implementation of the most suitable smart solutions can be distracted from Table 11 and Figure 15. What strikes the most is the strong influence the contractor has on the implementation of all four smart solutions (see Figure 16). The contractor is the only market stakeholder that has influence on more than one smart solution. This makes the contractor the most important market stakeholder for municipalities to stimulate. The other market stakeholders that have a strong influence on solely one smart solution and are the Wholesaler, Shipping company, Logistic company, IT company, and the Designer. Having a strong relation

to one particular smart solution ensures that also these market stakeholders are important for municipalities to stimulate. When looking at the level of influence that Subcontractors and Advisors have, it can be recognised that also these to market stakeholders are important for municipalities to consider. This, because of the general level of influence these two market stakeholders have on all four smart solutions. The market stakeholders that the municipality does not need to pay attention to are the Waste processor, Recycling company, and Research company. This because these market stakeholders have no influence on the implementation of one single smart solution.

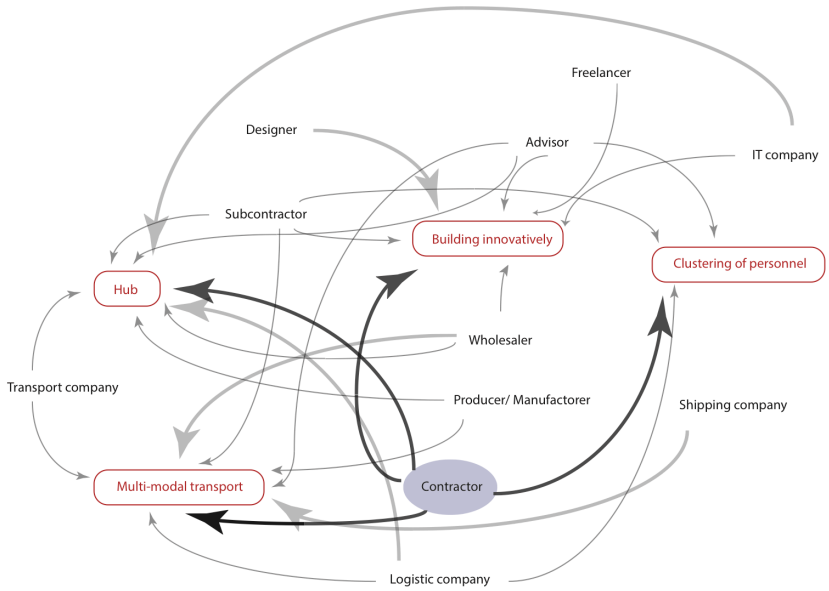


Figure 16: Influence of contractor (own figure)

Besides the observations relating to the level of influence can also observations concerning the interrelation between market stakeholders and smart solutions be distracted out of Figure 15. When looking at the four smart solutions, it stands out that the largest amount of market stakeholders has an influence on the Hub solution. From the total of fourteen market stakeholders, eight market stakeholders have an (large) influence on the implementation. The amount of market stakeholders that have an influence on the Multi-modal transport and Building innovatively is also high. In both cases, seven market stakeholders have an (large) influence on the implementation of the smart solution. Furthermore, it can be discovered that in the case of the 'Clustering of personnel' solution only one market stakeholder has a large influence on the implementation of the solution. In this case this means that municipalities can almost exclusively stimulate the contractor in order to implement the clustering of personnel transport solution. In all other cases, a minimum of two market stakeholders that have a strong relation to the implementation is observed.

Moreover, Figure 15 also shows the market stakeholders that can be stimulated in order to reduce nuisances related to accessibility and liveability per most suitable solution. In Figure 17 the relations between market stakeholders that have a strong influence on the four most

suitable smart solutions are visualised. In the case of the Hub solution, it is recommended to stimulate the main Contractor, Logistic companies, and IT companies. In the case of Multi-modal transport solution, the focus of the stimulation should be on the main Contractors, Wholesalers, and Shipping companies. In the case of the Innovative building solution it is recommendable to stimulate the main Contractor and Designers. Finally, in the case of the Clustering of personnel transport it is advised to stimulate the Contractor as mentioned before.

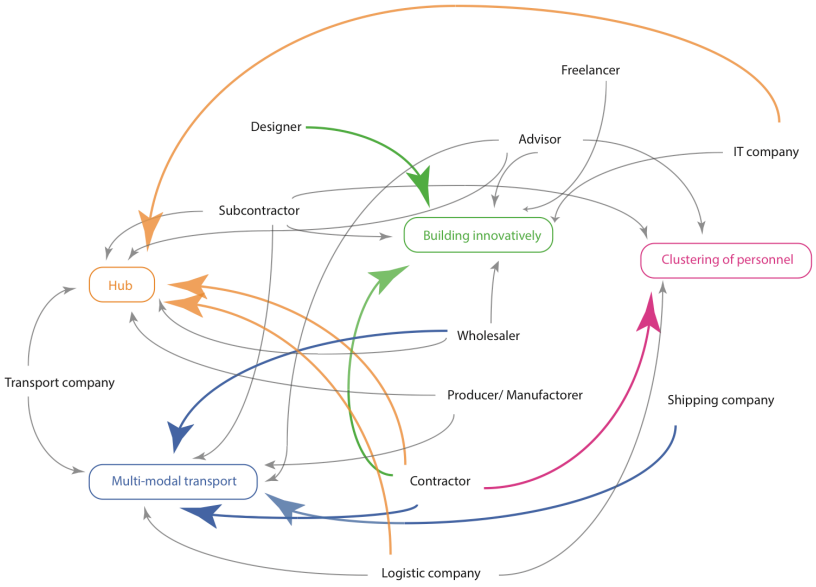


Figure 17: Market stakeholders per most suitable smart solution in construction logistics (own figure)

The just mentioned market stakeholders do give insight in the actors on which municipalities should focus when stimulation of the most suitable smart solution is required. However, it does not provide any information on the extent in which municipalities are able to encourage the mentioned market stakeholders to implement the smart solutions.

In order to obtain more insight on this topic a quick analysis is conducted in which is searched for the level of influence that municipalities have on encouraging market stakeholders to implement the four most suitable smart solution in construction logistics. In order to make sure that the substantiation of the choices made in the analysis are as best as possible is made use of knowledge obtained trough all carried out interview sessions, the performed focus group and the read literature. By means of the continuous increasing learning process throughout the whole research progress, the analysis is constantly adjusted to the latest information available.

The expected influence that municipalities have on encouraging market stakeholders can be found in Table 12. The first column displays the four most suitable smart solutions in construction logistics. The second column shows the market stakeholders that have a large influence on the implementation of the most suitable smart solutions (see Figure 17). The third column shows the expected level of influence that municipalities have on encouraging

market stakeholders. The level of influence is identified with a ++, + and +/-. Finally, the fourth column provides a short substantive explanation of the choices made related to the expected level of influence provided in column three.

In the third column of Table 12, a ++ can be read as 'Municipalities have a large influence on encouraging this market stakeholder to implement the most suitable smart solutions in construction logistics', a + as 'Municipalities have general influence on encouraging this market stakeholder to implement the most suitable smart solutions in construction logistics' and a +/- as 'Municipalities have little influence on encouraging this market stakeholder to implement the most suitable smart solutions in construction logistics',

Table 12: Influence that municipalities have on encouraging market stakeholders to implement smart solutions

Most suitable smart solution	Influential market stakeholders on smart solution	Influence municipality on encouraging market stakeholder	Substantive explanation
Hub	Contractor	++	By means of incorporating the Hub in tendering request or by enforcement in contract.
	Logistic company	+	Often part of Tender team. Tendering and enforcing.
	IT company	+/-	Indirectly, subsidise development of IT programs that ,amongst others, facilitate Hubs.
Multi-modal transport	Contractor	++	By means of incorporating the multi-modal transport in tendering request or by enforcement in contract.
	Shipping company	+	Often part of Tender team. Tendering and enforcing.
	Wholesaler	+/-	Indirectly enforcing the contractor that all delivered materials needs to be shipped over water.
Building innovatively	Contractor	+	Encouraging) the contractor to make use of innovative construction techniques such as 3d printing and prefabbing in tender request.
	Designer	+	Encouraging the designer to make use of innovative construction techniques such as 3d printing and prefabbing in Tender request.
Clustering of personnel transport	Contractor	++	By means of incorporating 'Clustering in peroneal' in tendering request or by enforcement in contract.

Table 12 displays that municipalities have a high influence on encouraging Contractors to implement the Hub, Multi-modal transport and Clustering of personnel solutions into projects. It is striking that for those three solutions the same two actions (tendering request and enforcement in contract) can be taken in order to do so. Furthermore, it can be noted that municipalities have a general level of influence on the Logistic company to implement the Hub solution, Shipping company to implement Multi-modal transport and Designer & Contractor to implement the Building innovatively solution. Lastly, Table 12 shows that the municipalities have only little influence on encouraging IT companies and Wholesalers respectively implementing the Hub and Multi-modal transport solutions.

4.2.4 Conclusions on market stakeholders

When looking at Table 11 & 12, Figure 15, 16 & 17, an answer to Sub-Research Question 1.2: 'Which market stakeholders have a strong relation to the implementation of the most suitable smart solutions in construction logistics?' can be given.

It has become visible that the Contractor, Wholesaler, Shipping company, Logistic company, Designer, and IT company have the highest level of influence on the implementation of the most suitable smart solutions in construction logistics (see Figure 18). Although the six market stakeholders have a high influence, they are not all equally feasible for municipalities to stimulate. The smart solutions on which municipalities should focus when stimulation of smart solutions is required are Contractor, Shipping company, Logistic company and Designer.

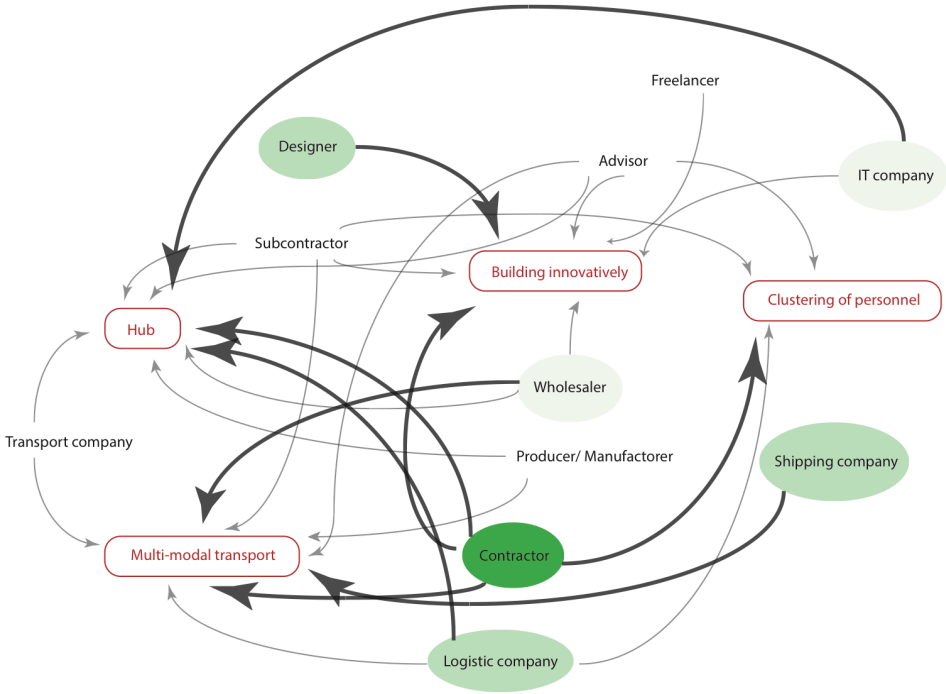


Figure 18: Influence market stakeholders and municipalities (own figure)

Municipality has a high influence on encouraging the market stakeholder.
Municipality has general influence on encouraging the market stakeholder.
Municipality has a little influence on encouraging the market stakeholder.

Word — Most suitable smart solution
Word — Market stakeholders
Market stakeholder has a large influence on the implementation of the smart solution
Market stakeholder has little influence on the implementation of the smart solution

The previous obtained observations visualised in Figure 18 will be translated into the functional Design Requirements in Chapter 7.

4.3 Obstacles and Incentives

In this Section an answer to Sub-Research Question 1.3: 'Which obstacles inhibit and which incentives stimulate market stakeholders to implement smart solutions in construction logistics?' will be provided. The answer to Sub-Research Question 1.3 determines the reasons why market stakeholders do or do not implement smart solutions in construction logistics. This information provides insight for municipalities to find out on which topics municipalities should focus when stimulation of the implementation of smart solutions is wanted.

In Subsection 4.3.1, by means of interview sessions, an overview has been made of the obstacles and incentives that market stakeholders face by (not) implementing smart solutions in construction logistics. Subsequently, in Subsection 4.3.2 the relation between the obstacles and incentives is outlined. Finally, in Subsection 4.3.3 an answer to Sub-Research Question 1.3 is given and the other findings are shared.

4.3.1 Interviews on obstacles and incentives that market stakeholders face

In Section 4.2, the market stakeholders that relate strongly to the implementation of the suitable smart solutions in construction logistics were clarified. In this Subsection, the results obtained in Section 4.2 will be used. The following stakeholders that have a strong influence on the implementation were determined: Contractor, Wholesaler, Shipping company, Logistic company, Designer, and IT company. Besides the usage of the market stakeholders, there has also been made use of the four most suitable smart solutions in construction logistics that were obtained in Section 4.1. These include I. HUB, II. Multimodal transport, III. Building innovatively, and IV. Clustering of personnel transport.

Company selection

In order to obtain information related to the obstacles and incentives that market stakeholders face when implementing smart solutions in construction logistics, one representative of each market stakeholder that has a strong relation to the implementation of the most suitable smart solutions is interviewed. Requirements have been set on the selection of which specific interviewee represents the stakeholders group best. There has been looked at the level of application of smart solutions in construction logistics in the company and whether the activities of the company are conducted in urban confined areas. In addition, the to be selected companies should be aware of the most suitable smart solutions in construction logistics, and have come into contact with them or have at least already applied one of the smart solutions. In the following Table 13, the selected companies are shown, the job description of the interviewee is explained, as well as the relation to the selected solution types. In Appendix A.1 a fuller description of the interviewees is provided. This list contains a description of all persons that have participated in this project.

In Table 13 it can be observed that two contractors are interviewed. By means of the large influence contractors have is it chosen to gain more knowledge about the obstacles and incentives contractors are facing. In addition, it can be recognised that both contractors are representing a different construction sector, being the utility sector and the infrastructure

sector. Even though the utility sector is not within the scope of this project, it is chosen to still conduct an interview in this sector. This has to do with the much higher numbers of projects in which smart solutions in construction logistics are applied in utility projects than in the infrastructure sector. This has led to a much higher level of experience by utility contractors than infrastructure contractors.

Table 13: Interviewees – obstacles and incentives

Interviewee	Stakeholder	Company	Job description	Construction sector	Applied
	Contractor		Main executor	Utility	I,III
	Contractor		Senior Project leader	Infrastructure	I,III,IV
	Logistic company		Manager construction logistics	Utility/ Infrastructure	I
	IT company		Founder and director	Utility/ Infrastructure	I
	Designer		Founder and partner	Utility/ Infrastructure	III
	Wholesaler		(ex) Logistic director	Utility/ Infrastructure	I,III
	Shipping company		Manager	Utility/ Infrastructure	I, II

Interview execution

All seven participants are interviewed following the same semi-structured interview guide that can be found in Appendix B.3. All interview sessions lasted between 45 and 90 minutes. During the interviews, all points that are stated in the interview guide are mentioned and discussed. Furthermore, room is given for the interviewee to speak freely about additional obstacles and incentives.

Interview Processing

Each interview is recorded in order to be able to re-listen the interview, and a summary has been made of the interviews with the use of this recording. However, all obstacles and incentives are literally reproduced and processed into a transcript. Subsequently, the transcript of all mentioned obstacles and incentives are structured according Table 14. This table can be found on the following page.

Table 14: Structure interview processing of obstacles and incentives

General	
Obstacles	
Incentives	
per smart solution	
Obstacles	I. HUB
	II. Multi-modal transport
	III. Innovatively building
	IV. Clustering of personnel
Incentives	I. HUB
	II. Multi-modal transport

	III. Innovatively building
	IV. Clustering of personnel

After structuring all interviews in the same way, the interview outcomes are combined and listed. This is shown in Appendix B.4. In this list, the difference in market stakeholders of which the obstacles and incentives are derived, is indicated through the use of different colours. In this way, it is easy to see from which market stakeholder the obstacle/ incentive is originating.

Interview outcomes

The two tables below (15 and 16) show the outcomes derived from following the previous explained steps. Herein, Table 15 displays the general obstacles and incentives that are acquired during the interview sessions. However, the obtained obstacles and incentives per smart solution are divided into two tables of which one (Table 16) shows solely the usable obstacles and incentives in order to be able to answer Sub-Research Question 1.3. The table that can be found in Appendix B.5 contains the obstacles and incentives that can be read as the positive and negative boundary conditions of the smart solutions types. The boundary conditions provide an insight into the pros and cons of the four most suitable smart solution types, which will be used as extra information during the entire research and design process. On the left side of both Tables 15 and 16, characters are stated. When more characters are present on the left side, this means the obstacles and incentives are specified more than ones. The characters in both Table 15 and 16 correspond to the characters in the full list of obstacles and incentives, which can be found in Appendix B.4.

Table 15: General obstacles and incentives

General Obstacles	
1	Client is dominating in choice of sustainable goals
2/3/8	Leakage of transparency in transport cost
4	Contractor is not encourage to order in bigger amounts
5	Difficulty in fair profit distribution when implementing smart solutions in construction logistics
6	Shorter ordering times
7	The Mind-set of contractors
9	Not good maintenance of EMVI-criteria
10	Very difficult to get a berth permit
11	Bad connection between wet and dry side of quay to transfer goods
12	A lack of interest by city districts
13	Very high investment cost to invest in electric cars
14	Definition Building logistics in not clear
15	BREAAM certification almost does not focus on building logistics
16	Nothing about building logistics is asked for in design tender
17	A social change is necessary within contracting companies
18	A contract should be a mean instead of a goal (Flexibility needed)
19	Difficult to get permits
20	BLVC not holy when speaking about the stimulation of construction logistics
21	Wholesaler does not give a discount when delivering at HUB/LOP
General Incentives	
A	More transparency and trust in each other
B	Contractor should feel the urge to order more early and in bigger quantities
C	Transportation by boat can transport more freight than trucks

D	If a crane on a boat is present, no transfer point is necessary
E	Places in which it is impossible to transport by road can sometimes be supplied by boats
G	Maintaining EMVI criteria
H/X	Ticket window especially for unique sustainable (construction) logistic ideas
I	Better connection between loading an unloading places on road and water
J	Subsidise more research and start-ups
K	Wholesalers should be transparent in their costs
L/R	Optimal if employees breakdown their cost (stop working franco)
M	Standardise definition of building logistics
N	Standardise at what level nuisances occur
O	Ask for Construction phasing plan in tender
P	Maintaining and a reporting obligation
Q	Initiating a performance ladder focussing on building logistics
T/U	Tender only BREAAM projects (also helps to collect data concerning emissions)
V	Tender in combinations of designers and contractor to obtain better integrated work.
W	Much less failure cost when tendering in combinations
Y	Introducing evaluation moments in contract to give new construction logistic solutions a chance during the process
Z	Using EMVI-criteria is a good mean to stimulate construction logistics

Table 16: Obstacles and incentives per most suitable smart solution

Obstacles per smart solution	
1. HUB	
v.	Difficult revenue model to let HUB/LOP operating
vii./viii.	Not enough space is available to situate an HUB
xiii.	HUB only profitable when linking with different projects
xv.	Hard to find a good location close to the project location and highway
2. Multi-modal transport	
3. Building innovatively	
xxv.	Little time upfront building projects
xxvi.	Tenders do not encourage to work with prefab parts
4. Personnel Transport	
xxix.	Very hard to find good places to park (P&R)
Incentives per smart solution	
1. HUB	
a/c/d/e/i	Municipality facilitates a LOP (by using social return)
b/j	Providing places upon which HUBs can be situated
2. Multi-modal transport	
k	More HUB/LOPs
m	Providing places in which transfer from water to roads can take place.
3. Building innovatively	
o/p/q	In tendering phase, more focus should go to prefabrication & 3D printing (Designer & Contractor)
4. Personnel Transport	
t	Introducing special OV-card by municipalities

4.3.2 Relation of obstacles and incentives

In order to obtain more information on obstacles and incentives that market stakeholders face, an analysis by the researcher is made focussing on the potential combinations that are possible when combining the acquired obstacles and incentives. The result of this analysis can be found in Table 17 and Table 18. In Table 17, the general obstacles are linked to the

general incentives where possible, and in Table 18 the obstacles and incentives per most suitable smart solutions are combined. The characters in both Table 17 and Table 18 correspond to the characters in the full list of obstacles and incentives which can be found in Appendix B.4.

Table 17: Obstacles combined with incentives – General

Obstacle		**Incentive**	
1	Client is dominating in choice of sustainable goals		
2/3/8	Leakage of transparency in transport costs	A,K & R	More transparency in the costs and more trust in each other
4/6	Contractor is not encouraged to order in bigger amounts	B	Contractor should feel the consequences of ordering in small amounts
5	Difficulty with fair profit distribution when implementing BP		
7	The mind-set of contractors		
9	Bad maintenance of EMVI-criteria	G&P	Maintain if EMVI-criteria are executed & setup up a notification obligation
10	Hard to get a berth permit for city suppliers	H&X	Start ticket window for sustainable ideas to make it more easily
11	Bad connection between the wet and dry side of quay to transfer goods	I&H	Connecting wet and dry loading and unloading places. (Ticket window)
12	A lack of interest of city districts		
13	Very high investment costs to invest in electric cars	J	Subsidise research and help start-ups
14	Definition Building logistics in not clear	M	Standardise definition of Building logistics
15	No quantitative data available about building logistics (Emissions, CO2)	T&U	Tender only BREAAM/lean projects (this helps to collect data concerning emissions)
16	Nothing concerning building logistics is asked for in design tender		
17	A social change is necessary within contracting companies		
18	A contract should be a mean instead of a goal (flexibility is needed)	Y	Introducing evaluation moments in contract to give new construction logistic solutions a chance during the process
19	Difficult to get permits		
20	BLVC not holy when speaking about the stimulation of construction logistics		
21	Wholesaler does not give a discount when delivering at HUB/LOP		
		C	Transportation by boat can often carry more freight than trucks
		D	If a crane on a boat is present, no transfer point is necessary
		E	Places that cannot be reached by road can sometimes be supplied by boat
		L/R	Optimal if employees breakdown their costs (Stop working Franco)
		N	Standardise at what level nuisances occur
		O	Ask for Construction phasing plan in tender

		V	Tender in combinations of designers and contractor to obtain better integrated work
		W	Much less failure costs when tendering in combinations
		Z	Using EMVI-criteria is a good mean to stimulate construction logistics

Table 18: Obstacles in combination with incentives - per most suitable smart solutions

Obstacle		**Incentive**	
1. HUB			
v.	Difficult revenue model to let HUB/LOP operating	a/c/d/e/i	Municipality facilitates a LOP (by using social return)
vii./viii.	Not enough space is available to situate an HUB	b/j	Providing places upon which HUBs can be situated
xiii.	HUB only profitable when linking with different projects		
xv.	Hard to find a good location close to the project location and highway	b/j	Providing places upon which HUBs can be situated
2. Multi-modal transport			
		k	More HUB/LOPs
		m	Providing places in which transfer from water to roads can take place
3. Building innovatively			
xxv.	Little time upfront building projects		
xxvi.	Tenders do not encourage to work with prefab parts	o/p/q	In tendering phase, more focus should go to prefabrication & 3D printing (Designer & Contractor)
4. Personnel Transport			
xxix.	Very hard to find good places to park (P&R)		
		t	Introducing special OV-card by municipalities

4.3.3 Conclusions on obstacles and incentives that market stakeholders face

When looking at Table 15, 16, 17 and 18 an answer to Sub-Research Question 1.3: 'Which obstacles inhibit and which incentives stimulate market stakeholders to implement smart solutions in construction logistics?' can be given.

When reading the conclusion, it should be kept in mind that the obstacles and incentives are a result of solely seven interview sessions.

The following observations relating to the acquired obstacles and incentives that market stakeholders face when implementing (the most suitable) smart solutions in construction logistics can be distracted from Table 15, 16, 17, and 18. The first thing that is noticeable is the large number of times it is indicated that one of the main causes of the non-implementation of certain smart solutions relates to the leakage of transparency in transport costs in construction projects. At this moment, transport costs are often incorporated in the costs of construction materials which makes it very difficult to get a grip on the amount spend on solely the transport of materials. When implementing solutions such as the Hub,

transparency in transport costs is one of the most important requirements to let this solution financially be a success, as the revenue model of a Hub relates to the separately calculation of transport costs. However, it should be also said that the leakage of transparency in transport costs is less the case when materials can be delivered with FTL. Often in the case of FTL, transport costs are calculated separately. This ensures that a difference has to be made in the importance of this obstacle in utility and infrastructure projects as the share of FTL and LTL in both sectors significantly differ. However, even within civil structure projects, many differences can also be observed in the share of FTL and LTL. For example, when constructing a viaduct/ aqueduct, the share of FTL is much higher than in the execution of a car/bicycle garage. This is due to the much bigger finishing phase the construction of a car/bicycle garage requires, as much installation work needs to be installed.

The obstacle that relates to the previous one, is that often contractors are not encouraged to order large amounts of materials when ordering materials that cannot be delivered in FTL. As the transport costs are often incorporated in the material costs, it does not make a significant difference when ordering materials in small or big amounts. However, also in this case a difference should be made between the dissimilar construction sectors and project types.

Two obstacles that directly focus on the role of municipalities and other governmental agencies relate to the poor maintenance of award criteria and the bad connection between wet and dry side of quay walls to transfer goods. On both obstacles also incentives are obtained. In case of the poor maintenance of award criteria, it is proposed to better maintain the criteria and to setup a notification obligation. Herein, contractors that are participating in tenders have to describe how they are going to fulfil promises they make and how this will be notified to the client. In the case of the bad connection between wet and dry side of quay walls it is recommended to focus more on connecting both sides of quay walls and to create places upon which the transfer from water to road or visa versa can take place.

Not all obstacles and incentives are discussed. Only the most important ones were mentioned.

The obstacles and incentives mentioned in this Section will be incorporated in the input requirement that can be found in Chapter 7.

4.4 Actions and Instruments

In this Section an answer to Research Question Q1: 'Which set of instruments can Dutch municipalities deploy to positively stimulate the implementation of smart solutions in construction logistics in urban confined areas?' is given. The answer on Q1 provides insight in the instruments that municipalities can deploy in order to stimulate market parties to implement smart solutions in construction logistics. Besides this, this chapter also gathers information related to the possible actions that municipalities can take in order to stimulate market stakeholders to implement smart solutions in construction logistics. All gathered information in this Section is of major importance since it provides a large share of the substantive knowledge that is needed to develop the supporting tool for employees of municipalities.

In order to answer Research Question 1, two steps are taken. First, in Subsection 4.4.1, is by means of a focus group explored what actions municipalities can take and which instruments municipalities can deploy in order to stimulate market parties to implement smart solutions in construction logistics. Hereafter, in Subsection 4.4.2, the results are explained in order to respond to Research Question 1.

4.4.1 Obtaining actions and instruments through a focus group

The obtained obstacles and incentives (Table 15,16, 17, and 18) that were derived in Subsection 4.3.1 and 4.3.2 will be used in this Subsection. Besides this, also the actions that were found in literature and that are implementable by municipalities (Preferred Network, HUB, Distribution network and Procurement) are used. These smart solutions were obtained in Section 3.2.

Interviewee selection

Through a focus group, there has been looked at the actions and instruments municipalities can take and deploy in order to stimulate market stakeholders to implement smart solutions in construction logistics. When gaining actions and instruments, it is chosen to discuss all possibilities even in the case they take place outside the scope of this thesis. This is done in order to provide the total overview of possible actions and instruments. For this reason, it is chosen to conduct this focus group with three strategic advisors working for the municipality of Amsterdam. This, because strategic advisors generally have a very broad and solid overview of the entire municipality, since clients they work for are often situated in different departments. Besides this, their tasks also often take place on multiple different management levels. The three strategic advisors that were interviewed can be found in Table 19. A more detailed version of the description of the interviewees can be found in Appendix A.1

Table 19: Interviewee - Actions and instruments

Interviewee	Job description	Organisation	Department
	Strategic advisor	Municipality of Amsterdam	Engineering company
	Strategic advisor	Municipality of Amsterdam	Engineering company
	Strategic advisor	Municipality of Amsterdam	Engineering company

Focus group

During a session of two hours, the actions and instruments municipalities can take and deploy were discussed. Before the participators of the focus group gathered, Table 20 (representable for the entire Tables 17 and 18) and Table 21 were printed on A0 and brought to the meeting location. The focus group started by showing a ten-minute instruction presentation in which the topic, background, problem statement, scope and research (thus far) was presented to the participants. After that, the participants were firstly asked to respond to the obstacles and incentives by introducing actions that municipalities can take (See 1. Actions in Table 20). Subsequently, the participants were asked to translate these actions into instruments in which the action can take place (See 2. Instruments in Table 20). Finally, the participants were asked to also translate the actions derived from literature into deployable instruments (See 3. Instruments in Table 21). During the focus group the mentioned actions and instruments were directly written on the A0 papers.

Table 20: Framework actions and instruments following up on obtained obstacles and incentives

Obstacle		Incentive		1.Action		2.Instrument	
1	Client is dominating in choice of sustainable goals						
2/3/8	Leakage of transparency in transport costs	A,K & R	More transparency in costs and more trust in each other				

Table 21: Framework instruments following up on actions derived from literature

Action	3. Instruments
Preferred Network	
HUB	
Distribution network	
Procurement	

Focus group outcome

On this and the following three pages, Table 22, 23, and 24 display the outcome of the focus group. Table 22 represents the instruments following up on actions that municipalities can take derived from literature. In addition, Table 23 and 24 represent the actions and instruments following up on obstacles and incentives mentioned by market stakeholders.

Table 22: Instruments following up on actions municipalities can take derived from literature

Action	Instrument
Preferred network	BLVC
HUB	Policy
Distribution network	Coordination department
Award criteria	Procurement

Table 23: Actions and instruments following up on obstacles and incentives per smart solution

Obstacle		Incentive		Action		Instrument	
1. HUB							
v.	Difficult revenue model to let HUB/LOP operating	a/c/d/e/i	Municipality facilitates a LOP	v.1	Municipality facilitates a LOP	v.1	Policy
vii./viii.	Not enough space is available to situate an HUB	b/j	Providing places upon which HUBs can be situated	vii./viii.1	Providing places upon which HUBs can be situated	vii./viii.1	Policy
xiii.	HUB only profitable when linking with different projects			xiii.1	Combining project	xiii.1	
xv.	Hard to find a good location close to the project location and highway	b/j	Providing places upon which HUBs can be situated	xv.1	Providing places upon which HUBs can be situated	xv.1	Policy
2. Multi-modal transport							
		k	More HUB/LOPs	k.1	Municipality facilitates a LOP	k.1	
		m	Providing places in which transfer from water to roads can take place.	m.1	Providing places in which transfer from water to roads can take place.	m.1	Policy
3. Building innovatively							
xxv.	Little time upfront building projects			xxv.1	Providing more time upfront the building projects	xxv.1	
xxvi.	Tenders do not encourage to work with prefab parts	o/p/q	In tendering phase, more focus should go to prefabrication & 3D printing (Designer & Contractor)	o.1	In tendering phase, more focus should go to prefabrication & 3D printing (Designer & Contractor)	o.1	Procurement
4. Personnel Transport							
xxix.	Very hard to find good places to park (P&R)			xxix.	Providing good places to park (P&R) at the border of the city	xxix.	
		t	Introducing special OV-card by municipalities	t.1	Introducing special OV-card by municipalities	t.1	

Table 24: Actions and instruments following up on general obstacles

Obstacle		Incentive		Action		Instrument	
1	Client is dominating in choice of sustainable goals			1.1 1.2 1.3	Focussing on sustainable execution of own projects (BREAAM, lean) Showing the direction of the municipalities sustainable goals Making it attractive for private clients to choose for sustainable execution options	1.1 1.2 1.3	Procurement Communication Policy
2/3/8	Leakage of transparency in transport costs	A,K & R	More transparency in costs and more trust in each other	2.1	As municipality, setting the right example in transparency of transport costs	2.1	Material agency
4/6	Contractor is not encouraged to order in bigger amounts	B	Contractor should feel the consequences of ordering in small amounts	4.1 4.2 4.3 4.4 4.5	Taxing transport journeys Stricter licencing Tendering BREAAM, Lean Facilitate LOP Facilitate HUB space	4.1 4.2 4.3 4.4 4.5	Policy Procurement Policy Policy
5	Difficulty in fair profit distribution when implementing BP			5.1	Focusing on transparency in costs and more trust in each other	5.1	Material agency
7	The mind-set of contractors			7.1 7.2	Showing projects in which smart solutions in building logistics are executed well. Stimulating changes in companies by executing collaborative innovative projects	7.1 7.2	Communication
9	Bad maintenance of EMVI-criteria	G&P	Maintain if EMVI-criteria are executed & setup up a notification obligation	9.1 9.2 9.3	Introducing fines Introducing notification obligation Better maintenance of EMVI-criteria and/ or BLVC-framework	9.1 9.2 9.3	Contract management Procurement Contract management
10	Hard to get a berth permit for city suppliers	H&X	Start ticket window for sustainable ideas to make it (what) more easy	10.1 10.2 10.3	Increase interest of municipalities Start ticket window/ contact person Make city supplier part of destination plan	10.1 10.2 10.3	 Policy Policy
11	Bad connection between wet and dry side of quay to transfer goods	I&H	Connecting wet and dry loading and unloading places. (Ticket window)	11.1	Better coordination between wet and dry side of quay	11.1	
12	A lack of interest of city districts			12.1	Encouraging the importance of smart solutions in building logistics	12.1	Communication
13	Very high investment costs to invest in electric cars	J	Subsidise research and help start-ups	13.1 13.2	Subsidise research and help start-ups Execute innovative projects in collaboration with market parties	13.1 13.2	Policy
14	Definition Building logistics is not clear	M	Standardise definition of Building logistics	14.1	Standardise definition of building logistics in own projects	14.1	

15	No quantitative data available concerning building logistics (Emissions, CO2)	T&U	Tender only BREAAM/lean projects (helps to collect data concerning emissions)	15.1	Focussing on sustainable execution of projects (BREAAM, lean) in own projects to obtain more data	15.1	Procurement
16	Nothing about building logistics is asked for in design tender			16.1	Inclusion of a building logistics category in design tenders.	16.1	Procurement
17	A social change is necessary within contracting companies			17.1		17.1	
18	A contract should be a mean instead of a goal (flexibility is needed)	Y	Introducing evaluation moments in contract to give new construction logistic solutions a chance during the process.	18.1	Introducing evaluation moments in contract to give new construction logistic solutions a chance during the process.	18.1	Contract management
19	Difficult to get permits	H	Start ticket window for sustainable ideas to make it more easily	19.1	Start ticket window/ contact person	19.1	Policy
20	BLVC not holy when speaking about the stimulation of construction logistics			20.1	Using other instruments to stimulate construction logistics	20.1	Procurement
21	Wholesaler does not give a discount when delivering at HUB/LOP			21.1	Encouraging wholesalers to give a discount	21.1	
		C	Transportation by boat can carry more freight than trucks	C1	Focus on transportation by boat	C.1	Policy
		D	If a crane on a boat is present, no transfer point is necessary	D1	Focus on transportation by boats with crane	D.1	Policy
		E	Places that cannot be reached by road can sometimes be supplied by boat	E1	Focus on transportation by boat	E.1	Policy
		L/R	Optimal if employees breakdown their costs (Stop working Franco)	L.1	As municipality, setting the right example in transparency of transport costs	L.1	Material agency
		N	Standardise at what level nuisances occur	N.1	Develop definitions of nuisance	N.1	Procurement
		O	Ask for Construction phasing plan in tender	O.1	Ask for Construction phasing plan in tender	O.1	Procurement
		V	Tender in combinations of designers and contractor in order to obtain better integrated work.	V.1	Tender in combinations of designers and contractor to obtain better integrated work.	V.1	Procurement
		W	Fewer failure costs when tendering in combinations	W.1	Tender in combinations of designers and contractor to obtain better integrated work.	W.1	Procurement
		Z	Using EMVI-criteria is a good mean to stimulate construction logistics	Z.1	Using EMVI-criteria is a good mean to stimulate construction logistics	Z.1	Procurement

4.4.2 Action and instruments conclusions

When looking at Table 22, 23, and 24 an answer to Research Question 1: 'Which set of instruments can Dutch municipalities deploy to positively stimulate the implementation of smart solutions in construction logistics in urban confined areas?' can be given.

The instrument that follows up on the obstacles and incentives derived from market stakeholders (Table 23 and 24) are: Procurement, Communication, Policy, Material agency, and Contract management. The four instruments that follow up on actions derived from literature (Table 22) introduce besides Procurement and Policy two new instruments, being BLVC and Coordination department.

When looking at Tables 22, 23, and 24 the following findings related to the actions and instruments can be observed. Beware that the obtained actions and instruments are a result of one single focus group consisting of three participants, excluding the researcher. Additionally, it should be kept in mind that the actions and instruments are based on the obstacles and instruments quoted by seven interviewees. These interviewees represent the six market stakeholders with the highest level of influence on the implementation of the most suitable smart solutions in construction logistics in civil structure projects.

Procurement

In total, the instrument 'Procurement' is specified 13 out of the 40 times an instrument was mentioned during the focus group. Three times the same action is proposed in which it is advised to focus on the sustainable execution of projects by means of introducing certification such as BREAAM (Utility sector) and Lean. This action is mentioned in order to ensure contractors are going to implement smart solutions in construction logistics more often as it is required in the contract. Besides this, the action is also mentioned in relation to encouraging contractors to order materials in smarter ways as the project is for example procured lean. Lastly, the action is mentioned in order to enhance the available quantitative data related to kilometres travelled and emissions of construction related freight traffic.

Furthermore, the introduction of a notification obligation in contract is seen as a recommendable action. This to ensure the, amongst others, award criteria can be better maintained. In addition, it is twice advised to make use of award criteria to stimulate smart construction logistical solutions. Moreover, is is recommended to standardise the definitions of catch-all concepts, such as construction logistics and nuisances in tender documents to minimise confusion concerning definitions. Finally, in tender dossiers, it is also recommended to focus on prefabrication and 3D printing techniques.

Communication

The instrument 'Communication' is mentioned 3 out of the 40 times an instruments was proposed during the focus group. The three actions that have led to the introduction of the instrument communication relates, among other things, to showing the direction of municipalities their sustainable goals. This, in order to inform market stakeholders on what to expect relating to for example construction logistics in design tenders. In addition, as a

municipality, it is recommended to advertise with projects in which less nuisances are observed because of well executed construction logistics during the execution of construction project. This, in order to enhance the view on construction logistics and to change contractors their mind-sets. The last action relates to internal communication within municipalities. It focusses on increasing the importance of well executed construction logistics within municipalities.

Policy

In total, the instrument 'Policy' is specified 16 out of the 40 times an instrument was mentioned during the focus group. The actions relate to taxing transport journeys, providing places in which Hubs can be situated, providing places in which transfer from water to roads can take place, facilitating a LOP, and establishing a ticket window/ contact person focussing on sustainable ways of city distributors. Furthermore, the following three actions were proposed: make the city supplier part of the destination plan, subsidise research, and focus on transportation by boat.

Material agency

The instrument 'Material agency' is mentioned 3 out of the 40 times an instruments was proposed during the focus group. Three times the same action was mentioned. The action relates to setting the right example in the transparency of transport costs as a municipality. This in order to stimulate other stakeholders to also be more transparent in the costs of the transportation of materials.

Contract management

The instrument 'Contract management' is also mentioned 3 out of the 40 times an instrument was proposed during the focus group. The first action is about better maintenance of award (EMVI) criteria and, if present, a BLVC-plan. This to make sure that the tender offer that wins a contract also carries out the work that he/she promised in the offer. The second action relates to the first action and consists of an operation in which fines in contracts are introduced in order to maintain the offers made in the contract. The last action focusses on the introduction of evaluation moments in contracts. This in order to give new construction logistic solutions a chance of implementation whenever it appears that the applicability of new or other solutions benefit more to the reduction of nuisances than the currently applied solution(s).

BLVC (Bereikbaarheid, Leefbaarheid, Veiligheid en Communicatie)

The instrument 'BLVC' is proposed 1 out of the 40 times an instrument was proposed during the focus group. The instrument is based on an action that is derived from literature. The action is called preferred network and is characterised by municipalities that enforce suppliers and transporters to make use of prescribed routes to and from building sites. This to increase road safety and improve traffic flows in confined areas.

Coordination department
In total, the instrument 'Coordination department' is specified 1 out of the 40 times an instrument was mentioned during the focus group. The action on which the instrument is based is distribution network. The action focusses on coordinating trucks based on their origin and destination. Suppliers and building sites are connected to each other in the way in which suppliers deliver from the nearest possible location. This in order to minimise the amount of transportation in cities.

The gathered information on the actions and instruments is of major importance for this project since it provides a large share of the substantive knowledge that is needed to develop the supporting tool for employees of municipalities.

The previous obtained observations related to actions and instruments (Procurement, Communication, Policy, Material agency, Contract management, BLVC, and Coordination department) will be translated into the input Design Requirements in Chapter 7.

5. UAV-GC Process

The goal of this Chapter is to provide an answer to Research Question 2: 'How does the flowchart of municipalities' UAV-GC procured civil structure projects look like from start (initiation phase) to the end (realisation phase)?'. In order to do so, the flowchart of municipalities' UAV-GC procured infrastructure construction projects is mapped. The answer to Research Question 2 provides insight into the process steps that are taken by employees of municipalities in order to complete UAV-GC procured civil work projects. The obtained information in this Chapter will be used as the foundation on which the development of the supporting tool is further completed.

5.1 Flowchart of municipalities' UAV-GC procured projects

The mapping process of the UAV-GC flowchart is divided in three parts and proceeds as follows. In Subsection 5.1.1 an analysis is conducted on the 'Plan- en Belsluitvormingsproces Infrastructuur' (Gemeente Amsterdam, 2004) of which the content can contribute to the construction of the UAV-GC flowchart. Subsequently, in Subsection 5.1.2, three interview sessions are conducted in order to map the flowchart of municipalities' UAV-GC procured infrastructure-construction projects using the results obtained in Subsection 5.1.1. Finally, in Subsection 5.1.3, an answer to Research Question 2 will be provided through the introduction and explanation of the UAV-GC flowchart.

5.1.1 Analysis Plan- en Belsluitvormingsproces Infrastructuur (UAV procured projects)

In order to start constructing the flowchart of civil projects procured by municipalities, information about the UAV-GC contract procedure is needed. Since the UAV-GC administrative condition is quite new within Dutch municipalities, it is hard to find such information. Hence the little information available on the UAV-GC process steps from a municipality' perspective, it is chosen to, beforehand the creation of the UAV-GC flowchart, gather process information on by municipalities' UAV procured projects. This is done in order to get insight into the determined decisions made by municipalities and the corresponding process steps between UAV and UAV-GC process steps. In order to find the necessary information, the UAV procedure called 'Plan- en Besluitvormingsproces Infrastructuur' (PBI), developed by the municipality of Amsterdam (2004), is utilised. In the following paragraphs, this document will be analysed in order to extract the process similarities of the municipalities' procured UAV and UAV-GC.

Document content

The flowchart in the PBI document (Figure 20) further zooms in on the actions and products that are needed to be undertaken in each phase. For the little information available in the figure, the flowchart has been adjusted with all other available information derived from the document. This has resulted in a more comprehensive project-phasing graph as can be seen in Figure 19 on the following pages.

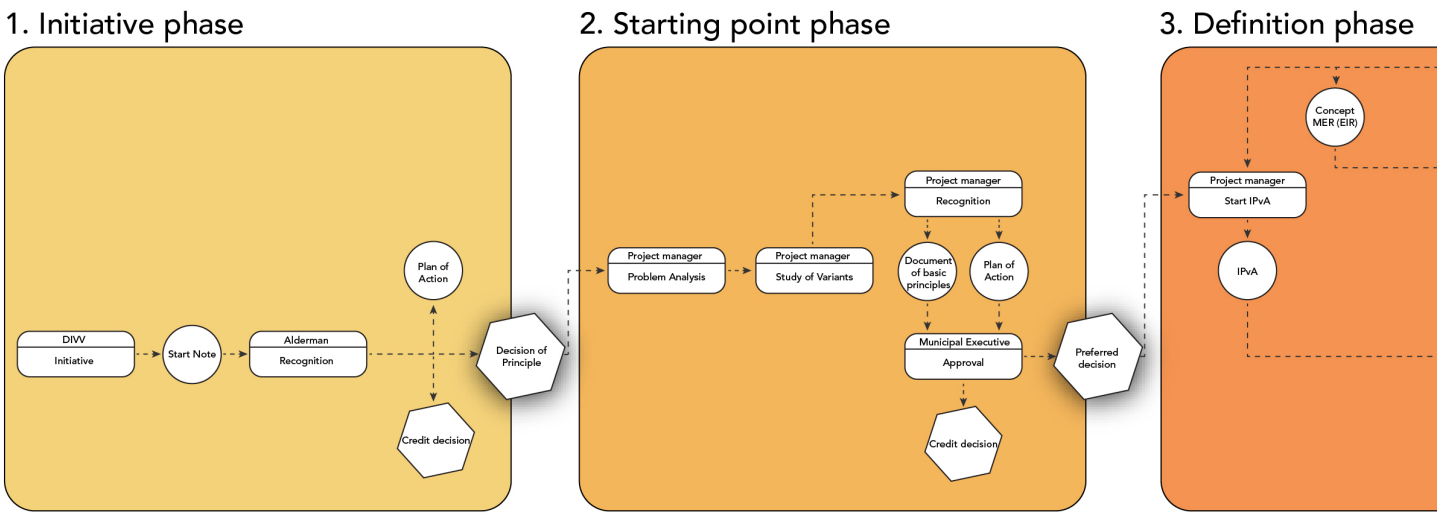
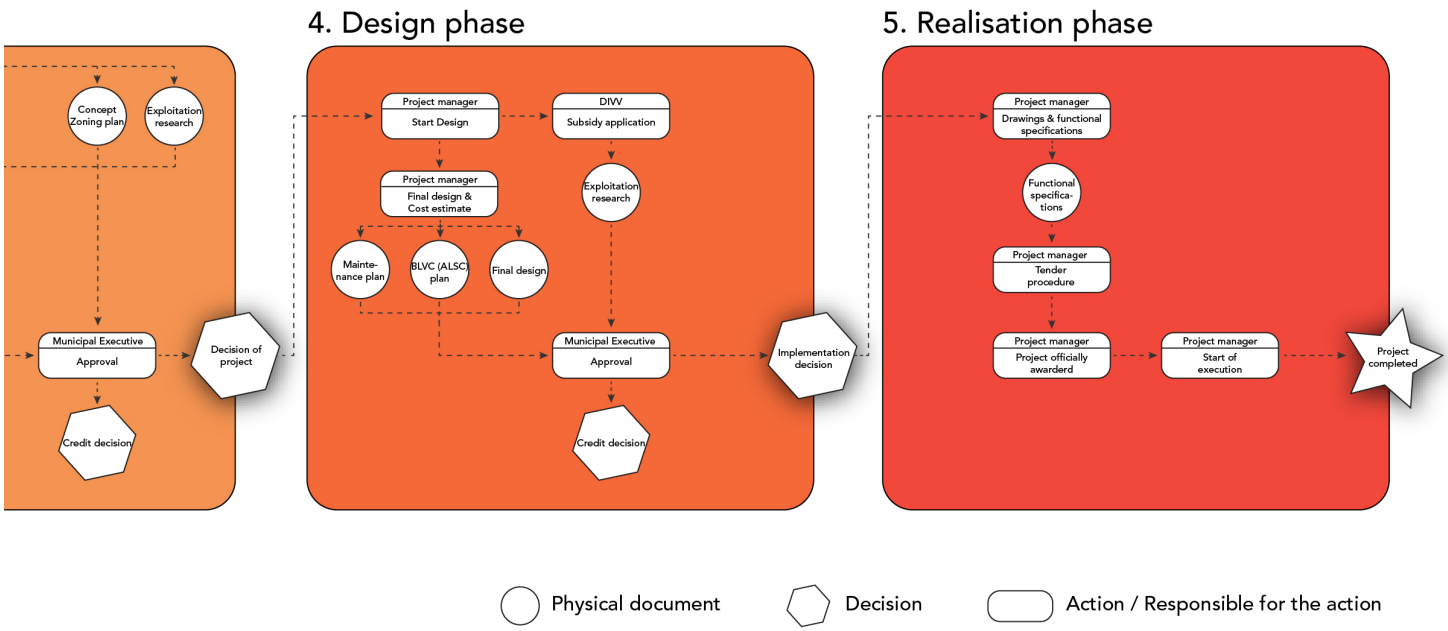


Figure 19: Adjusted flowchart of UAV process steps 'Plan- en Besluitvormingsproces Infrastructuur' (Gemeente Amsterdam, 2004) (own figure)


4. Design phase
5. Realisation phase
Concept Zoning plan
Exploitation research
Municipal Executive
Approval
Decision of project
Credit decision
Project manager
Start Design
DIVV
Subsidy application
Project manager
Final design & Cost estimate
Exploitation research
Mainte-nance plan
BLVC (ALSC) plan
Final design
Municipal Executive
Approval
Implementation decision
Credit decision
Project manager
Drawings & functional specifications
Functional specifica-tions
Project manager
Tender procedure
Project manager
Project officially awarderd
Project manager
Start of execution
Project completed
Physical document
Decision
Action / Responsible for the action

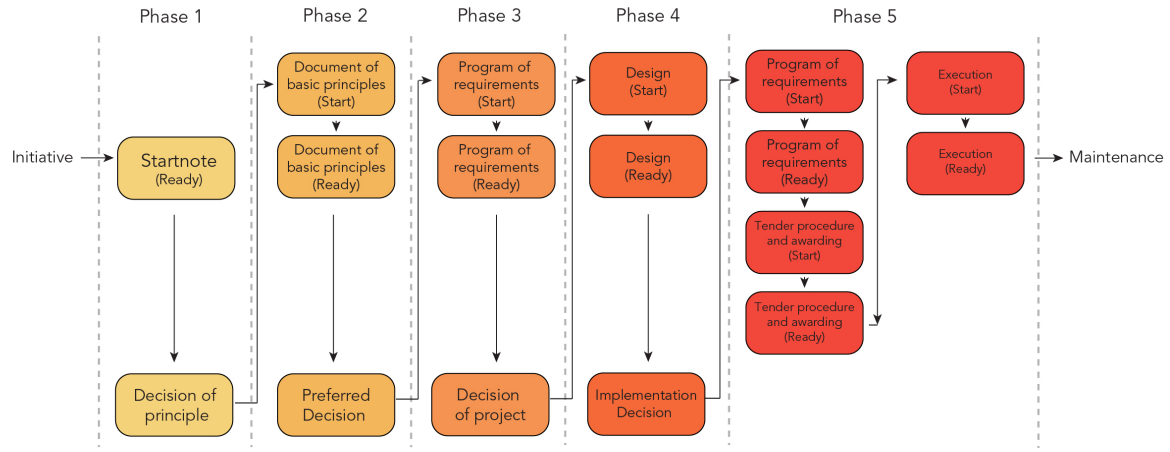


Figure 20: UAV-Flowchart PBI, (Gemeente Amsterdam, 2004) (own figure)

In Figure 20, three different shapes symbolize the process elements. A rectangular shape means that the process element exists of an action. This action can be taken by the stakeholders that are mentioned above the indicated action names. When the process element is round shaped, this means the element consists of a physical document. This can contain for example an action plan or drawing specifications. The process elements that are hexagon shaped correspond with decisions that can be made by various stakeholders within municipalities.

When observing Figure 19 and 20, it becomes clear that the process scheme of UAV-procured projects exists of five project phases, being the Initiative phase, Starting point phase, Definition phase, Design phase, and Realisation phase. Furthermore, it can be recognised that before each new project phase starts, a decision by the responsible alderman or city council has to be taken. Within the execution of UAV procured projects, it can also be discovered that the design of the project takes place in the second from last phase.

Interview sessions

After analysing the process steps of the UAV-procured projects, it is important to gain knowledge on the similarities between UAV and UAV-GC process steps. In addition to the fact that this document is already fourteen years old is, it important to find out if the decision making process is still up to date for UAV procured projects. To be able to do this, three interview sessions of about an hour are held with a strategic/ purchasing advisor and two project managers working for the engineering company of the municipality of Amsterdam.

The three interviewees are described in Table 25. A more detailed version of the description of the interviewees can be found in Appendix A.1. The semi-structured interview guide that was used during the interview sessions can also be found in the Appendices. More precisely, in Appendix C.1

Table 25: Interviewee – UAV & UAV-GC procedure

Interviewee	Job description	Organisation	Department
	Strategic/Purchasing advisor	Municipality of Amsterdam	Engineering company
	Project Manager	Municipality of Amsterdam	Engineering company
	Project Manager	Municipality of Amsterdam	Engineering company

During the sessions, the graph visualised in Figure 19 was presented to the interviewees. The interviewees were asked three questions of which only the first two questions are important for this Section. First they were asked what the shortcomings of the PBI document are, and secondly to describe to what extent the process steps of an UAV-GC procured civil project corresponds to the process steps of an UAV procured civil project. Thirdly, they were asked about their vision on the appearance and usability requirements the final design of the tool according to them should fulfil.

Interview outcome
In relation to the first question, the following shortcomings relating to the PBI flowchart were mentioned:

- The flowchart mainly focusses on private law instead of administrative law.
- The document is out of date (2004).
- The graph does not consistently contain information about the actions project managers take during each step.
- Project managers rarely use the PBI document.

Looking back at the second question, the following similarities between the UAV and UAV-GC administrative conditions were pointed out:

- The process division in five phases corresponds to the process division in UAV-GC procured civil projects.
- All decision moments in UAV projects correspond to the UAV-GC decision moments.
- The proposed actions, documents and decision that take place in project phases one and two (Initiative and Starting point phase) fully correspond to the process elements in UAV-GC procured civil project.

Results to bring along
Figure 21 and Figure 22 (following page) can be used as input for the mapping of the UAV-GC flowchart. In Figure 21, the five phases together with the four decisions moments are visualised. The graph can be used as a writing pad on which process steps can be placed when developing the UAV-GC flowchart. Figure 22 displays the process steps that can be directly used when developing the UAV-GC flowchart.

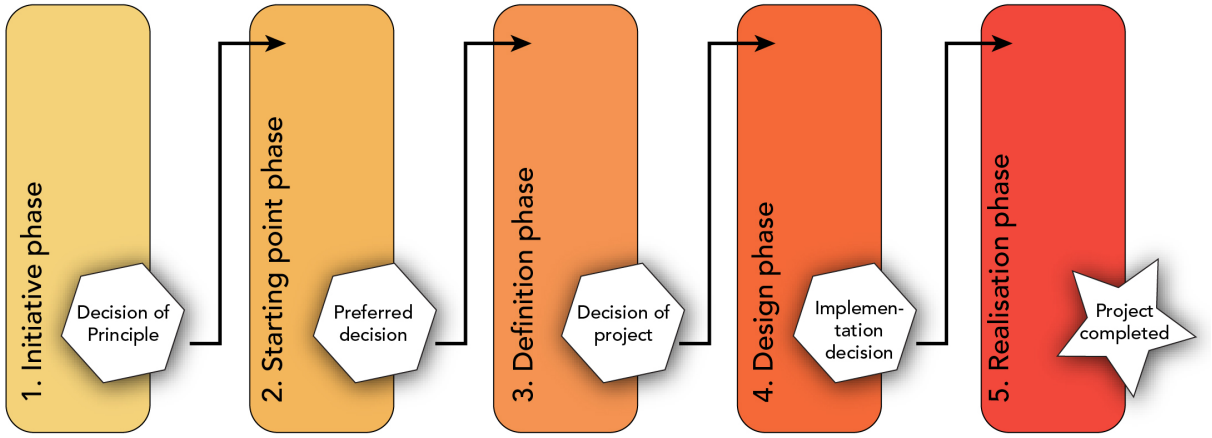


Figure 21: Framework UAV-GC Flowchart (own figure)

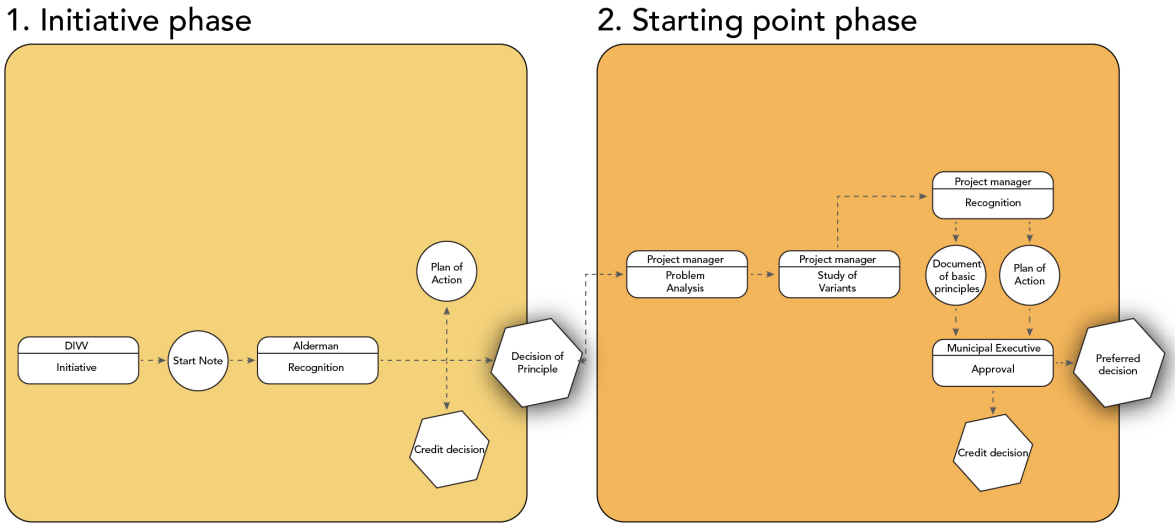


Figure 22: Usable process steps of UAV-procedure (Gemeente Amsterdam, 2004) (own figure)

5.1.2 Mapping of UAV-GC flowchart

In this Subsection, the UAV-GC flowchart will be developed. The participants that are interviewed in order to make this possible are listed in Table 26. A more detailed version of the description of the interviewees can be found in Appendix A.1

Table 26: Interviewee - Development of UAV-GC flowchart

Interviewee	Job description	Organisation	Department
	Purchasing advisor/ contract manager	Municipality of Amsterdam	Engineering company
	Purchasing advisor	Municipality of Amsterdam	Engineering company
	Purchasing advisor	Municipality of Amsterdam	Engineering company

The development of the UAV-GC flow chart is achieved by asking the first professional to explain how the process steps of the municipalities' UAV-GC procured civil projects look like, using Figure 21 as a writing pad and Figure 22 as process step input. After translating the obtained information in a draft version of the flowchart, the flowchart is send back to the professional to do a final validation of the visualised process steps. In this way, the second version of the UAV-GC flowchart is created.

In order to not only base the findings on one person's knowledge, two other professionals are interviewed. During the second interview session the second draft version of the flowchart is introduced and functions as a writing pad. After conducting the second interview, the flow chart will be adapted with the obtained conclusions and will thereafter be used as input for the third interview session. By adapting the flowchart for the third time, the final version of the flowchart of municipalities' UAV-GC procured civil projects has been created. The final version of the flowchart can be seen in Figure 23 on the following two pages.

5.1.3 UAV-GC flowchart Conclusions

When looking at Figure 23 an answer to Research Question 2: 'How does the process of municipalities' UAV-GC procured civil projects looks like from start (initiation phase) to the end (realisation phase)?' can be given.

The UAV-GC flowchart displays the process divided in four phases, being the Initiative phase, Principle phase, Definition & Design phase, and Realisation phase. Each phase again consists of actions that should be undertaken, documents that need to be submitted, and administrative decisions that have to be made. A total of 23 steps have to be taken in order to go through the entire procedure. In contrast to the UAV flowchart (Figure 19), in the UAV-GC flowchart are the Definition and Design phase merged into one phase. However, no large differences in both flowcharts can be observed that relate to the process elements in the first two phases. The usage of the obtained UAV-GC procedure will be translated into the Input Design Requirements in Chapter 7.

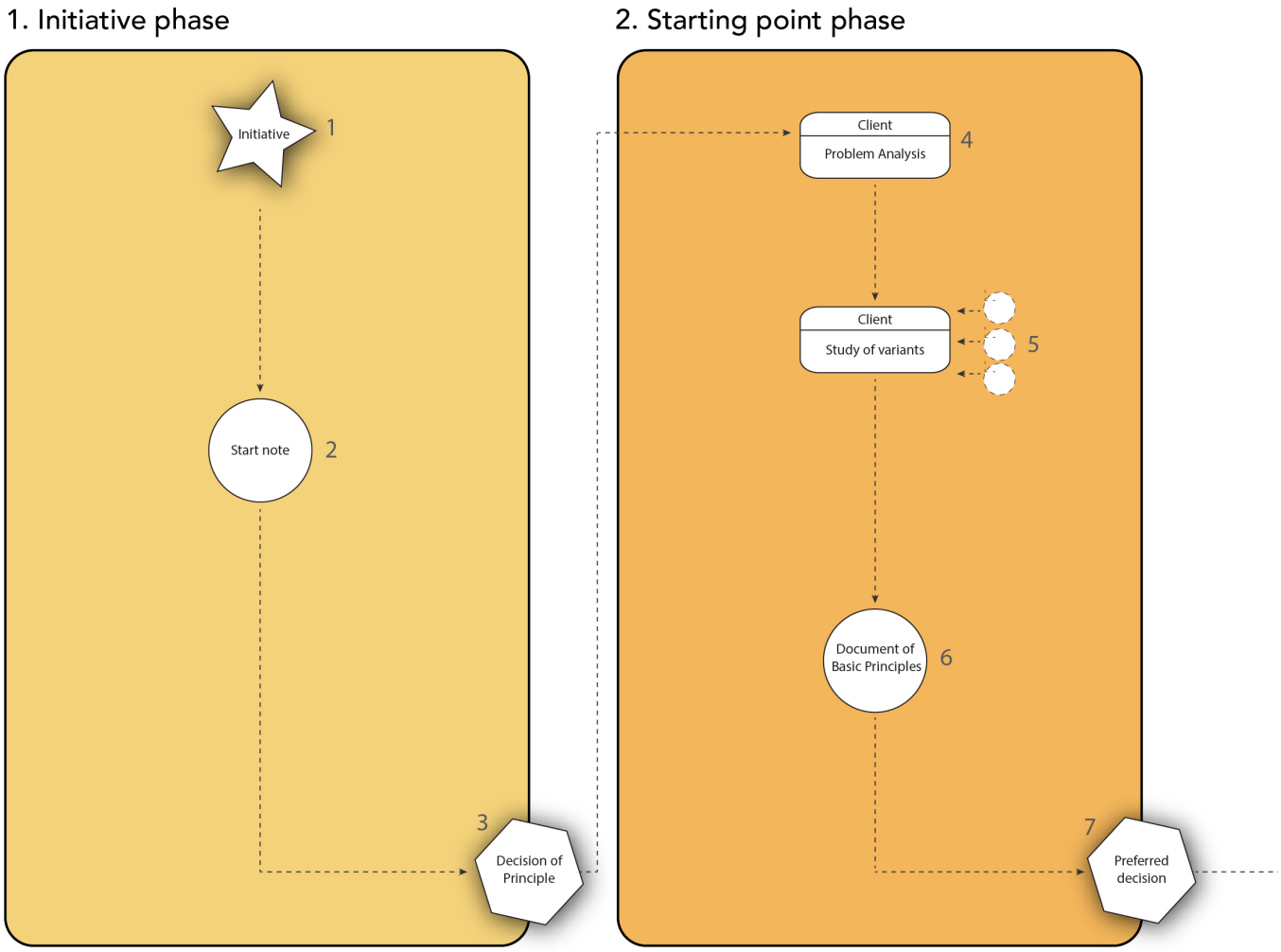
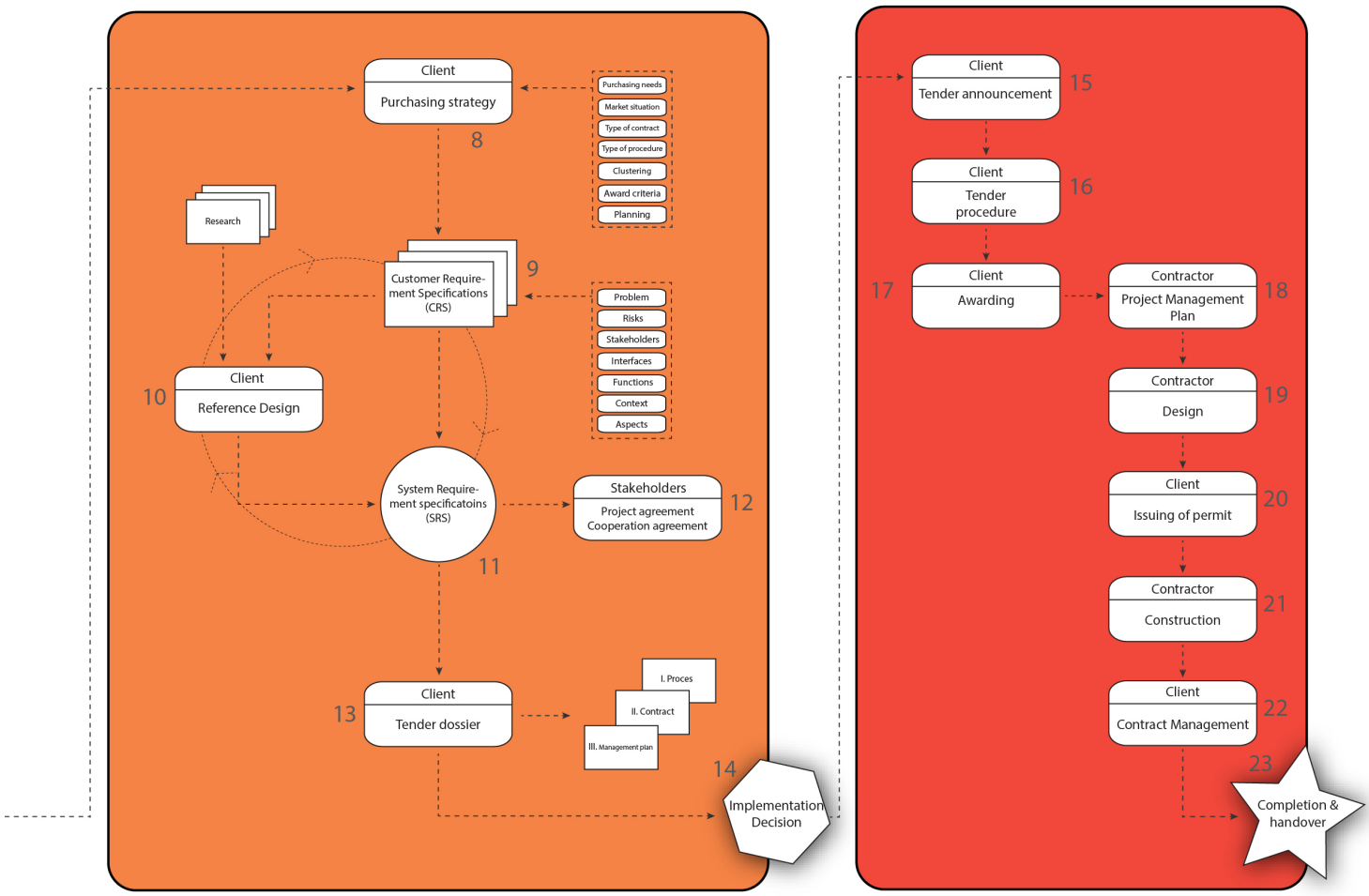


Figure 23: UAV-GC flowchart (own figure)

3&4. Definition & Design phase

5. Realisation phase



Description of process elements in UAV-GC flow-chart

If a rectangular shape is observed, the process element exists of an action. This action can be taken by the stakeholders that are mentioned above the indicated action names. When the process element is round shaped, this means the element consists of a physical document. This can contain for example an action plan or drawing specifications. Hexagon shaped process elements symbolises the elements that corresponds to decisions that can be made by different stakeholders within municipalities.

Initiative phase

The main goal of this phase is to find out if the responsible aldermen (and sometimes the bench of mayor and aldermen) recognizes a problem and considers the problem as a project.

The following three steps are taken in order to complete the initiative phase.

1. According to an established procedure, a new *Initiative* is presented to the responsible alderman.
2. During the procedure, the project management team hands over a *Start note.* The start note consists of information about the following elements:
    - Problem description containing the motive, level of scale, urgency, and expected developments
    - Relation to policy framework
    - Related stakeholders
    - Financial aspects
    - Planning of administrative decision making
    - Plan of action
3. Subsequently, the start note is adopted by the responsible alderman (and sometimes the bench of mayor and aldermen) in the *Decision of principle*.

Starting points phase

In this phase, the aim is to introduce several solutions paths. After this, a rating takes place resulting in a preferred decision that will be elaborated on in the next two phases.

The following four steps are taken in order to complete the starting points phase.

4. A *Problem Analysis* is conducted in which the relevant stakeholders are observed, the area is further defined, and the problem is explored to a greater extent.
5. After obtaining this information, several distinctive solutions paths are introduced. To test to what extent the solution paths are achievable and technically feasible, the solutions paths are further explored in a *Study of variants*. The study examines the general consequences each solution path has on stakeholders its interest, level of support, urban planning aspects, and the environmental impact. After mapping out the different aspects, an estimate of the cost per solution is obtained.

6. All examined information is collected and processed into *Documents of basic principles.*
7. Hereafter, the decision making process is executed by the bench of mayor and aldermen and if necessary the city council. A decision whether the process will continue is made, and if so, a preferred solution path is taken. This takes place in the *Preferred decision.* By knowing which solution path is selected, the project has officially started.

Definition and Design phase

The following four steps are taken in order to complete the Definition and Design phase.

8. A start is made by launching a *Purchasing strategy*. Herein, the following seven themes are discussed: Purchasing needs, market situation, type of contract, award criteria, clustering, and planning (Gemeente Amsterdam, 2012)
    - *Purchasing needs* – Description of purchasing need, location, works/supplies/ services, value of contract, term of contract, conditions, risks, opportunities, and joint purchasing.
    - *Market situation* – In which way will be worked with the market parties? What information can be obtained from the market parties?
    - *Type of contract* – Which type of contract is suitable? And why is this the best suitable contract.
    - *Type of tendering procedure* – Which type of tendering procedure is suitable? And why is this the best suitable tendering procedure?
    - *Clustering* – Can different projects be clustered?
    - *Award criteria* – Description of award criteria, exclusions, suitable requirements, and financial & economic standing.
    - *Planning* – Explanation of used deadlines.

The following steps (9,10&11) should be obtained iteratively and do therefor not function when executing the steps in a linear order.

9. A start is made in obtaining *Customer Requirement Specifications (CRS).* The specifications consist of information about the problem, risks, stakeholders, interfaces, functions, context, and aspects.
10. After obtaining a draft version of the CRS, a start is made in the development of a *Reference design.* This requires more research into technical aspects.
11. Subsequently, the outcome of both the customer requirements specifications and the reference design serve as input for the *System Requirements Specifications (SRS).* Hereafter, the information will be used as new input for the CRS.

Steps 9, 10 & 11 will be repeated for a number of times in order to finally come up with the final CRS, reference design, and SRS.

12. Stakeholders come to a *Project agreement* (input CRS). Stakeholders come to a *Cooperation agreement* (input SRS)
13. After coming to the agreements, the *Tender dossier* is drawn up. The dossier consists of three parts, being the product requirements, process requirements, and management plan.
14. In order to announce the tender, first an *Implementation decision* is taken by the municipal council. By taking this decision, the project credit is also determined.

Realisation phase

The following four steps are taken in order to complete the Realisation phase.

15. The *Tender is announced* on Tenderned. By doing this, the contracting party wants to inform interested parties about the upcoming tender (not obliged).
16. Start of *Tender procedure*. Contracting party announce their project on Tenderned.
17. Market parties that are interested respond to the tender procedure by uploading documents on Tenderned. The contracting party reviews all applications preliminary awards the best scoring party. If the remaining parties do not appeal against the preliminary awarding, the tender is *Officially awarded*. If not, the case goes to court.
18. After signing the contract, the winning party hands over several documents to the client. One of the documents is the *Project management plan.*
19. The winning contractor starts to execute the *Design* part of the contract.
20. When the plan satisfies the stated requirements, the municipality *Issues the permit* that enables the contractor to start working in the public space.
21. The contractor starts to execute the *Construction* part of the contract.
22. It is now the responsibility of the municipality to execute the *Contract Management* well. It is of major importance to check whether the offers that are done by the contractor are fulfilled.
23. Subsequently, the work is *Completed and Handed over* to the administrator.

6. Instrument specifications

The goal of this Chapter is to provide an answer to Research Question 3: 'In which way can instruments obtained in Q1 stimulate the implementation of smart solutions in construction logistics, in municipalities' own executed UAV-GC procured civil structure projects?'. The answer to this question provides insight into the usage of the instruments. This information will be utilised during the development of the supporting tool in Chapter 8 Design.

Chapter 6 is divided in two parts. In Section 6.1, the instrument specifications are dealt with. Subsequently, in Section 6.2 an answer to research Question 3 is given and the other conclusions are shared.

6.1 Specifications

As the instrument Policy is beyond the scope of this thesis, this particular instrument has not been further investigated during this Section. However, the other six in Section 4.4 obtained instruments (Procurement, Communication, Material agency, Contract management, BLVC and Coordination department) are further researched.

By means of six semi-structured interview sessions (one interview for each instrument) information is gathered on the usage of the instruments, in which way the instruments can contribute to or obstruct the implementation of smart solutions in construction logistics and how the instrument specialists view the obstacles and incentives that were enumerated by the interviewed market stakeholders in Section 4.4. The semi-structured interview guides can be found in Appendix D.1-7. The UAV-GC flowchart that has been created in Section 5.1 (Figure 23) is showed during the interview sessions in order to enable the instrument specialist to clearly indicate at what moment the contributors and obstructers occur. The interviewees all work at different departments within the municipality of Amsterdam as shown in Table 27. A more detailed version of the description of the interviewees can be found in Appendix A.1. After recording the interview sessions, the interviews were summarised. Subsequently, the necessary information was collected and described.

Table 27: Interviewee- Instrument specifications

Instrument	Interviewee	Job description	Department within the municipality of Amsterdam
Procurement		Senior advisor purchasing	Engineering company
Communication		Senior communications advisor	Engineering company, Ground & Development, Traffic & Public space
Material agency		Advisor Materials and usage	Material agency
Contract management		Advisor Purchasing/ Contract manager	Engineering company
BLVC		Senior advisor traffic engineer	Engineering company
Coordination department		Senior policy maker	Traffic & Public space

The information is explained as follows: Subsections 6.1.1 – 6.1.6 consist of each an instrument obtained in Section 4.4. In each Subsection, first a description of the instrument is given after which there is looked at the way in which the instrument can contribute to or obstruct the implementation of smart solutions in construction logistics. If a contributor or obstructer takes place on a specific moment during the UAV-GC process scheme, a number will mark this. This number corresponds to the process steps in the UAV-GC flow chart presented in Figure 23. The following order is applied:

6.1.1 Procurement
6.1.2 Communication
6.1.3 Material agency
6.1.4 Contract management
6.1.5 BLVC
6.1.6 Coordination department

6.1.1 Procurement

Instrument explanation
All governmental bodies and semi-public bodies are obliged to acquire supplies, works and services above certain costs by means of a European or National tendering procedure. The costs determine if the procedure should be handled through a European or National procedure in which different types of tender procedures are possible. Contracting authorities are obliged to award the contract by means of the best price-quality ratio unless the contracting authority can justify why the contract is awarded on lowest price (PIANOo Expertisecentrum Aanbesteden, 2017c). When award criteria are used in the tender procedure it should be bear in mind that the award criteria should create extra value to the project, provide solution space and facilitate distinctive solutions. Besides this, the award criteria should be transparent, proportional and not discriminatory (PIANOo Expertisecentrum Aanbesteden, 2017d). Besides the choice in tender procedure, the type of contract can also be chosen as shown in Table 28.

Table 28: Different types of contracts (PIANOo Expertisecentrum Aanbesteden, 2017b)

Type	**Administrative conditions**	
	UAV	UAV-GC
Design, Build, Finance, Maintain & Operate (DBFMO)		
Design, Build, Finance & Maintain (DBFM)		X
Design, Build, Maintain (DBM)		X
Design & Construct (DC)		X
Engineering & Construct (EC)		X
Performance contracts		X
Traditional contracts (For example RAW)	X	
Hybrid contracts	X	X
Framework agreements.		X

The UAV-GC types of contracts consist of the DBFMO, DBFM, DBM, DC, EC, performance contracts, hybrid contracts, and framework agreements. These types of contracts are also called integrated contracts, as different parts of the projects are combined with each other in one single contract. This stimulates mutual alignment between contracting parties, which can result in advantages in sustainability, innovation, quality, cost reductions, time savings, financial security, controlling and managing risks (PIANOo Expertisecentrum Aanbesteden, 2017b).

Contributors/ Obstructions

During the interview sessions, the following ways the instrument 'Procurement' can contribute or obstruct the implementation of smart solutions in construction logistics in municipalities' own executed UAV-GC procured infrastructure projects came forward:

Contributors

- Sustainability aspects should become a part of the project goals.
- Ensuring a stimulus that enables project managers to integrate sustainable aspects. This stimulus can be financial.
- Providing more space for solutions in the tendering request.
- Include market parties in a very early stage by organising market consultation sessions (6).
- Integrating (monitoring) contract managers in an early stage (9).
- Stimulating innovative solutions through EMVI criteria.
- Considering the impact building logistics has on the implementation phase (6).
- Introducing a notification obligation.

Obstructions

- Project managers are driven by project goals (often time and costs) and are hold accountable for the project goals.
- Innovation is often a specific product that cannot be asked for in the EMVI-criteria (Most Economically Advantageous Tender).
- Much innovative ideas cannot be asked for in the tendering request.
- The strength of the market is underestimated.
- Development in contract management is necessary.
- BLVC does not give an incentive to optimise.
- Very difficult to control certain EMVI-criteria.

6.1.2 Communication

Instrument explanation

The instrument communication consists of internal and external communication. Internal communication focuses primarily on the knowledge transfer between employees and departments, whereas external communication focuses on the communication between the municipality and its citizens.

For internal communication, the municipality of Amsterdam makes use of a webpage (intranet). On this webpage information is collected concerning the tasks of different departments, its employees, and more general information. Furthermore, the municipality appointed a number of internal communication managers for each department.

For external information, the municipality of Amsterdam makes use of spokespersons, a main telephone number, a webpage, and social media. In case it is expected that a certain project will get much attention, a project communication manager is introduced.

Contributors/ Obstructions
During the interview session, the following ways on how the instrument 'Communication' can contribute to the implementation of smart solutions in construction logistics in municipalities' own executed UAV-GC procured infrastructure projects came forward:

Contributors

- More often introducing project evaluation moments after which the conclusions should be communicated to the employees of municipalities.
- Sharing both positive and negative project information internally.
- Creating more awareness of construction logistics (accessibility and liveability) by making use of the spokesperson, website and social media.

6.1.3 Material agency

Instrument explanation
The material agency of the municipality of Amsterdam focusses on five different services, being the central purchasing of paving materials and street furniture, temporary traffic control measures, the material management of public lightning and traffic lights, re-use and recycling in the public space and ice-control measures.

The municipality purchases paving materials and street furniture centrally, as it provides a uniform appearance and as it brings a reduction in costs. Once every two to four years, the municipality of Amsterdam launches a tender on bricks, natural stones, bicycle racks and many other paving materials and street furniture. The wholesaler that wins the tender will deliver the materials for the municipality its projects during those two to four years. This makes it for the contractor that works for the municipality compulsory to purchase materials at the winning wholesaler for a fixed price.

With this working method, the municipality of Amsterdam withdraws itself since the contractor and the wholesaler directly have to cooperate.

Contributors/ Obstructions
During the interview sessions, the following ways on how the instrument 'Material agency' can contribute or obstruct the implementation of smart solutions in construction logistics in municipalities' own executed UAV-GC procured infrastructure projects came forward:

Contributors

- In the construction phase of the GWW sector, the wholesaler already asks for additional costs when the contractor does not order full truckloads.

Obstructions

- The requirements related to the obligation of purchasing paving materials and street furniture are often not correctly specified in the contract, which is likely to cause delays.

6.1.4 Contract management

Instrument explanation

This instrument focuses on monitoring the contract during the design and execution phase of a project. All the instruments and process specifications that are agreed on are included in the contract and need to be fulfilled by the contractor. Within an UAV-GC contract, it is the contractor's duty to report back what he has been working on. This means that there will be no management director on site controlling the execution of the contract, as generally happening in traditional contracts. Within a UAV-GC contract, the client has a more observing role involved on the side-lines.

Contributors/ Obstructions

During the interview session the following ways on how the instrument 'Contract management' can contribute or obstruct the implementation of smart solutions in construction logistics in municipalities' own executed UAV-GC procured infrastructure projects came forward:

Contributors

- Considering the way in which the offers on the award can be controlled during the development of the purchasing strategy (9).
- Ensure that the contract manager during the execution phase is part of the developing phase of the contract.
- Introducing bonus/malus in contract.

Obstructions

- The contract manager during the execution is often not the same person as the contract manager during the development of the contract.

6.1.5 BLVC

Instrument explanation

When working in the public space of the city of Amsterdam, a BLVC-plan (accessibility, liveability, safety, and communication plan) is required to obtain a WIOR-permit (working in the public space -permit). This plan, which should be delivered by the contractor, deals with the questions: 'What is going to happen?' 'Where is this going to happen?' 'When is this going to happen?' 'Why is it going to happen?' 'What are the consequences related to traffic?'

and 'In what ways is dealt with the communication around the operations?' (Gemeente Amsterdam, 2017c).

The notion of BLVC is, despite the fact that it is founded by the municipality of Amsterdam, not Amsterdam specific. Several conferences are being organised in which the notion of BLVC is discussed with various market parties and governmental bodies. The only difference is that within the Amsterdam context, the contractor working in the public space is obliged to deliver a BLVC-plan, whereas in other places this is not the case.

Looking at a by the municipality of Amsterdam UAV-GC procured infrastructure project, there are three instances in which BLVC comes forward. The first instance happens in process step number 5 in the flow chart. During this step a BLVC-scan is conducted. A BLVC-scan is an internal document that mainly focuses on the accessibility the solution direction (Process step 5) provides. The second instance occurs during the Customer Requirement Specifications, Reference Design and System Requirements Specifications loop (Process step 9,10,11). A BLVC-framework is constructed that exists of the minimum requirements as set up by accessibility, liveability, safety and communication (BLVC). This framework is a component of the tender dossier, which will be assembled in process step 13. The last instance takes place in between process step 19 and 20. In this moment, a contractor is obliged to hand over a BLVC-plan to obtain a permit to start working. In this BLVC-plan, the contractor reacts to the specified minimum requirement outlined in the BLVC-framework.

Contributors/ Obstructions

During the interview sessions, the following ways on how the instrument 'BLVC' can contribute or obstruct the implementation of smart solutions in construction logistics in municipalities' own executed UAV-GC procured infrastructure projects came forward:

Contributors

- BLVC-framework: Minimum requirements in BLVC-framework can be increased project specifically.
- BLVC-framework: Extra requirements can be added project specifically.
- Impact on accessibility and liveability during the realisation of the project (4) & (5).
- Specific parts of BLVC-framework can be used as award criteria.
- The incorporation of definitions in BLVC-framework.
- EMVI: only when innovative, otherwise as requirement in BLVC-framework
- In BLVC-framework: The incorporation of Preferred network.
- In BLVC-framework: The incorporation of Access management.
- In BLVC-framework: The incorporation of Waste management.
- In BLVC-framework: The incorporation of mandatory usage of Hub.
- In BLVC-framework: The incorporation of mandatory usage of transport by water.
- In BLVC-framework: The incorporation of mandatory usage of public transport by the contractor its employees.
- In BLVC-framework: The incorporation of desirable operating time slots.
- In BLVC-framework: Guidelines for construction site management.

Obstructions

- BLVC-scan focuses more on the impact the solution direction has on the accessibility (mobility) (5).
- The feasibility of the BLVC-framework should be checked (reference plan).
- BLVC does not stimulate innovation; it is set as a requirement.

6.1.6 Coordination department

Instrument explanation

The coordination department of the municipality of Amsterdam focuses on three aspects. Firstly, they focus on combining projects in order to reduce the amount of constructions tasks. This is cost efficient and prevents opening the ground more often than necessary. Secondly, the department issues the WIOR permit (Working in public spaces permit) in which they assess BLVC-plans (accessibility, liveability, safety and communication plan). Finally, the department monitors the amount of projects that are executed at the same time and adjust schedules were necessary.

As soon as a market party, governmental body or semi-governmental body plans to open up the ground to carry out works, the coordination department starts looking for other parties that possible want to join carrying out tasks. This 'make work with work' approach tries to ensure fewer detached activities in the public space.

Contributors/ Obstructions

During the interview session the following ways on how the instrument 'Material agency' can contribute or obstruct the implementation of smart solutions in construction logistics in municipalities' own executed UAV-GC procured infrastructure projects came forward:

Contributors

- Combining projects in order to reduce the amount of projects.
- The coordination department has a coordinating role in bringing parties together. Usage could be made of the relations the department has when implementing for example a hub that is mandatory to use.

6.2 Conclusions on instrument specifications

By means of obtaining information related to the six instruments, an answer can be provided to Research Question 3: 'In which way can instruments obtained in Q1 stimulate the implementation of smart solutions in construction logistics in municipalities' own executed UAV-GC procured civil projects?'. The answer to the Research Question will be given for each instrument separately, except for Procurement and Contract management, as these two instrument are highly intertwined. In addition, the ways in which the instrument Coordination Department can stimulate implementation of smart solutions is not described in this Subsection. This is because the obtained contributor does not take place within the execution process of construction projects within municipalities.

Beware that the obtained findings are a result of only one interview for each instrument.

Procurement/ Contract management
The instrument 'Procurement and Contract management' can stimulate the implementation of smart solutions in the following ways. First, when sustainability aspects become part of the project goals set by the project owners (for example, by making extra money available), the project manager is encouraged to, among other things, focus on implementing smart solutions in construction logistics. Secondly, including market parties in a very early stage (starting point phase) by organising market consultation sessions (6). During the sessions, insight into the newest solutions related to construction logistics will be provided. During the strategic point phase, also consider the impact construction logistics has on the different projects solutions (6). Thirdly, EMVI criteria can be used to stimulate smart solutions in construction. Hence, is should be noticed that when setting up the award criteria, the contract manager that will be controlling the project (or often controls projects) gives input on the testability of the to be established award criteria during the execution. Besides this, it must be ensured that in the tender request is asked for explanations on how the contractor is going to fulfil the notification obligation. Furthermore, in the award criteria catch-all concepts and very specific formulated award-criteria should be avoided if candidates cannot foresee the content yet. An other boundary condition of constructing award criteria is that the criteria should create added value, provide solution space and facilitate distinctive solutions. In addition, the award criteria should also be transparent, proportional and non-discriminative.

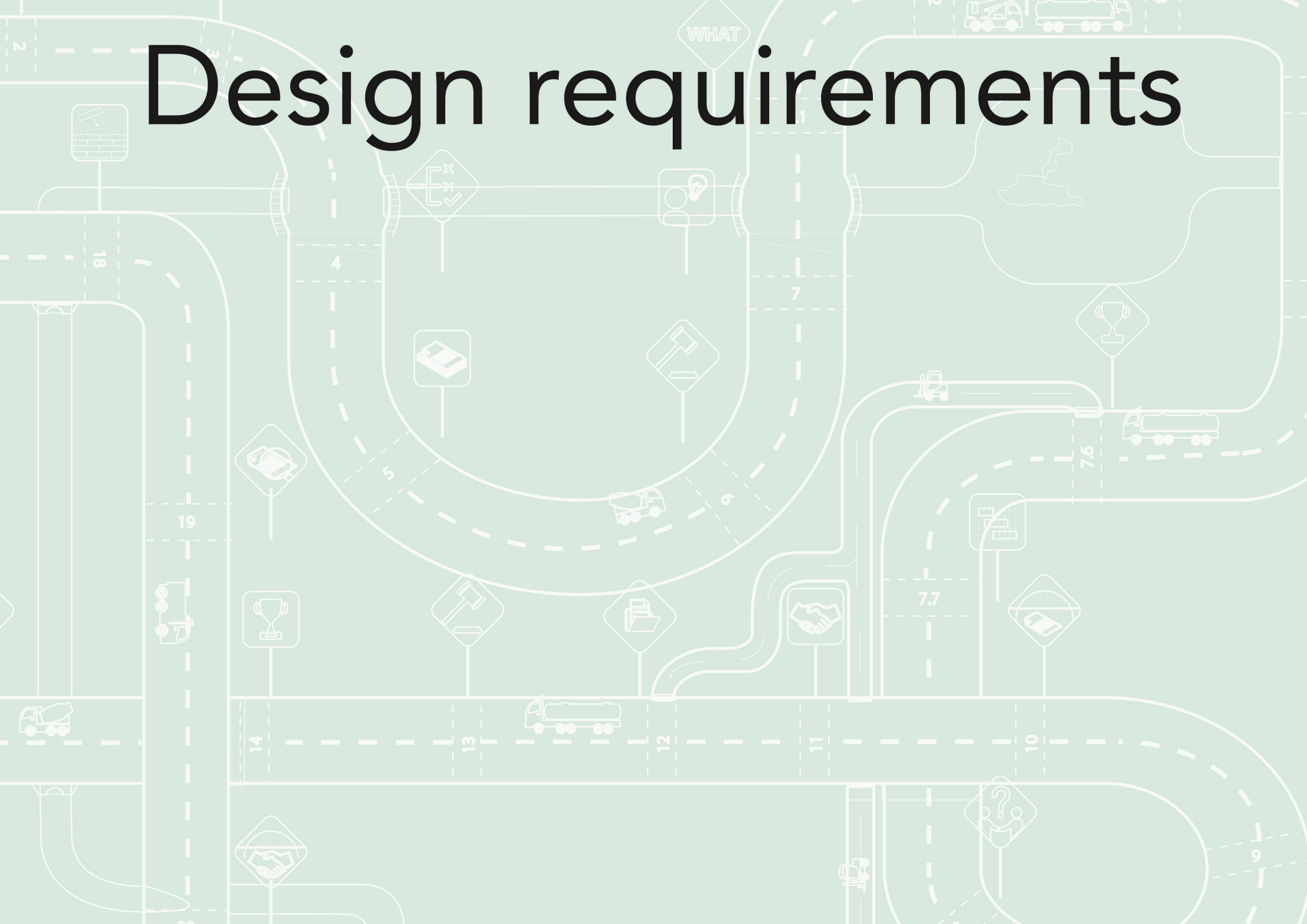
Communication
The instrument 'communication' can stimulate the implementation of smart solutions in the following two ways. First, by internally sharing both positive and negative information related to construction logistics to enlarge the common knowledge of employees working on civil projects within municipalities. Secondly, by creating more awareness externally of construction logistics, through making use of a spokesperson, website, social media, or a competition (For example, 'Best executed construction logistics construction project of the year').

Material agency
The instrument 'Material agency' can stimulate the implementation of smart solutions in the following way. By obliging wholesalers that deliver materials for municipalities to asks for additional costs when the contractor does not order FTL. However, this is already often the case in infrastructure projects.

BLVC
The instrument 'BLVC' can stimulate the implementation of smart solutions in the following ways. When constructing a BLVC-framework (9,10,11), minimum requirements can be set related to, for example, accessibility and liveability. The minimum requirements can be increased or reduced project specifically. The BLVC framework can require the incorporation of a preferred network, access management, waste management, and desirable operating time slots. Besides this, the BLVC-framework can also incorporate the requirements related to the mandatory usage of a hub, usage of transport over water, and public transport by the contractor its employees. Hence, is should be noticed that catch-all concepts should be avoided in BLVC-framework in order to avoid confusion related to the stated concepts. Besides this, the feasibility of the BLVC-framework should be checked in the reference plan before the tender dossier (13) is constructed. It should also be observed that a BLVC-framework does not stimulate innovation; it is set as a requirement. Finally, in case of very complex projects that are located in confined urban areas, it is recommended in the Study of variants (5) to also take the consequences of the solutions that relate to the level of liveability and accessibility into account during the execution of projects.

The previous obtained contributors and obstruction of each deployable instrument will be translated into the input Design Requirements in Chapter 7.

Design requirements



7. DESIGN REQUIREMENTS

The goal of Chapter 7 is to describe the design requirements. These requirements are of major importance, since they are used as a starting point for the creation of the tool. The 40 requirements are divided in six categories of which the first five are mandatory.

1. Functional requirements
2. Non-functional requirements
3. Input requirements
4. Appearance requirements
5. Usability requirements
6. Desirable requirements

The requirements are derived from the Objective, Scope (Sections 1.3 and 1.4) and Research Sections 4.1, 4.2, 4.3, 4.4, 5.1, 6.1 and 6.2.

The first part of the requirements consists of the functional required criteria. The Functional requirements entail what the supporting tool is supposed to do. These criteria are obtained from the Problem Analysis (Section 1.2), Objective (Section 1.3) and Research Sections 4.2 and 4.3

Functional Requirements

1. The tool must contribute to a reduction of nuisances caused by the execution of construction works (Objective).
2. The tool must contribute to achievement of the sustainable goals that are set by municipalities (Objective)
3. The tool must contribute to an increase of the liveability and accessibility of urban confined areas during the construction phase (Objective).
4. The tool must make sure it translates strategic and tactical information into a more operational approach (Objective)
5. The tool must be able to give advise on which actions municipalities can take to stimulate market stakeholders to implement smart solutions in construction logistics (Objective).
6. The tool must be able to to give advise on which actions municipalities can take in order to optimise their own UAV-GC procured infrastructure processes in respect to the reduction of nuisances (Objective).
7. The tool must be able to show at which time municipalities should deploy their instruments (Objective).
8. The tool must indicate on time when municipalities have to start preparing the to be deployed instruments (Objective).
9. The tool must indirectly make sure market stakeholders will more often implement smart solution in construction logistics (Objective).
10. The tool must be able to let future users make a selection of usable means (Objective).
11. The tool must primarily focus on possibilities to stimulate the ‘HUB’, ‘Multi-modal transport’, ‘Building innovatively’ and ‘Clustering of personnel transport’ smart solutions (Section 4.1)

12. The tool must primarily focus on stimulating the most important market stakeholders (Contractor, Wholesaler, Shipping company, Logistic company, Designer and IT company) to implement smart solutions in construction logistics (Section 4.2).

The second part of the needed Design Requirements consists of the Non-functional requirements the supporting tool should satisfy. The Non-functional requirements are derived from the Scope in which this thesis is conducted (Section 1.4).

Non-Functional Requirements

13. The tool must focus on projects in which municipalities act as the main client and also fulfils the role of a licensor, coordinator and owner of ground (Scope)
14. The tool must focus on civil projects that are executed by municipalities (Scope)
15. The tool must focus on civil projects that are UAV-GC procured (Scope)
16. The tool must focus on municipalities that have to deal with large building tasks which are located in urban confined areas (Scope)
17. The tool must focus on the realisation of civil works in the GWW sector such as parking garages, aqueducts, bridges and quay walls (Scope)
18. The tool must focus on the operational level of the execution of civil projects (Scope)
19. The tool must be applicable for employees of municipalities who work on the operational level of the execution of civil projects (Scope)
20. The tool must be applicable by all Dutch municipalities (Scope)

The third part of the Design Requirements consist of the Requirements that relate to the, in this project, obtained input. The information that is obtained in Chapter 4, 5 and 6 is used for this. Only the relevant information that is usable for the tool is translated into requirements.

Input Requirements

21. The tool must take the obstacles and incentives, derived in Section 4.3 in consideration.
22. The tool must take the derived actions municipalities can take, derived in Section 4.4 in consideration.
23. The tool must include the obtained UAV-GC flowchart (Section 5.1)
24. The tool must include the obtained contributors and obstructions of the instrument Procurement & Contract management (Section 6.1 and 6.2).
25. The tool must include the obtained contributors and obstructions of the instrument Communication (Section 6.1 and 6.2).
26. The tool must include the obtained contributors and obstructions of the instrument Material agency (Section 6.1 and 6.2).
27. The tool must include the obtained contributors and obstructions of the instrument BLVC (Section 6.1 and 6.2).

The fourth and fifth parts of the design requirements are obtained during the interview sessions conducted in Section 5.1. The appearance and Usability requirements are the answer to the third question raised in Subsection 5.1.1.

Appearance Requirements

28. The tool must have a neat appearance
29. The tool must not consist of an overload of information.
30. The tool must not consist of much text.
31. The tool must not contain abbreviations.

Usability Requirements

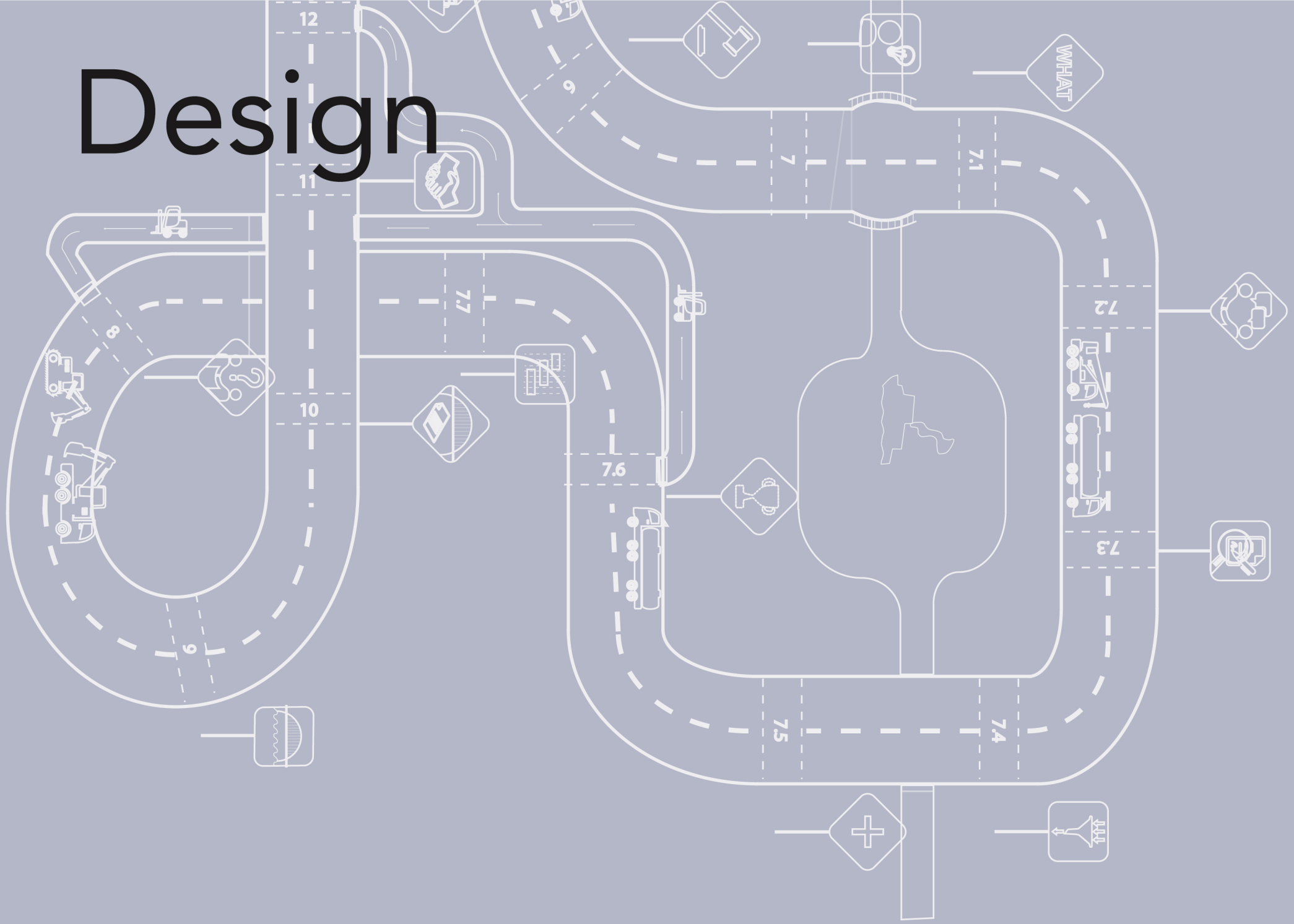
32. The tool must be well readable (Minimum text size 12).
33. The tool should be portable in a bag.
34. The tool should be printable on hard-copy.

Finally, the requirements are stated of which the tool desirably satisfies.

Desirable Requirements

35. It would be desirable if the tool is interactive.
36. It would be desirable if the tool can be found online.
37. It would be desirable if the way in which the tool is presented is also applicable for by municipalities procured utility projects.
38. It would be desirable if the tool is easy adaptable for UAV administrative conditions.
39. It would be desirable if the tool is easily adaptable for other (semi) governmental bodies as for example Rijkswaterstaat, Water authorities and Housing association procuring UAV-GC engineering structure projects.
40. It would be desirable if the tool can be understand by people that not (yet) work in the field of UAV-GC procured.

Design



8. DESIGN

The goal of Chapter 8 is to introduce the construction process of the supporting tool and to show how the final version of the tool works. In Section 8.1 the design process is explained, after which in Section 8.2 the final version of the tool, a Project Roadmap is explained. Subsequently, in the final Section of this Chapter (8.3) the final evaluation steps of the Project Roadmap are executed.

The final version of the supporting tool, the Project Roadmap, can be find in the separate booklet provided by this thesis.

8.1 Design process

The Basic Design Cycle (Roozenburg and Eekels, 1995) is utilised during the development of the supporting tool. Therefor, several iterative design steps are taken which are explained below.

Analysis phase
The mandatory and desirable requirements are used as a starting point in the design phase of the tool (Deign requirements).

Synthesis phase
First, the instrument contributors and obstructions (result of Chapter 6) are placed on the right position on the UAV-GC project flow chart (see Figure 23 in Chapter 5). This is done by writing down the instrument contributors and obstructions on post-its and sticking them on the flow chart. Hereinafter, the primarily separated information parts on post-its are bundled and replaced on the flowchart in Illustrator. This result can be seen in Figure 24 and Appendix E.1

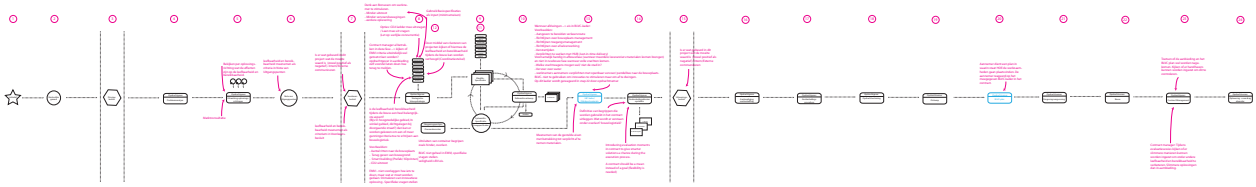


Figure 24: First attempt of tool (provisional design) (own figure)

Validation phase
Subsequently, the first attempt of the tool (provisional design) is validated mainly on the *substantive* side of the tool.

Four professionals working for the engineering company of the municipality of Amsterdam participated in the validation session related to the substantive side of the tool. The participators can be found in Table 29. A more detailed version of the description of the interviewees can be found in Appendix A.1.

Table 29: Interviewee - validation of tool (substantive)

Interviewee	Job description	Department within the municipality of Amsterdam
	Purchasing advisor/ Contract manager	Engineering company
	Senior project leader	Engineering company
	Strategic advisor	Engineering company
	Senior advisor traffic engineer	Engineering company

This validation session lasted for about 2.5 hour. During the session, the first tool attempt (Figure 25 and Appendix E.1) was printed on a readable scale and displayed on a wall. Furthermore, an introduction presentation was given that switched to the displaying of each individual step of the flow-chart including instrument contributors and obstructions. Each step on the flow-chart was presented, even if no new remark was added. This was done in order to prevent a biased outcome of the session.

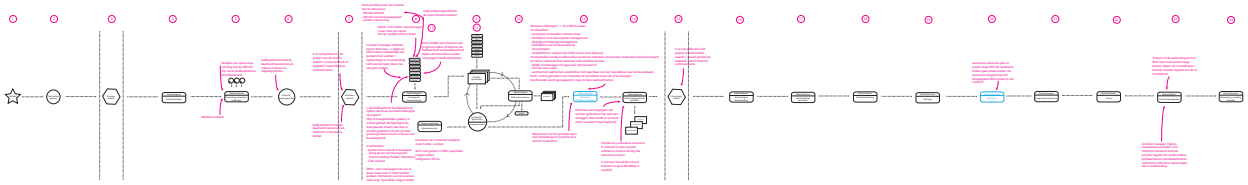


Figure 25: Supporting tool alternative 1 (own figure)

Since the validation session was recorded, it was possible to re-listen what was said during the session. A summary was made after witch the new gained information was processed into a second draft version of the tool, which can be seen in Figure 26 (also in Appendix E.2). After this validation step, the main content of the tool has not changed anymore, solely the package around it.

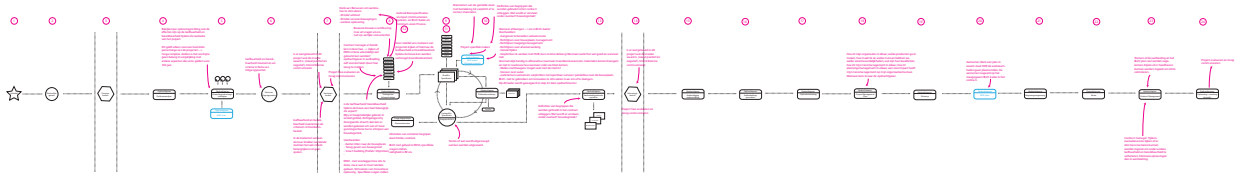


Figure 26: Supporting tool alternative 2 (own figure)

After conducting the first validation session, another validation session was conducted with the focus on the *general extent* of the second attempt of the tool**.** An advisor in sustainability and area development working for the municipality of Rotterdam participated in the second validation session as can be seen in Table 30. A more detailed version of the description of the interviewees can be found in Appendix A.1.

Table 30: : Interviewee - validation of tool (generic extent)

Interviewee	Job description	Organisation	Department
	advisor in sustainability and area development	Municipality of Rotterdam	Urban development

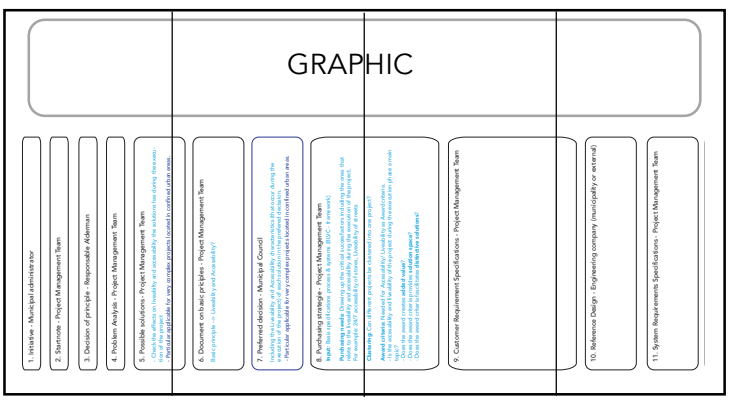
This session focused on the extent in which the tool is generic applicable within municipalities. In total, the validations session lasted 1.5 hour. During the session, Figure 26 was showed and discussed. The main finding that emerged during the session was that all municipalities in the Netherlands (and even municipalities abroad) are exactly following the same procedure of executing infrastructure works within the public space. The only difference is the way in which municipalities name their actions and instruments. This seems to imply that the developed tool can be generic implementable, provided that the actions and instruments names are adapted to each municipality. Another important finding that emerged is that especially for a city such as Rotterdam, that has never faced any problems related to accessibility and liveability, this tool can be eminently suitable since the city is facing problems now.

Evaluation phase

In addition, there has been looked to what extent the second attempt of the tool (Figure 26) satisfies the stated design requirements stated in chapter 7. When comparing the second attempt of the tool with the Design Requirements the following observations can be distracted. The second attempt of the tool almost satisfies all functional, non-functional and input requirements. However, the attempt does not satisfy one single appearance requirements and some usability requirements. Namely, the tool does not have a neat appearance (28) as it consists of an overload of information (29), much text (30) and abbreviations (31). Besides this, the tool is without folding not portable in a bag (33) and hard to print (34) as the size deviated from a printable size.

Synthesis phase

By using the obtained information from the previous phase a new design of the supporting tool is created (Figure 27). Alternative 3 is characterised by the division of text and image. Besides this, the alternative is designed as a foldable menu card which is easy to transport.



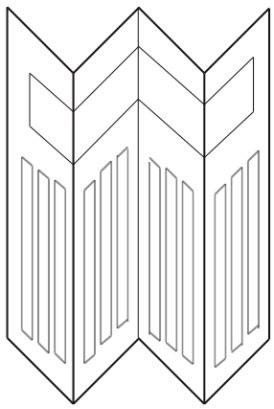


Figure 27: Supporting tool alternative 3 – Menu card (own figures)

Evaluation phase

Subsequently, the supporting tool alternative 3 is evaluated in order to test to what extent the supporting tool satisfies the Design Requirements. Just as 'supporting tool alternative 2' does this alternative almost satisfies all functional, non-functional and input requirements. However, again the design does not satisfy all appearance and usability requirements. Although the new design alternative is more structured and appealing, does the supporting tool still contains of an overload of information (29), is the design of the tool still to large when printed on a readable scale (32) and therefor also not easy to print (33).

Synthesis phase

By using the obtained information from the previous phases, again, a new design of the supporting tool is created (Figure 28). Alternative 4 is characterised by a division of text and image and can be seen as a Project Roadmap.

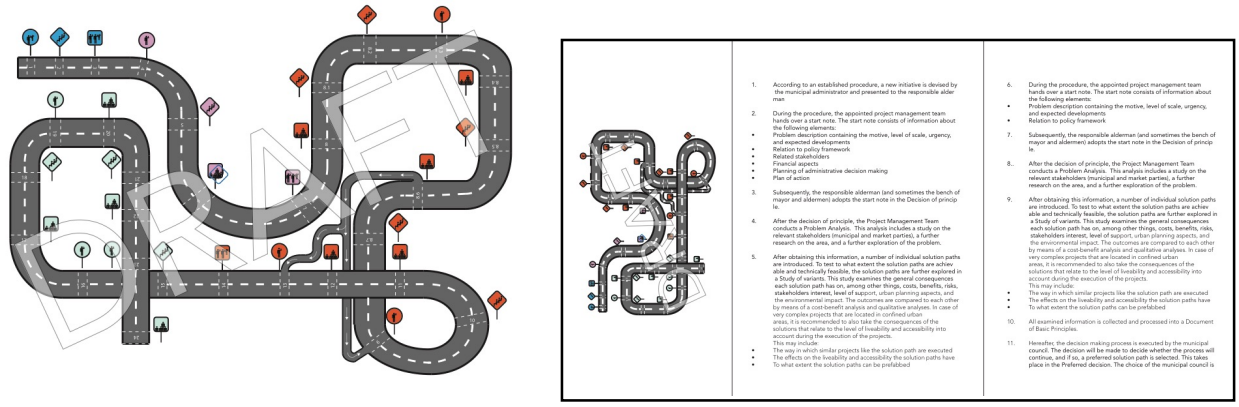


Figure 28: Supporting tool alternative 4 - Project Roadmap (own figures)

Evaluation phase

As alternative 4 satisfies almost all Design Requirements (including the requirements related to appearance and usability, the alternative is further developed.

The final version of the Project Roadmap, can be find in the separate booklet provided by this thesis. An explanation of the final supporting tool is given in Section 8.2. Afterwards, in Section 8.3, the last evaluation steps are described.

8.2 Description of Project Roadmap

The Project Roadmap is designated for employees of Dutch municipalities working on the execution of UAV-GC procured civil structure projects, to contribute to a reduction of nuisances that are caused by the execution of construction works.

The Project Roadmap is issued in a small booklet in A5 size that is divided in text and image. The booklet has a convertible cover showing a graphic on the inside. The first page of the booklet shows the content of the Project Roadmap. The booklet is structured in the following order: introduction, necessary information, Project Roadmap graphic and text, and recommendations. The 'Introduction' text reviews the relation between the Project Roadmap booklet and this thesis. The 'Necessary information' discusses the main outcomes of this thesis and ensures all necessary information is provided in order to understand the Project Roadmap text.

The Project Roadmap graphic (both showed on the inside of the convertible cover and on two pages in the booklet) consists of a road with 20 intersections. Each intersection represents actions in the UAV-GC procured process of civil structure projects. In addition to the intersections, also icons and numbers are present. The icons represent the actions that take place during each intersection. When the traffic icons are diamond shaped, it means that actions can be taken in order to reduce construction related nuisances. When the traffic icons are square shaped, it means that no new actions are prescribed during the process step. In this case, only a process step description is present.

The numbers correspond to the Project Roadmap text. Herein, each process step is described and where necessary supplemented with explanations of actions (written in blue). Occasionally, orange sentences can be found in the text. These sentences refer to the obstacles and incentives the actions respond to.

The text of the the Project Roadmap is kept as limited as possible. In addition, the text is written in a simple but very understandable style. The inclusion of complicated words has for that reason been avoided. This is done in order to make the Project Roadmap inviting to use. While reading the main body of the booklet, the graphic is always visible on the unfolded cover. This makes sure the reader realises at which moment in time the actions are proposed and can quickly search for actions that take place in a specific process step. This is also the reason why the text can be read as a whole, but also allows the reader to only read information about specific process steps. The Project Roadmap also guides employees by showing in the text which actions can be taken, what the actions consists of and at what moment in time the actions should be taken. Furthermore, the Project Roadmap displays in which moment the action should have taken place (if necessary), which party should take the action and what the preconditions of the actions are.

Finally, the Project Roadmap booklet consists of a list of remaining recommendations intended for municipalities.

8.3 Evaluation of Project Roadmap

This Section is divided in two Subsections. In Subsection 8.3.1, the results of the user test will be explained. Subsequently, in Subsection 8.3.2 the Project Roadmap will be verified on the basis of the specified Design Requirements drawn up in previous Chapter.

8.3.1 User-session

Interviewee selection

In order to find out how future users evaluate the Project Roadmap, a user-test is conducted. The test is carried out by two employees working for the municipality of Amsterdam as can be seen in Table 31. A more detailed version of the description of the interviewees can be found in Appendix A.1. It is chosen to conduct the test with a contract manager and purchasing advisor as they represent two large groups of future-users of the supporting tool. Namely, contract managers and purchasing advisors are, amongst others, involved in drawing up award criteria, BLVC plans and monitoring the offer during the execution of construction works. These three means are one of the main pillars on which the Project Roadmap – Unobstructed Constructed is based.

Table 31: Interviewee – User test

Interviewee	Job description	Organisation	Department
	Contract manager	Municipality of Amsterdam	Engineering company
	Purchasing advisor	Municipality of Amsterdam	Engineering company

User Tests

During a test of about an hour the participants were asked to fill in the user test form witch can be found in Appendix E.3. The user test consists of two different parts that proceeded as follows: In de first part of the test, the two participant were asked to check out the Project Roadmap for about twenty minutes without knowing hardly anything of the development of the tool. During those twenty minutes, they were also asked to write down their first observations related to the Project Booklet. Subsequently, in the second step of the user test, the participants were asked to fill in the questionnaire that can be found in the second part of the form.

User Test outcome

Both completed forms can be found in Appendix E.4. When summarising the obtained views on the Project Roadmap the following conclusions can be distracted.

Something that immediately strikes attention is the fact that both attendees highly score the appearance of the Project Roadmap. This is underpinned by the participants indicating the good looking and illuminating visualisations and the clear and neat appearance of the Project Roadmap. Moreover, it can be concluded that both participants do think that the supporting tool can indirectly (highly) contribute to a reduction in nuisances related to accessibility and liveability. This has probably something to do with the fact that the participants also indicate

that the Project Roadmap provides good insight in the possible implementable actions that municipalities can take. Furthermore, both participants point out that the Project Roadmap does not consist of too much text. However, one participant indicates that the whole text should be properly read in order to fundamentally say something about it. In addition, the A5 size of the Project Roadmap is appreciated. However, the attendees address that an online version of the tool would be highly valued. After all, it is recommended by the attendees to provide a Dutch version of the tool as this will enable all possible future users to make use of the Project Roadmap.

8.3.2 Evaluation of Project Roadmap

When verifying the Project Roadmap according to the stated Design Requirements, the following findings can be derived:

Functional requirements

- The Project Road map satisfies all functional requirements 1-12.

Non-functional requirements

- The Project Road map satisfies non-functional requirements 13-19.
- The project Road map satisfies non-functional requirement 20, providing that the names of the UAV-GC steps and instrument names are adapted to each municipality.

Input requirements

- The Project Road map satisfies all input requirements 21-27.

Appearance requirements

- The Project Road map satisfies appearance requirements 28-30.
- The Project Roadmap does satisfy appearance requirements 31, providing that BLVC is seen as a name instead of an abbreviation.

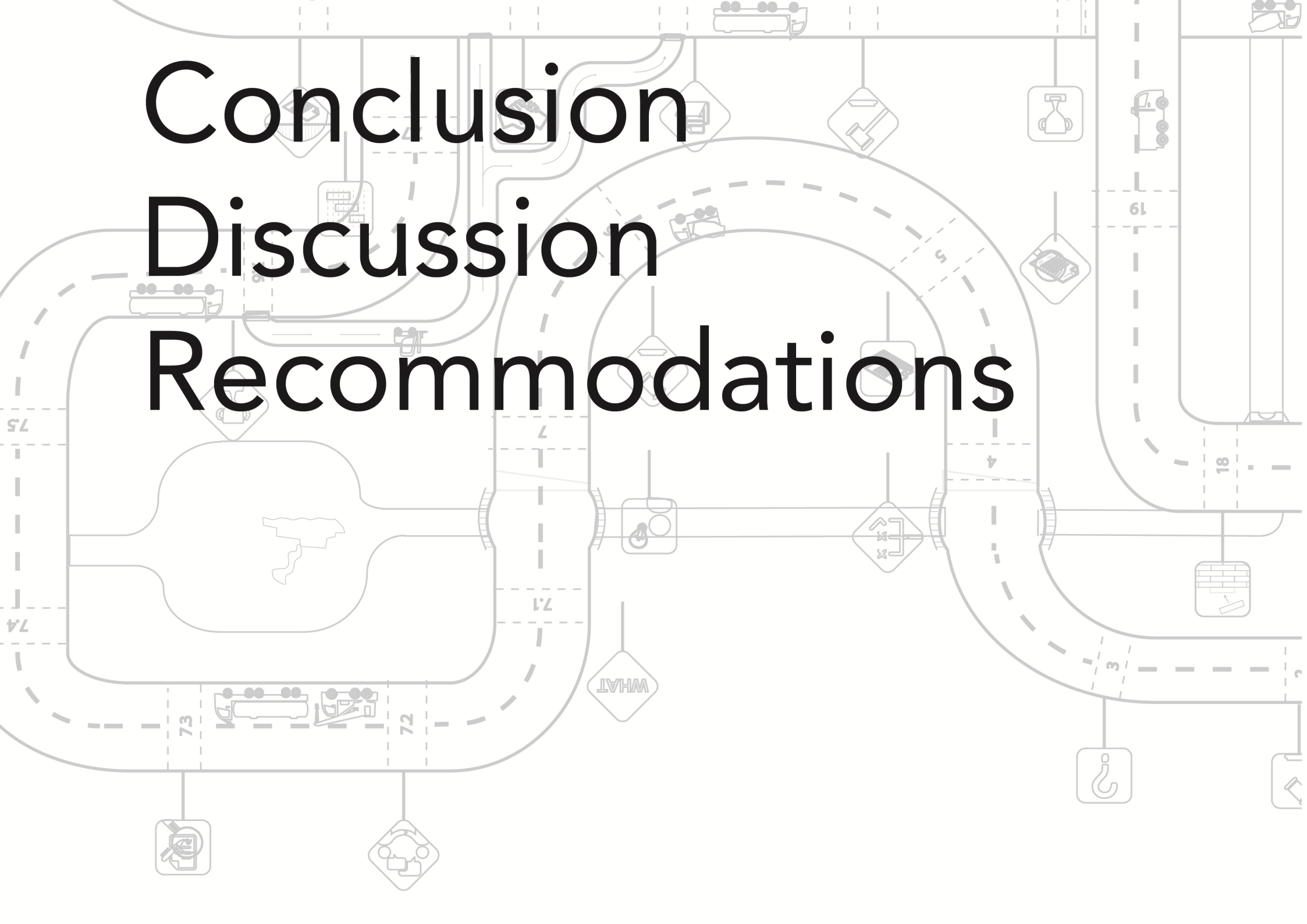
Usability requirements

- The Project Road map satisfies all usability requirements 32-34.

Desirable requirements

- The Project Roadmap does not satisfy desirable requirement 35 as this version of the Project Roadmap is not interactive.
- The Project Roadmap does not satisfy desirable requirement 36 as this version of the Project Roadmap can not be found online yet
- The project Roadmap does satisfy desirable requirement 37, 38 & 39, as the way in which the tool is presented is also applicable for by municipalities procured utility projects, UAV-procured projects and other governmental agencies.
- The project Roadmap partially satisfies desirable requirement 40 as the tool enables people with little knowledge on UAV-GC procured projects to get an understanding of by municipalities procured UAV-GC processes. However, little knowledge about the UAV-GC procedure is required.

Conclusion
Discussion
Recommodations



9. Conclusion, Discussion and Recommendations

9.1 Conclusion

This research is completed to develop a supporting tool that provides guidance to employees of municipalities working on the realisation of UAV-GC procured civil works. More specifically, the tool aims to help employees of municipalities to stimulate market parties to implement smart solutions in construction logistics. These smart solutions could be of great significance, as on the one hand they reduce the additional nuisances caused by the execution of construction projects, and on the other hand increase the liveability and accessibility of urban confined areas during the execution of construction projects.

In order to achieve this, the following Design Statement has been established: *'Developing a tool that will give support to employees of municipalities working on the realisation of UAV-GC procured civil works, helping them to stimulate market stakeholders to implement smart solutions in construction logistics into projects.'*

To respond to the Design Statement, a literature study has been conducted in order to find out which solutions are currently considered as smart solutions in construction logistics. Through this literature study, the following eleven solutions were selected: Preferred network, Hub, Multimodal transport, Distribution network, Building innovatively, Mobile/ Combination/ Finishing container, Clustering of personnel transport, Building ticket, Logistic Team, Award criteria, and Integrated information facilities. The literature study also focussed on the implementers of the eleven smart solutions. Through this research, a list of the solutions that can be implemented by market stakeholders or municipalities could be set up. The smart solutions that can be implemented by market stakeholders are the HUB, Multimodal transport, Building innovatively, Mobile/ Combination/ Finishing container, Clustering of personnel transport, Building ticket, Logistic Team, and Integrated information facilities. In contrast, the smart solutions in construction logistics that can be implemented by municipalities are Preferred network, HUB, distribution network, and award criteria.

Thereafter, substantive knowledge related to three different topics was required in order to set up Design Requirements and subsequently develop the supporting tool. The main topics that were researched relate to municipalities their deployable instruments, the UAV-GC process, and instruments specifications. For each of the topics, a different Research Question was stated.

First, a research was conducted in order to answer Research Question 1*: Which set of instruments can Dutch municipalities deploy to positively stimulate the implementation of smart solutions in construction logistics in urban confined areas?*' Through the outcome of three sub-researches, an answer to Research Question 1 could be provided.

The answer to the first sub-research question provided, among other things, insight into the level of influence that municipalities have on the implementation of smart solutions that are

implementable by market parties. Through the answer, the extent of the municipalities their influence on the implementation of smart solutions became clear. The smart solutions on which a municipality has a large influence are the HUB, Multi-modal transport and Clustering of personnel. The solution on which a municipality has an average influence is the building innovatively solution. Municipalities have a small influence on the implementation of the four remaining solutions.

Besides the gained knowledge on the level of influence that municipalities have, the answer to the first-research question also provided insight in the applicability of the smart solutions when applied in civil projects. The importance for this relates to the fact that the smart solutions do not originate in the infrastructure sector, but in the utility sector. This is reflected in the conclusion as in five out of eight cases, the implementation of a certain solution in a civil project, provides less reduction of nuisances related to accessibility and liveability than when the same solution would be implemented in a utility project. Conversely, a larger reduction is expected in the case of the Multi-modal transport solution. This has to do with the differences between the types of ordered materials, the way is which the materials can be transported and the quantities in which the materials are transported in both sectors.

When combining the results of the in sub-research question 1 obtained information, the following can be concluded. The most suitable smart solutions, on which municipalities should focus when the stimulation of smart solutions in civil projects is required, are the Hub, Multimodal transport, Building innovatively, and Clustering of personnel transport solutions. This is because these four smart solutions score high/ average on the level of influence that municipalities have on the implementation, and everything except minus on the applicability of the smart solution in civil projects.

Answering the second sub-research question provided insight into the market stakeholders that strongly relate to the implementation of the smart solutions. This investigation showed that the Contractor, Wholesaler, Shipping company, Logistic company, Designer, and IT company have the highest level of influence on the implementation of the most suitable smart solutions in construction logistics. However, as municipalities do not always have the same amount of influence on market stakeholders to stimulate the implementation of smart solutions in construction logistics, it is recommended to focus on the Contractor, Shipping company, Logistic company and Designer. Municipalities generally have the most influence on these four market stakeholders to stimulate the implementation.

The last sub-research question relates to the obstacles and incentives that market parties face when implementing smart solutions in construction logistics. During this research, it was often indicated that one of the main causes of the non-implementation of certain smart solutions relates to the leakage of transparency in transport costs in construction projects. Besides this obstacle, also obstacles that directly relate to the role of municipalities were mentioned, like for example poor maintenance of award criteria.

The last step in answering Research Question 1, consisted of a focus group that collectively searched for the actions and instruments municipalities can take and deploy. The instrument that followed up on the obstacles and incentives derived from market stakeholders and the actions derived from literature are: Procurement, Communication, Policy, Material agency, Contract management, BLVC, and Coordination department.

A research was performed in order to answer Research Question 2: *How does the process of municipalities' UAV-GC procured civil projects look like from the start (initiation phase) to the end (realisation phase)?* This investigation has resulted in a flowchart visualising the process of UAV-GC procured civil projects. The flowchart displays the process that is divided in four phases, being the Initiative phase, Principle phase, Definition & Design phase, and Realisation phase. Each phase again consists of actions that should be taken, documents that need to be submitted, and administrative decisions that have to be made. A total of 20 steps have to be taken in order to go trough the entire procedure.

Finally, a research was carried out in order to answer Research Question 3: *In which way can instruments obtained in Q1 stimulate the implementation of smart solutions in construction logistics in municipalities' own executed UAV-GC procured civil projects*? This to obtain insight into the applicability of the instruments in order to make use of them during the construction of the supporting tool. The research has led to the knowledge of the instruments Procurements & Contract management, Communication, Material agency and BLVC.

The instrument 'Procurement and Contract management' can stimulate the implementation of smart solutions in the following main three ways:

- Use award criteria to stimulate the usage of smart solutions in construction.
- Ensure that sustainability aspects become part of project goals.
- Make sure award criteria are properly monitored during the execution o construction projects.

The instrument 'Communication' can stimulate the implementation of smart solutions in the following two main ways:

- Sharing both positive and negative information related to construction logistics internally.
- Creating more external awareness of construction logistics.

The instrument 'Material agency' can stimulate the implementation of smart solutions in the following way:

- Obliging wholesalers that deliver materials for municipalities to asks for additional costs when the contractor does not order FTL.

Finally, the instrument 'BLVC' can stimulate the implementation of smart solutions in the following two main ways:

- Constructing a BLVC framework in which minimum requirements related to accessibility and liveability during the execution phase can be specified.

- In case of very complex projects that are located in confined urban areas, it is recommended to, in an early stage, take into account the consequences of the solutions that relate to the level of liveability and accessibility during the execution of projects.

By obtaining answers to all three Research Questions, the Design Requirements could be formulated, after which the design process of the supporting tool followed. In total, 40 Design Requirements were stated in the following five categories: Functional, Non-Functional, Input, Appearance, Usage, and Desirable.

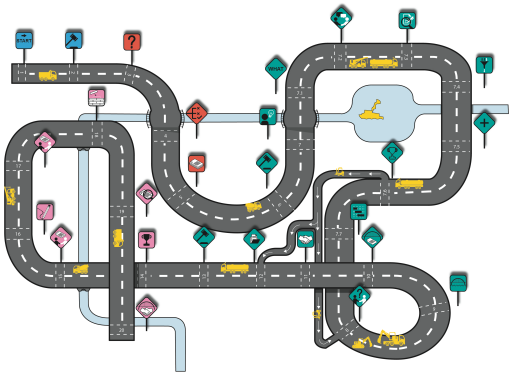


Figure 29: Project Roadmap graphic (own figure)

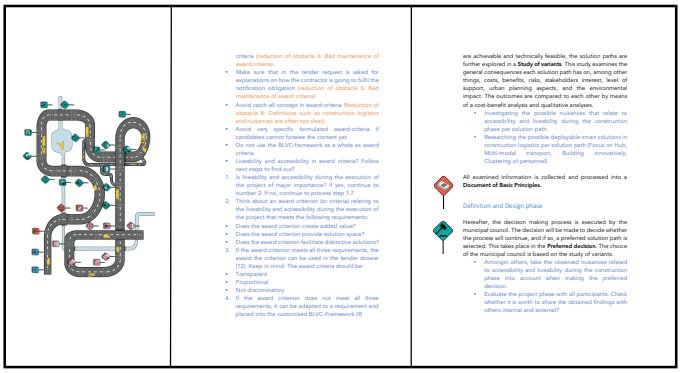


Figure 30: Project Roadmap text (own figure)

The final version of the tool can be considered as a Project Roadmap (Figure 29 and 30). It is presented as a small booklet printed in A5 size. The first page of the booklet shows the content of the Project Roadmap. The booklet is structured in the following order: Introduction, Necessary information, Project Roadmap graphic and text, and Recommendations. The 'Introduction' text reviews the relation between the Project Roadmap booklet and this thesis. The 'Necessary information' discusses the main outcomes of this thesis and ensures all necessary information is provided in order to understand the Project Roadmap text. The Project Roadmap graphic consists of a road with 20 intersections. Each of these intersections represents steps in the UAV-GC procured process of civil structure projects. In addition to the intersections, also icons and numbers are present. The icons represent the actions that take place during each intersection. When the traffic icons are diamond shaped, it means that actions can be taken in order to reduce construction-related nuisances. When the traffic icons are square shaped, it means that no new actions are prescribed during the process step. In this case, only a process step description is present. The numbers correspond to the Project Roadmap text in the main part of the booklet. Herein, each process step is described and where necessary supplemented with new actions. Finally, the Project Roadmap booklet consists of a list of remaining recommendations intended for municipalities.

Based on the evaluation of the Project Roadmap, both participators of the user test grated the appearance of the Project Roadmap with a high mark. Moreover, both participants do think that the supporting tool can indirectly (highly) contribute to a reduction in nuisances related to accessibility and liveability.

Furthermore, the evaluation has outlined that the Project Roadmap satisfies all functional, input, and usability requirements. It also satisfies all non-functional requirements only if the UAV-GC process steps and instrument names are adapted to each individual municipality. In addition, the Project Roadmap satisfies all appearance requirements providing that BLVC is seen as a name instead of an abbreviation. Lastly, the Project Roadmap satisfies about half of the stated desired requirements. However, with little effort the Project Roadmap can satisfy almost all desirable requirements.

In conclusion, after having successfully answered all three Research Questions, it can be said that the developed Project Roadmap responds to the specified Design Statement. This by showing how employees of municipalities that work on the realisation of UAV-GC procured civil works can stimulate market parties to implement smart solutions in construction logistics.

9.2 Discussion

9.2.1 Interpretation

The Project Roadmap can be used by all Dutch municipalities that are facing (or will be facing) accessibility and liveability problems relating to construction projects in confined urban areas. The tool provides guidance to these municipalities, by showing which specific instruments can be used in what specific way and in which specific moment. For a city, as for example Rotterdam, this tool can be very beneficial, as this city has never faced accessibility and liveability problems related to the construction industry up to this moment.

During the research and design process, it has become clear that the municipality of Amsterdam is taking the lead when it comes to the inclusion of smart solutions in construction logistics in their procurement processes. Until now, the municipality of Amsterdam is the only municipality that obliges contracting parties to deliver a BLVC-plan before starting to execute works in the public space. Furthermore, the municipality is already experimenting with accessibility and liveability issues incorporated in award criteria. Therefore, it has been beneficial that the research and design process of this research took place at this municipality.

9.2.2 Limitations

Some design and methodology characteristics occurred that have influence on the interpretation of the findings of the research and design.

- Some of the smart solutions on which the supporting tool is based are not scientifically proven to work solely or in combination with each other. Therefor, there is a chance that the supporting tool needs to be adjusted when more scientifically proven information on the smart solutions in construction logistics is obtained.

- The reader should bear in mind that the study is conducted at the engineering company of the municipality of Amsterdam. Therefore, the project roadmap can consist of terms that are municipality of Amsterdam specific.

- This study is unable to encompass all possible ways in which municipalities can operate to reduce nuisances related to the execution of construction projects. This relates to the scope of this thesis that focuses solely on the execution of civil structure project that are UAV-GC procured by municipalities.

- The obstacles and incentives that were found in Section 4.3 are solely based on seven interviews with six different market stakeholders. Therefor, it can be the case that some of the obstacles and incentives are just mentioned once or contradict to each other.

- The interview sessions that were held in order to formulate the obstacles and incentives that market parties are facing while implementing smart solutions in construction logistics (Section 4.3), did not solely focus on the execution of civil structure projects. Also the obstacles and incentives that market parties face during the execution of utility projects were discussed. This may have led to the inclusion of some obstacles and incentives that are only intended for the execution of utility projects.

- The obtained actions and instruments obtained in Section 4.4 are a result of one single focus group consisting of three participants (excluding the researcher). Additionally, it should be bear in mind that the actions and instruments are directly based on the obstacles and instruments obtained in Section 4.3.

- The retrieved data that relates to the applicability of the six deployable instruments (Section 6.1) is a result of conducting one interview session for each instrument. Therefore, it should be kept in mind that the obtained information relating to each instrument does not contain in-depth research information about the instruments.

9.2.3 Further Research

Further research should be undertaken to explore what municipalities can do to reduce nuisances related to emissions, liveability, and accessibility that are caused by:

- Civil projects that are UAV procured by municipalities.
- Area developments in which, among other things, the role of the municipalities is also to issue land to developers.
- Small renovation and restoration projects that are mostly executed by one-man businesses.

As already mentioned in the limitations, this thesis is partly based on the fact that the smart solutions in construction logistics that are derived from literature and interview sessions, do

contribute to a decrease of certain nuisances. However, this cannot be fully supported due to the low quantities of conducted researches in this field. Further research should be executed to give a clearer view on the advantages, disadvantages, and conditions the smart solutions have solely and in combination with each other. More attention should also be paid to the different outcomes the smart solutions have on the various types of construction projects, such as utility and infrastructure project. In fact, it may be the case that a specific smart solution reduces the amount of transportation drastically for utility projects, but has hardly any effect on infrastructure projects. In further research it could also be useful to explore what the position of municipalities is towards the facilitating of Hubs.

9.3 Recommendations

The following recommendations are obtained during the research and design process of this thesis. The recommendations are divided in three groups. First, recommendations that are intended for municipalities in general. Secondly, recommendations that focus on the content of the Project Roadmap and lastly, recommendations relating to the further development of the Project Roadmap.

Municipalities

- Research has revealed that many Dutch municipalities do not yet make use or are unaware of the possibilities that a BLVC-framework can offer. It is therefore recommended to advertise more on BLVC possibilities.

- During the conduction of the research, several policy actions that municipalities can possibly take were mentioned during the focus group. Unfortunately, the actions are not included as the actions are beyond the scope of this thesis. In order to not disregard the mentioned actions, it is recommended to further research the proposed actions related to policy. The actions relate to taxing transport journeys, providing places in which hubs can be situated, providing places in which transfer from water to roads can take place, facilitating a LOP, establishing a ticket window/ contact person focussing on sustainable ways of city distributors, make the city supplier part of the destination plan, subsidise research, and focus on transportation by boat.

Project Roadmap content

- Investigations have revealed that a large share of the actions that can be taken by municipalities in order to stimulate market parties to implement smart solutions in construction logistics take place during the Definition and Design phase. The recommendation is therefore to focus especially on this phase when stimulation of contractors is required.

- It is observed that the testability of award criteria and requirements are of major importance during the Definition and Design phase. This is because of the level of

verifiability that takes place during the realisation phase. It is therefore recommended to give testability of award criteria and requirements considerable attention during the Definition and Design phase.

- Due to the increasing urbanisation and the added number of complex building projects, the actions that are offered in the Starting point phase will become more important overtime. The importance of taking the consequences that solution paths have on the level of liveability and accessibility during the execution of the projects should therefore increase in the future.

- Project managers working for municipalities are often driven by project goals of which costs and time are the dominant factors. These factors are also the factors of which the project manager is accounted for. In order to stimulate project managers to execute projects in a more sustainable way (of which focusing on a smart logistic execution of the project is part), incentives can be introduced. An example could be receiving extra money for executing a project in a sustainable way.

- Project managers must operate in-between the policy frameworks set by the municipality. By tightening the policy frameworks, project managers are directly confronted with the consequence of having less solution space in which to manoeuvre. In the case of reducing nuisances related to liveability and accessibility it can therefore be intelligent to tighten policy frameworks related to for example environmental zones, requiring usage of HUBs, or taxing transportation by car/truck.

- As a municipality, investigate if mandatory requesting of a 'Bewuste Bouwers' code of conduct can be determined.

- During the conduction of the research, it is noted that most information that is about reducing nuisances and that relates to liveability and accessibility, can almost only be found by individual persons within municipalities. The recommendation is therefore to invest more in internal communication to ensure the knowledge is shared between all employees. Among other things, this could be done by introducing a database in which all EMVI-criteria can be found and in which can be searched for specific themes.

Further development of Project Roadmap

- It is advised to provide a Dutch version of the tool as this will enable more people to make use of the Project Roadmap.

- It is recommended to develop a version of the Project Roadmap that suits online usage. This will ensure that more municipalities will discover the Project Roadmap.

- It is recommended to keep supplementing the Project Roadmap with the latest information concerning municipalities its deployable instruments and smart solution in construction logistics in urban confined areas.

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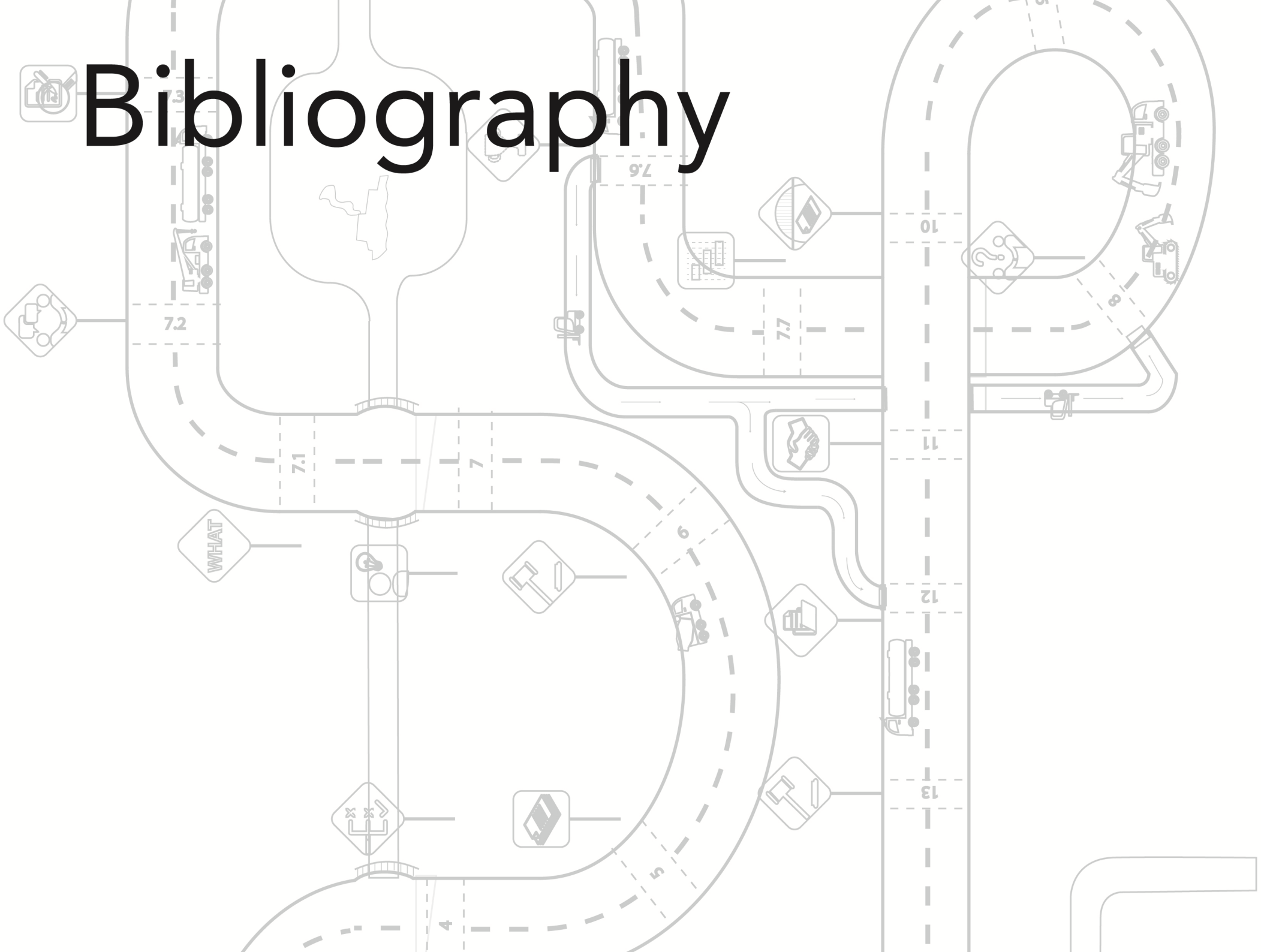

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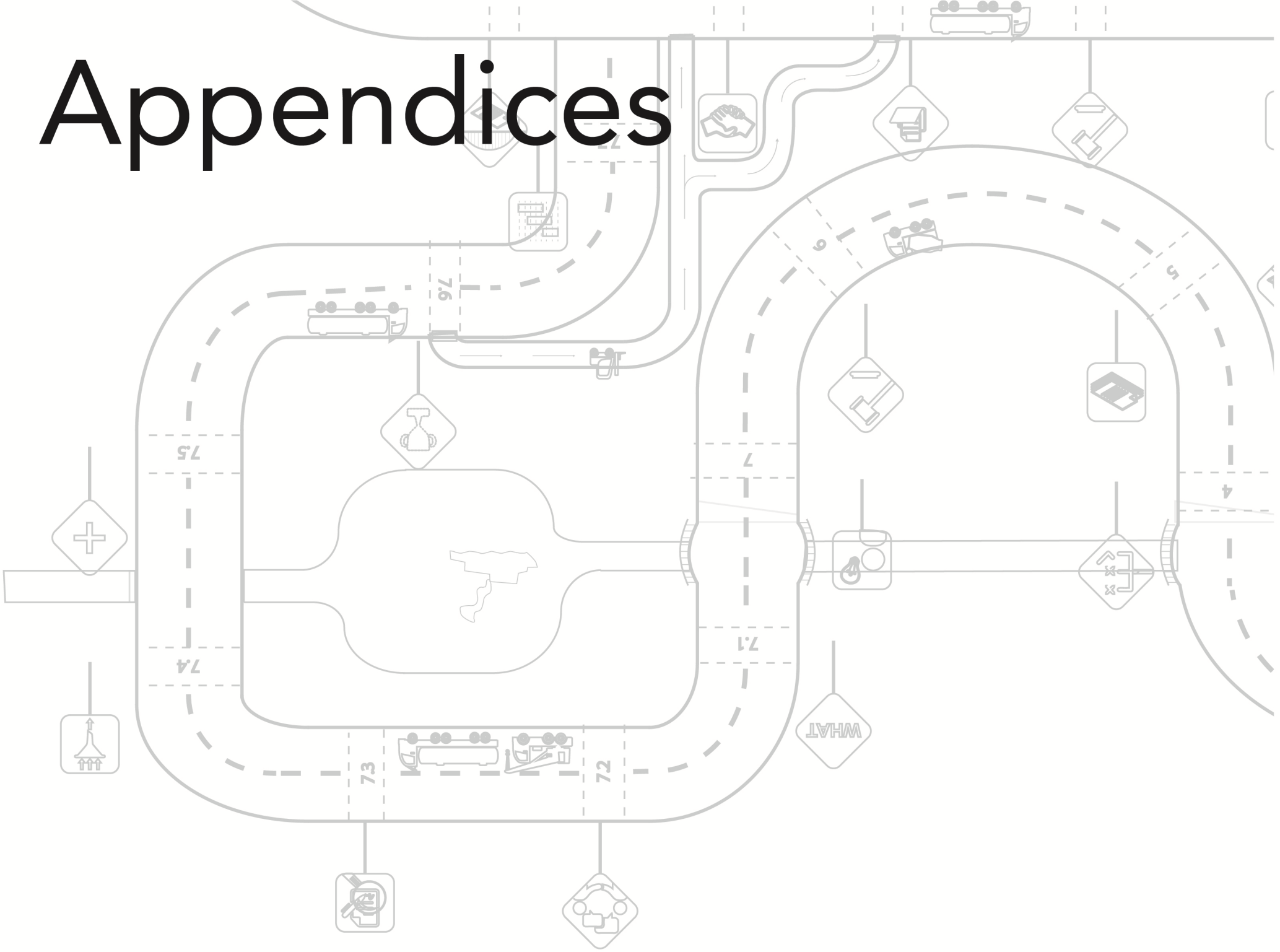
Appendices



Appendix A

A.1 List of all interviewees

Appendix B

B.1 Semi-structured interview guide stakeholders

Interview guide Searching for market stakeholder

Doel: Het inzicht krijgen in welke Stakeholders gerelateerd zijn aan slimme oplossingen in bouwlogistiek

1. **Introductie**
- Interviewer
- Geïnterviewde
- Uitleggen onderzoek

2. **Slimme oplossingen in bouwlogistiek uitleggen**
- HUB
- Multimodaal transport
- Slim bouwen
- Clusteren van personeelstransport

3. **Welke marktpartijen zijn daaraan gerelateerd?**

Stakeholders
Contractor
Transporter
Wholesaler
Manufacturer
Shipping company
Designer

B.2 Substantiation of level of influence on implementation of market stakeholders

Market stakeholder	Hub	Substantive explanation
Contractor	++	The contractor has a large influence on the implementations of the Hub since the contractor is the main stakeholder deciding weather the HUB solution is implemented within the project or not. The contractor is also the stakeholder that is mainly paying for the HUB solution to be in operation
Sub-contractor	+	The sub-contractor has some influence on the implementation of the HUB solution since the Sub-contractor also partly pays for the HUB solution to be in operation. This is because also his materials first need to be brought to the HUB space after which it is brought to the construction site.
Freelancer	-	As freelancers are mainly hired to work for the main contractor or sub-contractor it has no influence on the introduction of the HUB solution in the contractor its projects
Wholesaler/ Supplier	+	In civil project Wholesalers/ suppliers have some influence on the implementation of the HUB solution since Wholesalers and suppliers are the stakeholder that should deliver their materials in a different way than they normally do. In the utility sector the influence of the Wholesaler is much higher.
Producer/ Manufacturer	+	In civil project Producers/Manufacturers have some influence on the implementation of the HUB solution since Producers/ Manufacturers are the stakeholder that should deliver their materials in a different way than they normally do.
Transport company	+	In civil project Wholesalers/ suppliers have some influence on the implementation of the HUB solution since Wholesalers and suppliers are the stakeholder that should deliver their materials in a different way than they normally do.
Waste processor	-	Waste processors have nothing to do with the implementation of the HUB solution as the interfaces between a waste processor and the HUB solution are of minimal value
Shipping company	-	Shipping companies have nothing to do with the implementation of the HUB solution as the interfaces between a shipping company and the HUB solution are of minimal value. In case the HUB location is located by the water, the influence is higher)
Recycling company	-	Recycling companies have nothing to do with the implementation of the HUB solution as the interfaces between a recycling company and the HUB solution are not present
Logistic company	++	Logistic companies have a large influence on the implementation possibilities of the HUB solution. The solution requires logistic knowledge in order to be able to operate satisfactory.
IT company	++	IT companies have a large influence on the implementation possibilities of the HUB solution as the HUB solution requires sufficient IT programs (such as Building Information Model) in order to be able to operate satisfactory.
Designer (Structural engineer/ Architect)	-	Designers have nothing to do with the implementation of the HUB solution as the interfaces between a designer and the HUB solution are of minimal value
Advisor (Engineer)	+	In civil project advisers have some influence on the implementation of the HUB solution since advisor can be deployed to for example give advise about the usage of the hub solution
Research company	-	Research companies do not have any direct influence on the implementation of a HUB. However, the obtained research results can indirectly contribute to the usage of a HUB

Market stakeholder	Multimodal transport	Substantive explanation
Contractor	++	The contractor has a large influence on the implementations of Multi-modal transport since contractors In the GWW sector do often also act as a supplier of materials.
Sub-Contractor	+	The sub-contractor has some influence on the implementation of the HUB solution since also Sub-contractors its needed materials need to be shipped.
Freelancer	-	As freelancers are mainly hired to work for the main contractor or sub-contractor it has no influence on the implementation of the Multi-modal solution in the contractor its projects
Wholesaler/ supplier	++	Wholesalers have a large influence on the implementation of multi-modal transport as wholesalers their materials need to be shipped.
Producer/ Manufacturer	+	Producers/manufacturers have some influence on the implementation as their materials are sometimes directly brought to the construction site. More often, their product are brought to the construction site through wholesalers.
Transport company	+	Transport companies have some influence on the implementation as also transport companies have to cooperate with shipping companies in order to let multi-modal transport work
Waste processor	-	Waste processors have nothing to do with the implementation of multi-modal transport. It is only possible that multi-modal transport is deployed in order to dispose waste.
Shipping company	++	Without shipping companies this type of solutions would not even be possible. Ships are needed in order to transport materials over water.
Recycling company	-	Recycling companies have nothing to do with the implementation of multi-modal transport as the interfaces between a recycling company and the HUB solution are not present
Logistic company	+	Logistic companies have some influence on the implementation possibilities of multi-modal transport as little knowledge in logistics is useful when two modes of transport have to cooperate.
IT company	-	IT companies have nothing to do with the implementation of multi-modal transport as the interfaces between an IT company and the multi-modal transport solution are not present
Designer (Structural engineer/ Architect)	-	Designers have nothing to do with the implementation of multi-modal transport as the interfaces between Designers and multi-modal transport solution are not present
Advisor (Engineer)	+	Advisors have some influence on the implementation of the multi-modal transport solution since advisor can be deployed to for example calculate weather it is beneficial to implement multi-modal transport in projects.
Research company	-	Research companies do not have any direct influence on the implementation of a Multi-modal transport. However, the obtained research results can indirectly contribute to the usage of multi-modal transport

Market stakeholder	Building innovatively	Substantive explanation
Contractor	++	The contractor has a large influence on the implementations of Building innovatively as the contractor more often cooperates in design tenders with Design companies. Besides this, big contracting companies are often working on new innovative techniques such as 3Dprinting and Prefabbing.
Sub-Contractor	+	Sub-contractors have some influence on the implementation of 'Building innovatively' as also sub-contractors participate in design tenders. Besides this, they also participate in projects in which smart building techniques are applied.
Freelancer	+	Freelancers have some influence on the implementation of 'Building innovatively' as freelancers also participate in projects in which smart building techniques are applied.
Wholesaler/ supplier	+	Wholesalers have some influence on innovative building as they often provide already prefabbed components.
Producer/ Manufacturer	-	Producer/ Manufacturer have nothing to do with Building innovatively as Producer/ Manufacturers only provide rough materials such as sand, steel and stones
Transport company	-	Transport companies have nothing to do with the implementation of Building innovatively as the interfaces between Transport companies and building innovatively are not present
Waste processor	-	Waste processors nothing to do with the implementation of Building innovatively as the interfaces between Waste processors and building innovatively are not present
Shipping company	-	Shipping companies have nothing to do with the implementation of Building innovatively as the interfaces between Shipping companies and building innovatively are not present
Recycling company	-	Recycling companies have nothing to do with the implementation of Building innovatively as the interfaces between Recycling companies and building innovatively are not present
Logistic company	-	Logistic companies have nothing to do with the implementation of Building innovatively as the interfaces between Logistics companies and building innovatively are not present
IT company	+	IT companies have some influence on the implementation of building innovatively as some programs, such as grasshopper and Rhino can contribute to the prefabrication possibility of construction works.
Designer (Structural engineer/ Architect)	++	The Designers have a high level of influence on the implementation of building innovatively, as the architect and structural engineers must consider the innovative ideas
Advisor (Engineer)	+	Advisers have some influence on the implementation of the Building innovatively solution since advisors can be deployed to assist in finding new innovative construction methods
Research company	-	Research companies do not have any direct influence on the implementation of Building innovatively. However, the obtained research results can indirectly contribute to the usage of Building innovatively

Market stakeholder	Clustering of personnel transport	Substantive explanation
Contractor	++	Contractors have a high level of influence on the implementation of clustering of personnel as the contractor fully decides weather to implement the solutions or not. For sure, the clustering of personnel has a very high impact on the sub-contractors its employees.
Sub-Contractor	+	Sub-contractors have some influence on the implementation of the clustering of personnel as they decide weather they want to participate in projects in which this solution is applied. For sure, the clustering of personnel has a very high impact on the sub-contractors its employees.
Freelancer	-	As freelancers are mainly hired to work for the main contractor or sub-contractor a freelancer has no influence on the implementation of the clustering of personnel solution in the contractor its projects. In contrast, the freelancer will be effected when the solutions is implemented.
Wholesaler/ supplier	-	Wholesalers/ suppliers have nothing to do with the implementation of Clustering of Personnel transport as the interfaces between Wholesalers/ suppliers and Clustering of Personnel transport are not present
Producer/ Manufacturer	-	Producer/ Manufacturer companies have nothing to do with the implementation of Clustering of Personnel transport as the interfaces between Producer/ Manufacturer companies and Clustering of Personnel transport are not present
Transport company	-	Transport companies have nothing to do with the implementation of Clustering of Personnel transport as the interfaces between Transport companies and Clustering of Personnel transport are not present
Waste processor	-	Waste processors have nothing to do with the implementation of Clustering of Personnel transport as the interfaces between Waste processors and Clustering of Personnel transport are not present
Shipping company	-	Shipping companies have nothing to do with the implementation of Clustering of Personnel transport as the interfaces between Shipping companies and Clustering of Personnel transport are not present
Recycling company	-	Recycling companies have nothing to do with the implementation of Clustering of Personnel transport as the interfaces between Recycling companies and Clustering of Personnel transport are not present
Logistic company	+	Logistic companies have some influence on the implementation of the smart solution as
IT company	-	Logistic companies have some influence on the implementation possibilities of Clustering of personnel as little knowledge in logistics is useful when the clustering of personnel solution is executed in projects.
Designer (Structural engineer/ Architect)	-	Designers have nothing to do with the implementation of Clustering of Personnel transport as the interfaces between Designers and Clustering of Personnel transport are not present
Advisor (Engineer)	+	Advisers have some influence on the implementation of the Clustering of personnel solutions since advisors can be deployed to calculate what the best clustering options are in projects.
Research company	-	Research companies do not have any direct influence on the implementation of Clustering of personnel. However, the obtained research results can indirectly contribute to the usage of Clustering of personnel.

Interview guide Obstacles & incentives

Algemeen:
- Uitleg bedrijf
- Hoe wordt de bouwlogistiek binnen dit bedrijf vandaag de dag geregeld?
- Gaat dit bedrijf er nu anders mee om dan een aantal jaren gelen (5, 10, 15)?
- Wat is de reden van het wel/ niet implementeren van innovatievere oplossingen in de bouwlogistiek?

Per Stakeholder

1. Welke obstakels komen jullie tegen die het toepassen van innovatieve oplossingen tegen werken?

Obstakels algemeen
- Intern (bedrijfsvoering)
- Extern (Kartel)

Obstakels vanuit gemeente, provincie, rijk

2. Welke stimulansen kunnen het stimuleren van innovatieve oplossing in de bouwlogistiek behelpen?

Stimulansen algemeen
- Intern (toegevoegde waarde bedrijf)
- Extern (toegevoegde waarde sector)

Stimulansen gemeente, provincie, rijk

Per Innovatieve oplossing in de bouwlogistiek

I. HUB II. Multi-modal transport III. Building innovatively IV. Clustering of personnel

B.4 Results of interview sessions with stakeholders

Contractor
Wholesaler
Shipping company
Logistic company
IT Company
Designer
Contractor

General obstakels/ stimulansen Stakeholder

Obstakels

1. Opdrachtgever bepaald zelf in welke mate hij duurzaamheid op de kaart heeft staan (bijv. BREEAM of lean). De opdrachtgever is toch uiteindelijk degene die betaald. Dit werkt door in de aandacht die de aannemer aan duurzaamheid (bouwlogistieke innovaties) besteed.
2. Leveranciers leveren Franco, wat betekend dat er een nettoprijs wordt gevraagd en dat de bijkomende kosten daaronder vallen. Er is geen transparantie in de transportkosten en administratiekosten.
3. Leveranciers durven hun kosten niet transparant te maken omdat de bang zijn hun marktpositie kwijt te raken, en ook dat ze dan niet meer worden gevraagd om te leveren buiten hun regio. De transportkosten zullen dan hoger uitvallen en dan is de leverancier minder aantrekkelijk voor bedrijven ver in het land.
4. Aannemer wordt op deze manier niet aangemoedigd om na te denken over zijn bestel gedrag. 2 x 100 buizen bestellen is even duur als 20 x 10 buizen (ongeveer, want er gaan soms wel kortingen overheen bij grote hoeveelheden).
5. Winstverdeling. Bij implementeren van slimme bouwlogistieke oplossingen zal de vraag zijn wie er dan met de winsten vandoor gaat.
6. Steeds kortere bestel tijden. Hoe korter de bestel tijd is van materialen (voor 12 uur bestellen is morgen leveren) kan er bijna niks meer goed worden georganiseerd.
7. Mindset van bouwbedrijven, altijd interessant voor score bij de EMVI, maar daarna bij de uitvoering zijn andere mensen en die zegt sorry ik ga voor de voor mij betrouwbare ouderwetse wijze mijn werkzaamheden uitvoeren.
8. Transportprijzen zijn nu niet transparant. Bedrijven hebben geen inzicht in hun transportkosten. Alles wat dus additioneel erbij komt zijn extra kosten.
9. Scoren bij de EMVI maar daarna geen handhaving of het wel daadwerkelijk gebeurt. Bestek directie UAV. Deels bouwbedrijf deel opdrachtgever en die zouden bepaalde controle momenten en eventuele handhaving moeten instellen. Dat gebeurt eigenlijk nooit.
10. Ligplaats vergunning krijgen heel moeilijk. (Nodig voor een exploitatievergunning). Zoek het maar uit! Al de plaatsen die eventueel mogelijk zijn staan in een bestemmingsplan beschreven en in dat bestemmingsplan staan geen ligplaatsen voor citysuppliers beschreven. Te weinig plek, er wordt geen voorrang gegeven.
11. Van natte naar droge, waternet is natte gedeelte. Op alle rakken daar liggen aanmeer plekken voor personen en voor vrachtvervoer. Voorkomt dat je over woonboten en plezierboten moet hijsen. Rakken perfect. Op de landzijde staat dan alleen een boom, een bord vol met fietsenrekken. Maar weinig plekken waar en een ligplaats is en ruimte is om te laden en te lossen.
12. Stadsdelen zijn niet geïnteresseerd, geen prioriteit om iets aan die droge kant te veranderen zodat vrachtverkeer over water beter mogelijk gaat worden.
13. Ivesteringen zijn heel hoog om elektrisch te gaan rijden. En de accucapaciteit is nog niet groot genoeg.
14. Het kapstok begrip logistiek: aantal gesprekken nodig om over hetzelfde begrip bouwlogistiek te spreken. Iedereen denkt er wat anders over. Met opstellen van offertes heel moeilijk tot de essentie komen. Verkeerde gronden geselecteerd worden.
15. In BREAAM wordt weinig aandacht gegeven aan bouwlogistiek. Ze kunnen het niet kwantificeren omdat er geen data over is.
16. In alleen ontwerp aanbestedingen staat nooit wat over bouwlogistiek
17. Vooral een sociale omslag nodig binnen bouwbedrijven
18. Een contract moet een middel zijn en niet een doel. (VB. Soms is flexibiliteit nodig om hoogste doel te bereiken.
19. Moeilijk om vergunningen te krijgen, allemaal eigen Keizerrijkjes
20. BLVC is niet het EI van Columbus als het gaat om het stimuleren van Bouwlogistieke innovaties.
21. Leverancier geeft nog geen vergoeding bij het afleveren bij een HUB i.p.v. bij de projectlocatie.

Stimulansen

A. Transparantie en vertrouwen. Met het transparant maken van de kosten (elke actor) en veel meer vertrouwen in elkaar zou de keten een stuk goedkoper en slimmer zijn.
B. Consequenties aannemer. De aannemer moet de consequenties van slecht gedrag (laat en kleine porties bestellen) gaan voelen.
C. Transport met een boot kan veel meer lading vervoeren dan per vrachtwagen in binnensteden
D. Wanneer op de boot een takelkraan aanwezig is kan er zonder overslagpunt een overslag plaatsvinden.
E. Plekken waar echt geen ruimte is om het transport via de weg te doen en wel aan het water liggen kunnen wel worden voorzien van materiaal aan en afvoer.
F. Tevreden over Waternet (natte zijde).
G. Handhaven of EMVI-criteria wel in de werkelijkheid worden toegepast.
H. Loket in Amsterdam om unieke manieren van duurzaamheid een plek te geven. Een coördinatiepunt voor de interne afstemming. Dwarsdoorsnede van Gemeente Amsterdam (Stadsdelen, waternet etc.). Zodat de vragen die je neerlegt niet eerst bij waternet (natte zijde), Gemeente Amsterdam (droge zijde) enzovoorts hoeft neerteleggen. Bedoelt voor mensen die vrachtvervoer over water mogelijk willen gaan maken.
I. Laad/los plekken op de weg worden samengevoegd met aanmeerplaatsen (rakken) op het water.
J. Subsidie geven aan onderzoeken naar ontwikkeling. Help start-ups (locatie, kennis etc.)
K. Leveranciers zouden kosten inzichtelijk moeten maken.
L. Optimaal als werknemers ook niet meer franco gaan werken maar dat alle kosten uit elkaar worden getrokken.
M. Standaardisatie van het begrip bouwlogistiek. Dat duidelijker is wat de uitvraag is. Wat is hun bril vanuit logistiek. Dat het mogelijk is om aanvragen te vergelijken. Protocol?
N. Vaststellen van wat is overlast
O. Bouwfaseringsplan – begin. Vraag in je tenderfase welke hoofdfaseringsstappen ga jij doen om tot een product te komen en hoe ziet jouw logistiek er dan uit. Onder logistiek verstaan wij dit en … kwantificeren.
P. Goed controleren en terug meldingsplicht.
Q. Prestatieladder initiëren > logistieke ladder met certificeringen. Neutraal beoordeling team. Zoals BREAAM en CO2 prestatieladders. Breder dan alleen bouw.
R. Het uit elkaar halen van de franco kosten van een werknemer. Alleen betalen voor de dienst die uitgevoerd wordt en niet het materiaal en gereedschap. Kosten uit elkaar trekken.
S. Veel aannemers in de Cobouw 50 zijn allemaal bezig met innovaties.
T. Alle projecten vanuit de Gemeente BREAAM aanbesteden
U. BREAAM aanbesteden genereerd data over onder andere CO2-uitstoot
V. Door aan te besteden in een bouwtender wordt er geïntegreerde gewerkt en al vanaf het begin nagedacht over de meest logische opbouw van het project.
W. Veel minder faalkosten bij een bouwtender
X. Er zal een overkoepelend orgaan moeten komen die de hele (bouw)logistiek in de stad regelt en aanstuurt.
Y. Evaluatie momenten in contract inbouwen om slimmere oplossingen een kans te geven.
Z. EMVI-criteria is een goed middel om bouwlogistieke innovaties te stimuleren

Obstakels/ stimulansen per oplossingstype

Obstakels

1. **HUB**

i. Hub niet lucratief voor veel materialen die lang en of gekke vormen hebben. En ook voor volle vrachten niet met zand, gips of andere grote porties.
ii. Loont niet genoeg voor onderaannemers, elke onderaannemer moet dan los worden gecontacteerd om dit te gebruiken. Moeilijk hen mee te krijgen.
iii. Een extra overslag doen
iv. Vroeger betalen
v. Heel moeilijk verdienmodel om HUB/ LOP draaiende te houden.
vi. Beste Locatie van HUB verandert elke keer weer bij groei van de stad en per project.
vii. Niet genoeg ruimte in stad wordt gereserveerd voor een hub. Steeds meer wordt de industrie naar de buitenranden verdreven en dit zal ervoor zorgen dat de Hub te ver van de project locatie is gesitueerd dat Just in time leveren niet meer mogelijk is.
viii. De locatie van een vast LOP zit nooit op een goede locatie. Lage bezettingsgraad.

ix. Het initiëren van een LOP/HUB vanuit gemeentes. Haalt de creativiteit en optimalisatie uit het bouwproces. Eigenlijk is een HUB waste in lean termen, en dat ga je dan ook nog eens faciliteren. Het zou meteen naar de bouwplaats moeten.
x. Kosten van Hub zijn expliciet. Huren, transport apart regelen, mensen die dingen oppakken en verplaatsen.
xi. Baten worden onvoldoende geoogst.
xii. Faalkosten zijn niet expliciet zichtbaar omdat ze mee worden gecalculeerd met totale bouwsom.
xiii. Hub alleen rendabel bij het koppelen van projecten of hele grote projecten.
xiv. Huren van een Hubruimte alleen 'betaalbaar' bij projecten boven de 100 miljoen.
xv. Moeilijk om een goede locatie te vinden die dichtbij de project locatie ligt en dicht bij de snelweg
xvi. Hub kosten zijn additionele kosten geld
xvii. Volume van GWW-projecten zijn vaak te klein om de extra kosten terug te verdienen

2. **Multi-modal transport**

xviii. Omdat er nu nog nauwelijks HUBs zijn, is het vaak niet mogelijk met de boot een projectlocatie te bereiken en wordt het vervoer toch per vrachtwagen gedaan.
xix. Magazijnen hebben nu voornamelijk een goede weg aansluitingen i.p.v. ligging aan water.
xx. De leveringen van fabrikant naar leverancier worden ook steeds kleiner, wat ervoor zorgt dat er ook steeds minder vervoer over water plaats vindt.
xxi. Niemand wil voorraden hebben tegenwoordig. Voorraad moet uit de keten.
xxii. Er is altijd een overslagpunt nodig en de kosten die daarbij komen kijken zijn additioneel.
xxiii. Vraagt om investering, en geen garantie dat het wat gaat opleveren. Speciaal type boot.

3. **Building innovatively**

xxiv. Prefabben ook risico, want als er wijzigingen zijn is alle moeite voor niks geweest. Vanaf nieuwbouw bouwen is het risico minder, bij renovatie groter risico.
xxv. Altijd weinig tijd aan de voorkant.
xxvi. In aanbestedingen wordt niet aangemoedigd om meer gebruik te maken van prefab onderdelen.
xxvii. Ligt elke keer weer anders of het Prefabriceren van bouwonderdelen handig of niet is.

4. **Clustering of personnel**

xxviii. Er zullen altijd uitzonderingen gemaakt moeten voor onderaannemers/ freelancers die met speciale materialen naar het werk komen. Alle werknemers geclusterd naar de bouwplaats laten komen gaat niet lukken.
xxix. Moeilijk om goede plekken te vinden om te parkeren (P&R). Dwingen bij onderaannemer, die gaat uiteindelijk afprijzen. Afdwingen.
xxx. Het moet een continue dienst zijn want anders haken mensen af.
xxxi. Gereedschap is niet altijd aanwezig, uitdaging voor een vakman. Wel bij repeterend werk.
xxxii. Pendelbus is niet voor elke werknemer in de goede richting. Bij een pendelbus zouden er meer bussen vanaf verschillende plekken moeten gaan rijden.
xxxiii. Verplicht carpoolen → hele lage reducties die je daar me haalt.
xxxiv. Vooral een sociale omslag nodig
xxxv. Niet voor alle werknemers handig om op een bepaald punt te clusteren i.v.m. de ligging van de projectlocatie.

Stimulansen

1. **HUB**

a) Gemeente besteed een LOP of HUB uit, en subsidieert. Uitvoeder wordt betaald door de gemeente.
b) Mogelijk maken van terreinen waar HUBS op gesitueerd kunnen worden
c) Mogelijk maken van strategische LOP. Taak van overheid. Voor iedereen toegankelijk. Beheer en controle kan worden uitgevoerd door marktpartij (Per uur betalen, per ruimte die je huurt, per kade stuk dat je gebruikt).
d) Het initiëren van een LOP/HUB vanuit gemeentes. Haalt de creativiteit en optimalisatie uit het bouwproces. Eigenlijk is een HUB waste in lean termen, en dat ga je dan ook nog eens faciliteren. Het zou meteen naar de bouwplaats moeten. Het zou wel kunnen voor een aantal jaar om een positief effect af te geven. Stimuleren om investeringskosten laag te houden.
e) LOP. Subsidiëren vanuit gemeente. Social Return inzetten. Soort werkplaats. Waarde toevoegen zoals zagen van hout, vervolgens naar bouw. Bij inschrijven staat dat er voor een bepaald deel van de aanneemsom gebruik moet worden gemaakt van een HUB, niet voor beton maar wel voor de afbouwfase.
f) Transport door een extern transportbedrijf of het zit vast aan de HUB
g) Degene die het transport van de hub naar de bouwplaatsen doet wil zoveel mogelijk leveringen bundelen om zo de meeste winst te kunnen maken.
h) Betalen van de handling van een palletplaat. Afwijkende materialen worden verrekend naar een paletplaat.

i) Gemeente zou LOP moeten initiëren op strategische punten in de stad
j) Helpen bij het zoeken voor HUB – Ruimtes

2. Multi-modal transport
k) Meer HUBS/ LOPS bouwen.
l) Voor leverancier is het leveren van materialen per boot naar een HUB heel erg interessant. Kosten zullen hierdoor dalen.
m) Mogelijk maken van terreinen aan de rand van de stad waar overslag kan plaats vinden om de materialen die over water worden geleverd op te slaan en verder te vervoeren.

3. Building innovatively
n) Bijna alle leidingsystemen worden al geprefabed.
o) Overheid als opdrachtgever in aanbestedingen focussen op Prefab gebouwen. In ontwerp daar al over nadenken. Misschien zelfs het aangeven van hoeveel ritten nodig zijn.
p) In aanbestedingen, architecten meer sturen voor prefab oplossingen.
q) In aanbestedingen, architecten meer sturen voor 3D-oplossingen.
r) Meer tijd geven in het uitdenken
s) Zelf onderdelen printen (bijv. deurknoppen) komt er wel snel aan.

4. Clustering of personnel
t) Speciale Ov-kaart regelen vanuit gemeente, zodat alle bouwvakker met het ov gaan.
u) Carpoolen.

B.5 Obstacles/ incentives per most suitable smart solution in construction logistics

Obstacles per best practise	
1. HUB	
i.	Not useable for materials with strange forms and full load portions
ii.	Not lucrative for subcontractors
iii.	Extra trans-shipment
iv.	Earlier payment
v.	Difficult revenue model to let HUB/LOP operating
vi.	Location of HUB changes for each new project
vii./viii.	Not enough space is available to situate an HUB
ix.	Facilitating a LOP takes out the creativity of the building process
x./xvi.	Cost of HUB/LOB are explicit costs
xi.	Benefits will be insufficiently harvested
xii.	Failure costs are not explicitly visible
xiii.	HUB only profitable when linking with different projects
xiv.	Renting HUB space only profitable when project costs are above 100m
xv.	Hard to find a good location close to the project location and highway
xvii.	Volume of GWW projects are often to small to earn back the costs
2. Multi-modal transport	
xviii.	Because of the lack of HUBs is it often impossible to reach project site by boat and is chosen to do everything by truck
xix.	Stockrooms are nowadays located close to highways in stead of rivers
xx.	Deliveries send by manufacturers to wholesalers become smaller and smaller, which results in less traffic over water.
xxi.	No party want to have stock nowadays
xxii.	Extra transfer is necessary which results in additional costs
xxiii.	Requires extra investments without knowing what it will bring
3. Building innovatively	
xxiv.	There is a chance that there will be changes in the project, a risk to prefab. Especially when renovating
xxv.	Little time upfront building projects
xxvi.	Tenders do not encourage to work with prefab parts
xxvii.	Sometimes prefabbing is useful, sometimes it is not
4. Personnel Transport	
xxviii.	Exceptions always have to be made for subcontractors/freelancers that come to work with special materials/ tools
xxix.	Very hard to find good places to park (P&R)
xxx.	It should be a continuous shuttle service, otherwise will people quit
xxxi.	Tools are not always present. Challenge for professionals
xxxii./ xxxv.	Start location of shuttle bus is not in the good direction for all employees
xxxiii.	Not much reductions to win if obliging carpooling
xxxiv.	A social change is necessary within contracting companies

Incentives per smart solution	
1. HUB	
a/c/d/e/i	Municipality facilitates a LOP (by using social return)

b/j	Providing places upon which HUBs can be situated
f	Transport by separate company or connected to the HUB facilitator
g	Transporter of the last mile wants to bundle as much as possible in truck
h	Calculate odd sizes to pallet size
2. Multi-modal transport	
k	More HUB/LOPs
l	Very interesting for wholesaler. Reduction in costs
m	Providing places in which transfer from water to roads can take place.
3. Building innovatively	
n	All piping systems are already prefabbed nowadays
o/p/q	In tendering phase, more focus should go to prefabrication & 3D printing (Designer & Contractor)
r	More time upfront
s	On location 3-Printing of small objects, such as door handles, will come soon
4. Personnel Transport	
t	Introducing special OV-card by municipalities
u	Carpooling

Appendix C

C.1 Semi structured Interview guide

Interview guide Project managers & Strategic/ Purchasing advisor

1. **Introduction**
- Explanation project

2. **PBI Document**
- Explanation map (Plan- en besluitvormingsproces Infrastructuur (PBI))
- Example Infrastructure project
- Shortcomings

3. **Similarities between AUV and UAV-GC procedure**
- Which UAV-steps correspond to UAV-GC process steps
- Which UAV-GC steps deviate from UAV-GC process steps

4. **Design requirements**
- When does a supporting tool helps you?
- What information is necessary?
- Which tool are you using? And why?
- Which requirements relating to appearance does the supporting tool needs to satisfy?
- Which requirements relating to usability does the supporting tool needs to satisfy?

Appendix D

D.1 Semi-structured interview guide

Interview guide Instrument specialists

1. **Explanation research so far**

2. **Flowchart of UAV-GC procured infrastructure projects**
- Explanation of UAV-GC flowchart

3. **Instruments**
- Possibilities → What is possible?
  Project/ Policy?
  Examples?
- Restrictions → What is needed?
  Examples?
- Conditions → ?

4. **When in time?**

5. **Obstacles/ Incentives/ Actions**

Procurement	→	Appendix D.2
Communication	→	Appendix D.3
Material agency	→	Appendix D.4
Contract management	→	Appendix D.5
BLVC	→	Appendix D.6
Coordination department	→	Appendix D.7

D.2 Procurement

Instrument	Obstacle		Incentive		What to do?	
Procurement	1	Client is dominating in choice of sustainable goals			1.1	Focussing on sustainable execution of projects (BREAAM, lean) in own projects
	4/6	Contractor should feel consequence of ordering in small amounts	B	Contractor should feel consequence of ordering in small amounts	4.3	Tendering BREAAM, Lean
	9	Not good maintenance of EMVI-criteria	G&P	Maintain if EMVI-criteria are executed & setup up a notification obligation	9.2	Introducing notification obligation
	15	No quantitative data available building logistics (Emissions, CO2)	T&U	Tender only BREAAM/lean projects (helps to collect data concerning emissions)	15.1	Focussing on sustainable execution of projects (BREAAM, lean) in own projects to obtain more data
	16	Nothing about building logistics is asked for in design tender			16.1	Inclusion of a building logistics category in design tenders.
	22		O	Ask for Construction phasing plan in tender	22.1	Develop definitions of nuisance
					IV.	usage of selection criteria during the tendering phase.
					•	inclusion of criteria related to building logistics in both program requirements and award criteria.

D.3 Communication

Instrument	Obstacle		Incentive		What to do?	
Communication	7	The Mind-set of contractors			7.1	Showing projects in which smart solutions in building logistics are executed well.
	12	A lack of interest by city districts			12.1	Encouraging the importance of smart solution in building logistics

D.4 Material agency

Instrument	Obstacle		Incentive		What to do?	
Material agency	2/3/8	Leakage of transparency in transport cost	A,K & R	More transparency in cost and more trust in each other	2.1	Setting the right example as municipality in transparency of transport costs
	5	Difficulty in fair profit distribution when implementing BP			5.1	Focussing on transparency in cost and more trust in each other
	20		L/R	Optimal if employees breakdown their cost (Stop working Franco)	20.1	Setting the right example as municipality in transparency of transport costs

D.5 Contract management

Instrument	Obstacle		Incentive			What to do?
Maintenance Department	9	Not good maintenance of EMVI-criteria	G&P	Maintain if EMVI-criteria are executed & setup up a notification obligation	9.3	Better maintenance of EMVI-criteria and/ or BLVC-framework

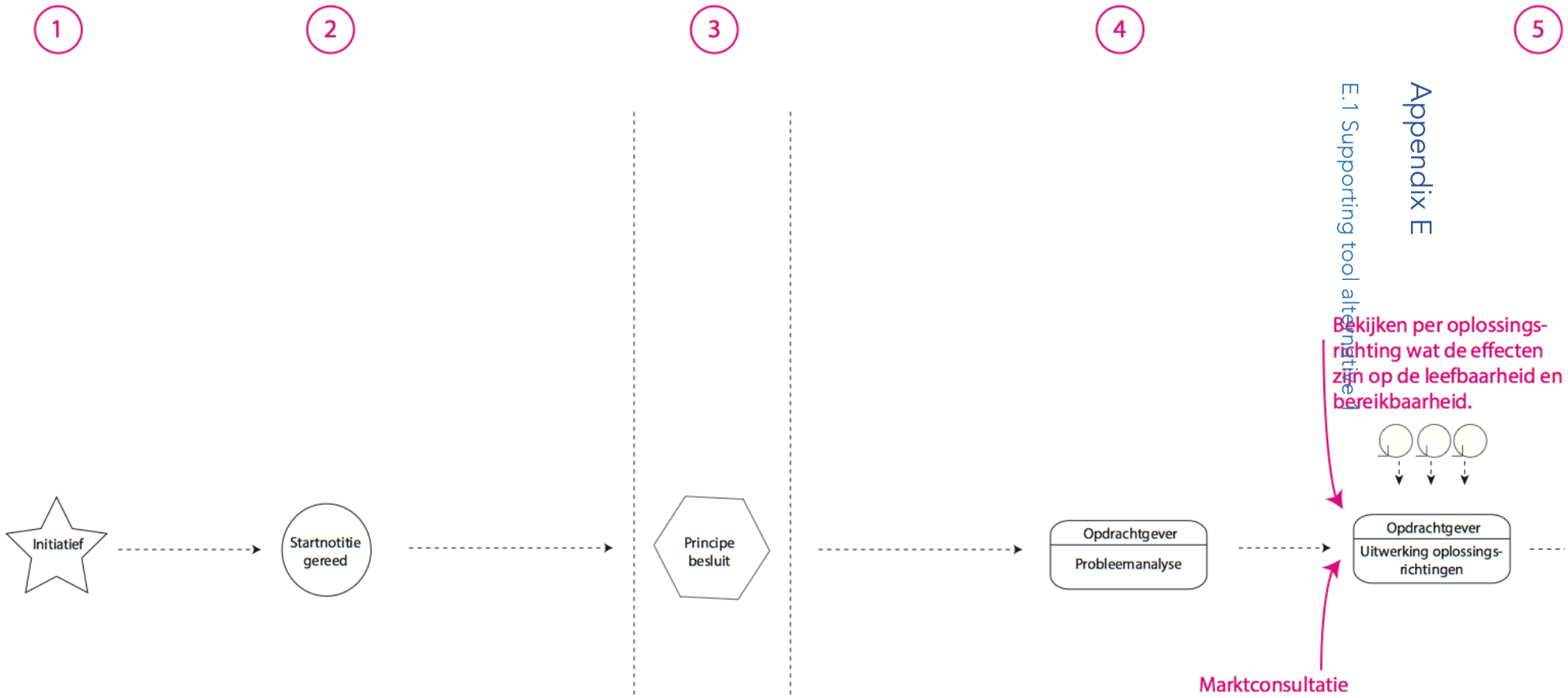
D.6 BLVC

Instrument	Obstacle		Incentive		What to do?	
BLVC	4/6	Contractor is not encourage to order in bigger amounts	B	Contractor should feel consequence of ordering in small amounts	4.1	Taxing transport journeys
	9	Not good maintenance of EMVI-criteria	G&P	Maintain if EMVI-criteria are executed & setup up a notification obligation	9.1	Introducing fines
						minimalizing travel distances in urban areas
						steering on using arterial roads
						Preferred network
					VI.	selecting desirable operating timeslots.
					XI.	plan which contains information about the consequences concerning the accessibility,

						liveability, safety and communication
					XII.	guidelines for construction site management
					XVII.	inclusion of building logistics in traffic plans when the execution phase of the project takes very long.
					XVIII.	demanding a plan on how building logistic is taking care of during the execution phase of the project

D.7 Coordination department

Instruments	Obstacle		Incentive		What to do?	
Coordination department					XVIII.	appointing a project organisation to coordinate several building projects in a city


1
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Initiatief
Startnotitie gereed
Principe besluit
Opdrachtgever
Probleemanalyse
Opdrachtgever
Uitwerking oplossings-richtingen
Bekijken per oplossings-richting wat de effecten zijn op de leefbaarheid en bereikbaarheid.
Marktconsultatie

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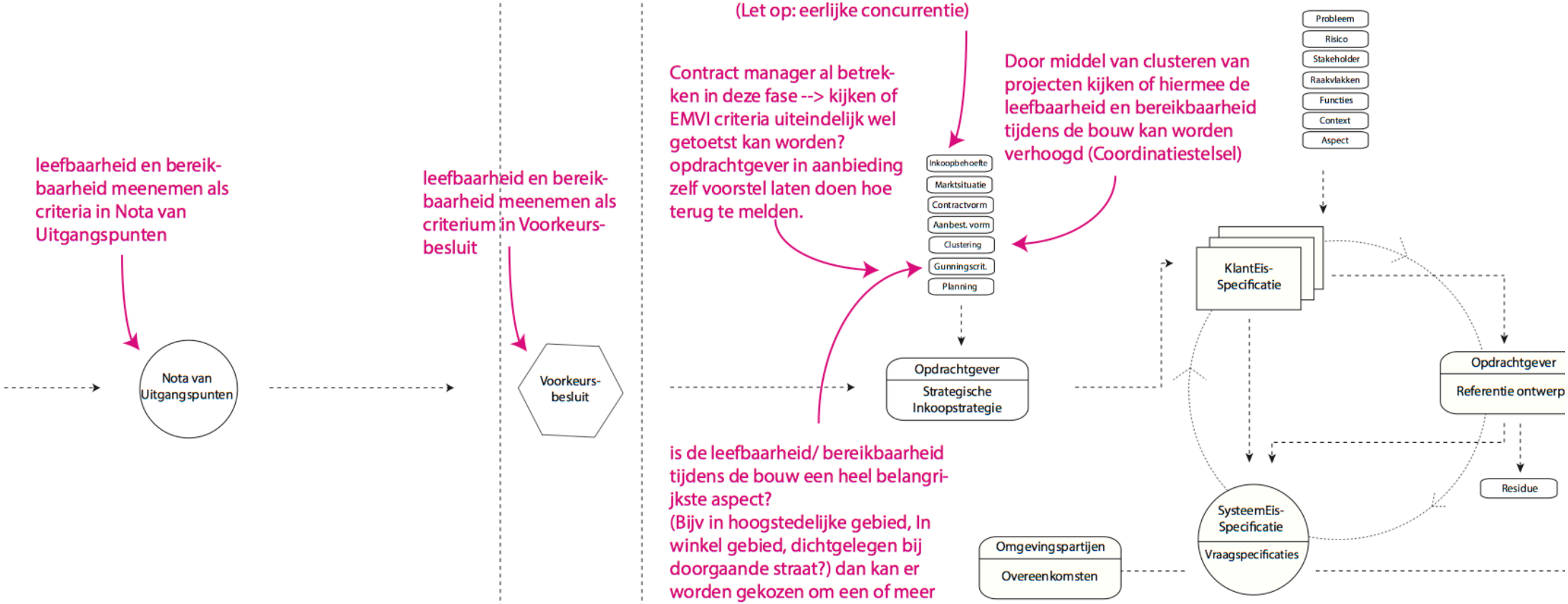
leefbaarheid en bereikbaarheid meenemen als criteria in Nota van Uitgangspunten

leefbaarheid en bereikbaarheid meenemen als criterium in Voorkeursbesluit

Opties: CO2 ladder mee uitvragen / Lean mee uit vragen (Let op: eerlijke concurrentie)

Contract manager al betrekken in deze fase --> kijken of EMVI criteria uiteindelijk wel getoetst kan worden? opdrachtgever in aanbieding zelf voorstel laten doen hoe terug te melden.

Door middel van clusteren van projecten kijken of hiermee de leefbaarheid en bereikbaarheid tijdens de bouw kan worden verhoogd (Coordinatiestelsel)



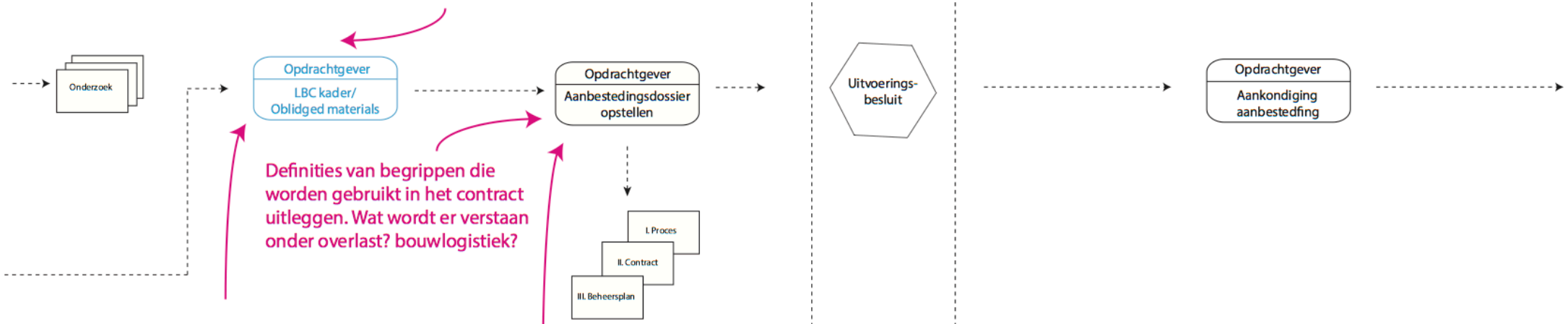
is de leefbaarheid/ bereikbaarheid tijdens de bouw een heel belangrijkste aspect?
(Bijv in hoogstedelijke gebied, In winkel gebied, dichtgelegen bij doorgaande straat?) dan kan er worden gekozen om een of meer gunningscriteria toe te schrijven aan bouwlogistiek.

Voorbeelden:
- Aantal ritten naar de bouwplaats
- Terug geven van bouwgrond
- Smart building (Prefab/ 3Dprinten)

EMVI - niet voorleggen hoe iets te doen, maar wat er moet worden gedaan. Stimuleren van innovatieve oplossing

13 14 15 16

/anneer afdwingen --> eis in BLVC-kader:
oorbeelden:
Aangeven te bereiden verkeersroute
Richtlijnen over bouwplaats management
Richtlijnen toegangsmanagement
Richtlijnen over afvalverwerking
Venstertijden
Verplichten te werken met HUB (Just-in-time delivery)
oornamelijk handig in afbouwfase (wanneer meerdere leveranciers materialen komen brengen)
n niet in ruwbouw fase wanneer volle vrachten komen.
Welke vrachtwagens mogen wel/ niet de stad in?
Vervoer over water
werknemers aannemers verplichten met openbaar vervoer/ pendelbus naar de bouwplaats.
LVC- niet te gebruiken om innovaties te stimuleren maar om af te dwingen.
p dit kader wordt gereageerd in stap 22 door opdrachtnemer



Definities van begrippen die worden gebruikt in het contract uitleggen. Wat wordt er verstaan onder overlast? bouwlogistiek?

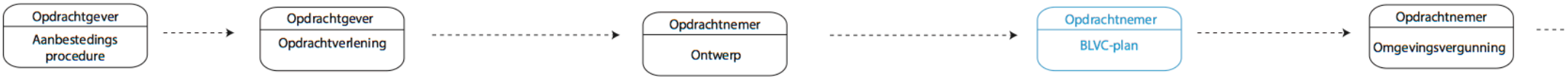
Meenemen van de gestelde eisen met betrekking tot verplicht af te nemen materialen.

Introducing evaluation moments in contract to give smarter solutions a chance during the execution process.

A contract should be a mean instead of a goal (flexibility is needed)

17 18 19 20 21

Aannemer dient een plan in waarin staat HOE de werkzaamheden gaan plaatsvinden. De aannemer reageerd op het meegegeven BLVC kader in het contract.



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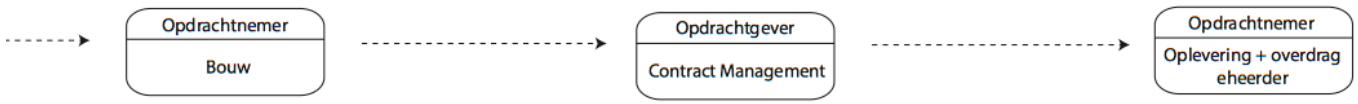
Toetsen of de aanbieding en het BLVC plan wel worden nage-komen. Kijken of er handhavers kunnen worden ingezet om dit te controleren.



Contract manager: Tijdens evaluatiesessies kijken of er slimmere manieren kunnen worden ingezet om onder andere leefbaarheid en bereikbaarheid te verbeteren. Slimmere oplossingen dan in aambieding.

1

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E.2 Supporting tool alternative 2

Bekijken per oplossingsrichting wat de effecten zijn op de leefbaarheid en bereikbaarheid tijdens de realisatie van het project.

Dit geldt alleen voor een heel klein percentarge van de projecten --> mega complex. Anders is het van bijna geen belang in vergelijking met andere aspecten die soms gelden voor 100 jaar.

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leefbaarheid en bereikbaarheid meenemen als criteria in Nota van Uitgangspunten

Nota van Uitgangspunten

Is er wat gebeurd in dit project wat de moeite waard is (zowel positief als negatief). Intern/Externe communiceren

Voorkeurs-besluit

leefbaarheid en bereikbaarheid meenemen als criterium in Voorkeurs-besluit.

In de toekomst van een alsmaar drukker wordende stad kan het een steeds belangrijkere rol gaan spelen.

Project fase evalueren en terug communiceren

Denk aan Bonussen om werknemer te stimuleren.
- Minder uitstoot
- Minder vervoersbewegingen
- eerdere oplevering

Bewuste bouwers certificering mee uit vragen als eis.
(Let op: eerlijke concurrentie)

Contract manager al betrekken in deze fase --> kijken of EMVI criteria uiteindelijk wel getoetst kan worden? opdrachtgever in aanbieding zelf voorstel laten doen hoe terug te melden.

Door middel van clusteren van projecten kijken of hiermee de leefbaarheid en bereikbaarheid tijdens de bouw kan worden verhoogd (Coordinatiestelsel)

Inkoopbehoefte
Marktsituatie
Contractvorm
Aanbest. vorm
Clustering
Gunningscrit.
Planning

Opdrachtgever
Inkoopstrategie

is de leefbaarheid/ bereikbaarheid tijdens de bouw een heel belangrijkste aspect?
(Bijv in hoogstedelijke gebied, In winkel gebied, dichtgelegen bij doorgaande straat?) dan kan er worden gekozen om een of meer gunningscriteria toe te schrijven aan bouwlogistiek.

Voorbeelden:
- Aantal ritten naar de bouwplaats
- Terug geven van bouwgrond
- Smart building (Prefab/ 3Dprinten)
-

EMVI - niet voorleggen hoe iets te doen, maar wat er moet worden gedaan. Stimuleren van innovatieve oplossing . Specifieke vragen stellen

als input (minimumeisen systeem. en BLVC Kader als minimum eisen Process.

Meenemen van de gestelde eisen met betrekking tot verplicht af te nemen materialen.

Probleem
Risico
Stakeholder
Raakvlakken
Functies
Context
Aspect

Project specifiek maken

Opdrachtgever
BLVC kader/
Oblidged materials

KlantEis-Specificatie

Opdrachtgever
Referentie ontwerp

Residue

SysteemEis-Specificatie
Vraagspecificaties

Omgevingspartijen
Overeenkomsten

Uitsluiten van container begripen zoals hinder, overlast.

BLVC niet geheel in EMVI, specifieke vragen stellen.
veiligheid is BV eis.

Testen of wat wordt uitgevraagd wel kan worden uitgevoerd.

Definities van begrippen die worden gebruikt in het contract uitleggen. Wat wordt er verstaan onder overlast? bouwlogistiek?

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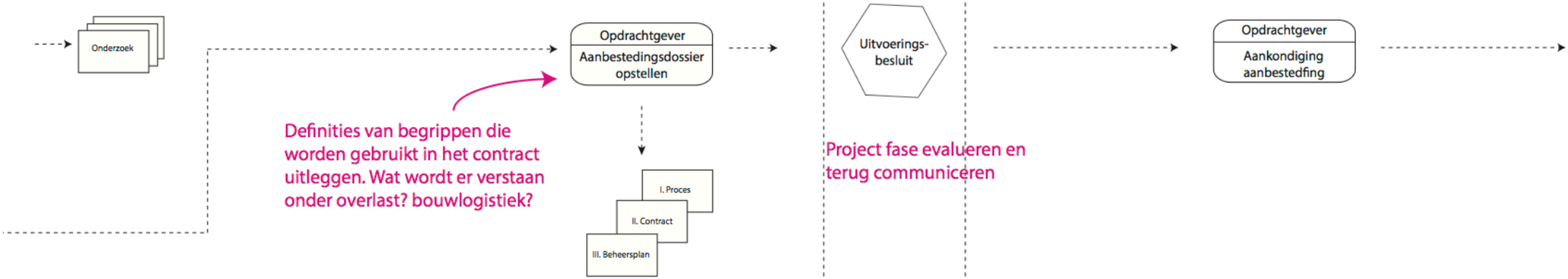
Wanneer afdwingen --> eis in BLVC-kader:
Voorbeelden:
- Aangeven te bereiden verkeersroute
- Richtlijnen over bouwplaats management
- Richtlijnen toegangsmanagement
- Richtlijnen over afvalverwerking
- Venstertijden
- Verplichten te werken met HUB (Just-in-time delivery) Wanneer werkt het wel goed en wanneer niet

Voornamelijk handig in afbouwfase (wanneer meerdere leveranciers materialen komen brengen) en niet in ruwbouw fase wanneer volle vrachten komen.
- Welke vrachtwagens mogen wel/ niet de stad in?
- Vervoer over water
- werknemers aannemers verplichten met openbaar vervoer/ pendelbus naar de bouwplaats.

BLVC- niet te gebruiken om innovaties te stimuleren maar om af te dwingen.
Op dit kader wordt gereageerd in stap 22 door opdrachtnemer

Is er wat gebeurd in dit project wat de moeite waard is (zowel positief als negatief). Intern/Externe communiceren



Definities van begrippen die worden gebruikt in het contract uitleggen. Wat wordt er verstaan onder overlast? bouwlogistiek?

Project fase evalueren en terug communiceren

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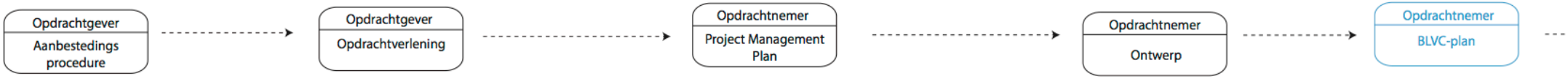
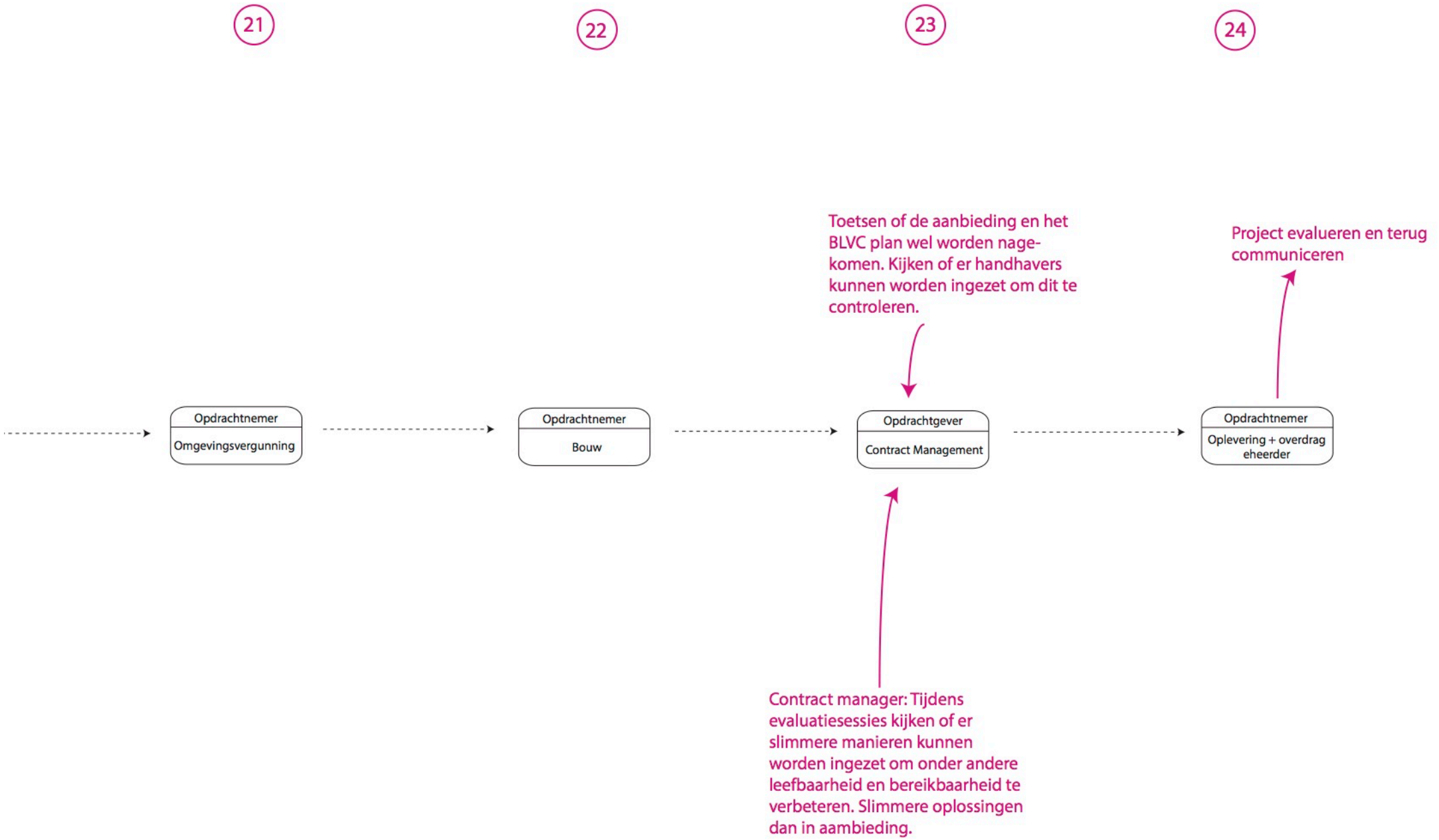
Hoe zit mijn organisatie in elkaar, welke producten ga ik maken, hoe maakt ik ze, welke mensen hebben we, welke verantwoordelijkheden, wat zijn hun kwaliteiten, hoe zit mijn risicomanagement in elkaar, hoe zit planningsmanagement in elkaar, wat voor impact heeft mijn risicomanagement op mijn organisatiestructuur. Wanneer kom ik naar de opdrachtgever.

Aannemer dient een plan in waarin staat HOE de werkzaa heden gaan plaatsvinden. De aannemer reageerd op het meegegeven BLVC kader in h contract.




21
22
23
24
Opdrachtnemer
Omgevingsvergunning
Opdrachtnemer
Bouw
Opdrachtgever
Contract Management
Opdrachtnemer
Oplevering + overdrag eheerder
Toetsen of de aanbieding en het BLVC plan wel worden nage-komen. Kijken of er handhavers kunnen worden ingezet om dit te controleren.
Project evalueren en terug communiceren
Contract manager: Tijdens evaluatiesessies kijken of er slimmere manieren kunnen worden ingezet om onder andere leefbaarheid en bereikbaarheid te verbeteren. Slimmere oplossingen dan in aambieding.

E.3 User test form

User-test Project Roadmap – Unobstructed Constructed

Naam:..... **Functieomschrijving:**.....

Datum:..... **Tijd**..... **Locatie**.....

Stap 1: 20 min observeren.

Eerste bevindingen:.....

Stap 2: Vragenlijst.

Voor het antwoorden van deze vragenlijst is het van belang de scope van de Project Roadmap goed gelezen te hebben. De scope is te vinden in de Project Roadmap op bladzijde 2.

1. Denkt u dat de Project Roadmap indirect een bijdrage kan leveren aan het verminderen van overlast (ofwel vergroten bereikbaarheid en leefbaarheid) veroorzaakt door de uitvoer van civiele constructie projecten?

	1	2	3	4	5	
Geen bijdrage	◯	◯	◯	◯	◯	Grote bijdrage

Reden:.....
.....

2. In welke mate geeft de Project Roadmap inzicht in de stappen die ondernomen kunnen worden om marktpartijen te stimuleren slimme oplossingen in bouwlogistiek te implementeren in civiele constructie projecten?

	1	2	3	4	5	
Geen inzicht	◯	◯	◯	◯	◯	Heel veel inzicht

Reden:.....
.....

3. Zijn de acties die kunnen worden ondernomen door gemeentes op een operationeel niveau verwoord?

JA / NEE

Reden:.....
.....

4. In welke mate geeft de Project Roadmap inzicht in hoe gemeenten het UAV-GC proces kunnen inzetten om overlast gerelateerd aan de bouw in steden te verminderen?

	1	2	3	4	5	
Geen inzicht	◯	◯	◯	◯	◯	Heel veel inzicht

Reden:.....
.....

5. Wat vindt u van het uiterlijk van de Project Roadmap

	1	2	3	4	5	
Niet Aantrekkelijk	◯	◯	◯	◯	◯	Aantrekkelijk

Reden:.....
.....

6. In welke mate vindt u de Project Roadmap overzichtelijk?

	1	2	3	4	5	
Niet overzichtelijk	◯	◯	◯	◯	◯	Heel overzichtelijk

Reden:.....
.....

7. Vindt u dat de Project Roadmap te veel informatie bevat?

	1	2	3	4	5	
Te weinig informatie	◯	◯	◯	◯	◯	Veel te veel informatie

Reden:.....
.....

8. Wat vindt u van het formaat van de Project Roadmap

	1	2	3	4	5	
Te klein formaat	◯	◯	◯	◯	◯	Te groot formaat

Reden:.....
.....

9. Zou u het fijn vinden als er ook een online te gebruiken versie van de Project Roadmap is?

JA / NEE

Reden:.....

User-test Project Roadmap – Unobstructed Constructed

Naam:…… **Functieomschrijving:** Contractmanager

Datum: 16-01-2018 **Tijd**: 14:30 **Locatie**: Plaza IB

Stap 1: 20 min observeren.

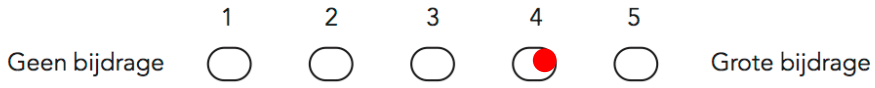
Eerste bevindingen:

- Overzichtelijk en verzorgd.
- Duidelijke markering van de hoofdbegrippen door dik te drukken en terug te laten komen
- Engels is professioneel en vrij technisch. De vraag is of alle medewerkers van de gemeenten engels goed beheersen
- Duidelijke uitsplitsing van de fases en alle tussenliggende substappen. Het kan zijn dat het voor andere gemeenten niet helemaal aansluit op hun fase-omschrijving.
- Goed dat bij elke stap ook benoemd wordt aan welke obstakel het invulling geeft.
- Zowel integraal te lezen als aparte componenten voor een betreffende fase.

Stap 2: Vragenlijst.

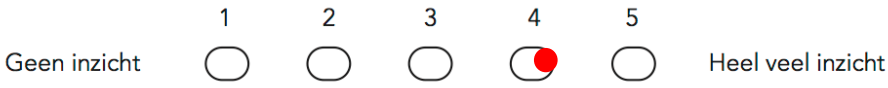
Voor het antwoorden van deze vragenlijst is het van belang de scope van de Project Roadmap goed gelezen te hebben. De scope is te vinden in de Project Roadmap op bladzijde 2.

1. Denkt u dat de Project Roadmap indirect een bijdrage kan leveren aan het verminderen van overlast (ofwel vergroten bereikbaarheid en leefbaarheid) veroorzaakt door de uitvoer van civiele constructie projecten?



Reden: Het bevat praktische handvatten voor iedere fase

2. In welke mate geeft de Project Roadmap inzicht in de stappen die ondernomen kunnen worden om marktpartijen te stimuleren slimme oplossingen in bouwlogistiek te implementeren in civiele constructie projecten?



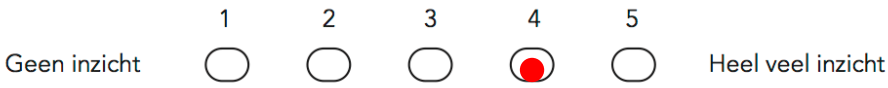
Reden: De stappen zijn duidelijk onderscheiden door herkenbare en eenduidige omschrijving ''bordjes'', kleuren en nummering.

3. Zijn de acties die kunnen worden ondernomen door gemeentes op een operationeel niveau verwoord?

JA / NEE

Reden:.....
.....

4. In welke mate geeft de Project Roadmap inzicht in hoe gemeenten het UAV-GC proces kunnen inzetten om overlast gerelateerd aan de bouw in steden te verminderen?



Reden:.....
.....

5. Wat vindt u van het uiterlijk van de Project Roadmap

	1	2	3	4	5	
Niet Aantrekkelijk	○	○	○	○	●	Aantrekkelijk

Reden: Zie opmerking

6. In welke mate vindt u de Project Roadmap overzichtelijk?

	1	2	3	4	5	
Niet overzichtelijk	○	○	○	○	●	Heel overzichtelijk

Reden: Zie opmerking

7. Vindt u dat de Project Roadmap te veel informatie bevat?

	1	2	3	4	5	
Te weinig informatie	○	○	●	○	○	Veel te veel informatie

Reden: Het juiste niveau kort en bondig omschreven waarmee voldoende informatie wordt gegeven.

8. Wat vindt u van het formaat van de Project Roadmap

	1	2	3	4	5	
Te klein formaat	○	○	●	○	○	Te groot formaat

Reden Handzaam, tekst nog goed leesbaar.

9. Zou u het fijn vinden als er ook een online te gebruiken versie van de Project Roadmap is?

JA / NEE

Reden: Ja, sluit aan op nieuwe werkwijze.

User-test Project Roadmap – Unobstructed Constructed

Naam: …… **Functieomschrijving:** Inkoopadviseur/ contract manager

Datum: 16-01-2018 **Tijd**: 14:30 **Locatie**: Plaza IB

Stap 1: 20 min observeren.

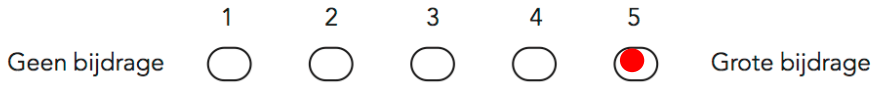
Eerste bevindingen:

- Oogt zeer leesbaar (is het ook)
- Goede visualisaties
- Opbouw Project Roadmap volgt de (inhoudelijke) opbouw van Amsterdamse inkoopstrategie en selectie/ gunningsleidraad → deze opbouw komt hierdoor goed over (herkenbaar) en zal dat waarschijnlijk ook zijn voor andere gemeenten → goede keuze. Een weg dient herkenbaar en voorspelbaar te zijn.

Stap 2: Vragenlijst.

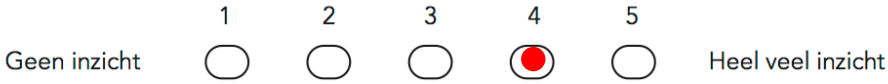
Voor het antwoorden van deze vragenlijst is het van belang de scope van de Project Roadmap goed gelezen te hebben. De scope is te vinden in de Project Roadmap op bladzijde 2.

1. Denkt u dat de Project Roadmap indirect een bijdrage kan leveren aan het verminderen van overlast (ofwel vergroten bereikbaarheid en leefbaarheid) veroorzaakt door de uitvoer van civiele constructie projecten?



Reden: Indien een projectteam de Roadmap volgt en serieus stilstaan bij de invulling van deze stappen, kan de bijdrage zeer groot zijn. Deze systematische aanpak zal veel projectteams kunnen helpen bij het verminderen van overlast.

2. In welke mate geeft de Project Roadmap inzicht in de stappen die ondernomen kunnen worden om marktpartijen te stimuleren slimme oplossingen in bouwlogistiek te implementeren in civiele constructie projecten?



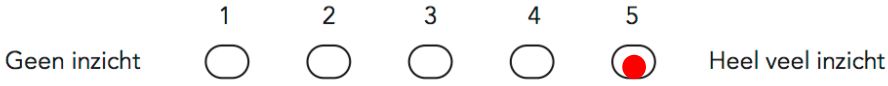
Reden: Duidelijke stappen. Al kan het voorkomen dat verschillende personen activiteiten anders interpreteren/ aanvullen.

3. Zijn de acties die kunnen worden ondernomen door gemeentes op een operationeel niveau verwoord?

JA / NEE

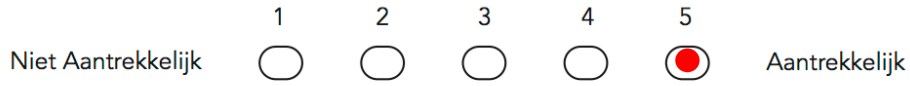
Reden:.....
.....

4. In welke mate geeft de Project Roadmap inzicht in hoe gemeenten het UAV-GC proces kunnen inzetten om overlast gerelateerd aan de bouw in steden te verminderen?



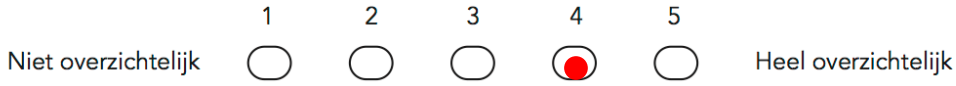
Reden:
.....

5. Wat vindt u van het uiterlijk van de Project Roadmap



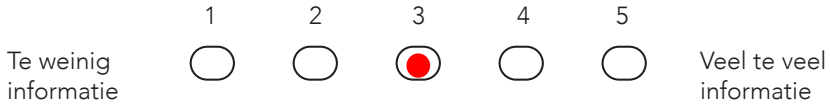
Reden:

6. In welke mate vindt u de Project Roadmap overzichtelijk?



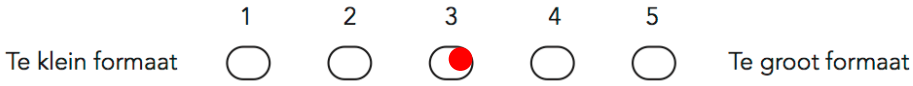
Reden: Visualisaties zijn verhelderend

7. Vindt u dat de Project Roadmap te veel informatie bevat?



Reden: Ik zou het een keer moeten doorlopen/ gebruiken om hier echt iets over kunnen te zeggen.
→ De introductie voor het stappenplan (Roadmap), plaatst alles in een helder kader.

8. Wat vindt u van het formaat van de Project Roadmap



Reden: Past in elke tas!

9. Zou u het fijn vinden als er ook een online te gebruiken versie van de Project Roadmap is?

JA / NEE

Reden:

2018, January 21.

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