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Cost performance analysis between Design-Build and Design-Bid-Build projects in The Netherlands

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Bachelor Thesis

Colophon

Title:	Cost performance analysis between Design-Build and Design-Bid-Build projects in the Netherlands
Author:	Matijn Wubbels
Contact:	m.b.wubbels@student.rug.nl
Student Number:	s3432424
Study:	BSc Spatial Planning and Design
University:	University of Groningen – Faculty of Spatial Sciences
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Supervisor:	Dr. S. Verweij

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Abstract

Despite extensive research efforts by academics over the years to provide clarity on cost performance between Design-Build and Design-Bid-Build, much ambiguity remains.

Therefore, this research aims to gain more understanding in cost performance of Design-Build and Design-Bid-Build projects in The Netherlands. This study attempts to do so by analysing 179 Design-Build and Design-Bid-Build projects statistically. The results are complemented with an interview.

The statistical tests showed that 1) there is no cost performance advantage of Design-Build over Design-Bid-Build or the other way around 2) there is no relationship between project type and cost performance of contracts 3) there is a statistically significant relationship between contract owners and cost overrun. These tendencies are confirmed by the conducted interview.

From the interview was concluded that declining numbers of personnel and decreasing knowledge levels among employees on the contract owners' side lead to cost overrun. To counter cost overrun, this study recommends contract owners to invest in human resource capacity and knowledge levels among employees.

Keywords: *cost performance, Design-Build, Design-Bid-Build, project delivery method*

1. Introduction

1.1 Scientific relevance

Over the years much attention has been given to the analysis of Design-Build and Design-Bid-Build projects. The studies by Songer & Molenaar (1996), Konchar & Sanvido(1998) and Ibbs *et al.* (2003) argue that Design-Build contracts perform better than Design-Bid-Build contracts in terms of time schedule. More recent studies by Hale *et al.* (2009), Sullivan *et al.* (2017), and Cho *et al.* (2020) conclude similar results by stating the schedule advantages of Design-Build. This illustrates the consensus among academics about the performance advantages of Design-Build contracts with regard to time keeping.

The general agreement of academics on the cost advantages of Design-Build procurement in comparison with Design-Bid-Build is however more disputed. Songer and Molenaar already expressed this unclarity in 1996 by saying that little empirical evidence exists to confirm the cost savings through DB procurement. Throughout the years, the costs advantage of Design-Build over Design-Bid-Build and the other way around remains unsettled in contemporary literature (Park and Kwak, 2017).

This uncertainty is supported by Ibbs *et al.* (2003) who argue that there is no cost performance advantage between Design-Build and Design-Bid-Build. On the other hand, there are authors with other conclusions such as Minchin *et al.* (2013) who conclude in their research that Design-Bid-Build outperforms Design-Build regarding cost performance. Contrarily, Hale *et al.* (2009) and Rosner *et al.* (2009) came to the conclusion that Design-Build has cost performance advantage over Design-Bid-Build. Similar conclusions were arrived at by Korkmaz *et al.* (2010), Sullivan *et al.* (2017), and Mosley Jr. and Bubshait (2017).

1.2 Social relevance

Cost overrun for large capital investment projects, such as Design-Build and Design-Bid-Build projects, carries along substantial negative effects for investors, tax payers, involved organisations and companies (Flyvbjerg, 2009; Flyvbjerg and Budzier, 2011). Therefore, this study attempts to shed more light on cost overrun in procurement. These findings can be used to improve cost performance in the future. Flyvbjerg (2006, 2007) and Flyvbjerg *et al.* (2009) emphasize the usage of findings to implement more realistic planning and policymaking for future projects (Verweij et al., 2015).

The insights are translated into recommendations for reduction of cost overrun. By providing recommendations to reduce cost overrun, it becomes more attainable to reduce cost overrun for policy makers, project managers, project calculators, etcetera for the projects they are involved in.

1.3 Research problem

Within academic literature on project delivery systems and cost performance, the international context has received much attention. The Dutch context has also witnessed substantial research efforts on this topic. For instance Cantarelli *et al.* (2012a, 2012b, 2012c) examined the cost overrun of Dutch projects. Moreover Verweij and van Meerkerk (2020a, 2020b) also discussed cost overrun in relation to the Dutch context.

In spite of the aforementioned research efforts, there has been little research on the Dutch context with cost performance specifically related to Design-Build and Design-Bid-Build.

Given this research gap, the aim of this research is to gain more insights in the cost overrun of Dutch Design-Build and Design-Bid-Build projects in the infrastructure field and to provide recommendations to reduce cost overrun.

Hereby, the following main research question guides this thesis:

Q1) - "*How do Design-Build and Design-Bid-Build projects in the Dutch infrastructure field perform with regard to costs?"*

The main research question is accompanied by the following sub-questions:

Q2.1) – "*What is the cost performance of Design-Build project in the Dutch infrastructure field?"*

Q2.2) – "*What is the cost performance of Design-Bid-Build projects in the Dutch infrastructure field?"*

Q2.3) – "*Which project delivery method performs better in terms of cost performance?"*

Q2.4) – "*How can the difference in cost performance between Design-Build and Design-Bid-Build in the Dutch infrastructure field be explained?"*

Q3) – *"How can the cost overrun of Design-Build and Design-Bid-Build projects be reduced?"*

With question 1 it becomes possible to address the aim of this research. In other words, it allows for exploration of cost performance of Design-Build and Design-Bid-Build projects and thus it establishes a better understanding of cost overrun. The questions 2.1 up until 2.4 provide nuance and together they build up to question 1. Question 3 enables this study to present recommendations for reduction of cost overrun in Dutch infrastructural projects.

1.4 Reading guide

The third chapter houses the theoretical framework. Within the theoretical framework relevant literature for this study is explained and operationalized. Furthermore, the conceptual model and the hypotheses can be found here.

The fourth chapter contains the methodology. As part of this, the research strategy, data collection, data processing, case selection, descriptive statistics and the ethical considerations can be found here.

In line with chapter five, which shows the results, the conclusions that are drawn in this study are shown in the sixth chapter.

Within the seventh chapter all the references for this thesis are accommodated. The eighth and last chapter is where the attachments can be found.

2. Theoretical framework

2.1 Definitions

Infrastructure Field

With infrastructure field, Design-Build and Design-Bid-Build projects in the Dutch Grond-Weg-Waterbouw (GWW) branch are meant in this research. This branch entails projects within civil engineering. It relates to the planning, designing and execution of those projects. Commonly seen projects are roads, bridges, canals, and tunnels (Voort, 2017).

Project delivery methods

Projects can be realised through project delivery methods (PDM). Project delivery methods define relationships between project stakeholders and the moment in time when they interact with one another for the project (El Asmar *et al*., 2013; Konchar and Sanvido, 1998). Different project delivery methods exist with the purpose to execute each project efficiently, to increase schedule and cost performance, to reduce disputes, to take advantage of innovation, and to enhance collaboration among stakeholders (Tran and Molenaar, 2014).

Design-Bid-Build

Design-Bid-Build (DBB) is a project delivery method wherein contract owners partner with designers in contracts to develop designs based on the requirements as set out by the owner. With the design finalized, a contractor is contracted by the owner for the building phase in another contract (El Asmar *et al*., 2013; Hale *et al*., 2009).

In Dutch procurement there are several contract forms. These contracts are based on the '*Uniforme Administratieve Voorwaarden' (*U.A.V.). There are multiple editions of the *Uniform Administrative Conditions.* These are shown in table 1 (CROW, 2014). The differences between each edition are not discussed as they entail very specific, practical details not fitted for the purpose of this research.

U.A.V. editions

Project delivery method	Edition	Contracts	Description
Design-Bid-Build	1	*U.A.V. 1989*	Projects are executed by contractors on the basis of construction-ready designs. The contractor for the execution has no involvement with the design.
	2	*U.A.V. 2012*	
	3	*U.A.V. 2015*	
	4	*U.A.V. 2020*	

Table 1 – U.A.V. editions

On the one hand, there is the owner of the contract who specifies the work to be carried out and supplies a design or the design is drafted through another contract. On the other hand, there is the contractor who made the best bid on the building contract and is therefore allowed to build the design as specified in the contract. Given the description above, contracts using the *U.A.V.* can be categorized as Design-Bid-Build contracts.

Design-Build

Design-Build (DB) is a project delivery method where one contract is drafted with one contractor to construct a project. This company is responsible for designing and building of the project. (El Asmar *et al.*, 2013; Hale *et al*., 2009).

Besides *U.A.V.* there are also the '*Uniforme Administratieve Voorwaarden Geïntegreerde Contracten'* (UAV-GC). These can be seen in figure 2.

UAV-GC editions

Project delivery method	Edition	Contracts	Description
Design-Build	1	*UAV-GC 2000*	Projects start with creating construction designs. After procurement the contractor who delivered the construction design can execute the construction works or another company is awarded the contract.
	2	*UAV-GC 2005*	

Table 2 – UAV-GC editions

With UAV-GC contracts are made between one contractor and owner of the contract for all the phases of one project. Therefore UAV-GC contracts are categorized as Design-Build contracts.

Further explanation of the contract types and their description can be found in Appendix 1.

Owner of the contract

Within existing literature there has not been any specific focus on contract owners and their relation to cost performance. Therefore, this study has constructed it owns identification of contract owners. These can be seen in table 3.

Referral	Owner
1	Municipalities
2	Regional government
3	Waterboard
4	Private companies

Table 3 – Contract owners

Cost performance

To investigate how Design-Build and Design-Bid-Build projects perform in terms of costs, this thesis analysed cost overrun. The term cost overrun is also referred to as 'cost increase' or 'cost growth' (Love *et al.*, 2014).

The comprehensive article by Flyvbjerg *et al.* (2018, p. 175) on costs defines this concept as:

"*Cost overrun is the amount by which actual costs exceeds estimated cost, with cost measured in local currency, constant prices, and against consistent baselines expressed in percentages."*

As Flyvbjerg *et al.* (2018) mentions, cost overrun can either be expressed in absolute terms or in relative terms. Within this study, the cost overrun is measured in relative terms as this allows for precise testing between different projects, periods of time, geographics and investments. Measuring cost development in relative terms implies expressing the actual costs as a percentage of the estimated cost (Flyvbjerg *et al.*, 2018).

Hereby it is important to precisely define the moment in time until when the costs are included. This moment in time, also referred to as '*baseline',* is of great importance for measuring cost overrun.

The definition of baseline in cost overrun research has witnessed many research efforts. On the one side there are the scholars who want to study the decisions made by decision makers in planning. Therefore these academics define the baseline for cost overrun as *'the budget at the time of decision to build'* (Flyvbjerg *et al.*, 2018). Among the authors who adapt this definition of baseline in their studies are Ansar *et al.* (2014, 2016), Cantarelli *et al.* (2012a, 2012b, 2012c), Cantarelli *et al.* (2010), Flyvbjerg (2014, 2016), Flyvbjerg *et al.* (2002, 2004, 2009) and Flyvbjerg and Budzier (2011).

In contrast, other scholars adhere a different definition of the baseline. They suggest that the baseline should be the difference between the original contract value (i.e. contract value during the contract awarding) and the actual construction costs at the physical completion of projects (Love *et al.*, 2014). Among the academics who apply this definition are Rowland (1981), Hinze *et al.* (1992), and Zeitoun and Oblander (1993). More recent publications which adhere to this definition are Hale *et al.* (2009), Verweij and van Meerkerk (2020a, 2020b), and Verweij *et al.* (2015).

In academic literature on cost overrun the dichotomy around '*baseline*' has been heavily debated. The definition of baseline is inherent to the research purpose (Cantarelli *et al.*, 2010a; 2010b). The same authors underline this issue in Flyvbjerg *et al.* (2018, p. 176) with the following statement:

"…*the choice of baseline should reflect what it is you want to measure..."*

With this being said, there is no universal 'correct' baseline. The baseline should be tailored to the research and the research purpose. The research purpose of this study is to investigate the cost performance of different contracts.

The following definitions for cost performance as adopted from Love *et al.* (2014) are used in this thesis:

Cost performance	
English	Definition
Cost overrun	Difference between original contract value and actual construction value with a positive value indicating cost overrun and a negative value indicating cost underrun
Forecasted / Estimated costs	The original contract value
Actual costs	The actual construction value

Table 4 – Cost performance

Project type

In the studies on cost overrun many different project type classifications have been made. However, all these classifications are unfitted for the dataset at hand in this thesis. They are too broad. Subsequently, this broad scope leads to loss of detail and information loss. Therefore, this study constructs its own classification fitted for the data which are used. This classification is shown in table 5. The explanation and clarification for each project type can be found in the chapter Appendix 2.

Referral	Project
1	Decontamination projects
2	General maintenance
3	Waterworks
4	Nature works
5	Road maintenance
6	Road (re)construction
7	Sewerage (re)construction
8	(re)development of public space
9	Site preparation
10	Housing preparation

Table 5 – Project types

2.2 Conceptual model

The cost performance advantage between the two project delivery methods Design-Build and Design-Bid-Build remains undetermined (Ibbs *et al.,* 2003; Park and Kwak, 2017; Songer and Molenaar, 1996). On the one side, there are studies which suggest that Design-Bid-Build performs better in terms of cost than Design-Build (Minchin *et al.,* 2013). On the other side, there are authors who argue that Design-Build performs better regarding cost than Design-Bid-Build *(Hale et al., 2009; Korkmaz et al., 2010; Mosley Jr and Bubshait, 2017; Rosner et al.,* 2009; Sullivan *et al.,* 2017).

The majority of research suggests that Design-Build has cost performance advantage over Design-Bid-Build. Hereafter three frequently recurring causes for this trend are discussed.

1) In their research on project procurement systems for mechanical, electrical, and piping projects in Saudi Arabia, the authors found that Design-Build project performed better than Design-Bid-Build in terms of cost and also faced less change orders than Design-Bid-Build (Mosley Jr and Bubshait, 2017).

Where it could prove difficult to deviate from Design-Bid-Build contracts if changes occur, within Design-Build contracts there is more adaptability to unforeseen changes. This can be explained by the fact that the contractor is responsible for both the design and construction. The need for formal contract processes to handle design errors is thereby rendered obsolete. Formal contract processes are known as changes orders. These change orders can cause large cost overruns (Park and Kwak, 2017; Verweij *et al.*, 2015).

2) Within Design-Build projects there is more flexibility as the responsibility over both the designing and building is in hands of one contractor. This allows to start with construction before the design is completed (Park and Kwak, 2017).

3) Through the opposing essence of separate party contracting for each phase of procurement it becomes more difficult to deviate from the original contractual agreement. If all parties, i.e., owner, A/E and contractor, are in negotiation about the modification of the contract, the nature of Design-Bid-Build contracts could prevent flexible communication and interactive learning among the parties. On its turn, this could lead to inefficient settlement of unforeseen circumstances (Perkins, 2009).

Considering these three arguments it is argued that Design-Build projects perform better than Design-Bid-Build projects with regard to cost.

Many scholars researched different procurement methods. In these research different distinguishments were made for the projects. For instance, Verweij *et al.* (2015) categorized the projects in their study on reasons behind contract change as follows: *road projects, partly road projects, bridges, and tunnels.* The study by Cantarelli *et al.* (2012c) focussed on determinants which influence cost performance. Within their research, the authors classified the projects by the project types *road, rail, tunnels, and bridges.* Besides analysis on multiple project types, there has also been ample research on single project types. For example, Shrestha *et al.* (2007) studied highway projects and Ibbs *et al.* (2003) researched buildings as project type.

Since the conventional project types as discussed above differ greatly from the classification in this study, it is impossible to express expectations about the influence of certain project types in this research on cost performance based on existing literature. However, the articles by Cantarelli and Verweij indicated relationships between project type and cost overrun. For example, Cantarelli *et al.* (2012c) found that cost overrun is the largest for *road projects*. Moreover Verweij *et al.* argue that project size influences cost overrun. Therefore, it can be assumed that project type influence cost performance.

The same line of reasoning also applies to contract owners. There has not been much research on the relation between contract owner and cost performance. Berends (2000) studied risk management among contract owners with different procurement methods. However, research on contract owners and cost performance lacks. The relationships between the variables are visualized in the conceptual model in figure 1.

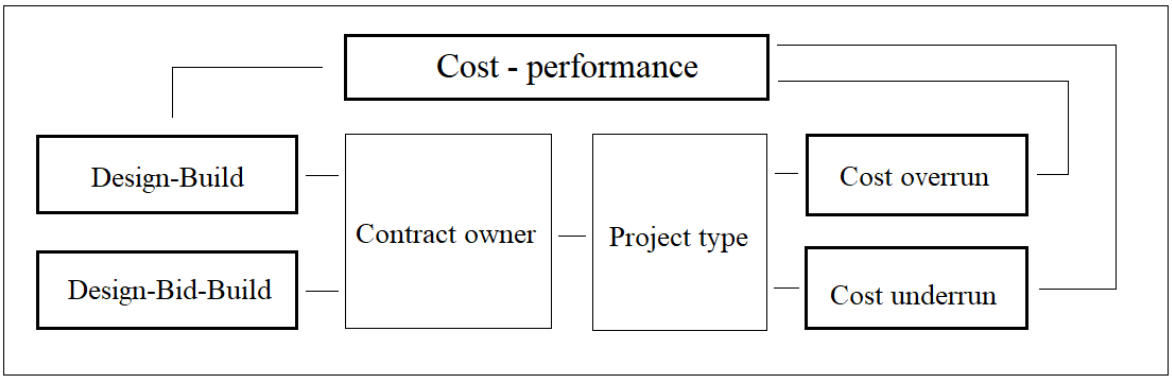

Figure 1 - Conceptual model

2.3 Hypotheses

The relationships as explained in chapter 2.2 translate into the following variables.

Dependent variable 1 | *Cost performance*

Independent variable 1 | *Influence of contract type on cost performance*

Independent variable 2 | *Influence of project type on cost performance*

Independent variable 3 | *Influence of contract owner on cost performance*

Considering the tendency towards the cost performance advantage of Design-Build over Design-Bid-Build within academic literature, the following hypotheses are derived:

H_0 (A) = Design-Build does not perform better in terms of cost than Design-Bid-Build.

H_1 (A) = Design-Build does perform better in terms of cost than Design-Bid-Build

H_0 (B) = The project type has no influence on cost performance

H_1 (B) = The project type has influence on cost performance

H_0 (C) = The contract owner type has no influence on cost performance

H_1 (C) = The contract owner type has influence on cost performance

3. Methodology

3.1 Research strategy

This thesis used mixed methods to investigate the topic at hand. Herein secondary quantitative data were gathered which was analysed statistically. The results were supplemented with a semi-structured interview (Clifford *et al.*, 2016).

3.2 Data collection

Quantitative data collection

Contractors were approached for data. One contractor was willing to share their project data. With the contractor five meetings were held to discuss the data collection. First instructions were given by project managers on how to work in the company's database. After this instruction several days were spent to become acquainted with the system. In the second and third meeting the data were inspected for suitability. Between the third and fourth meeting the majority of the data was transferred to the dataset for this study. In the fourth meeting the contractor joined for a moment the transfer of data from the contractors database to the dataset for this study in Excel. The fifth meeting was used to discuss any problems that were encountered and to control the transferred dataset for any peculiarities.

Qualitative data collection

A semi-structured interview was conducted with Head of Production Planning from the same contractor who shared their project data. The interview took place at the contractors office on the 7th of May 2021.

Moreover, the interview also served for in-depth discussing of the quantitative data analysis. As a consequence of this discussion with the participant, it became possible to increase the reliability of the analysis as the characteristics of the data could be discussed (Verweij *et al.*, 2015).

In summary, during the interview the participant was first made acquainted with the different variables. That is, the different project types, owners of contracts, and contract types were explained to him. Hereafter it was explained how cost performance is defined.

Following this explanation, the participant was asked on his perception of cost performance in relation to contract types. In addition, his experience with cost performance with regard to project type and owner of contract were also discussed. Hereby the quantitative data analysis results were not yet discussed.

Then, the results were presented to the participant. With the results known to the participant, the interview continued unstructured with only a few areas of interest. The participant was asked if these results correspond with reality. Moreover, he was asked if he could explain certain situations occurring in the dataset. For instance, high cost overrun with a certain contract type, project type, and certain contract owners. The interview guide can be found in Appendix 3.

3.3 Case selection

In their research Flyvbjerg *et al.* (2003) discuss sampling related to cost-performance research. Commonly, data should be drawn from large populations. Accordingly, the drawn sample needs to depict the population fittingly. This can be achieved by randomized sampling. Through randomization it can be guaranteed with high probability that the sample represents the population. At the same time, this implies that all the non-controllable factors are minimized. Furthermore, the sampling strategy should ensure accurate representation of subgroups and the corresponding occurrence and importance within the population (Flyvbjerg *et al.*, 2003).

It is pointed out, however, by Flyvbjerg *et al.* (2003) that in human studies it is nearly impossible to meet the ideal conditions. In studies dealing with human affairs, controlled laboratory experiments, wherein ideal conditions can be met, are almost unattainable. This is also the case with cost overrun studies (Flyvbjerg *et al.*, 2018). Therefore, Flyvbjerg *et al.* (2003) opted to apply a different selection criteria. In their research, the authors selected their samples on the basis of data availability.

Raisbeck *et al.* (2010) stress that one must be cautious with the selection of project samples to counter selection on the basis of successful or underperforming results. Therefore, all the available complete project data were included. With this, no projects were willingly left out of the study. With this no valuable distributional information is lost (Flyvbjerg *et al.*, 2018). Distributional information is a vital requirement for high-end data analysis (Lovallo and Kahneman, 2003; Flyvbjerg, 2008, 2013a; Lovallo *et al.*, 2012).

From the initial dataset of 187 projects from the contractor, eight projects were left out of the dataset for this study. This brings the included number of projects within this study to 179. The eight cases are outliers in comparison with the rest of the cases. This can be explained by the fact that those eight cases are emergency decontamination projects. Given the fact that those projects are emergencies, they are not representative for the other projects in the dataset which are regular, non-emergency projects. Therefore, the excluded projects cannot be compared with the other projects.

3.4 Data processing

Quantitative data

From the databank the objects as stated in table 6 were transferred to the data set of this study. Furthermore, the aid of the employees reduced the probability of non-sampling errors occurring. Non-sampling errors are errors that take place during the acquisition, recording and editing of statistical data. It is important to minimize these errors where possible. This can be done through careful editing, validation checks, and instrument calibration (Burt *et al.*, 2009). The help of the employees validated the data in this study and therefore reduced the non-sampling errors as much as possible.

Data from contractor	
Object	Unit
Contract owner	Text
Project number	Numbers or Text
Description	Text
Contract type	Text
Project Type	Text
Years	Numbers
Forecasted Costs	€
Actual Costs	€

Table 6 – Data Objects and Units

Since the projects took place over different years, the data were corrected for inflation. The absence of correction for inflation in the dataset could lead to major errors, considering the fluctuating inflation levels during the projects (Flyvbjerg *et al.*, 2003).

All projects were converted to the 2015 level using the appropriate indices. The concerning levels were adopted from the '*Centraal Bureau voor de Statistiek'* or '*Central Bureau for Statistics'* according to the values for the engineering branche (Statline, 2021). All the projects were measured in euros (€), therefore conversions between different currencies are not required.

Qualitative data

The interview was conducted in Dutch since the contractors' employee is Dutch and is thus most comfortable with speaking his mother tongue. The answers were translated to English for the comparability and readability of this research. The recorded interview was transcribed using oTranscribe.

The interview was recorded under consent. This consent was gained and expressed at the beginning of the interview. The consent was formally written down in the consent form which can be found in Appendix 4. The Dutch version which has been handed to the respondent can be found in Appendix 5. To guarantee anonymity, the blank consent form is placed in the appendix. The filled-in consent form is in possession of the author.

3.5 Ethical considerations

The data in this thesis are confidential. Therefore the data in this research are classified and only inspected by the authors of this research. The company name will be left out and any link to them will be erased. With this the data are completely anonymized. By ensuring anonymity, the participant of the interview can speak freely and the project leaders can share the project data without having to worry about reliability (Clifford *et al.*, 2016).

4. Results

4.1 Descriptive statistics

In the research 179 projects were included. Table 7 gives an overview for the core values of the projects' database.

The total project portfolio amounted to €147.903.909,40 with the average project being €826.278,82. The smallest project totalled €34.662,95. On the contrary, the largest project accounted for €7.310.607,00. The median for the actual cost is €505.575,00.

Statistics

Actual Costs

N	Valid	179
	Missing	0
Mean		826278,8232
Median		505575,0000
Mode		720336,00
Minimum		34662,95
Maximum		7310607,00
Sum		147903909,4

Table 7 - Overview of actual costs

Contract type

In the database 82,7% of the projects was issued as Design-Bid-Build. The other projects were issued with Design-Build contracts (17,3%). The distribution of contract types can be seen in table 8. The crosstabulation of the independent variables can be found in Appendix 7.

Contract type

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Design-Build	31	17,3	17,3	17,3
	Design-Bid-Build	148	82,7	82,7	100,0
	Total	179	100,0	100,0	

Table 8 – Distribution of contract type

Owner of contract

The most contracts were issued by municipalities (79,3%). The distribution of contract owners can be seen in table 9.

Owner of the Contract

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Municipalities	142	79,3	79,3	79,3
	Regional government	12	6,7	6,7	86,0
	Waterboard	17	9,5	9,5	95,5
	Private companies	8	4,5	4,5	100,0
	Total	179	100,0	100,0	

Table 9 - Owner of contract

Project type

The most frequently seen projects in the dataset are the (re)development of public space projects (19%) and the road (re)construction projects (18%). Also sewerage (re)construction projects (15%) and water work projects (15%) are highly present in the dataset. The percentages per project are shown in the bar chart in figure 2.

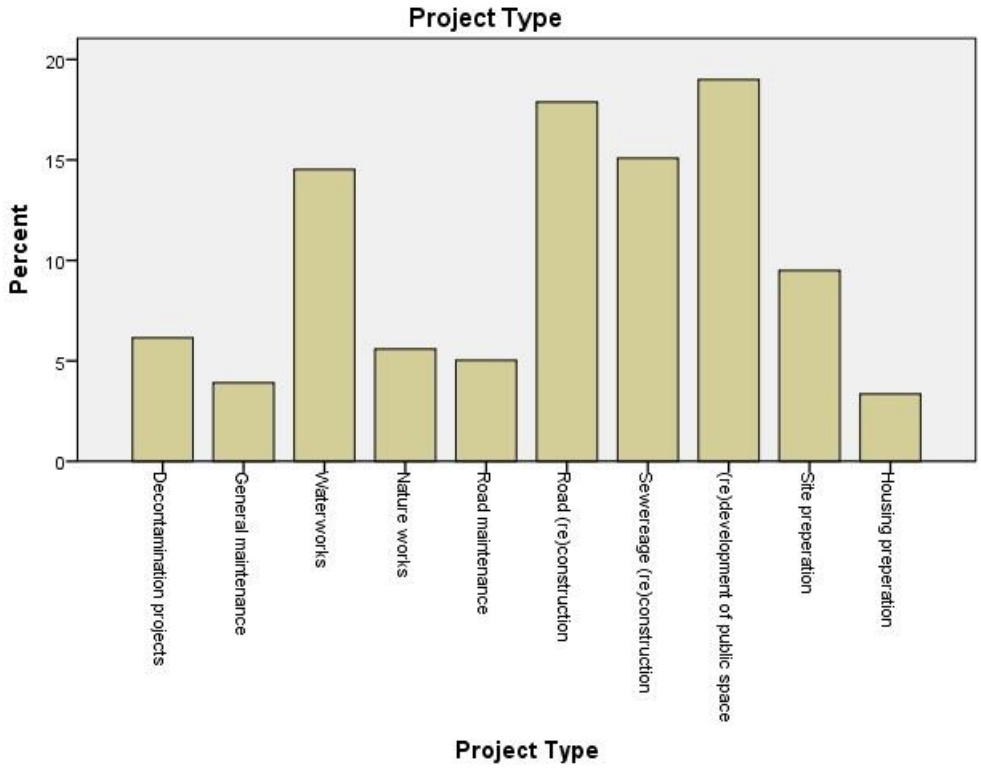

Figure 2 - Bar chart Project Type

4.2 Normality

To analyse cost performance, first the normality of the data was tested. The tests that were used to determine normality can be found in appendix 6. The results led to the conclusion that the variable cost performance of design-build and design-bid-build is **not normally** distributed.

Various possibilities to counter the non-normality have been explored and tested. Transforming the variables cost overrun with logarithmic transformation (log10) resolved the skewness partially. However, due to the presence of zero and negative values, many cases were excluded from the transformation. Therefore, this did not improve the situation.

The same variables were also transformed by taking the square root. This proved to be a better solution than the logarithmic transformation as it included more cases. But valuable information was lost as the square root transformation makes it impossible to discern between negative and positive values.

Therefore, this research resorts to non-parametric testing. In addition, the Central Limit Theorem can be applied since the sample size for both cost overrun with Design-Build and cost overrun with Design-Bid-Build is larger than 30. This allows for parametric testing as normality is assumed.

Distribution of cost performance

Skewness influences the appropriate Measure of Central Tendency. Generally speaking, the most commonly used measure of central tendency is the mean. For (extremely) skewed distributions the most fitting measure is the median. The median is insensitive to the large outliers that accompany skewness (Burt *et al.*, 2009). The distribution of Design-Build and Design-Bid-Build contracts' cost performance can be found in figure 3 and 4. Furthermore, the data within those figures is unimodal as they have one distinct peak (Burt *et al.*, 2009). For kurtosis values larger than three are considered leptokurtic. In the same line of reasoning the histograms in figure 3 and 4 have very sharp peaks and the kurtosis values are larger than three (5,171 & 3,468 respectively). Therefore the distributions of cost performance can be considered leptokurtic (Burt *et al.*, 2009).

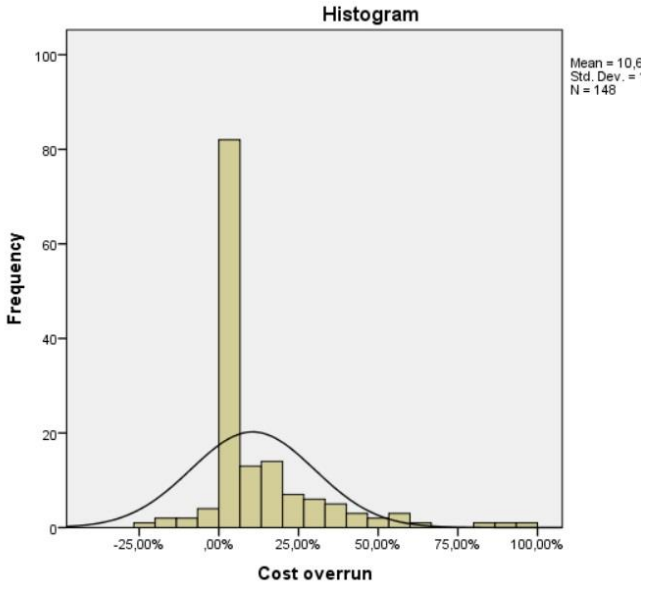

Figure 3 – Cost overrun Design-Bid-Build

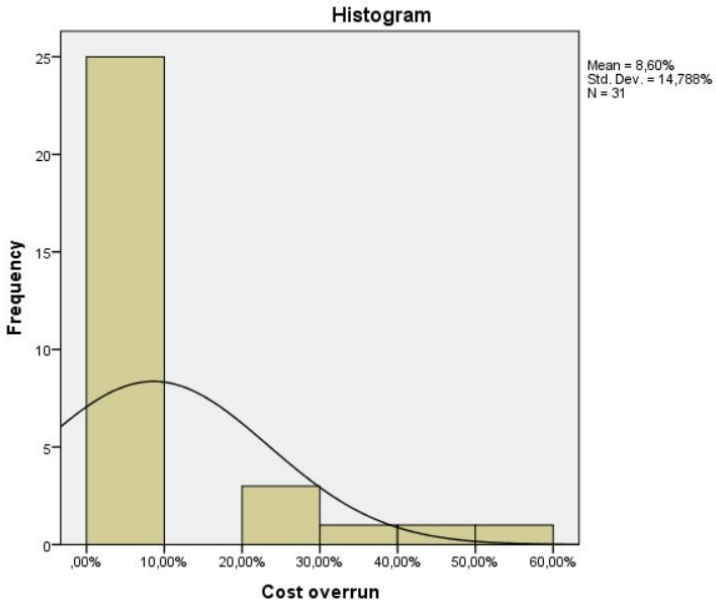

Figure 4 – Cost overrun Design-Build

Looking at figures 3 and 4, it can be observed that both cost performances are skewed. When the value for Skewness is larger than zero it is positively skewed (Burt *et al.*, 2009). The skewness in figure 3 and 4 is larger than zero (2,070 & 2,049 respectively) and therefore positively skewed.

Q2.1) – *"What is the performance of Design-Build projects in the Dutch infrastructure field?"*

The average Design-Build project experienced a cost overrun of 8,60%. The median cost overrun is 1,34%. The largest cost overrun amounted to 55,56%. Nearly half of the Design-Build projects were delivered with no cost overrun (48,4%). Within the dataset there were no projects which experienced cost underrun.

Q2.2) – *"What is the performance of Design-Bid-Build projects in Dutch infrastructure field?"*

The average Design-Bid-Build project experienced a cost overrun of 10,60%. The median cost overrun is 0,00%. The largest cost overrun on a project nearly doubled the initial costs. This maximum cost overrun is 96,94%. Almost half of the projects was finalized with no cost overrun (48% - n = 48). To a stronger degree there were also Design-Bid-Build projects which were yielded with cost underrun (n = 9). The largest cost underrun was 26,25%.

4.3 Inferential statistics

This section answers the research questions Q2.3 – Q2.4 by statistical testing.

Q2.3) – "*Which project delivery method performs better in terms of cost performance?"*

To statistically determine whether Design-Build projects perform significantly better than Design-Bid-Build projects the Mann-Whitney test was conducted. The test showed that between Design-Build (Median = 1,34%) and Design-Bid-Build (Median = 0,00%) there is **no** difference in cost performance (Mann-Whitney U = 2245, z = -0,196, *p* = 0,845).

The large number of samples allows the application of the Central Limit Theorem. Therefore, H_0 (A) was also tested with the Independent Samples Test. The Levene's test showed that the variance between the two project delivery methods is equal with F = 0,731 and *p* = 0,404. The Independent Samples Test then showed that *t* (df = 177) = -0,541 and *p* = 0,589. Thus, the test is **not** significant, and we do not reject H_0 (A).

H_0 (A) = *Design-Build does not perform better in terms of cost than Design-Bid-Build.*

This implies that there is no difference between the cost performance of Design-Build and Design-Bid-Build.

Q2.4) – "*How can the difference in cost performance between Design-Build and Design-Bid-Build in the Dutch infrastructure field be explained?"*

To determine what influences cost performance a Kruskall-Wallis test has been conducted between project type and cost performance. This test showed that there is no statistically significant difference in cost performance between different project types, with Chi-Square = 16,418, df = 9, p = 0,59. Thus, H_0 (B) is not rejected.

H_0 (B) = *"The project type has no influence on cost performance"*

This suggests that project type has no influence on the cost performance of projects.

To determine what influences cost performance a Kruskall-Wallis test has been conducted between contract owner and cost performance. This test showed that there **is** a statistically significant difference in cost performance between contract owners, with Chi-Squire = 9,408, df = 3, p = 0,024.

H_0 (C) = "*The contract owner type has no influence on cost performance"*

Thus, H_0 (C) is rejected and H_1 (C) is accepted.

H_1 (C) = "*The contract owner type has influence on cost performance"*

This means that the contract owner has influence on cost performance. The Mann-Whitney test has been conducted between different combinations of contract owner and cost performance to further investigate which contract owner has a significant relationship with cost overrun. The test showed that *municipalities* and *companies* as contract owners have a statistically significant relationship with cost overrun (Mann-Whitney U = 292,00, z = -2,430, p = 0,015)

4.4 Cost overrun explanations

Q2.4) – "*How can the difference in cost performance between Design-Build and Design-Bid-Build projects in the Dutch infrastructure field be explained?"*

The following section tries to give explanations for cost overrun by using the results from the interview. Many contract owners face declining levels of human resources and knowledge levels among employees according to the respondent. The consequences of this are mentioned hereafter:

1)

The lack of knowledge and capacity influences the cost performance. For instance, with Design-Bid-Build projects often third parties are brought in to assist with the design phase due to the lack of capacity on the owner of the contracts' side. In turn, this leads to poor designs which are offered to the market for biddings. Subsequently, the contractor for the build phase experiences cost overrun due to fallacies in the design.

2)

Furthermore, outdated budgets are used in certain projects since there are not enough employees on the contract owners' side to keep budgets up-to-date. The projects are designed on budgets which have been established years ago. Often the outdated budgets are not tested to the contemporary situation. As a result, the discrepancies within the design phase lead to cost overrun in the build phase. This phenomenon occurs with nearly every project type according to the interviewee.

3)

It is difficult to align the design and building phase with each other. There is not enough time due to restricted workforce capacity to fine-tune both phases with each other. The respondent told that he has worked on ample projects (i.e. Design-Build projects) where they were already building without having any idea what the next steps were or what the conceptual design was going to be. This led to a standstill of the building project team which resulted in cost overrun.

4.5 Cost overrun recommendations

Q3) – *"How can the cost overrun of Design-Build and Design-Bid-Build projects be reduced?"*

The following recommendations are extrapolated from the interview. The first step to reduce cost overrun is by increasing capacity in workforce among contract owners. This enables them to do more work 'in-house' instead of outsourcing work to other companies with cost overrun as a result.

The second step entails an increased focus on education. In line with increasing capacity, it would be beneficial to invest in education of employees. With more employees who are better trained reducing cost overrun becomes more attainable.

These two recommendations counter the consequences of declining employee numbers and knowledge levels as discussed in chapter 4.4.

5. Conclusions

Q1) = "*How do Design-Build and Design-Bid-Build projects in the Dutch infrastructure field perform with regard to costs?"*

The statistical tests showed no significant cost performance advantage of Design-Build over Design-Bid-Build or the other way around. In addition, no significant relationship was found between project type and cost performance. Other statistical tests between cost overrun and contract owner showed that the contract owners *municipality* and *company* have a significant relationship with cost overrun.

It must be noted that in the dataset Design-Bid-Build projects (6,1%) experienced cost underrun. On the contrary, Design-Build projects have not experienced cost underrun.

The conducted interview confirmed that there is no difference in cost performance between the two contract types. From the interview it was concluded that the respondent experienced knowledge withdrawal and human resource capacity limitations among owners of contracts regardless of the contract type, especially for governmental owners of contract such as municipalities this was the case. To counter cost overrun, this study recommends contract owners to invest in human resource capacity and knowledge levels among employees.

6. Discussion

This study offered a contribution to existing literature about cost performance advantage between Design-Build and Design-Bid-Build. It attempted to fill the research gap on cost performance and Design-Build and Design-Bid-Build specifically in the Dutch context. In addition, this research provides recommendations to counter cost overrun.

With the methods used in this thesis, it is concluded that there is no difference in cost performance between Design-Build and Design-Bid-Build. This study has analysed multiple variables in its attempt to explain cost performance related to project delivery methods. The variables are contract type, project type and contract owner. The year in which the project was realized was not included as a variable. Further research could include time as a variable to increase understanding on this topic.

Whereas Design-Build contracts include design costs, Design-Bid-Build contracts do not include design costs. Rather, Design-Bid-Build contracts solely include the construction costs. Evidently, this has consequences for both the definition of costs and the comparability between contract types. It could therefore be argued that comparing Design-Build and Design-Bid-Build is like comparing apples with oranges. Through thorough and extensive discussion of the definitions and methodology this comparison was justified as much as possible.

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Appendices

Appendix 1

The '*RAW-Systematiek'* proceeds on the distribution of risk and responsibilities which have been defined in the *Uniforme Administratieve Voorwaarden (*UAV) for the execution of (technical) construction projects. It could be argued that the *Uniforme Administratieve Voorwaarden* sets the outlines for such projects and that the *RAW-Systematiek* specifies the technical requirements of each project (CROW, 2014).

The terms '*Standaard RAW Bepalingen'* and '*RAW-Systematiek'* are often used interchangeably. For many contracts the 'Standaard RAW Bepalingen' or 'Standard RAW Determinants' forms the technical basis. *RAW* is an abbreviation for *Rationalisatie en Automatisering Grond, Water- en Wegenbouw* (CROW, 2014). The *RAW-Systematiek* is a set of technical, administrative and juridical requirements which form the basis for the execution of contracts (PIANOo - Expertisecentrum Aanbesteden, 2021).

Contracts that utilize the different editions of the *U.A.V.* are often constructed by the owner of the contract. The drafted contract includes the work to be carried out, the quantities and the design. The contract is then offered to the market as request for proposal. Different companies draw up a bid which they submit to the owner of the contract. The owner of the contract selects a contractor to carry out the project as specified in the contract with the accompanying *RAW-Systematiek and U.A.V. edition* on the basis of a certain criteria. This criteria could be the company who offers the lowest price or the company who paid the most attention to sustainable methods

With *U.A.V. GC* the contractor provides the design and the construction. The design can either be drafted by the contractor themselves or by a party which has been committed to the project as a subcontractor. With the finalized design, the project can be executed. Normally, the first contractor which also took care of the design is allowed to carry out the project. However, this is not always the case.

There are multiple variations on Design-Build contract types. A Dutch example is the *bouwteam*. This is a *project specific partnership* between the owner of the project, the contractor and possibly other firms such as engineers and architects. Within the *bouwteam* there are essentially two phases, the design phase and the building phase. If the agreement for the project is made it does not automatically mean that the design and building phase is done by the same company (Synquis, 2020). Note that the *bouwteam* is not a contract type in itself. The *bouwteam* is rather an arrangement between parties based on the UAV-GC contracts.

Appendix 2

Here the different project types are clarified.

1) Decontamination projects

Decontamination projects or ‘sanering projecten’ are projects wherein substances or products are removed from the environment where they are located and do not belong naturally. A list of these substances can be found hereunder.

List of substances within decontamination projects

Dutch	English
Verontreinigd water met olie	Polluted water with oil
Minerale olie	Mineral oil
Olie	Oil
Zware metalen	Heavy metals
Asbest	Asbestos
Amosiet asbest	Amosite
Teer	Tar
Polycyclische Aromatische Koolwaterstoffen (PAK)	Polycyclic Aromatic Hydrocarbons (HAC)
Zink	Sink
Nikkel	Nickel
Kwik	Mercury
Zwavel	Sulfur
Sulfaat	Sulphate
Fluoride	Fluoride
Cyanide	Cyanide
Zoutzuur	Hydrochloric acid
Ludox PW50	Ludox PW50
Natriumnitriet	Sodium nitrite
Xyleen	Xylene
Polychloorbifenyl (PCB)	Polychlorinated biphenyls (PCBs)
Acetyleen	Acetylene
Lubront	Lubront
Lubront 710-2	Lubront 710-2
Barium	Barium
Natronloog	Caustic soda
Natrium hypochlorite	Sodium hypochlorite
Natriumhydroxide	Sodium hydroxide
Aceton	Acetone
Vluchtige OrganoChloor-verbindingen (VOCL)	Volatile Organochlorine Compounds (VOC)

The decontamination projects come along with strict protocols to prevent further spreading of the hazardous materials. Therefore, relatively small projects could turn out costly due to the intensive legislation and obligations around decontamination projects. The decontamination projects are carried out under the BRL7000 and the accompanying Protocol 7001 to safeguard the correct containment of the substances.

2) General maintenance

General maintenance or ‘algemeen onderhoud’ are projects wherein objects receive efforts to repair or sustain the object. The general maintenance could apply to buildings, parks, public greenery, and public space.

3) Waterworks

Waterworks or ‘water gebonden projecten’ are projects that take place directly on or around bodies of water. Also projects that will facilitate water management in the future are grouped under this project type. Among the frequently seen projects are dredging of canals, creating new bodies of water for water storage, water defences, quays and building water management constructions such as pumps stations and regulatory stations.

Within other projects, waterworks are regularly included. In those cases, they fulfil small portions of the whole project. Projects are only included with the project type ‘waterworks’ when the purpose of the project is to facilitate (better) water management.

4) Nature works

Nature works or ‘natuur gebonden projecten’ are projects that take place directly within or around nature areas. For instance, forests, plains, large parks and nature reserves. Projects that facilitate the existence or preservation of nature are also gathered under this project type.

5) Road maintenance

Road maintenance or ‘wegen onderhoud’ are projects that relate to roads as their current form is in need of replacement. Occasionally, portions or the whole road are overhauled. Hereby, there are no adaptations to the original design. In other words, the layout of surroundings and materials remains the same, the road is only brought back to its original shape.

6) Road (re)construction

Road (re)construction or ‘wegen reconstructie’ are projects that (re)construct roads as their current form no longer fits their purpose. Often, the current lay-out of the roads is not in line with the user of the roads. Examples of such projects are roads that are made more bike and pedestrian friendly and roads that are made less car friendly. It happens frequently that such projects are executed together with sewerage (re)construction projects. However, under this project type only road (re)construction projects are gathered.

7) Sewerage (re)construction

Sewerage (re)construction or ‘riool vervanging’ are projects that (re)construct sewerage systems as the systems are outdated, damaged or in need of repair. Frequently seen sewerage (re)construction projects entail the realisation of separated systems wherein rain water and waste water are drained separately. This benefits the treatment plant as the capacity only needs to be adapted to the waste water and not to the rain water which shall be drained to bodies of water or into the soil.

8) (re)development of public space

(re)development of public space or ‘herinrichting’ are comprehensive projects where multiple aspects are gathered in one project. In practice, this entails the combination of road (re)construction and sewerage (re)construction. The aforementioned activities are good opportunities to enhance the public realm. This leads to more public values being added to the environment during the road (re)construction and sewerage (re)construction activities. For instance, city centres are made more attractive by removing motorized traffic flows, adding greenery, and adding interactive street furniture.

9) Site preparation

Site preparation or ‘bouwrijp maken’ are projects wherein basis infrastructure, such as roads and cables/sewerage, are constructed in preparation of housing construction. The development of new housing brings along intense periods of construction. To ensure accessibility during construction, simple yet robust roads are constructed in the new neighbourhood which can endure heavy construction traffic. Site preparation includes the construction of sewerage and simple road construction. For the road construction only the main carriageway is constructed, pavement and bicycle paths are left out of the construction as only heavy construction traffic will use the roads.

10) Housing preparation

Housing preparation or ‘woonrijp maken’ projects follows the site preparation projects. After the site preparation, buildings can be build. When the realisation of new buildings is finalized, it is time to proceed with housing preparation. This entails the construction of complete infrastructure such as pavement, bicycle paths, and multiple carriageway. Furthermore, if there is going to be greenery in the neighbourhood this is also created during the housing preparation. Housing preparation is the last step before the new housing and new neighbourhood become completely liveable.

Appendix 3
Interview Guide

Introductie

Hallo, ik ben Matijn Wubbels. Allereerst wil ik u bedanken voor uw aanwezigheid en medewerking aan dit interview. Daarnaast wil ik u bedanken voor het verlenen van toegang tot uw database. Dit heeft aanzienlijk bijgedragen aan mijn onderzoek.

Momenteel werk ik aan mijn Bachelor-scriptie als onderdeel van de Bachelor Spatial Planning and Design aan de Faculteit der Ruimtelijke Wetenschappen van de Rijksuniversiteit Groningen.

Binnen mijn scriptie doe ik onderzoek naar de prestatie van verschillende contract types in relatie tot kosten management. Hiervoor wil ik u graag enkele vragen stellen.

Dit interview wordt opgenomen zodat na afloop de resultaten verwerkt kunnen worden. Zou u kunnen aangeven of u akkoord gaat met de opname van dit gesprek?

Ik wil mededelen dat u tijdens het gesprek altijd uw vragen kunt stellen. Daarnaast is het altijd mogelijk het interview af te breken als u dat wilt.

Heeft u voordat we beginnen vragen of opmerking?

Verkennende vragen

De onderstaande vragen dienen als hulpmiddel. Het gesprek waarin deze vragen gesteld worden zal dienen als verkenning van het onderwerp en de deelnemers aan dit interview. Binnen dit verkennende deel is er ruimte om kennis met elkaar te maken. Het doel van dit verkennende deel is het comfortabel geraken met de setting.

1. Zou u uzelf kort kunnen voorstellen?
2. Indien nog niet beantwoord door vraag 1.
    a. Wat is uw functie bij de aannemer?
3. Indien nog niet beantwoord door vraag 1.
    a. Zou u uw taken en verantwoordelijkheden vanuit uw functie kunnen toelichten?
4. Indien nog niet beantwoord door vraag 1.
    a. Bent u op de hoogte en/of bekend met het onderwerp in kwestie?

Kennismaking met onderzoek

In mijn onderzoek ben ik nieuwsgierig naar de kosten prestatie van verschillende contractvormen. In de literatuur wordt een onderscheid gemaakt tussen contract vormen waarin het ontwerp van een project opgenomen is en dus deel uitmaakt van het contract. Aan de andere zijde zijn er de contracten waar enkel de uitvoering deel uitmaakt van het contract. Het discussie punt onder academici vloeit voort uit het debat of de inclusie van het ontwerp in het contract kostenbesparend werkt.

Voor mijn onderzoek heb ik kosten prestatie van verschillende contracten als volgt geformuleerd: *kostenprestatie = aanneemsom – gefactureerd bedrag.*

Categorieën en frequenties

Voor dit onderzoek heb ik data mogen gebruiken vanuit uw project database. Binnen de data zijn de volgende categorieën en hoeveelheden geïdentificeerd.

Contract type	Contract vormen	Frequentie
Design-Build (DB)	*UAV-GC 2000* *UAV-GC 2005*	31
Design-Bid-Build (DBB)	*U.A.V. 1989* *U.A.V. 2012* *U.A.V. 2015* *U.A.V. 2020*	148

Toelichting: Voor de Design-Build contract types zijn overige contractvormen waarin ontwerpen meegenomen worden ook bij inbegrepen.

Vanuit de dataset heb ik de volgende project types geïnventariseerd.

Nr.	Project type	Frequentie
1	Sanering projecten	11
2	Algemeen onderhoud	7
3	Water gebonden projecten	26
4	Natuur gebonden	10
5	Onderhoud aan wegen	9
6	Aanleg van wegen	32
7	Aanleg van riool	27
8	Herinrichting openbare ruimte	34
9	Bouwrijp maken (BRM)	17
10	Woonrijp maken (WRM)	6

Vanuit de dataset heb ik de volgende contracteigenaren geïdentificeerd.

Nr.	Contract eigenaar	Frequentie
1	Gemeenten	142
2	Regionale overheid	12
3	Waterschap	17
4	Bedrijven	8

Heeft u over de categorisatie en indeling van de data nog vragen?

Indien u geen vragen heeft, stel ik u een aantal vragen over deze categorieën in relatie tot kosten prestatie zonder dat u op de hoogte bent van de data analyse resultaten.

Inhoudelijke vragen (deel 1)

Toelichting: Deze vragen zijn bedoeld als sturing voor het gesprek. Naast deze vragen is er ruimte voor andere onderwerpen of vragen welke tijdens het gesprek aan bod komen.

Verdeling

Vraag 1: Komt de verdeling van contract types overeen met uw ervaring in de praktijk?

Vraag 2: Komt de verdeling van project types overeen met uw ervaring in de praktijk?

Vraag 3: Komt de verdeling van contract eigenaren overeen met uw ervaring in de praktijk?

Kosten prestatie

Vraag 4: Naar uw ervaring in de praktijk, welke contractvorm presteert beter qua kosten?

Vraag 5: Naar uw ervaring in de praktijk, welke project type presteert het beste qua kosten?

Vraag 6: Naar uw ervaring in de praktijk, welke contract eigenaar presteert het beste qua kosten?

Combinatievragen

Vraag 7: Merkt u dat bepaalde combinaties van contract types, project types en contract eigenaren vaak voorkomen in de praktijk?

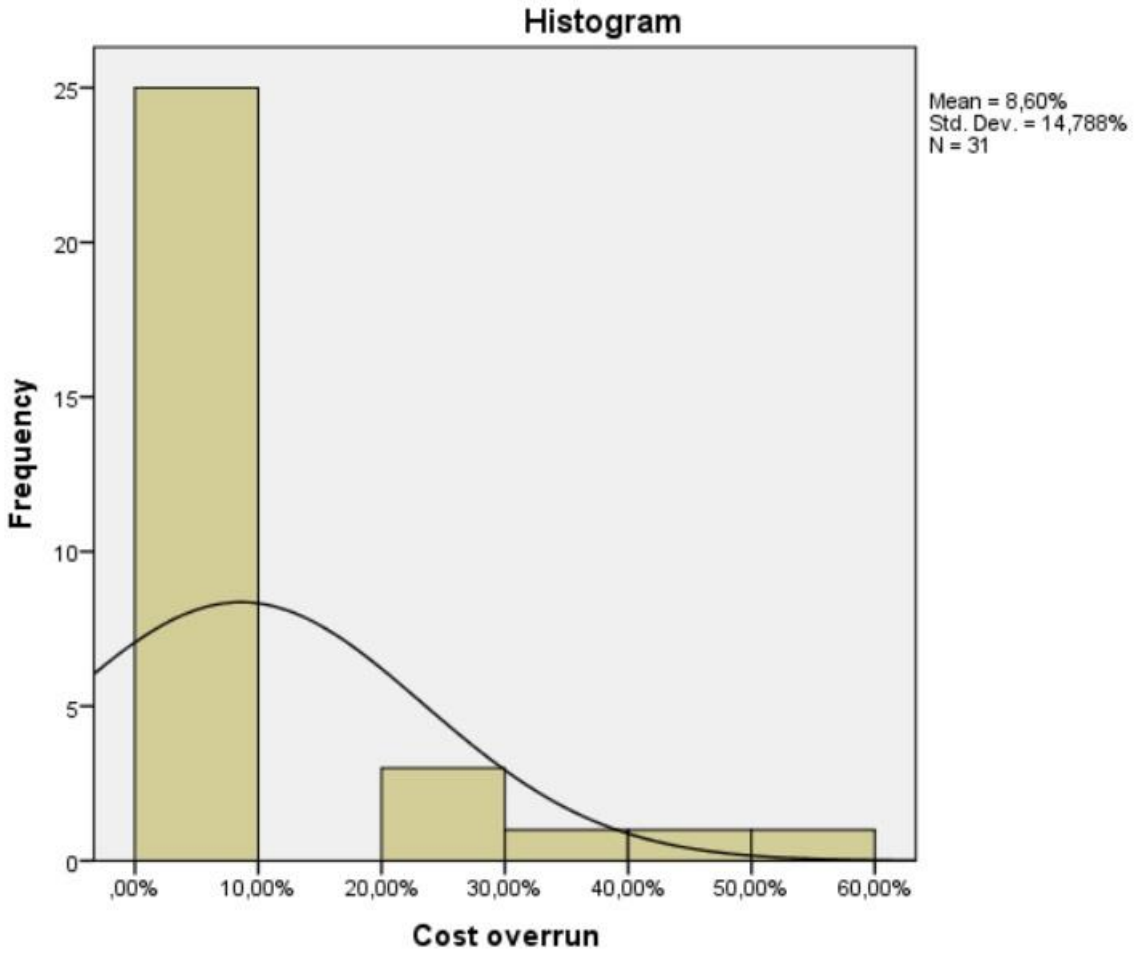
Vraag 8: Merkt u dat bepaalde combinaties van contract type, project type en contract eigenaren in de praktijk leiden tot kosten overschrijding dan wel kosten besparing?

Vraag 9: Ervaart u andere zaken uit de praktijk gerelateerd tot kosten besparing die nog niet benoemd zijn?

Hierna toon ik u de resultaten van de data analyse. Als de resultaten doorgenomen zijn, leg ik u enkele vragen voor met betrekking tot de kosten prestatie.

Resultaten data analyse

Uitleg statistische methode vooraf en tijdens dat de resultaten besproken worden.



Design-Build

In de onderstaande tabel staat beknopt de gemiddelden en medianen van de kosten prestatie per project type met het contract type Design-Build. Gemiddeld wordt een project met het contract type Design-Build met 8,59% aan kosten overschreden. De mediaan voor een project met het contract type Design-Build is 1,34% voor kosten overschrijding.

Kosten overschrijding per project type

Report

Costoverrun_DesignBuild

Project Type	Mean	N	Std. Deviation	Median
General maintenance	,0000	1	.	,0000
Waterworks	12,9039	3	21,20566	1,3338
Nature works	2,2905	2	3,23928	2,2905
Road maintenance	,0000	2	,00000	,0000
Road (re)construction	13,8889	5	23,56712	5,8425
Sewerage (re) construction	6,7048	5	10,24026	4,4264
(re)development of public space	10,3044	11	15,44529	2,8547
Site preperation	3,4282	2	4,84824	3,4282
Total	8,5957	31	14,78778	1,3338

Kosten overschrijding per contract eigenaar

In de onderstaande tabel staat beknopt de gemiddelden en medianen van de kosten prestatie per contract eigenaar met het contract type Design-Build.

Contracten in beheer van het waterschap ervaren gemiddeld de grootste kosten overschrijding. Hier moet echter geconcludeerd worden dat één waarneming de resultaten enorm beïnvloedt. Daarom kan deze uitkomst niet vergeleken worden.

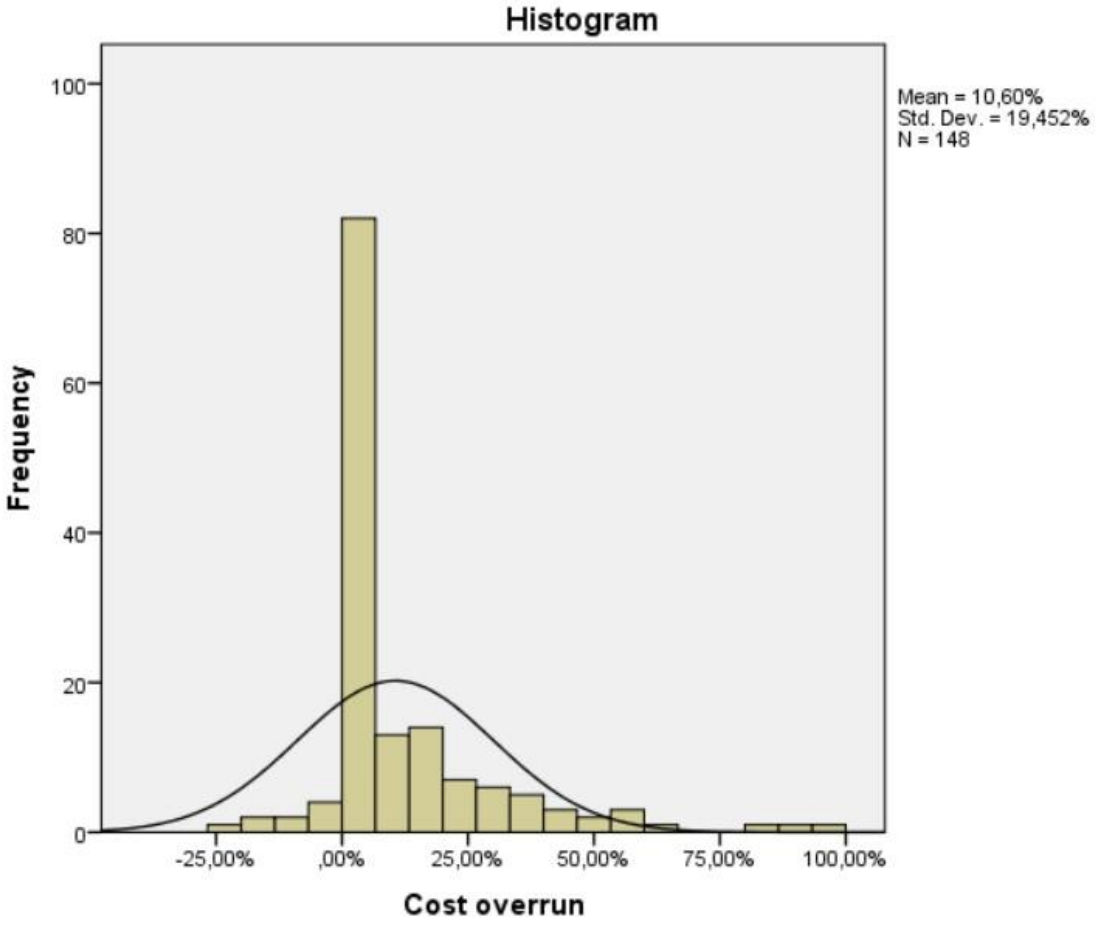
Gemiddeld zijn contracten in beheer van de gemeente het meeste onderhevig aan kosten overschrijding met 8,5%. Hierbij is de mediaan 2,8% kostoverschrijding.

Report

Costoverrun_DesignBuild

Owner of the Contract	Mean	N	Std. Deviation	Median
Municipalities	8,4847	27	14,55750	2,8547
Regional government	,0000	2	,00000	,0000
Waterboard	37,3780	1	.	37,3780
Private companies	,0000	1	.	,0000
Total	8,5957	31	14,78778	1,3338

Design-Bid-Build



In de onderstaande tabel staat beknopt de gemiddelden en medianen van de kosten prestatie per project type met het contract type Design-Bid-Build. Gemiddeld wordt een project met het contract type Design-Bid-Build met 10,6% aan kosten overschreden. De mediaan voor een project met het contract type Design-Build is 0,00% voor kosten overschrijding.

Kosten overschrijding per project type

Report

Costoverrun_DesignBidBuild

Project Type	Mean	N	Std. Deviation	Median
Decontamination projects	2,7327	11	9,06348	,0000
General maintenance	,0000	6	,00000	,0000
Waterworks	10,4200	23	22,52684	,0000
Nature works	4,3383	8	15,91516	,0000
Road maintenance	6,9844	7	11,03481	,0000
Road (re)construction	12,6460	27	17,18761	8,1725
Sewerage (re) construction	9,7016	22	19,88745	,0000
(re)development of public space	9,0359	23	13,63705	5,5988
Site preperation	21,4285	15	32,26608	,0000
Housing preperation	21,8368	6	20,07791	21,1229
Total	10,5978	148	19,45209	,0000

Kosten overschrijding per contract eigenaar

In de onderstaande tabel staat beknopt de gemiddelden en medianen van de kosten prestatie per contract eigenaar met het contract type Design-Bid-Build. Gemiddeld zijn contracten in beheer van de gemeente het meeste onderhevig aan kosten overschrijding met 12,3%. Hierbij is de mediaan 2% kostoverschrijding.

Report

Costoverrun_DesignBidBuild

Owner of the Contract	Mean	N	Std. Deviation	Median
Municipalities	12,2945	115	19,09828	2,0050
Regional government	3,1848	10	6,40193	,0000
Waterboard	7,6720	16	28,12939	,0000
Private companies	,0000	7	,00000	,0000
Total	10,5978	148	19,45209	,0000

Voordat we verder gaan met het tweede deel van de inhoudelijke vragen, heeft u nog vragen over de resultaten van de data analysis?

Inhoudelijke vragen (deel 2)

Toelichting: Deze vragen zijn bedoeld als sturing voor het gesprek. Naast deze vragen is er ruimte voor andere onderwerpen of vragen welke tijdens het gesprek aan bod komen.

Kosten prestatie

Vraag 1: Komt de kosten prestatie van de contract types overeen met uw ervaring in de praktijk?

> Vraag 1a: Kunt u vanuit uw ervaring in de praktijk deze verschillen in kosten prestatie verklaren?

Vraag 2: Komt de kosten prestatie van project types overeen met uw ervaring in de praktijk?

> Vraag 2a: Kunt u vanuit uw ervaring in de praktijk deze verschillen in kosten prestatie verklaren?

Vraag 3: Komt de kosten prestatie van contract eigenaren overeen met uw ervaring in de praktijk?

> Vraag 3a: Kunt u vanuit uw ervaring in de praktijk deze verschillen in kosten prestatie verklaren?

Verdieping

Vraag 4: Herkent u dat Design-Build project geen kostenbesparing ervaren in de praktijk?

Vraag 5: Kunt u dit vanuit uw ervaring in de praktijk verklaren?

Vraag 6: Herkent u dat Design-Bid-Build projecten wel kostenbesparing ervaren in de praktijk?

Vraag 7: Kunt u dit vanuit uw ervaring in de praktijk verklaren?

Verbetering

Vraag 8: Ziet u mogelijkheden om de kosten prestatie van Design-Build contracten te verbeteren?

Vraag 9: Ziet u mogelijkheden om de kosten prestatie van Design-Bid-Build contracten te verbeteren?

Vraag 10: Ziet u mogelijkheden om de kosten prestatie van de project types te verbeteren?

Vraag 11: Ziet u mogelijkheden om de kosten prestatie met de verschillende contract eigenaren te verbeteren?

Einde

Bedankt voor uw tijd. Hiermee is het interview ten einde gekomen.

Heeft u vragen voor mij of punten die u verheldert wilt hebben?

Indien u geen vragen meer heeft, schakel ik hierbij de opname uit. Mocht u na het uitschakelen nog de behoefte hebben om verder te praten, dan is dit zeker mogelijk.

Appendix 4

English version

Consent form

Hereby Matijn Wubbels, here after referred to as interviewer, and [name participant], here after referred to as interviewee, express and declare their consent for an interview.

Within the interview, the interviewer asks the interviewee about the cost performance of different contract types.

Consent - Interviewer

The interviewer acknowledges the rights of the interviewee. The interviewee is always allowed to cancel the interview and revoke their consent to this interview. The interviewer provides the interviewee with the results of the interview and the thesis if the interviewee desires to. The interviewer states and ensure the anonymity of the interviewee unless the interviewee states otherwise.

Consent - Interviewee

The interviewee understands that the interview is being recorded for research purposes. The interviewee understands that the questions within the conversation are being used to answer questions about cost performance. If the interviewee desires to stop the interview, the interviewee is free to do so. The interviewee can always request to receive the results of the interview and thesis.

Signature interviewer	**Signature interviewee**
Matijn Wubbels	[Name interviewee}
06-05-2020	[Date of signing]

Appendix 5

Dutch version – handed to interviewee

Formulier voor toestemming

Hierbij drukken Matijn Wubbels, hierna te benoemen als **interviewer**, en [Naam geïnterviewde], hierna te benoemen als **geïnterviewde** , hun rechten en toestemming uit voor een interview.

Voor het interview wordt de **geïnterviewde** gevraagd naar de kostenprestatie van verschillende contract types.

Toestemming en rechten – Interviewer

De **interviewer** erkent de rechten van de **geïnterviewde**. Het is de **geïnterviewde** altijd toegestaan om het interview te stoppen. Daarnaast het is altijd mogelijk om terug te komen op de verleende toestemming. Na afloop van het interview verschaft de **interviewer** de **geïnterviewde** met de resultaten van dit interview en deze scriptie als de **geïnterviewde** hier interesse in heeft. De **interviewer** verzekert de anonimiteit van de **geïnterviewde** tenzij de **geïnterviewde** iets anders aan geeft.

Toestemming en rechten – Geïnterviewde

De **geïnterviewde** begrijpt dat het interview wordt opgenomen voor onderzoeksdoeleinden. De **geïnterviewde** begrijpt dat de gestelde vragen binnen het gesprek gebruikt worden om de onderzoeksvragen over kosten prestatie te beantwoorden. Als de **geïnterviewde** het interview wenst te beëindigen staat het de **geïnterviewde** dit te doen. Het staat de **geïnterviewde** vrij om de resultaten van dit interview en de scriptie op te vragen. De **interviewer** dient hiertoe medewerking te verlenen.

Handtekening interviewer	**Handtekening geïnterviewde**
Matijn Wubbels	[Naam geïnterviewde]
07-05-2021	[Datum ondertekening]

Appendix 6

This appendix contains the non-normality testing. Hereby the hypotheses are as follows:

H_0 (N1) = *The dependent variable (1) cost performance of Design-Build contract is normally distributed*

H_1 (N1) = *The dependent variable cost performance of Design-Build contract is not normally distributed*

And,

H_0 (N2) = *The dependent variable (2) cost performance of Design-Bid-Build contract is normally distributed*

H_1 (N2) = *The dependent variable cost performance of Design-Bid-Build contract is not normally distributed*

H_0 (N1)

To establish the normality of dependent variable 1, all the Design-Build projects were selected within the dataset. Secondly, several normality tests were conducted. The Shapiro-Wilkinson test showed that the variable cost overrun is not normally distributed with *p* = 0,000 for Design-Build projects. Also the Kolmogorov-Smirnov showed that the variable cost overrun is not normally distributed with p = 0,000.

Looking at figure X, the non-normality of dependent variable 1 is confirmed visually.

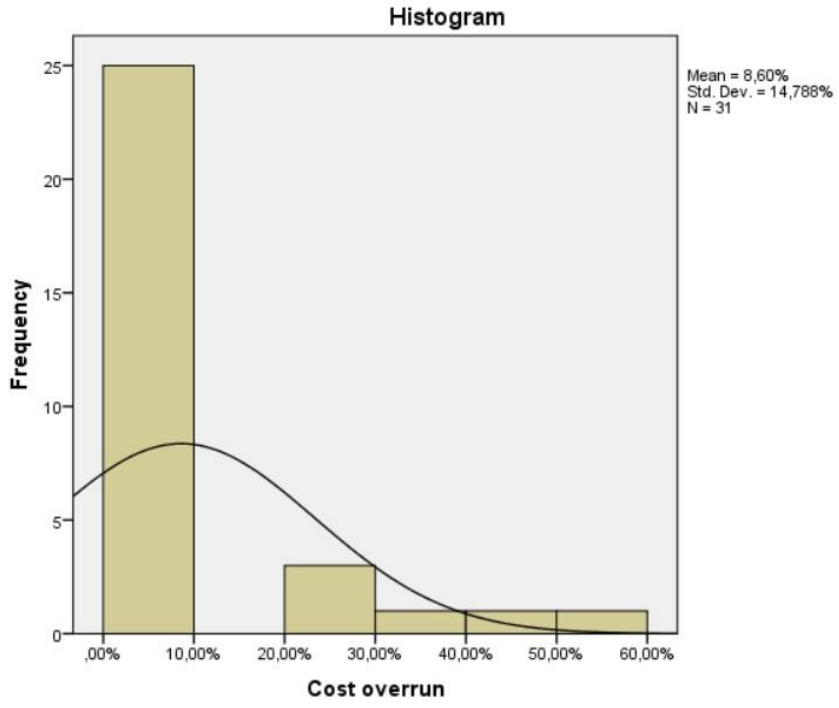


Figure 1 – Cost overrun for Design-Build projects

With this, we reject the hypothesis H_0 (N1) and thus accept the hypothesis H_1 (N1). This means that the dependent variable 1 is not normally distributed.

H_0 (N2)

For dependent variable 2, the same procedure was followed as with dependent variable 1. The Design-Bid-Build projects were selected within the dataset. Hereafter, the normality tests were conducted. The Shapiro-Wilkinson test showed that the variable cost overrun is not normally distributed with p = 0,000 for Design-Bid-Build projects. The Kolmogorov-Smirnov test also proved the non-normality of cost overrun with p = 0,000.

The non-normality of dependent variable 2 is visualized and confirmed in figure X

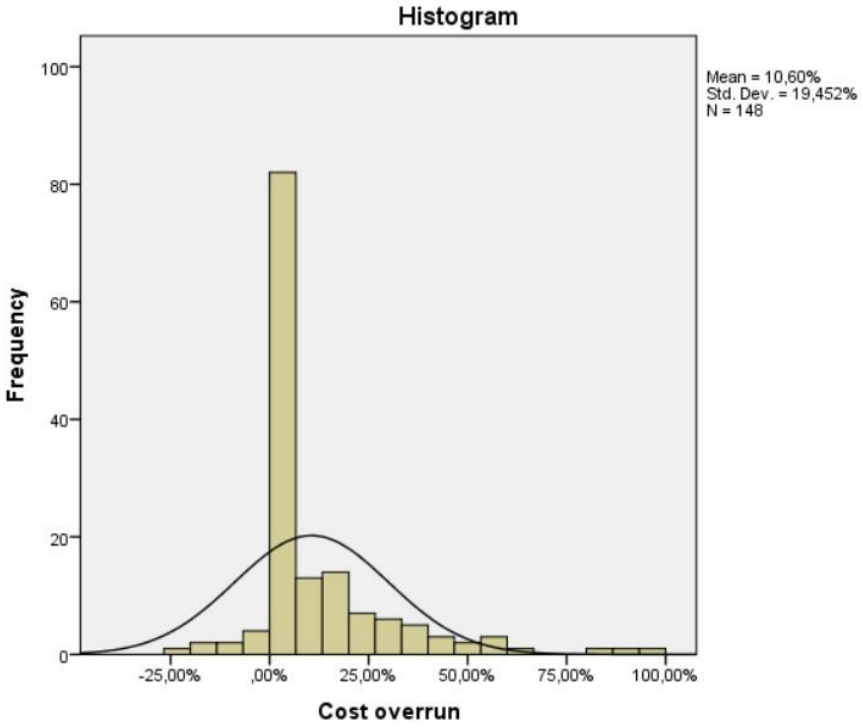


Figure 2 – Cost overrun for Design-Bid-Build projects

With this, we reject the hypothesis H_o (N2) and thus accept the hypothesis H_1 (N2). This implies that dependent variable 2 is not normally distributed.

Appendix 7

Under this chapter the crosstabulation tables between the variables are listed. This clarifies the distribution of variables among each other.

		Contract type		
		Design-Build	Design-Bid-Build	Total
Owner of the Contract	Municipalities	27	115	142
	Regional government	2	10	12
	Waterboard	1	16	17
	Private companies	1	7	8
Total		31	148	179

		Contract type		
		Design-Build	Design-Bid-Build	Total
Project Type	Decontamination projects	0	11	11
	General maintenance	1	6	7
	Waterworks	3	23	26
	Nature works	2	8	10
	Road maintenance	2	7	9
	Road (re)construction	5	27	32
	Sewerage (re) construction	5	22	27
	(re)development of public space	11	23	34
	Site preperation	2	15	17
	Housing preperation	0	6	6
Total		31	148	179

		Owner of the Contract				
		Municipalities	Regional government	Waterboard	Private companies	Total
Project Type	Decontamination projects	8	0	0	3	11
	General maintenance	0	4	0	3	7
	Waterworks	9	2	15	0	26
	Nature works	5	4	1	0	10
	Road maintenance	9	0	0	0	9
	Road (re)construction	31	1	0	0	32
	Sewerage (re) construction	25	0	1	1	27
	(re)development of public space	33	1	0	0	34
	Site preperation	16	0	0	1	17
	Housing preperation	6	0	0	0	6
Total		142	12	17	8	179