IMPLICATIONS OF THE TWO STAGE MODEL ON SUSTAINABILITY OF DUTCH INFRASTRUCTURE PROJECTS

Altan Ceylan
5185238

Boskalis | TU Delft

July 12, 2022
A. Ceylan

Implications of the Two-Stage Model on Sustainability of Dutch Infrastructure Projects

By

Altan Ceylan
Student number: 5185238

In partial fulfilment of the requirements for the degree of

Master of Science
in Construction Management and Engineering

at the Delft University of Technology
to be publicly defended on July 12th, 2022.

Thesis committee:

Chair	**Bert van Wee**	Delft University of Technology
Supervisor	**Jan Anne Annema**	Delft University of Technology
Supervisor	**Daan Schraven**	Delft University of Technology
Company supervisor	**Jord Groot**	Boskalis Nederland

An electronic version of this thesis is available at http://repository.tudelft.nl/.

Preface

In front of you lies the thesis 'Implications of the Two-Stage Model on Sustainability of Dutch Infrastructure Projects', which I carried out in partial fulfilment of my master's program in Construction Management and Engineering (CME) at Delft University of Technology. This research has been conducted from February to July 2022 under supervision of Boskalis Nederland. The process of completing this thesis brought me through many valuable experiences and knowledge from the professionals that were involved in this thesis.

Looking back at conducting this research and having the desired outcome, I was able to combine two topics that are currently extremely relevant in the Dutch construction industry. The results from this research provide insights for parties in the Dutch construction industry in implementing sustainable solutions in two-stage infrastructure projects and how it can create impact on the Dutch construction industry.

I would like to express my gratitude to my graduation committee from the Delft University of Technology, Bert van Wee, Jan Anne Annema and Daan Schraven, for helping me through this process. Their constructive feedback contributed a lot in improving the clarity and the academic quality of this research. In addition, the dynamics in the meetings have motivated and challenged me to make the most out of this research. My questions were always answered clearly and on time which I truly appreciated.

Second, I would like to thank my supervisor Jord Groot from Boskalis Nederland. He gave me the opportunity to perform this research at one of the biggest contractors of the Netherlands. His critical view on various topics helped me to think through different aspects and steered me in the right direction. Also, he helped me to get in touch with colleagues from Boskalis Nederland that had affiliation with my research topic which delivered valuable information for this research.

Further, I would like to thank all the respondents of the interviews. The interviews led to interesting discussions and data about sustainability and the two-stage model. Without them it was not possible to carry out this study.

Last but not least, I would like to thank my family and friends for all their support which motivated me to achieve the maximum during my entire career as a student.

Enjoy reading!

Altan Ceylan
Zaandam, July 2022

Abstract

The Dutch cabinet, organizations, and companies in the Netherlands anticipated to the Paris Agreement of 2015 by forming a national Climate Agreement. This package of measures influences the Dutch infrastructure sector where the objective is to become more sustainable (Rijksoverheid, 2019). The responsibility for keeping the infrastructure of the Netherlands at the highest level lies with Rijkswaterstaat. Rijkswaterstaat is aware that increasing demands are being made in terms of sustainability and efficiency in the Dutch infrastructure sector. Implementing these demands requires a sustainable, innovative, financially healthy, and competitive infrastructure sector. However, due to the current market dynamics and the way in which risks in large projects are handled, market forces are in danger of being lost (Rijkswaterstaat, 2019). In order to enable the transition to this desirable infrastructure sector, Rijkswaterstaat introduced the "two-stage model" as an instrument which may help to carry out the transition. The two-stage model is defined as "*A process in which explicit attention is paid to risks and inherent uncertainties during the entire execution phase and the price agreement is only made for the riskiest parts of the execution phase when risks can be better estimated, and clearer agreements can be made on the distribution of risks.*" (Rijkswaterstaat, 2020a, p.23).

Rijkswaterstaat has introduced the two-stage model in the Dutch construction industry in order to reduce risks in large and complex projects (Rijkswaterstaat, 2020a). However, it is also possible that the two-stage model can influence the sustainability of infrastructure projects since the risks are reduced and a different way of collaboration between market parties and public parties is introduced. Nevertheless, it is unknown if the two-stage model makes an impact on sustainability of infrastructure projects. Boskalis Nederland, where this research is performed, is interested in if the two-stage model can make an impact on sustainability of infrastructure projects because of the high relevance of these two topics in the Dutch infrastructure sector. Therefore, the main objective of this study is to explore the impact of the two-stage model on sustainability of infrastructure projects. Taking into account the knowledge gap, the problem statement and the research objective, the main research question is defined as follows:

"What is the impact of the two-stage model on sustainability of Dutch infrastructure projects?"

The expectation regarding the impact of the two-stage model on sustainability of infrastructure projects is that the model will offer market parties and public parties more room to discuss, incentivise and implement sustainable solutions in infrastructure projects because of the integral collaboration between the parties in the project team. The impact of the two-stage model on sustainability could be seen when comparing the model to a one-stage collaboration model. For example, a technical specification (which is a one-stage collaboration model), is characterized by having result-oriented specifications prescribed by the public client which results in leaving little freedom for the contractor for sustainable input in infrastructure projects. In contrast, the two-stage model is characterized by collaboration between the involved parties which creates more freedom for input on sustainability from the involved parties. This may lead to a bigger chance to implement sustainable solutions in infrastructure

projects. The essential difference between the two collaboration models is the collaboration aspect between the involved parties, which eventually may make a difference in chances to implement sustainable solutions in infrastructure projects.

Research method

Data collection has been performed in order to answer the main research question and to achieve the objective of this study. The data collection started with literature review and desk research on the two-stage model in the Netherlands, sustainability tools that can be implemented in Dutch infrastructure projects, and factors that influence sustainable infrastructure development. Documents were analysed and summarized where the found data was used as a part of the foundation for the entire research. In order to explore the impact of the two-stage model on sustainability of Dutch infrastructure projects, the differences between the two-stage model and one-stage collaboration models had to be analysed. This analysis was performed by conducting semi-structured interviews with professionals of different parties in the Dutch construction industry that worked on or are currently working on two-stage infrastructure projects in the Netherlands. The preparation of the semi-structured interviews started with drawing up interview questions from data that was extracted from the desk research and literature research combined with the sub questions and the objective of this research. Because of saturation of information, 12 semi-structured interviews have been conducted which consisted of four respondents from contractors, four respondents from advisory companies and four respondents from public clients. The answers of the respondents have been coded using the Structural Coding method where categorizations were made solely based on the research questions for further qualitative data analysis in order to answer them.

Conclusion research question

The two-stage model is characterized by integral collaboration between the public client and the contractor with freedom for discussions between the parties. The results of the interviews show that working with jointly determined sustainability objectives with the help of tools as the Ambitieweb, guide to achieving sustainability in two-stage infrastructure projects. In addition, the two-stage model is characterized with a risk distribution that is jointly determined, while early risks of solutions are discussable at an early stage. This leads to the best solution, socially, financially and supported by the project team. In brief, the two-stage model is characterized by many factors that are linked to collaboration between the project team that falls under organizational integration. This, while organizational integration was also the most chosen driver for implementing sustainability in Dutch infrastructure projects among the respondents.

On the other hand, a technical specification which is a form of a one-stage collaboration model, is characterized by factors that are contrary to the two-stage model. According to the respondents, there is a lack of sustainable input since the public client prescribes what must be done without the help of the contractor. The risk distribution also differs from the two-stage model, where the risks of a technical specification are mainly allocated to the contractor. This results in risk-avoiding behaviour on the part of the contractor, which can lead to not implementing sustainable solutions in infrastructure projects since they can be too risky.

Based on the factors resulting from the interviews, technical specifications are characterized by having a lack of organizational integration while the two-stage model focusses more on this driver. Therefore, the two-stage model has more influence on sustainability of Dutch infrastructure projects.

With the answer to the main research question in hand, the main objective of this research study has been reached. An exploration of the impact of the two-stage model on sustainability of infrastructure projects has been performed.

Recommendations

According to the results from this research, organizational integration is the most important driver that influences sustainability in Dutch two-stage infrastructure projects. The factor of cooperation falls under organizational integration and is one of the main factors that differs from two-stage and one-stage collaboration models. However, the respondents of the interviews for this research indicated that they encountered problems of cooperation during the Dutch two-stage infrastructure projects: problems such as falling back into old behaviour and the emergence of mistrust between the involved parties. With this in hand, public and market parties are advised to give collaboration a prominent role in future two-stage infrastructure projects by considering the following aspects:

- Deploy employees from the involved parties that are open to cooperation and sustainability. Some employees are still traditionally minded and not open to innovations and sustainability, which hinders the process of implementing sustainable solutions.
- If sustainability is one of the objectives of the two-stage project, the implementation of shared sustainability goals that are going to be pursued throughout the project is advised.
- Use periodic meetings in which the satisfaction of soft skills such as collaboration and communication with the involved parties is measured. This could be done with surveys based on shared core values, where the results are shared in a transparent manner. From this it can follow whether there are factors that can be improved within the process that leads to development of the project team.

The aspects described above will speed up the process since it will improve cooperation between the involved parties and will also create an environment in which sustainable opportunities can be exploited.

In addition, it is advised to take into account that the two-stage model is not suitable for every type of project. The two-stage model is linked to high-risk complex projects with many uncertainties where construction knowledge of the contractor is needed (Rijkswaterstaat, 2020; Ma & Xin, 2011). If the client already knows what he wants, then a technical specification would be more suitable because of the simplicity of what needs to be executed in the given time period.

Another barrier that most of the professionals encountered is that there is a lack of experience with the two-stage model which leads to falling back to the traditional roles of the involved

parties. In order to stimulate the implementation of the two-stage model in the Dutch construction industry, more experience is needed. Therefore, it is suggested that public parties should tender two-stage projects more often in order to gain more experience with the model. And in order to create more knowledge on the two-stage model in the Dutch construction industry, Rijkswaterstaat should publish more evaluations of two-stage projects. Parties will learn from the made mistakes and possible improvements mentioned in these evaluations. Also, according to the respondents, when the two-stage model is proven to work forward momentum will carry the development and use of the model further.

Lastly, the interviewed professionals proposed the following solutions to accelerate the transition to a climate neutral construction sector. Public parties should:

- Make sustainability a fixed criterion in the tender.
- Consider phased exclusion of traditional construction equipment. This may eventually result in an innovation push and stimulation to purchase zero-emission construction equipment.
- Make use of market surveys or market consultations. This action will give an understanding of what exactly is needed from the market parties and public parties to stimulate the transition to a zero-emission construction industry.

Table of contents

PREFACE ..... **V**

ABSTRACT ..... **VI**

Research method VII
Conclusion research question VII
Recommendations VIII

LIST OF FIGURES ..... **XII**

LIST OF TABLES ..... **XII**

LIST OF ABBREVIATIONS ..... **XIII**

1. INTRODUCTION **1**

1.1 Problem context 1
1.2 Problem statement 3
1.3 Research objective 4
1.4 Research questions 4
1.5 Scientific and practical relevance 5
1.6 Thesis outline 5

2. RESEARCH DESIGN **6**

2.1 Research methods 6
2.2 Desk research 8
2.3 Semi-structured interviews 9

3. THE TWO-STAGE MODEL IN THE NETHERLANDS **12**

3.1 Definition and general characteristics 12
3.1.1 Stage one and stage two 13
3.2 Tender procedure in the Netherlands 14
3.2.1 Market exploration / consultation 14
3.2.2 The choice of procedure 14
3.2.3 The selection of candidates 14
3.2.4 Qualitative award criteria 15
3.2.5 Price related criteria 16

4. THE PARIS AGREEMENT AND THE DUTCH INFRASTRUCTURE SECTOR **18**

4.1 The Paris Agreement 18
4.2 Developments in the Dutch infrastructure sector 18
4.2.1 Arrangements for the Dutch infrastructure sector 19
4.2.2 Measurements and developments 19
4.2.3 Results from studies 25

5. ACHIEVING SUSTAINABILITY IN INFRASTRUCTURE PROJECTS **26**

5.1 Sustainability in the construction industry 26
5.2 Drivers for sustainable infrastructure development 27
5.2.1 Project economy 28
5.2.2 Social utility 28
5.2.3 Environmental implication 29
5.2.4 Organizational integration 29
5.3 Barriers of sustainable infrastructure development 30
5.3.1 Financial barriers 31
5.3.2 Steering mechanisms 31
5.3.3 Innovation 32
5.3.4 Underpinning knowledge 32
5.3.5 Organizational barriers 33

6. RESULTS SEMI-STRUCTURED INTERVIEWS 34

6.1 Dutch Climate Agreement 34
6.2 Project suitability to the two-stage model 35
6.3 Implementation of sustainability in Dutch two-stage infrastructure projects 37
6.4 Comparison two-stage and one-stage infrastructure projects 39
6.5 Stimulation of sustainability in two-stage infrastructure projects 40
6.5.1 Organizational integration 40
6.5.2 Social utility 40
6.5.3 Project economy 40
6.5.4 Environmental implication 41
6.6 Barriers of the two-stage model 41

7. DISCUSSION 43

7.1 Comparison research findings with literature 43
7.1.1 The Dutch Climate Agreement 43
7.1.2 Project suitability 43
7.1.3 Cooperation 45
7.1.4 Difference in risk distribution between two-stage and one-stage infrastructure projects 45
7.1.5 Barriers of the two-stage model 46
7.2 Research limitations and assumptions 47

8. CONCLUSIONS AND RECOMMENDATIONS 48

8.1 Conclusions 48
8.2 Recommendations for future practice 52
8.3 Recommendations for further research 53

9. BIBLIOGRAPHY 55

A. BRIEF SUMMARY RIJKSWATERSTAAT'S EVALUATION 64

B. ADVANTAGES AND AREAS OF CONCERN OF THE TWO-STAGE MODEL 66

C. VARIANTS OF THE TWO-STAGE MODEL 69

D. PRICING PROCESS OF THE TWO-STAGE MODEL 75

E. DETAILS OF THE TWO-STAGE MODEL IN THE DUTCH CONSTRUCTION INDUSTRY CONTEXT 78

F. MAIN CONTENT OF THE PARIS AGREEMENT 83

G. STRATEGY AND PROGRESS OF THE PARIS AGREEMENT 84

H. THE DUTCH CLIMATE AGREEMENT AND THE DUTCH INFRASTRUCTURE SECTOR 89

I. INTERVIEW QUESTIONS 91

J. TRANSCRIPTIONS OF THE SEMI-STRUCTURED INTERVIEWS ..... FOUT! BLADWIJZER NIET GEDEFINIEERD.

A1: Interview contractor A ..... **Fout! Bladwijzer niet gedefinieerd.**
A2: Interview contractor B ..... **Fout! Bladwijzer niet gedefinieerd.**
A3: Interview contractor C ..... **Fout! Bladwijzer niet gedefinieerd.**
A4: Interview contractor D ..... **Fout! Bladwijzer niet gedefinieerd.**
B1: Interview advisor A ..... **Fout! Bladwijzer niet gedefinieerd.**
B2: Interview advisor B ..... **Fout! Bladwijzer niet gedefinieerd.**
B3: Interview advisor C ..... **Fout! Bladwijzer niet gedefinieerd.**
B4: Interview advisor D ..... **Fout! Bladwijzer niet gedefinieerd.**
C1: Interview public client A ..... **Fout! Bladwijzer niet gedefinieerd.**
C2: Interview public client B ..... **Fout! Bladwijzer niet gedefinieerd.**
C3: Interview public client C ..... **Fout! Bladwijzer niet gedefinieerd.**
C4: Interview public client D ..... **Fout! Bladwijzer niet gedefinieerd.**

List of figures

Figure 1: Flow chart of the research methods 8
Figure 2: Ambitieweb (Ministerie van Infrastructuur en Milieu, 2016) 23
Figure 3: Omgevingswijzer (Ministerie van Infrastructuur en Milieu, 2016) 24
Figure 4: The three dimensions of sustainability (Liu et al., 2019) 26
Figure 5: Preferred design process versus traditional design process (Laedre & Svalestuen, 2014) 66
Figure 6: The Pre-award model (Huith, 2021) 69
Figure 7: The 'Exit-Model' after award (Huith, 2021) 70
Figure 8: The 'Entry-model' after award (Huith, 2021) 71
Figure 9: Main variants of the Bouwteam model (Clemens, 2021) 72
Figure 10: Hybrid model (Huith, 2021) 74
Figure 11: Global greenhouse gas emissions and warming scenarios (Ritchie, 2020) 88

List of tables

Table 1: Research methods 6
Table 2: Drivers for sustainable infrastructure development that fall under the pillars operationalizing sustainability 27
Table 3: Barriers of sustainable infrastructure development 30
Table 4: Professionals' views on the Dutch Climate Agreement 35
Table 5: Responses on project suitability 36
Table 6: Implementation of sustainability in Dutch two-stage infrastructure projects 38
Table 7: Experienced barriers of the two-stage model 41
Table 8: Experienced benefits of the two-stage model by the interviewed professionals 44

List of abbreviations

ARW 2016	Aanbestedingsregelement Werken 2016 (Tender Regulation Works 2016)
BN2021	Model Bouwteam Overeenkomst 2021 (Model Bouwteam Agreement 2021)
BPKV	Beste prijs-kwaliteitsverhouding (Best Price Quality Ratio)
BVP	Best Value Procurement
D&C	Design & Construct
DBFM	Design Build Finance Maintain
DEI+	Demonstratie Energie- en Klimaatadaptie (Demonstration Energy and Climate Innovation)
DG2020	Duurzaam Gebouwd 2020 Bouwteam model
EIA	Energie-investeringsaftrek (Energy Investment Allowance)
EMVI	Economisch Meest Voordelige Inschrijving (Economically Most Advantageous Tender)
ETF	Enhanced Transparency Framework
LCA	Life Cycle Assessment
MIA	Milieu-investeringsaftrek (Environmental Investment Allowance)
MKI	Milieukostenindicator (Environmental Cost Indicator)
MVI	Maatschappelijk Verantwoord Inkopen (Conscious and Targeted Socially Responsible Procurement)
NDC	Nationally Determined Contribution
RVO	Rijksdienst voor Ondernemend Nederland (The Netherlands Enterprise Agency)
SBIR	Strategic Business Innovation Research
SSEB	Subsidieregeling Schoon en Emissieloos Bouwmaterieel (Subsidy Scheme for Clean and Emission-Free Construction Equipment)
TCO	Total Cost of Ownership
UNFCCC	United Nations Framework Convention on Climate Change
UAV	Uniform Administratieve Voorwaarden (Uniform Administrative Conditions)
UAV-GC	Uniform Administratieve Voorwaarden voor Geïntegreerde Contracten (Uniform Administrative Conditions for Integrated Contracts)
VAMIL	Willekeurige afschrijving milieu-investeringen (Random Depreciation of Environmental Investments)

1. Introduction

The two-stage model is becoming more popular in the Dutch construction industry. This research describes what the impact of the two-stage model is on sustainability of Dutch infrastructure projects. Research has been conducted into what the two-stage model procedure looks like in the Dutch construction industry. Besides that, this research elaborates on which sustainability tools can be implemented in Dutch two-stage infrastructure projects and which factors explain the drivers and barriers of achieving sustainability in infrastructure projects. In addition, this research elaborates on how sustainability can be improved in Dutch two-stage infrastructure projects and what the barriers are of one-stage infrastructure projects in terms of sustainability. The study is carried out in the Netherlands with the support of the Technical University of Delft and Boskalis Nederland. This chapter elaborates on the problem context in section 1.1, the problem statement in 1.2, the research objective in section 1.3, research questions in section 1.4, the scientific and practical relevance in section 1.5, and the structure of the report in section 1.6.

1.1 Problem context

In 2015, the 21st Conference of Parties of the annual UNFCCC took place in Paris, France, where 196 governments agreed to the Paris Agreement to combat climate change and unleash actions and investments towards a low carbon, resilient and sustainable future. The objective of the Paris Agreement is to limit global warming to well below 2, preferably to 1.5 degrees Celsius, compared to pre-industrial levels. The agreement entered into force on 4 November 2016 (UNFCCC, 2015b). The Paris Agreement works on a 5-year cycle of climate action carried out by countries so rapid reductions of global emissions can take place in order to achieve a balance between emissions and removals in the second half of the century (European Commission, n.d.-c). The Dutch cabinet, organizations, and companies in the Netherlands anticipated the Paris Agreement by forming a national Climate Agreement in 2019, which includes a package of measures in order to achieve the objectives of the Paris Climate Agreement. This package of measures has had influence on the Dutch construction industry, the objectives for this industry are to achieve a climate-neutral and circular construction industry and have zero-emissions construction traffic and mobile machinery (Rijksoverheid, 2019).

In the same year of the Dutch Climate Agreement, Rijkswaterstaat published “Toekomstige Opgave Rijkswaterstaat”. In this publication Rijkswaterstaat mentioned the goal of a transition to a financially sound, competitive, innovative, and vital civil engineering sector in the Netherlands. According to Rijkswaterstaat (2019), this transition is necessary since there is a reduction in the number of tenders for large and complex works where the risk may occur that there will be no contractors for future large and complex projects. The reason for this is that contractors are not satisfied with the risk-return ratio in the Dutch civil engineering sector. Another reason why the transition is necessary is that the Dutch civil engineering sector lags behind other sectors when it comes to digitization, productivity, innovation, knowledge sharing and knowledge transfer. This transition is one for the market as a whole, resulting in a healthier, more sustainable, and more innovative sector. In order to reduce risks, participation of market parties is essential. Contractors must increase their productivity which

should result in lower failure costs and lower costs for the client. Clients should give more structure to the current fragmentation of various pilots at municipal or provincial level in order to stimulate the purchasing power. This would result in the stimulation of innovations by market parties (Rijkswaterstaat, 2019).

Rijkswaterstaat sees themselves as the driving force for the Dutch market since it has the social task of keeping the infrastructure of the Netherlands at the highest level. Rijkswaterstaat acknowledges that the civil engineering sector will keep on growing, while at the same time the demand for the sector will change in composition and complexity. This means that the civil engineering sector will have to make its contribution to sustainability. This growth and change, combined with a scarcity of well-trained people, is putting pressure on the sector according to Rijkswaterstaat (2020a). In addition to the change in the type of work, social changes place new demands on the construction, maintenance, upkeep, and the use of the infrastructure of the future. For example, there are social requirements with regard to sustainability. The Rutte-III coalition agreement has translated the agreements from the Paris Climate Agreement into the specific targets for the Netherlands of a 49% CO_2 reduction by 2030 compared to 1990 as described in the Dutch climate agreement. Few specific targets are currently being formulated at project level.

However, these Rijkswaterstaat targets are included in the tender through instruments such as the 'CO_2 Performance Ladder' and 'DuboCalc', which are aimed at CO_2 reduction and the use of sustainable materials. The demand for new functionalities is becoming more important. The change in the type of work, the sustainability objectives, the limited social acceptance of nuisance, overrun in time and money and the future requirements for infrastructure functionalities are a challenge for the entire Dutch civil engineering sector (Rijkswaterstaat, 2020a).

Rijkswaterstaat would like to reduce the risks of large projects and projects with a high complexity by implementing the “two-stage model” (Rijkswaterstaat, 2019). This two-stage model is a new development in the Dutch construction industry. Rijkswaterstaat defined this model as: “*A process in which explicit attention is paid to risks and inherent uncertainties during the entire execution phase and the price agreement is only made for the riskiest parts of the execution phase when risks can be better estimated, and clearer agreements can be made on the distribution of risks.*” (Rijkswaterstaat, 2020a, p.23).

After a two-stage contract has been awarded to a contractor, the client, and the contractor work together on stage one. In this stage they work together on the design phase where they have the space to discuss different solutions and ideas on sustainability, safety, or innovation for example (Boes & Fijneman, 2021). At the end of stage one, parties must have developed an execution design and reached an agreement on the price of the design in order to carry out stage two (Huith, 2021). Nonetheless, if the design phase has successfully been completed, an execution agreement will be concluded between the parties and the realization phase will start. If parties cannot come to an agreement, the two-stage contract ends after the design phase. CROW mentions that the traditional tender (e.g., UAV-contract, UAV-GC-contract) involves the selection of the best solution for the best price, while the two-stage model involves the selection of the party with whom the best solution for the best price can be formulated together and then implemented (CROW, 2020).

On the third of March 2020, Rijkswaterstaat presented the action plan “Op Weg Naar een Vitale Infrasector” to the Dutch House of Representatives. In this action plan, Rijkswaterstaat gives the impetus into a long-term transition process to a vital infrastructure sector in the Netherlands. A few transition goals were set by Rijkswaterstaat in order to make this transition (Rijkswaterstaat, 2020a).

An evaluation of the two-stage model was published by Rijkswaterstaat later that year in 2020. Rijkswaterstaat evaluated six two-stage infrastructure projects that were realized in the Netherlands, where the aim of the evaluation is to unlock as much information as possible from these projects so future projects can learn from them. The six projects that were evaluated are: Nijkerkerbrug (construction of a bridge), Pannerdenschkanaal (groyne lowering), Stadsdijken Zwolle (dike reinforcement), Zuidasdok (expansion of the A10-zuid, road infrastructure works, development of a high-quality public transport terminal), Zuid-Willemsvaart (diversion of the Maxima Canal, replacement of a number of locks) and Model Waterschap Rivierenland (dike reinforcement). The evaluation points out that the first signs are positive on the contribution of the two-stage model to the transition goals of Rijkswaterstaat (Rijkswaterstaat, 2020b). A brief summary of this document can be found in Appendix A. However, it is unknown how sustainability was implemented in each phase of these two-stage projects and how the two-stage model made an impact on the sustainability of the projects. This, while it is necessary for Rijkswaterstaat and other parties in the Dutch construction industry to comprehend these aspects in order to make a transition to a vital infrastructure sector where sustainability plays a huge role.

1.2 Problem statement

To summarise, Rijkswaterstaat wants to make a transition to a more vital infrastructure sector where sustainability and efficiency play huge roles. This, while the Rutte-III coalition agreement has translated the agreements from the Paris Climate Agreement into the specific targets for the Netherlands of a 49% CO_2 reduction by 2030 compared to 1990. This leads to a change into among others the sustainability objectives and future requirements for infrastructure functionalities on project level. Rijkswaterstaat has introduced the two-stage model in the Dutch construction industry in order to reduce risks in large and complex projects (Rijkswaterstaat, 2020a). From its evaluation, Rijkswaterstaat concluded that the first signs of the two-stage model are positive. In addition, the two-stage model contributes to the transition goals to a vital infrastructure sector of Rijkswaterstaat (Rijkswaterstaat, 2020b). However, it is also possible that the two-stage model can make an impact on sustainability of infrastructure projects since the risks are reduced and a different way of collaboration between market parties and public parties is introduced. Because risks are being reduced, it might create a breeding ground for implementing sustainable solutions and working more efficiently. Nonetheless, it is unknown if the two-stage model can make an impact on sustainability of infrastructure projects. Sustainable construction was described by Goh et al. (2019) as the delivery of environmentally friendly, socially acceptable, and economically efficient projects without any dimension dominating the others. With this in hand, insights should be created on how to make the Dutch construction industry more sustainable which will contribute to the transition of Rijkswaterstaat and the Paris Climate Agreement.

1.3 Research objective

From Boskalis Nederland, where the research is performed, the question arose how the two-stage model can contribute to making infrastructure projects more sustainable. Boskalis Nederland is currently working on several two-stage projects, and it acknowledges that the two-stage model is becoming very relevant in the Dutch infrastructure sector. The main objective of this study is to explore the impact of the two-stage model on sustainability of infrastructure projects. The expectation when using the two-stage model is that it will offer market parties and public parties more room to discuss, incentivise and implement sustainable solutions in infrastructure projects because of the integral collaboration between the parties in the project team. After achieving this objective, public parties may consider choosing the two-stage model more often for their infrastructure projects if the model tends to have a certain form of impact on sustainability. In addition, public parties may implement certain factors in (the tender of) two-stage contracts that can stimulate sustainability in their two-stage projects. Also, with the help of this research, market parties can anticipate these factors in order to win tenders of two-stage contracts and make their infrastructure projects more sustainable. This will not only lead to letting public parties and market parties work more cost and time efficiently, but also will improve the image of parties in the Dutch construction industry by becoming more sustainable. More importantly, a sustainable infrastructure project will be delivered in the end.

1.4 Research questions

Taking in account the knowledge gap, the objective and the problem statement, the main research question is stated as follows:

"What is the impact of the two-stage model on sustainability of Dutch infrastructure projects?"

In order to answer the main research question, the following sub questions are formulated:

SQ1. What does the two-stage model procedure look like in the Dutch infrastructure sector?
SQ2. Which tools can be implemented in two-stage infrastructure projects in order to meet the sustainability conditions of the Paris Climate Agreement, and how are they currently implemented?
SQ3. Which drivers and barriers explained in scientific literature may influence sustainability in two-stage infrastructure projects?
SQ4. How could the implementation of sustainability in Dutch two-stage infrastructure projects be improved?
SQ5. What are the barriers of the one-stage collaboration model which influence the implementation of sustainability?

1.5 Scientific and practical relevance

In order to achieve social tasks such as the climate objectives and the energy transition, the infrastructure sector will have to become more sustainable. Due to the use of large volumes of raw materials and high energy consumption, the sector contributes enormously to the total CO_2 emissions (TNO, 2021). Therefore, efforts must be made to make the sector more sustainable through the use of sustainable solutions.

The relevance of this research is to investigate whether the two-stage model is capable of making the sector more sustainable, despite the fact that the main goal of the two-stage model is to reduce the risks of large and complex projects (Rijkswaterstaat, 2020a). No research has been found on if, nor how the two-stage model can make an impact on sustainability of infrastructure projects. This research aimed to fill in this gap of knowledge, and therefore make its scientific contribution to the topic of sustainability in the construction industry.

The result of this research is practically relevant for public parties and market parties within the civil engineering sector who want to implement sustainable solutions by applying the two-stage model. Behind this practical relevance is a social relevance, being contributing to making the civil engineering sector more sustainable by stimulating sustainability with the use of the two-stage model for infrastructure projects.

1.6 Thesis outline

This report is structured as follows:

- Chapter 2 describes the research design.
- Chapter 3 gives an overview of the two-stage model in the Dutch construction industry context.
- Chapter 4 elaborates on tools and developments in the Dutch infrastructure sector that make projects more sustainable in order to meet the conditions of the Paris Climate Agreement.
- Chapter 5 goes in depth about factors that explain the drivers and barriers that may influence sustainability in two-stage infrastructure projects.
- Chapter 6 presents the results of the semi-structured interviews on experiences with the two-stage model, how the model influenced sustainability in Dutch two-stage infrastructure projects and its contrasts with a one-stage collaboration model.
- Chapter 7 goes in on the discussion of this research.
- Chapter 8 describes the conclusions of the research and recommendations for future practice and further research.

2. Research design

This chapter describes how the research is approached to address the problem statement given in the introduction. Section 2.1 describes which research methods were used to obtain information that helped to answer the research questions. Section 2.2 describes how the desk research and literature review were performed for this research, while section 2.3 goes in depth about the use of semi-structured interviews for more data collection.

2.1 Research methods

In this section, the research methods that have been used to answer the research questions are described. An overview of the research methods per research question and the collected information is shown in table 1. Figure 1 shows the flow chart of the research methods which were used in order to address the problem statement which is described in the introduction.

Table 1: Research methods

Research question	Research method	Collected information
What does the two-stage model procedure look like in the Dutch construction industry sector?	Desk research, literature review.	The definition of the two-stage model; the process including the tender procedure of the two-stage model in the Netherlands, advantages; downsides; variants of the two-stage model and Early Contractor Involvement (including DG2020 Bouwteam); the pricing process during the two-stage model.
Which tools can be implemented in two-stage infrastructure projects in order to meet the sustainability conditions of the Paris Climate Agreement, and how are they currently implemented?	Desk research, literature review, semi-structured interviews.	The main content of the Paris Agreement; the strategy of the Paris Agreement; how progress of the Paris Agreement is measured; the current state of progress; the arrangements, measurements, and developments in the Dutch infrastructure sector because of the Paris Agreement; progress of the Dutch infrastructure sector regarding the Paris Agreement; opinions of professionals in the Dutch

		infrastructure sector on the transition in the sector because of the Paris Agreement; how the sustainability tools are used in Dutch two-stage infrastructure projects.
Which drivers and barriers explained in scientific literature may influence sustainability in two-stage infrastructure projects?	Desk research, literature review.	The definition of sustainability; drivers for sustainable infrastructure development; barriers of sustainable infrastructure development.
How could the implementation of sustainability in Dutch two-stage infrastructure projects be improved?	Desk research, literature review, semi-structured interviews.	The most important driver among the respondents for implementing sustainability in Dutch two-stage infrastructure projects; advice from the respondents on how to improve
What are the barriers of the one-stage collaboration model which influence the implementation of sustainability?	Semi-structured interviews.	Characterizations of technical specifications; how respondents experienced technical specifications regarding the implementation of sustainability; barriers of technical specifications regarding the implementation of sustainability according to the respondents.

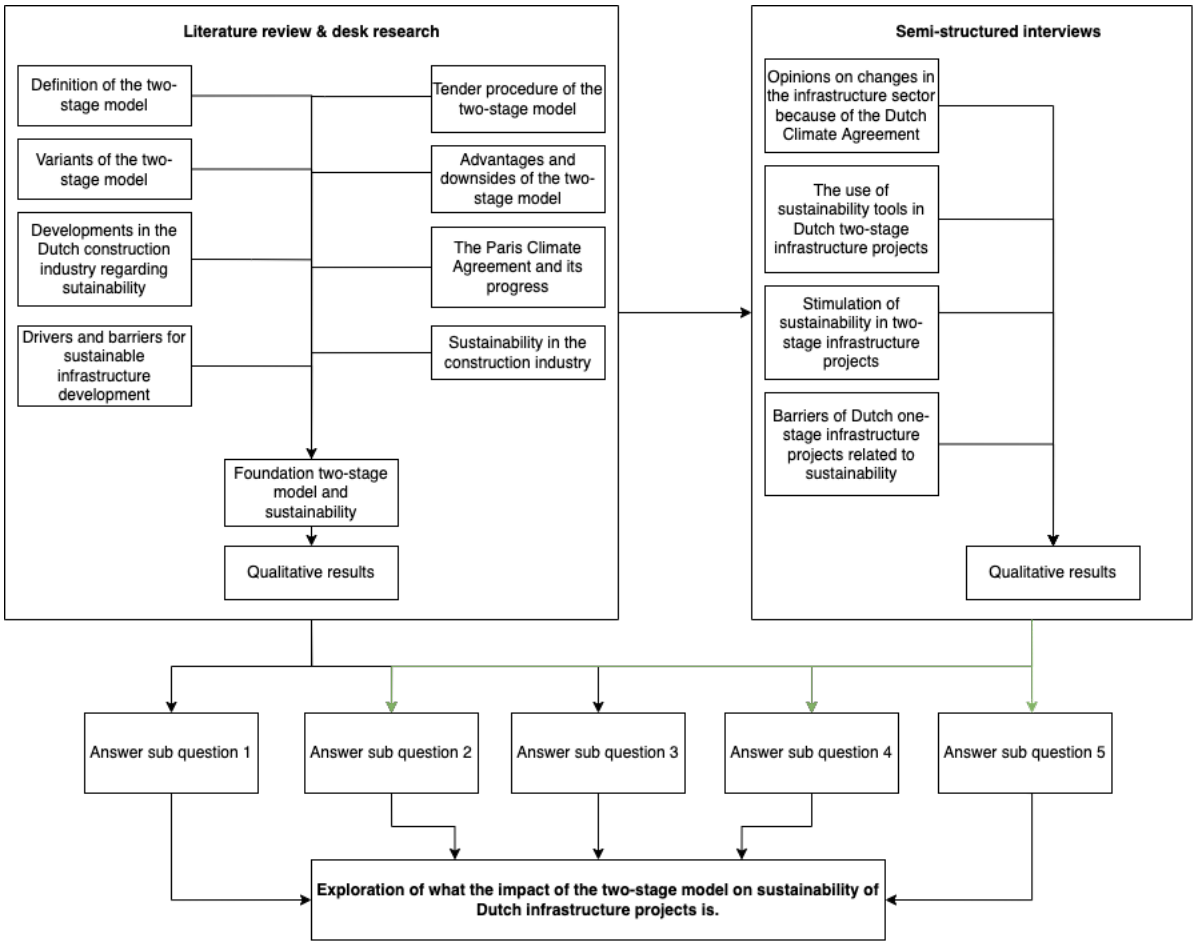

Figure 1: Flow chart of the research methods

2.2 Desk research

In order to gather important data for this research, desk research and literature review on the two-stage model have been performed. Relevant literature is essential for all research disciplines and all research projects, while literature reviews are useful when the aim is to provide an overview of the theoretical framework (Snyder, 2019). Also, with the help of desk research more insight can be created in the research area and already existing data (Jilcha Sileyew, 2020).

As for the first sub question, a few documents on the two-stage model in the Netherlands have been published by Rijkswaterstaat, CROW and Pianoo. These documents were analysed and summarized to define the two-stage model in the Dutch construction industry context and was used as a part of the foundation for the entire research. For the second sub question, the United Nations Framework Convention on Climate Change (UNFCCC) and the European Commission published documents about the Paris Agreement. This, while the Dutch cabinet translated their plans to achieve the objectives in the Paris Agreement into a national Climate Agreement. In addition, the Dutch government published documents about sustainability tools that can be implemented in infrastructure projects to make the sector more sustainable. These documents helped to answer the second sub question. Moreover, for the third and the fourth sub question a search for scientific literature and existing data has been conducted using the following online databases, search engines and construction related resources:

ResearchGate, Elsevier, Google Scholar. The search strategy was focused on articles and reports about the drivers and barriers for sustainable infrastructure development. Based on screening, unrelated articles to the research model and objectives have been excluded. After excluding the articles based on the title, keywords, and abstract, the remaining articles were reviewed in detail, and information was extracted for this research. A complete list of items was then collected within the research objective.

The keywords and its synonyms for the entire literature research (also translated in Dutch) were: (i.e., “Paris Climate Agreement 2015”, “Dutch Climate Agreement”, “Progress Climate Agreement”, “Two-Stage Model Construction Industry”, “Two-Stage Contracts the Netherlands”, “Variants Two-Stage Model Construction Industry”, “Early Contractor Involvement”, “Tender Procedure Two-Stage Contracts in the Netherlands”, “Experiences Two-stage Model the Netherlands”, “Collaborative Contracting”).

2.3 Semi-structured interviews

More data collection was obtained by conducting semi-structured interviews with professionals (e.g., directors, project managers, technical managers, and contract managers) of different parties in the Dutch construction industry that worked on or are currently working on two-stage infrastructure projects in the Netherlands. These respondents are considered to be particularly knowledgeable about the two-stage model because of their experiences with the model itself. Semi-structured interviews were suited for this particular research because it permits to seek new insights and ask questions from different perspectives (Jilcha Sileyew, 2020). While on the other hand, there is not much information about Dutch two-stage infrastructure projects and its impact on sustainability of infrastructure projects. In other words, there is a limitation in published documents and therefore semi-structured interviews are very suitable for this situation (Jilcha Sileyew, 2020).

The preparation of the semi-structured interviews started with drawing up interview questions from information that was extracted from the desk research and literature research combined with the sub questions and the objective of this research. Colleagues from the sustainability department of Boskalis Nederland made additional input to the interview questions which they were particularly interested in. The interview questions were divided into introduction of the two-stage project, tender-related questions, questions on the design phase and execution phase, questions on collaboration between parties within the Dutch construction industry, and lastly questions on the influence of the national Climate Agreement on the Dutch construction industry**.** These interview questions can be found in Appendix I.

After drawing up the interview questions, a search for professionals was performed and the interviews were planned. This search was done by making use of the company network of Boskalis Nederland and the personal network of the student. The respondents have been selected based on their position in the projects where the two-stage model was used. They were either actively involved in the decision making to make use of the two-stage model, the tender, design phase and / or the execution phase.

As for the scope of this research, the two-stage projects that were focused on are:

- The project must be conducted under the two-stage model.
- Projects in The Netherlands that are in the first stage, second stage, or completed with a maximum 5 years old. This in order to extract the most recent experiences with the two-stage model.
- The project must be an infrastructure project for a public client. Infrastructure project means the design, construction, development and operation of new infrastructure facilities or the rehabilitation, modernization, expansion, or operation of existing infrastructure facilities. These infrastructure facilities are physical facilities and systems that directly or indirectly provide services to the general public (United Nations, 2019).

Subsequently, the semi-structured interviews were conducted online with the respondents. Permission has been requested to record the interview, while notes have been taken to derive the most important and relevant thoughts of the respondent. This way, the interviewer can focus more on the answers of the respondent and not solely rely on taking notes. The respondents were asked the same questions in the same order. After conducting more and more interviews, information became saturated which meant no new information was obtained during an interview. With this assumption in hand, 12 semi-structured interviews have been conducted which consisted of four respondents from contractors, four respondents from advisory companies and four respondents from public clients.

The semi-structured interviews have been transcribed where a balance was sought in literalness and clarity. The transcript was red and checked with the respondent by providing comments on the written text. This helped to improve the quality of the extracted information since a check has been performed for correct representation of the responses. After approval from the respondent the transcriptions were red again, and the analysis was continued with Structural Coding. This style of coding applies a content-based or conceptual phrase representing a topic of inquiry to a segment of data that relates to a specific research question used to frame the interview. The similarly coded segments are then collected together for more detailed coding and analysis. The rationale for choosing Structural Coding is that it benefits of allowing quick access to relevant data for an analysis from a larger data set that originates from multiple respondents, while it is especially suitable for semi-structured interviews (Saldana, 2009). Categorizations were made solely based on the research questions for further qualitative data analysis in order to answer them. The codes can be seen in Appendix I. The questions that fall under the code “GQ1” are general questions which helped to promote the dialogue with the respondent. The code “GQ2” was used for general questions that are related to experiences with the two-stage model, which helped to extract more information about the use of thte two-stage model in the Netherlands. The last code for general questions is “GQ3”, which are questions about the Dutch Climate Agreement. The other questions are indicated with the code “SQ”, which represents the sub question of this research. The answers to each question indicated with the code SQ helped to answer that specific sub question.

Chapter 6 of this report is dedicated as the chapter that expresses the results of the semi-structured interviews. The results from the semi-structured interviews show what the

experiences, opinions, visions are on the two-stage model and its impact on sustainability of Dutch infrastructure projects. The extracted information from the interviews helped to find out how the two-stage model makes projects more sustainable, how sustainability can be stimulated and achieved in two-stage infrastructure projects, and what the factors are for implementing and achieving sustainability objectives in two-stage infrastructure projects.

3. The two-stage model in the Netherlands

Chapter three of this report introduces the two-stage model and aims at providing an understanding on what the two-stage model is, and how the two-model process works in the Dutch civil engineering industry. This chapter begins with section 3.1, the definition, and general characteristics of the two-stage model. The tender procedure of two-stage contracts in the Netherlands is described in section 3.2.

3.1 Definition and general characteristics

On the third of March 2020, Rijkswaterstaat presented a plan of action called "Towards a vital infrastructure sector" to the Dutch House of Representatives. This plan of action describes how Rijkswaterstaat wants to work together with its partners of the Dutch market to improve risk management and the predictability of infrastructure projects. In the plan of action, Rijkswaterstaat described that they will use the two-stage model as one of the instruments to reach a vital infrastructure sector. An additional goal of Rijkswaterstaat is to limit tendering efforts on both the client's and the contractor's side where possible (Rijkswaterstaat, 2020b). Rijkswaterstaat defined the two-stage model in their plan of action as: "*A process in which explicit attention is paid to risks and inherent uncertainties during the entire realization phase and the price agreement is only made for the riskiest parts of the realization phase when risks can be better estimated, and clearer agreements can be made about the distribution of risks*." (Rijkswaterstaat, 2020a, p.23).

The two-stage model is rather an umbrella term than something substantial, because different kinds of delivery models may be classified under this model. With a two-stage model, the client generally tenders a two-stage contract where the design phase and the realization phase are separated from each other (van Kruining, 2021). After the two-stage contract has been awarded, the client and the contractor work together on the first stage. In this stage they work together on the design phase where they have the space to discuss different solutions and ideas on sustainability, safety, or innovation for example (Boes & Fijneman, 2021). However, intensive collaboration between the client and the contractor is not necessarily standard within the two-stage model. An elaboration on different variants of the two-stage model can be found in Appendix C of this report. At the end of stage one, parties must have developed an execution design and reached an agreement on the price of the design in order to carry out stage two (Huith, 2021). How exactly the pricing process in the two-stage model works is explained in Appendix D of this report. If both parties cannot come to an agreement, then the two-stage contract stops right after the design phase (CROW, 2020; Designing Buildings, 2020). If stage one has been successfully completed, the second stage starts where client and contractor negotiate to a fixed price for the contract of the realization phase. Details about each stage are described in the following sub-paragraphs, the advantages, and the areas of concern of the two-stage model can be found in Appendix B.

As mentioned before, the client tenders a two-stage contract. CROW (2020) defines the two-stage contract as when:

- The client combines a 'design phase' and the right to an initial offer to the 'realization phase' of one or more works in one contract.

- No competition will take place after the staged contract has been concluded
- The client and the chosen contractor have the opportunity to jointly work on design work and / or optimization work to complete the design phase.
- There is a clear go / no go moment between the design phase and the realization phase. This determines whether the parties will collaborate with each other or not based on an agreement on the price for the realization phase.

3.1.1 Stage one and stage two

The client and the contractor make use of limited appointments, which is about taking decisions on the design based on the costs and the practical consequences for the construction methods. The latter is done by collecting all information on the execution for the sake of efficiency and the optimization of the execution. Since subcontractors and suppliers are more involved in the execution than the contractor himself, it is important to involve these parties in the design phase. They have to be involved by providing input to the design, alternative construction methods and price formation (Bleeker, 2021). Budget and quality to organize the required decisions for a successful execution of the project are the most important topics that are taken into consideration during this stage. In this stage, it is important to monitor the public client's ceiling price. This should be done in order to survey whether nothing is promised that later proves impossible to implement in the project's legal frameworks, the available budget or available time. In this stage, the project is usually in a complex context with many different stakeholders that have various objectives of their own. However, attention should be paid on how the contractor gets compensated for the performed work. In Article 10.1 of the DG2020 Bouwteam agreement (which is a two-stage variant), the client reimburses the contractor for his participation in the Bouwteam based on hourly rates increased by a reimbursement of possible cost items (Duurzaam Gebouwd, 2020). In Article 23 of the VGB 1992 model of the Bouwteam, the client will pay an amount or percentage of the price offered to the contractor by way of compensation for work performed. The amount will not be owed if it is attributable to the contractor that no execution contract has been concluded (VGBouw, 1992). An overview of aspects of stage one's limited appointment is described in Appendix E.

The client and contractor also identify, assess, and allocate the risks in a coordinated way. The mutual goal of the client and contractor is to estimate the reservation of time and money in terms of risks, as close to the actual occurring risks as possible. This common goal stipulates the client - contractor collaboration (Clemens, 2021). Subjects of joint risk management are described in Appendix E.

At the end of stage one, parties must have reached an agreement on the execution price in order to carry out stage two (Huith, 2021).This negotiation is a mathematical exercise using the pricing criteria (Designing Buildings, 2020). In Appendix H, a brief elaboration is shown of how this negotiation on the execution price takes place based on Article 12 of the DG2020 Bouwteam agreement. If the client and contractor cannot come to an agreement on the price for the execution, the client can again choose for the two-stage model or choose for a different method if the client would like to collaborate with a different contractor.

The second stage of the two-stage model is called the realization phase. During this stage, the more execution-oriented parties take the lead. This stage is about the efficient use of equipment and people in order to realize a project with a healthy financial return. The approved plans from the previous stage now serve as the basis for giving the execution the necessary peace and space (Boogaart, 2021).

3.2 Tender procedure in the Netherlands

The tender of a two-stage contract is aimed at establishing collaboration with parties in the construction industry. Therefore, it is important to make an advance on the collaboration during the tender procedure (CROW, 2020). This section describes how the tendering procedure for two-stage contracts works in the Netherlands based on CROW's report (2020).

3.2.1 Market exploration / consultation

CROW (2020) advises clients to make use of market exploration or market consultation for tenders that is aimed at establishing collaboration with one or more market parties. From the idea of using a two-stage contract, via the choice of the tender procedure, to ideas about requirements and criteria. Involving the market in advance has its advantages. Firstly, the input from the market can lead to improvements in the tendering procedure. It increases the chance that the client will receive more suitable tenders. Secondly, there can be more support and understanding among the market. During the market consultation for example, the client can indicate his goals and how these lead to the choices he has made (CROW, 2020).

3.2.2 The choice of procedure

In the tendering procedure, the emphasis is on finding the right party instead of finding the best technical solution. An intensive and time-consuming procedure such as a competitive dialogue is possible, but not always necessary (CROW, 2020). Good collaboration between the contractor and client in the design phase is critical for the success of the design phase, but also to the transition to the realization phase. Therefore, an interview round can be part of the award procedure. It is advised to limit the number of candidates, because otherwise it will be impossible for the client to give adequate scores on the basis of a large number of interviews. How the choice of procedure works in accordance with the Aanbestedingswet 2012 and Aanbestedingsregelement Werken 2016 (ARW 2016) can be found in Appendix E. The Aanbestedingswet 2012 is a procurement act that applies to all tenders and (semi-)public institution in the Netherlands which contains rules for tenders above and below the European thresholds (Pianoo, n.d.-b). The ARW 2016 contains rules and procedures for the tendering of works contracts below the European thresholds (Pianoo, n.d.-a).

3.2.3 The selection of candidates

Choices in Selected Tendering ('Meervoudig onderhandse procedure')
According to CROW (2020), the client has a lot of freedom in the choice of market parties that he would like to invite to participate in the selected tendering procedure. The client must be able to explain how he arrived at the choice of invitees, but not why he did not choose other candidates. Thanks to this freedom, the client can invite market parties who have achieved

good, relevant Past Performance scores (and have shown that they are a pleasant, cooperative, and expert contracting partner). It is recommended that no more than three market parties be invited for this procedure. The reason for this is because of the relatively limited size of the contract and the relatively difficult award procedure. If interview rounds would be used, it would cost bidders a lot of effort. But also conducting interviews and then weighing and scoring the results is a time-intensive job for the contracting authority.

Choices in a procedure with prior selection
There is a good chance that the larger two-stage contracts will attract the attention of many interested parties if they are put on the market through a restricted procedure (in Dutch: 'niet-openbare procedure'). By means of selection criteria, the number of candidates will have to be reduced to a maximum of five parties who can expect an invitation to tender through wishes of the client (CROW, 2020; Pianoo, n.d.-c). This differs from suitability requirement, which tests the suitability of the tenderers (Pianoo, n.d.-c).

In practice, it turns out to be very difficult to set good and meaningful selection criteria. After all, everything that the client wants to see from a market party is included as a suitability requirement and ideas about a technical solution may only be discussed in the award phase as an award criterion. What remains for the selection criteria are those characteristics of the tenderer that are not necessarily required, but which do constitute an advantage. For example, in a concrete tender, the suitability requirement of experience with a two-stage contract might go too far, since then many local market parties will be left out. This experience can be an advantage and therefore be considered as a selection criterion, unless there is a good chance that this will have the same effect. For example, if it is to be expected that there will be much interest in the project that only parties with the required experience will remain via this route (CROW, 2020).

3.2.4 Qualitative award criteria

The client indicates what his wishes are and what he expects from the tenderers by using the qualitative award criteria. These wishes will be different in two-stage tenders than in regular tenders (CROW, 2020). In a regular tender for a realization contract (UAV, UAV-GC), the wishes of the client usually relate to the quality of the work to be realized (project criteria), supplemented with criteria about the way in which the realization takes place such as reducing lead time and nuisance for the environment (process criteria) (CROW, 2020).

With a two-stage contract, the wishes of the client regarding the realization contract are no different. But because a design phase follows first, these project and process criteria are drawn up (further) jointly in a later stage. The client's wish when tendering for a two-stage contract could be to go through the design phase in such a way that it leads to the most optimal implementation of the project and process criteria for the realization. In two-stage tenders it is therefore not so much about the desired solutions, but the competences to arrive at the desired technical solutions that are used as award criteria (CROW, 2020).

The award criteria must be formulated in such a way that tenderers can effectively demonstrate that their tender contributes optimally to achieving the project objectives.

Examples of the most recurring qualitative award criteria are (CROW, 2020):

- Opportunity file
- Risk file
- Way of working together
- Team composition

These qualitative award criteria are described in depth in Appendix E.

3.2.5 Price related criteria

A difference between the tender of a regular contract and a two-stage contract is that the awarding of the two-stage contracts is based on 100% quality without a (fixed) pricing component. Nevertheless, the two-stage contracts have mechanisms to guarantee realistic pricing (CROW, 2020). Below a summary is described of examples of price-related award criteria that occur frequently in practice in two-stage contracts, in addition to the qualitative criteria (CROW, 2020). Other than the qualitative criteria, there is much discussion about the usefulness of these criteria in the tendering of two-stage contracts. For this reason, the pros and cons are listed for each criterion in Appendix E.

Price for fixed parts (stage two)
Unless the choice is made for a two-stage contract that entirely focuses on free innovation, a two-stage contract has parts that are not discussed in the design phase. If these components are sufficiently separate from the components that are covered in the design phase, a price can be charged for them, which plays a role as an award criterion (CROW, 2020).

Unit prices, rates, and hourly wages (stage two)
A variant on a price criterion based on prices for fixed components of the execution phase, is an award criterion based on unit prices, rates, or hourly wages (CROW, 2020). Multiplied by fictitious quantities, these prices usually lead to a fictitious sum, which serves as a criterion. Only when there is sufficient clarity about the size, an estimation of the quantities, multiplied by the unit prices, the rates or the hourly wages lead to a realistic estimation of the costs.

Surcharge percentages (stage two)
A surcharge percentage in which the general costs, profit and risks are united has a somewhat different character than unit prices and rates (CROW, 2020). A surcharge percentage applies for the entire realization phase and therefore forms a fixed surcharge on all rates and prices. A surcharge percentage will therefore have a less disruptive effect during the design phase.

Price control methods (stage one and two)
Another example in giving the price a role when awarding, is to score on price control methods. The element price is not scored in euros, but in a qualitative score. This concerns the answers to questions such as (CROW, 2020):

- How do you ensure that the contract price at the end of the design phase remains within the allocated budget?

- What measures do you take to ensure full transparency on pricing throughout the design phase?

These questions can also form part of mitigating measures in a risk file.

4. The Paris Agreement and the Dutch infrastructure sector

Chapter four of this report aims at providing an understanding of what the Paris Agreement is, how this agreement affects the Dutch infrastructure sector and which sustainability tools can be implemented in two-stage infrastructure projects. This chapter begins with section 4.1, which gives a description of the Paris Agreement. Section 4.2 elaborates on arrangements within the Dutch construction industry because of the Paris Agreement.

4.1 The Paris Agreement

In May 1992, governments across the world showed concern about climate change and strived for stabilization of the concentration of greenhouse gases by adopting the international treaty of the United Nations Framework Convention on Climate Change (UNFCCC) (UNFCCC, 1992). This treaty constitutes the foundational climate agreement that has provided the platform for most subsequent international climate agreements (Kuh, 2018). With the purpose of the UNFCCC, many major milestones were achieved such as the adoption of the Bali Action Plan (2007), the Copenhagen Accord (2009) and the Durban Platform for Enhanced Action (2012) (Matemilola et al., 2020). However, an agreement to combat climate change and unleash actions and investments towards a low carbon, resilient and sustainable future was agreed by 196 governments during the 21st Conference of the Parties of the annual UNFCCC held in Paris, France, in December 2015 (UNFCCC, 2015b). This agreement has been named the Paris Agreement and entered into force on 4 November 2016. Its goal is to limit global warming to well below 2, preferably to 1.5 degrees Celsius, compared to pre-industrial levels. To achieve this long-term temperature goal, countries aim to reach global peaking of greenhouse gas emissions as soon as possible to achieve a climate neutral world by mid-century. The Paris Agreement is a landmark in the multilateral climate change process because, for the first time, a binding agreement brings all nations into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects (UNFCCC, n.d.-c). The main content of the Paris Agreement can be found in Appendix F, the strategy of the Paris Agreement and the international progress is described in Appendix G.

4.2 Developments in the Dutch infrastructure sector

In 2019, the Dutch climate agreement was published as part of the Dutch climate policy. This is an agreement between the Dutch cabinet, organizations, and companies in the Netherlands to limit global warming as stated in the Paris Climate Agreement: to limit global warming to well below 2, preferably to 1.5 degrees Celsius, compared to pre-industrial levels. With this national Climate Agreement, the Dutch government has a central goal: to reduce greenhouse gas emissions in the Netherlands by 49% compared to 1990. The Dutch Climate Agreement is a package of measures with active support of as many contributing parties as possible (Rijksoverheid, 2019).

4.2.1 Arrangements for the Dutch infrastructure sector

The Dutch Climate Agreement included arrangements that have an impact on the Dutch infrastructure sector. These arrangements are described below.

Zero-emissions construction traffic and mobile machinery
Public authorities and parties within the construction sector will be focusing on achieving zero-emissions construction traffic and the use of zero and low-emissions mobile machinery in urban areas. This will be done in order to support the introduction of zero-emission zones. With the help of the Green Deal for Mobile Machinery and the Green Deal for Construction Logistics that were formed earlier, this arrangement will lead to savings of 0.4 Mt of carbon dioxide (Rijksoverheid, 2019). The exact agreements on this topic from the Dutch Climate Agreement can be found in Appendix H.

Climate-neutral and circular construction industry
The national government, alongside other local and regional authorities, has a strong impact on the development of the construction industry. The public authorities will therefore jointly work toward climate-neutral and circular procurement, to allow this sector to operate climate neutrally. This will involve among other things the circular use of raw materials. The agreements on this topic can also be found in Appendix H.

4.2.2 Measurements and developments

Subsidies and tax benefits
The Netherlands Enterprise Agency (RVO) is the organization where entrepreneurs and companies can apply for subsidies and tax benefits. A summary of possible subsidies and tax benefits regarding the implementation of sustainable solutions within Dutch infrastructure projects is described below.

Subsidy Scheme for Clean and Emission-Free Construction Equipment (SSEB): The subsidy is intended for making construction equipment and construction logistics more sustainable, in order to reduce nitrogen emissions in construction by 60% by 2030. The objective is to encourage companies in the construction sector to invest in construction equipment that is zero-emission or lower-emission (RVO, 2022d).

Energy Investment Allowance (EIA): This allowance is intended for companies that invest in a business asset that reduces CO_2 emissions, is energy efficient or uses sustainable energy. The allowance will cover the purchase price of (parts of) business assets on the Energy List, costs for facilities that are technically necessary for these assets and labour costs of own employees, hired employees and contractors who produce or install the asset. There is a budget of €149 million for 2022 (RVO, 2022b; RVO, 2022f).

Demonstration Energy and Climate Innovation: Circular Economy (DEI+): only for pilot projects and demonstration projects that implement waste recycling, reuse of products or parts, the use of biobased raw materials and renewable energy. The total budget available for DEI+ is €126.6 million (RVO, 2022a; RVO, 2022e).

Environmental Investment Allowance (MIA) and Random Depreciation of Environmental Investments (VAMIL): for investments in environmentally friendly assets and sustainability in the industry that meet the requirements of a description of the RVO's Environmental List. Examples of assets on this list are production equipment for bio-asphalt, and sustainable concrete of at least 30% recycled material. The allowance includes investments that promote a circular economy, reduce the use of (fossil) raw materials or limit emissions, and invest in environmentally friendly equipment and techniques. With the MIA, companies benefit from an investment deduction that can amount to 45% of the investment amount. This deduction is in addition to the usual investment deduction. With VAMIL, companies can write off 75% of the investment costs. The 2022 budget for MIA is €144 million. €25 million is available for VAMIL in 2022 (RVO, 2022c; RVO, 2022g).

Climate neutral construction site

From 2030, mobile equipment and means of transport on the construction site of Rijkswaterstaat projects will no longer emit CO_2, nitrogen oxides and particulate matter (Ministerie van Infrastructuur en Waterstaat, 2021d). A transition must be made from fossil fuels to non-fossil fuel driven equipment, especially by using electrical construction equipment, hydrogen-powered machines, or mains-powered machines (Duurzame-Infra, n.d.). The mobile equipment used in civil engineering, road construction and hydraulic engineering consume large amounts of fuel and therefore emit a lot of CO_2. As a result, these machines contribute to climate change and poor air quality. A transition to electric mobile equipment can make an important contribution to the Climate Agreement's objective of reducing CO_2 emissions (Natuur en Milieu, 2019).

According to Natuur en Milieu (2019), it appears that electric mobile equipment in terms of Total Cost of Ownership (TCO) is just as advantageous as, or even more economical than, fossil fuel-powered variants. Maintenance costs are considerably lower, and the fuel is also cheaper. Over the entire lifespan of a machine, the costs of the electric variant are usually no higher than those of a fossil-powered tool. However, the purchase price of an electric machine is significantly higher. On the other hand, Environmental Investment Allowance (MIA) and the Random Depreciation of Environmental Investments (VAMIL) which were mentioned earlier, offer companies tax opportunities in the Netherlands: electric or hybrid mobile machines that work quieter or have lower emissions as described in the Environmental List are eligible for these tax incentives (Natuur en Milieu, 2019).

In the short term up to and including 2022, Rijkswaterstaat will focus on action points such as the accelerated introduction of small electrical equipment and emission-free working in, among other things, roadside maintenance (Duurzaam-Infra, n.d.). For example, an emission-free construction site has already been set up by Van Kessel for the construction of the A58 Innovation Strip near Oirschot. The power supply came from a generator on hydrogen which functioned as power supply for the chain park, lighting, security, and car charging (Geurts, 2022). However, Rijkswaterstaat is already challenging the market to use electric excavators for riverbank and waterway maintenance and dyke improvement projects. The objective of Rijkswaterstaat is to phase out outdated, polluting construction equipment gradually in the coming years. The use of biodiesel fits in with the approach as long as there is still insufficient electrical equipment available, but eventually nitrogen- and particulate-emitting combustion engines will not be used anymore (Duurzame-Infra, n.d.).

Circularity

The construction sector uses large volumes of material where large waste flows are created by the construction, renovation, and demolition of buildings. Fortunately, this material - at least in the Netherlands - has been recycled on a large scale for years. After recycling, the majority of the recycled demolition waste is used as a foundation material for infrastructure (ground works, road base and hydraulic engineering). In the recent past it was the scale of the waste flows, currently the concerns about the major environmental impact of construction materials that drives the frontrunners in their efforts to introduce a circular economy. For instance, on the global scale, concrete, and steel production account for approximately 17% of all the CO_2 emissions related to human activity (RIVM, 2015).

With this in hand, Rijkswaterstaat wants to work in a circular way by 2030 by working without producing any waste. At the moment, the problem is that enormous amounts of building material are required, the extraction and transport of which have a negative impact on the climate. This impact is reduced with efficient use and reuse of materials since this will result in less CO_2 emissions. Rijkswaterstaat indicates that it already considers future reuse of materials when designing structures. In addition, the extension of the lifespan of materials and the use of materials from demolished structures are solutions that Rijkswaterstaat already implement (Ministerie van Infrastructuur en Waterstaat, 2021a).

One of the developments with which Rijkswaterstaat wants to tackle circularity is with the Strategic Business Innovation Research (SBIR) Circular Viaducts. This is a purchasing method that stimulates innovations in the market. An SBIR trajectory works like a phased competition. For each phase, the companies (or their consortia) continue with the best plans (Ministerie van Infrastructuur en Waterstaat, 2021b). Closing the Loop is one of the multiple circular solutions that various consortia are developing in response to the SBIR. Closing the Loop's principle is the high-quality reuse of parts of viaducts and bridges. Therefore, a consortium consisting of several corporations and companies will realize the first ten viaducts with more than 70% of high-quality reused viaduct parts, while the rest 30% mostly asphalt and residual concrete. This is economically attractive (24% reduction in indirect costs), structurally safe, technically feasible, and environmentally the reduction in CO_2 is worth 1.8 million kg per ten years (Antea Group, 2021). Materials from existing bridges and viaducts (e.g., abutments, girders, baffle plates, tubular steel, and railings) will be given a second life by implementing them in new bridges and viaducts. In this way supply (insight into what will become available) and demand (application possibilities for existing object components) will be brought together (Nebest, n.d.).

Circular procurement

In Dutch civil engineering projects, one of the instruments that is currently being used for achieving sustainability goals of the Paris Agreement and the national Climate Agreement is conscious and targeted socially responsible procurement (MVI) (Klimaatverbond Nederland, 2020). This means that, in addition to the price of the products, services or works, attention is also paid to the effects of purchasing on the environment and social aspects (Ministerie van Infrastructuur en Milieu, 2016; Pianoo, n.d.-d). DuboCalc and the CO_2 Performance Ladder form components of the MVI (Ministerie van Infrastructuur en Milieu, 2016).

DuboCalc is a program developed by Rijkswaterstaat to calculate and compare the sustainability and environmental costs of tenders. This tool calculates all environmental effects of material and energy consumption from extraction to the demolition and reuse phase. As a result, the environmental effects are expressed in euros, the Environmental Cost Indicator (MKI). The method is based on the Life Cycle Assessment (LCA) method in accordance with the ISO14040 standard and on the Determination Method for Environmental Performance of Buildings and Construction Works and uses data from the national environmental database. In order to make the environmental effects quantifiable, they are converted using the DuboCalc program into the effects they have on the environment, expressed in, among other things, CO_2 equivalents and SO_2 equivalents. These environmental effects are in turn translated into shadow prices. The MKI is a summation of these shadow prices. The higher the MKI, the worse the material is for the environment. The ultimate goal is to achieve significant environmental benefits in designs, executions, and tenders for civil engineering works. DuboCalc is therefore particularly interesting for registrations based on BKPV criteria (best price-quality ratio). Clients can thus quickly and uniformly assess tenders for environmental costs. Potential contractors and third parties can compare the environmental costs of different design and implementation variants and possibly improve their tender (Ministerie van Infrastructuur en Milieu, 2016).

Another component of MVI is the CO_2 Performance Ladder of the Climate Friendly Procurement & Entrepreneurship Foundation (SKAO). This is a sustainability instrument with the aim of substantially increasing CO_2 reduction in companies which involves reduction within the operational management and in the chain. Companies can achieve this through new forms of collaboration and innovation throughout the chain. The CO_2 Performance Ladder concerns energy saving, CO_2 reduction in the chain, and the use of sustainable energy. The CO_2 Performance Ladder is a CO_2 management system: it requires continuous improvement of insight, further CO_2 reduction measures, communication, and cooperation in business operations. In executing projects, but also in the chain. The CO_2 Performance Ladder has five levels, increasing from 1 to 5. For each level, requirements are defined that are set for the CO_2 performance of the company and its projects. These requirements arise from four perspectives: insight, reduction of emissions, transparency, and participation. A company's place on the ladder is determined by the highest level at which the company meets all requirements. Companies and governments can use the CO_2 Performance Ladder for tenders. The contracting authority can reward a higher score on the ladder with a concrete advantage in the tendering process in the form of a - notional - discount on the tender price.

In practice, working with the CO_2 Performance Ladder goes as follows. The contractor states in the offer that it will carry out the project on one of the five steps (ambition levels) of the CO_2 Performance Ladder. The higher the step, the higher the effort must be to emit less CO_2. A commitment of a higher step results in a higher notional deduction from the tender price, which increases the chance of winning the contract. The amount of this discount and the way in which it is calculated, in combination with other qualitative elements of the tender, is described in the tender documents (EMVI criteria). The contractor must fulfil the promise. If, after an agreed time, it appears that the step is not achieved, a sanction will follow that is one and a half times the advantage appreciated at the time of registration (Ministerie van Infrastructuur en Waterstaat, 2021c).

Ambitieweb

The Ambitieweb is a tool for the structured retention of the sustainability ambitions throughout infrastructure projects. The Ambitieweb is a visual representation of twelve sustainability themes (accessibility, energy, materials, soil, water, ecology, use of space, spatial quality, well-being, social relevance, investments, business climate) and the associated ambition levels. The Ambitieweb can be used in various ways (Ministerie van Infrastructuur en Milieu, 2016; Ambitieweb, n.d.):

- Displaying organizational goals and policy
- Determining the ambitions of a program
- Determining the ambitions of the project during different phases
- Evaluate the project

The levels in the Ambitieweb mean the following (Ministerie van Infrastructuur en Milieu, 2016):

- Level 1: Insight into the largest sustainability impact on the theme. In order to subsequently achieve a minimum sustainability performance such as meeting at least the RVO's MVI criteria.
- Level 2: Setting concrete reduction targets and achieving significant improvements on this theme.
- Level 3: Ambitious with the lowest possible tax (e.g., climate neutral), were necessary by stimulating new solutions and innovation.

A visualization of the Ambitieweb can be seen in the figure below.

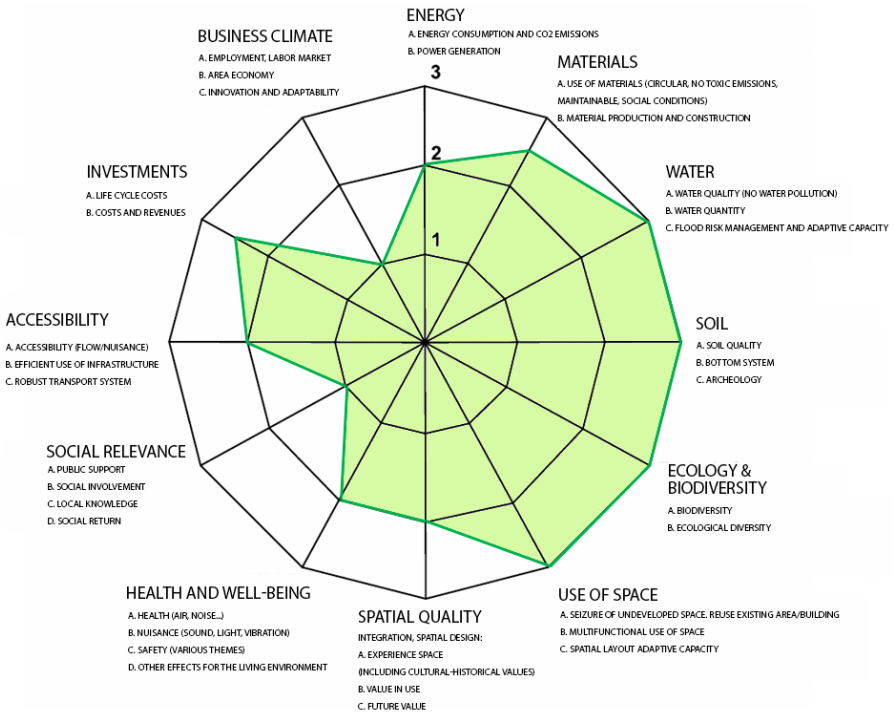

Figure 2: Ambitieweb (Ministerie van Infrastructuur en Milieu, 2016)

Omgevingswijzer

With the Omgevingswijzer an analysis is made of the impact of the project on the environment. This instrument helps to provide insight into the sustainability of tasks in projects in a systematic manner. Social, ecological, and economic sustainability (people, planet, and prosperity) are discussed in the Omgevingswijzer by answering an online questionnaire which ultimately results in a visual representation of the impact of the project on its environment.

The Omgevingswijzer and the Ambitieweb are comparable instruments with a different purpose. The Omgevingswijzer makes an analysis of the impact of the project on the environment, while the ambition web is a visual representation of twelve sustainability themes and the associated ambition levels. (Ministerie van Infrastructuur en Milieu, 2016). But twelve themes are also discussed in the Omgevingswijzer, each of which has been filled in with a number of points for attention. In this way, sustainability has been made concrete for the infrastructure sector. Together with the stakeholders or partners, an assessment is made on how the project or area development scores on each of these points of interest (Ministerie van Infrastructuur en Waterstaat, n.d.). An example of the Omgevingswijzer can be seen in figure 3.

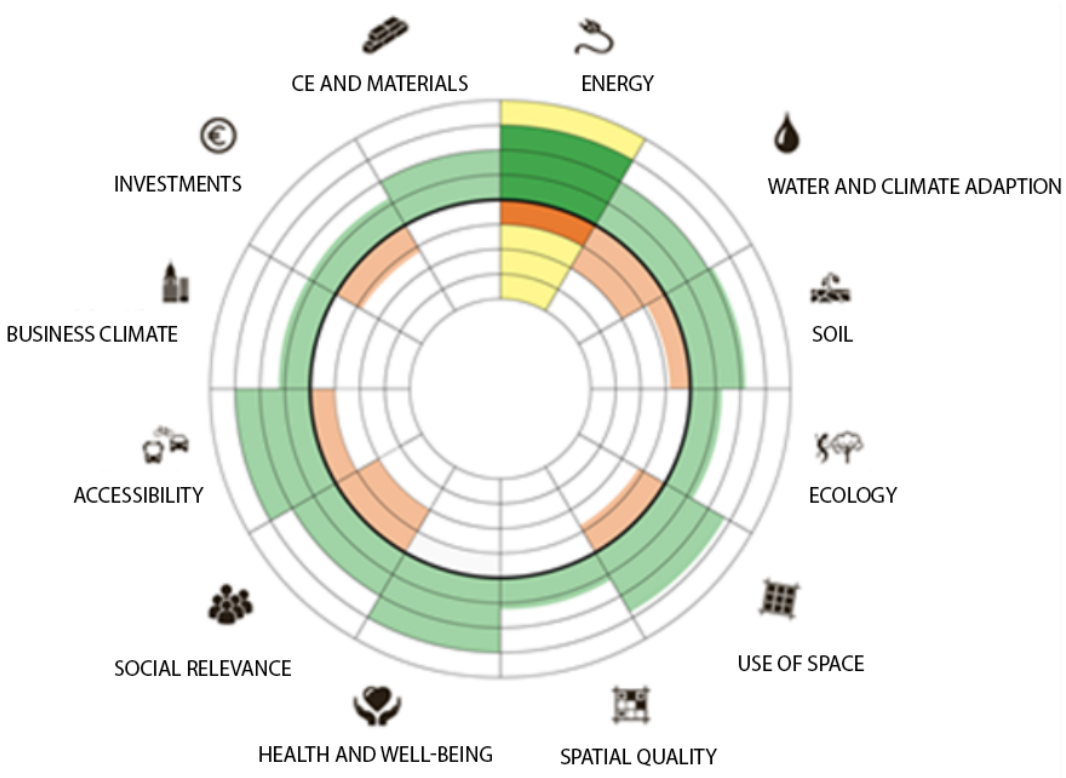

Figure 3: Omgevingswijzer (Ministerie van Infrastructuur en Milieu, 2016)

4.2.3 Results from studies

Various studies have shown that using MVI in the Dutch infrastructure sector contributes to a climate neutral and circular economy. For example, research by the RIVM (2020b) has shown that in pilots studied with DuboCalc, MVI had a potential effect of a total of 2.4 kilo tons CO_2. Another study by the RIVM (2020a) showed that the effect of circular procurement of roads in 2017-2018 was estimated at approximately 24,000 tons of CO_2. Most of the actually avoided emissions from these measures occur around the construction phase of roads due to the use of high-quality recyclate. The maximum gain with the measures to be quantified is estimated at 286,000 tons of CO_2 per purchasing year through the use of high-quality recyclate and 315,000 tons of CO_2 per purchasing year through life-extending measures. In addition, in samples of 10 tenders, 870 tons of greenhouse gas emissions (CO_2) and 11,460 tons of new material were avoided.

The development of the Dutch infrastructure sector between 2017 and 2020, expressed in CO_2 and saved primary material, has been investigated by TNO (2021). TNO has examined a few projects where instruments have been applied to significantly reduce the impact on the environment compared to current practice. In the period 2017-2019, the volume (in monetary terms) of the Dutch infrastructure sector increased by an average of 2.5% per year. In the Dutch infrastructure sector, an increase was observed between 2018 and 2019 in the percentage of public tenders using sustainable award criteria from 28% to 35%. For the 14 participating parties in the survey that were included in the 'Top 25 sustainable clients' of 2020, they jointly applied sustainable award criteria in 2018 and 2019 in 61% of the tenders and minimum requirements for sustainability in 47% of the tenders. In 14% of cases, the award criteria were highly distinctive.

The result from this study is as follow:

- CO_2 emissions: Total emissions from contractors increased between 2017 and 2018 and decreased between 2018 and 2019. No trend can be established on the basis of these three years. Within the investigated projects, it appears that emission reductions between 17% and 70% of CO_2 have been achieved at project level.
- MKI: MKI reductions of between 22% and 53% have been achieved in the investigated projects. More information is needed for the sector as a whole in order to draw broader conclusions in the future.
- Saving primary material: Based on the limited information available, no increase or decrease in the percentage of recycling is observed for concrete and asphalt. Within the investigated projects, concrete savings of between 5.5% and 42% and steel savings of between 25% and 60% are reported.
- Energy consumption of mobile equipment: A trend towards lower energy consumption and lower CO_2 emissions is visible. The improvement is in the order of 1 to 2% per year. Nitrogen emissions fall more sharply, resulting in an improvement in the MKI values of fuel consumption in the order of magnitude of 2 to 3% per year.

5. Achieving sustainability in infrastructure projects

Chapter five of this report focuses on factors that influence achieving sustainability in infrastructure projects extracted from scientific literature. Section 5.1 focuses on the definition of sustainability for this report based on scientific literature. Section 5.2 describes the drivers for sustainable infrastructure development. Section 5.3 elaborates on the barriers and tensions of sustainable infrastructure development.

5.1 Sustainability in the construction industry

Sustainability in the construction industry is defined in different ways in scientific literature. For example, L. Y. Shen et al. (2018) described that sustainable construction focuses on the reduction of harm to the environment, and might incorporate elements such as the prevention, reuse, and management of waste, with direct benefits to society, and with less focus on profitability. In addition, sustainability should seek a win–win outcome that promotes environmental benefits for society on the one hand, whilst seeking competitive advantages and economic benefits for construction companies on the other. On the other hand, Goh et al. (2019) described sustainable construction as the delivery of environmentally friendly, socially acceptable, and economically efficient projects without any dimension dominating the others. However, these definitions are mostly based on the concept of the triple bottom line. This concept was introduced in 1994 by John Elkington, where he suggests that sustainability in construction would be accomplished through attending social, environmental, and economic performance in project delivery, in which all sustainability dimensions should be considered to be equally important (Bamgbade et al., 2017).

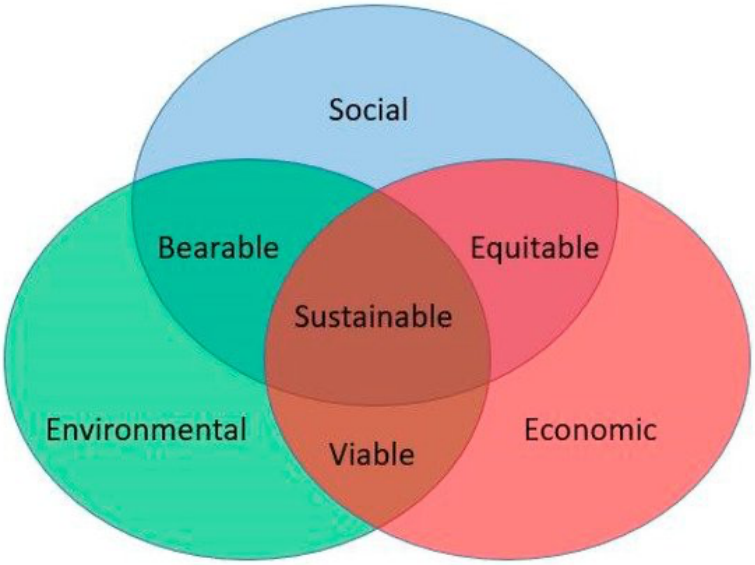

Figure 4: The three dimensions of sustainability (Liu et al., 2019)

Environmental sustainability in construction projects emphasises an efficient use of natural resources to minimise the impacts of the built environment on the earth and enhance the quality of the surrounding environment (Grierson, 2009). Social sustainability examines community development, public engagement, user comfort, and health and safety (Goh, 2017). Economic sustainability in construction projects refers to financial gains from individual projects for the benefit of project stakeholders (Zainul Abidin, 2010).

A strategic development can be provided via balanced and consistent synergy of these three components of sustainability. As ecological and social sustainability cannot present without economic sustainability, it is accepted that social sustainability is a precondition of economic

sustainability. The three components should be taken into consideration as inseparable parts of a whole because of their full integrations with each other (Yılmaz & Bakış, 2015). This concept is visualized in figure 4.

5.2 Drivers for sustainable infrastructure development

Various authors of scientific literature have considered several drivers that influence sustainable infrastructure development. This section provides a summation of these drivers that fall under the four pillars operationalizing sustainability from economic, social, environmental, and organizational perspectives which were described by Xue et al. (2018). These four pillars are the result of the empirical research of Xue et al. (2018), where they have performed literature research to find common indicators for sustainable infrastructure development derived from various scientific articles. The found indicators are shared under these pillars that are based on the three components described in section 4.1 and their suggestion of adding the organizational component. The organizational component is seen as an addition to the three components since it is essential for the delivery of projects, and it determines the direction of going sustainable or not (Diaz-Sarachaga et al., 2016; Xue et al, 2018). In order to deliver sustainable infrastructure projects, these drivers should be appropriately captured, managed, and aligned to existing business models. Table 2 gives an overview of the pillars operationalizing sustainability and its factors for sustainable infrastructure development which are described in-depth in the following subsections.

Table 2: Drivers for sustainable infrastructure development that fall under the pillars operationalizing sustainability

Pillar operationalizing sustainability (driver)	**Factors for sustainable infrastructure development**
Project economy	Financial performance; management of the company's relationship with customers; business expansion.
Social utility	Enhancement of safety and health for the public during construction and operation stages; labour practices; adaptability of the infrastructure to withstand external environmental disturbances and public requirement changes; the infrastructure should be in harmonious relationship with the local community; the infrastructure sets an example and provokes sustainable policies.
Environmental implication	Innovation: consideration of adopting environmentally friendly materials and technologies where the output of the construction should not contain a large amount of waste which contaminates the air, soil, and water; mitigation policies.

Organizational integration	Integration of precise estimation, timely allocation, and reasonable use of resources; close interaction and networking among involved stakeholders; open communication; trust; willingness to compromise and collaborate; relational contract approaches; fostering cooperation between the project team members with a longer-term mind-set and focussing on team efforts on whole-lifecycle performance and sustainable infrastructure; risk allocation.

5.2.1 Project economy

The first pillar described by Xue et al. (2018) is project economy. This pillar highlights financial performance (fiscal incentive policies, initial investment, project budget, life-cycle costs, profitability, payback time), management of the company's relationship with customers (marketing and brand management, market share, management opportunities, risk management), and business expansion (Shen et al., 2011; Gan et al., 2015; Martens & Carvalho, 2017; Xue et al., 2018). Economic factors such as these relate to the cost and benefit aspects of construction activities and are considered essential since it is the fundamental incentive for project initiation (Shen et al., 2015; Xue et al., 2018). In other words, when the company envisions a bright future, it will strive for the project. The in-depth feasibility study should be carried out as to whether the infrastructure development can be transformed into reality. However, if the project must be finished by the utilization of new technology that is expensive, it may exceed the budget line and not be sustainable in terms of project economy (Xue et al., 2018).

5.2.2 Social utility

The second pillar operationalizing sustainability is social utility, which is about the benefits the infrastructure project can bring to society (Xue et al., 2018). According to Valdes-Vasquez & Klotz (2013) a truly sustainable construction project must include social considerations about the end users and the impacts of the project in the community. Various factors fall under this pillar. First of all, the infrastructure should enhance safety and health for the public during construction and operation stages (Xue et al., 2018). But also, the labour practices should be safe and healthy (Martens & Carvalho, 2017). In addition, adaptability of the infrastructure plays a role. It is crucial that the infrastructure can resist environmental disturbances and be able to adapt to the scale of serviceability. For example, the population in the district of the project is boosting, so the passengers required to transport is more than the original amount designed for a metro project (Shen et al., 2015; Xue et al., 2018). Moreover, there should be a harmonious relationship with the local community who live around the infrastructure, (Martens & Carvalho, 2017). The sustainability it advocates raises the society's environmental consciousness and acquires public support that has an effect on (local) development (Shen et al., 2015; Xue et al., 2018). Furthermore, from the governmental level, sustainable infrastructure sets an example and provokes sustainable policies. It helps to obtain inspiration

about sustainability and creates a higher standard for similar projects. In brief, a social sustainable infrastructure improves the liveability of communities through the creation of a better environment and will enhance human health and wealth (Xue et al., 2018).

5.2.3 Environmental implication

The third pillar is called environmental implication, this pillar is created to reach sustainability targets within infrastructure projects. Eventually, this leads to creating business opportunities for sustainable products and services which may guide industries to a sustainable revolution, which then leads to the reduction of environmental footprints. As for the construction industry, it should consider adopting environmentally friendly materials and technologies where the output of the construction should not contain a large amount of waste which contaminates the air, soil, and water. These contaminated elements will affect people's lives and endanger their health (Xue et al., 2018). According to Munyasya & Chileshe (2018), the substitution of the traditional and harmful construction methods and materials to less harmful solutions falls under the factor of innovation. As for the consumed energy resources during the operation stage, it should be renewable, generating less waste and contamination, and making no contributions to global warming. In addition, energy should be produced and used in an efficient way but also be reduced (Munyasya & Chileshe, 2018; Xue et al., 2018). Therefore, proper choices made while designing various projects can help to reduce the environmental effects. Also, there are various mitigation policies that help to reduce the costs and increase environmental benefits of infrastructure projects. These policies are available at both the project and national level (Hinge et al., 2020).

5.2.4 Organizational integration

Organizational integration is the last pillar described by Xue et al. (2018), which is about the management dimension of infrastructure projects. Organizations manage more than one project at the same time with limited resources. Therefore, integration of precise estimation, timely allocation, and reasonable use of resources are critical to attain infrastructure sustainability. Key stakeholders also play a role in this pillar. All the stakeholders should make their own contributions to the project. For example, the owner should play the coordination role; the design team should come up with the optimal design scheme; the construction team should provide construction information to the design team for informed decision-making (Xue et al., 2018). According to Munyasya & Chileshe (2018), close interaction and networking among involved stakeholders is an important driver in ensuring sustainability in infrastructure projects. This way, the sustainability needs of the projects are adequately communicated.

However, due to the early involvement of multiple parties, conflicts of interests may happen because of different positions and preferences. An integrated relationship maintained among these parties could help strengthen common infrastructure sustainability objectives (Xue et al., 2018). The interaction between project participants is often a key factor in project management. Interactive processes include planning, communication, monitoring and control, and project organisation in order to facilitate effective coordination throughout the project life (Adetola et al., 2011). Jacobson & Ok Choi (2008) identified open communication and trust, willingness to compromise and collaborate, and respect as important factors for successful delivery of public private partnership projects.

Nevertheless, Kumaraswamy & Zhang (2008) mentioned that the adoption of relational contract approaches is necessary in order to secure a sustainable product in the complex and evolving nature of risks involved in partnerships and the large number of project stakeholders. Relational contract principles provide a sound basis for harmonising relationships between the contracting parties which reduces areas of disagreements. Factors that help in establishing this relationship are fostering cooperation between the project team members with a longer-term mind-set and focussing on team efforts on whole-lifecycle performance and sustainable infrastructure (Adetola et al., 2011).

Lastly, the allocation of risks is also considered as an important factor of sustainable infrastructure development falling under organizational integration. This is defined as the need for project participants to identify and understand all potential risks associated with a project in order to ensure that risks are properly allocated to the party with the best financial and technical capabilities to manage them has been widely acknowledged (Adetola et al., 2011). According to the paper of Bakhtawar et al. (2019), various authors have reported poor risk identification, ambiguous risk assessment, misplaced risk allocation and insufficient mitigation plans as major planning deficiencies causing delays, cost overruns, stakeholder dissatisfaction and ultimately project failure (Ke et al., 2013; Xiong et al. 2015; Shrestha et al. 2018; Srivastava, 2017). This means that there is a significant need to incorporate high-ranging social, environmental, and economic whole life cycle sustainability considerations in the project performance measurement and risk management processes (Soliño & Gago De Santos, 2010).

5.3 Barriers of sustainable infrastructure development

Numerous barriers that influence the development of sustainable infrastructure have been found from scientific literature. An overview of these barriers can be seen in table 3, elaboration on these factors per barrier is described in the next subsections.

Table 3: Barriers of sustainable infrastructure development

Barrier	**Factors that explain the barrier**
Financial	Higher investment costs compared with traditional building; risks of unforeseen costs; financial benefits of sustainable innovation adoption are marked by uncertainty; the need for assurance for the rate of return of clients; dilemma between the realization of sustainability objectives and investments.
Steering mechanism	The lack or the wrong type of steering mechanism; not implementing sustainability requirements in regulatory frameworks.
Innovation	Risk averse attitude of private parties; the need for platforms between designers and user groups.

Underpinning knowledge	Knowledge and awareness of the concept of sustainability; the wide content of sustainable construction; failure to describe sustainability requirements during the initiation stage of infrastructure projects.
Organizational	Lack of cooperation and networking; lack of stakeholder and local participation; problems in the communication and management between members of the project team; complex supply chain where parties may have competing interests.

5.3.1 Financial barriers

Barriers that are often addressed for sustainable construction is the fear of higher investment costs compared with traditional building and the risks of unforeseen costs. The adoption of sustainable construction solutions may be hindered because of apprehensiveness on higher risk based on unfamiliar techniques, the lack of previous experience, extra time for procurement, installation and inspection, difficulty of providing special materials for sustainable choices, the need to hire experts to implement sustainability standards (Tafazzoli, 2018). Besides, the utilization of sustainable construction technologies may also reflect the actual defects in the supply of well-developed and tested sustainable construction technologies (Häkkinen & Belloni, 2011). Therefore, the financial benefits of sustainable innovation adoption are marked by uncertainty because the financial implications of adoption of sustainable innovation remain unclear (Gauthier & Wooldridge, 2011). In addition, there is a dilemma between investments in infrastructure and the realization of sustainability objectives. Investments in infrastructure may be costly, as a result of which investments in less sustainable, but also less expensive infrastructure or in measures that are not infrastructure based may be more cost-effective (Koppenjan, 2015). Also, in view of infrastructure development consuming a lot of finances and resources, the clients would need some assurance that the rate of return from their investment is enough to motivate the investment in sustainable infrastructure development (Munyasya & Chileshe, 2018). If sustainability objectives lead to higher costs that risk the return on investments, these need to be compensated by either additional government contributions, or by redesigning the project in such a way that a positive cash flow is accomplished. One way to do so is by value capturing. For example, in the Netherlands capturing value can be accomplished by linking-up water infrastructure investments where nature development additional funds may become available for project development (Koppenjan, 2015).

5.3.2 Steering mechanisms

Studies of Munyasya & Chileshe (2018) and Häkkinen & Belloni (2011) concluded that the lack, or the wrong type of steering mechanism is one of the most important barriers influencing the adoption of sustainable infrastructure development. Munyasya & Chileshe (2018) addressed this barrier as establishing a governance framework to encourage greater transparency and responsibility in reporting and communicating sustainability requirements. Generally, market conditions and competition are underdeveloped in infrastructure construction and

infrastructure-based service delivery. As a result, private parties develop market power and may engage in rent seeking and opportunistic behaviour. In order to ensure the proper realization and functioning of new or existing public infrastructure by public-private partnership arrangements, governmental regulation is necessary (Heuvelhof & de Jong, 2009). Regulation is realized by contracts which include mechanisms to encourage private consortia to construct and operate the infrastructure effectively (Koppenjan, 2015). The instruments used for steering include normative regulatory instruments (e.g., building codes), informative regulatory instruments (e.g., mandatory labelling), economic and market-based instruments (e.g., certificate schemes), fiscal instruments and incentives (e.g., taxation and support), and voluntary action (e.g., public leadership programmes) (Köppel & Ürge-Vorsatz, 2007). Contracts should include sustainability requirements such as the reduction of the use of fossil resources, the reduction of greenhouse gasses and measures aimed at the adaptation to climate change (Koppenjan, 2015). Both innovation and regulation are needed to move the industry towards a more sustainable future; economic incentives and fiscal methods may stimulate innovation and create demand for new alternatives before those become cost-effective along with experiences (Häkkinen & Belloni, 2011).

5.3.3 Innovation

The risk averse attitude of private parties often result in a choice for proven technology rather than for innovative solutions, while governments often expect that private involvement automatically results in the adoption of innovative sustainable technologies. As governments often do not know which technologies contribute to sustainability objectives, they may ask the market to come up with proposals. Early private involvement with the procedure of competitive dialogues allows bidding consortia to come up with innovative ideas under competitive conditions. Competition in terms of sustainable performance leads to the use of sustainability performance criteria during procurement which stimulates the adoption of innovative sustainable technologies in infrastructure projects (Koppenjan, 2015). However, according to Häkkinen & Belloni (2011) one of the key issues is to establish platforms between designers and user groups such as consumer associations. Broadening the design process in such a way improves the possibilities to design widely accepted products which are better adapted to the needs of customers.

5.3.4 Underpinning knowledge

Knowledge and awareness of the concept of sustainability plays a major role in facilitating sustainable construction (Häkkinen & Belloni, 2011; Munyasya & Chileshe, 2018). The wide content of sustainable construction makes it difficult to assess the profitability or cost impacts of the implementation of sustainable technologies in infrastructure projects. This hinders cooperation, which leads to hindering the creation or use of innovative solutions. Therefore, the construction design team should clearly formulate sustainability issues in the project brief. As a consequence, failure to describe sustainability requirements during the initiation stage of infrastructure projects is one of the key challenges for sustainable construction. Increased awareness programs may lead to informing all the stakeholders on all the aspects of sustainability, which could help to overcome this barrier (Munyasya & Chileshe, 2018).

5.3.5 Organizational barriers

Lack of cooperation and networking makes it difficult for parties in the construction industry to describe sustainable requirements of construction when developing project briefs (Häkkinen & Belloni, 2011; Agarchand & Laishram, 2017; Munyasya & Chileshe, 2018). According to Agarchand & Laishram (2017), the lack of stakeholder and local participation plays an important role for this barrier. Government and private parties are often preoccupied with realizing their joined ambition, while neglecting their dependencies on third parties. Therefore, stakeholder management should be part of the strategies of governments which are aimed at aligning private, public and stakeholders' interests with each other and with sustainability objectives (Koppenjan, 2015).

Additionally, sustainable construction is hindered with problems in the communication and management between members of the project team (Mills & Glass, 2009; Häkkinen & Belloni, 2011). Sustainable construction requires close interaction of suppliers, professionals, and users because it requires high compatibility of all domains of design, construction, and user behaviour. The preferred design model for sustainable construction projects should consist of an integrated design process which includes all involved parties (owner, developer, designers, builder, tenant, and facility operator) from the beginning (Deane, 2008). According to Munyasya & Chileshe (2018), these types of projects require intense interdisciplinary collaboration, highly complex design analysis, and careful material and system selection already in every phase of the project. Besides, competing interests of parties in the construction industry also hinders the consideration of sustainability requirements (Häkkinen & Belloni, 2011). Knowledge management and sharing are essential factors for all innovations in large construction organizations (H. Robinson et al. 2010). Companies should share information about good practices in order to be able to benefit from learning from each other's experiences (Häkkinen & Belloni, 2011).

6. Results semi-structured interviews

Chapter six of this report gives an overview of the results from the semi-structured interviews, which were performed with 12 professionals of different parties in the Dutch construction industry that worked on or are currently working on two-stage infrastructure projects in the Netherlands. The interview questions can be found in Appendix I, the responses to the interviews can be found in Appendix J. Section 6.1 describes the professional's views on the Dutch Climate Agreement, while section 6.2 elaborates on how the two-stage model suited the professionals' projects. Section 6.3 elaborates on the implementation of sustainability in Dutch two-stage infrastructure projects. A comparison between one-stage and two-stage infrastructure projects is made in section 6.4. Section 6.5 elaborates on the stimulation of sustainability in two-stage infrastructure projects. Lastly, section 6.6 describes the experienced barriers of the two-stage model.

6.1 Dutch Climate Agreement

The interviewed professionals were asked questions on the awareness, necessity, and the feasibility of the transition in the Dutch construction industry. They also made recommendations for the Dutch construction industry to stimulate the transition. An overview of the answers are shown in table 4.

All interviewed professionals are aware of the transition to a climate neutral civil engineering sector. Despite that the professionals consider this transition necessary; it is largely felt that the transition is unfeasible with the current policy. In addition, according to three contractors the energy grid is too weak in order to become a climate neutral sector before 2030. Also, three contractors indicate that one of the reasons for under-use of zero-emission equipment is that large suppliers of construction equipment from abroad are not developing at the same pace as the Dutch civil engineering sector. In other words, there is a big difference in supply and demand. Besides, the transition costs too much time and money according to contractor A^{A1} and advisor D^{B4}. At the moment, the transition is considered more as an ambition of the government than something that is jointly worked towards as a sector.

The professionals have proposed various solutions to stimulate the transition. It was often suggested (contractors A^{A1}, B^{A2}, C^{A3}, advisor C^{B3} and public clients A^{C1} and B^{C2}) that clients should communicate more with market parties using market surveys or market consultations. This to gain an understanding of what exactly is needed from the market parties and themselves. In this way, this transition will be stimulated, with a realistic planning for the sector as the end product. It was also often proposed (contractors A^{A1}, D^{A2}, advisors B^{B2}, D^{B4}, and public client D^{C4}) to make sustainability a fixed criterion on which to score in the tender. However, according to advisor B^{B2} , public clients should understand that there may be a risk that projects will become more expensive and take longer. Contractor B^{A2}, public client B^{C2} and C^{C3}, see the phased exclusion of traditional equipment as a possibility to stimulate the transition. Despite the fact that the equipment will probably be sold to other countries, an impulse will be created for the market to participate in the transition to zero-emission equipment. However, the most made recommendation as a driver for the transition is the use of the two-stage model. According to public client B^{C2} for example, the strengths of public clients and market parties are combined in the two-stage model, which means that

conversations and knowledge sharing between these parties about sustainability can easily be established.

Table 4: Professionals' views on the Dutch Climate Agreement

	Interviewed professional											
Aspect of the transition	A1	A2	A3	A4	B1	B2	B3	B4	C1	C2	C3	C4
Necessity transition	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Feasibility transition									✓			
Barrier: Current policies are weak	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
Barrier: Weak energy grid	✓	✓	✓									
Barrier: Costs too much time and money	✓							✓				
Barrier: Difference supply and demand of zero emission construction equipment		✓	✓	✓								
Suggestion: Need for communication between public parties and market parties (market surveys / consultations)	✓	✓	✓				✓		✓	✓		
Suggestion: Make sustainability a fixed criterion in the tender	✓			✓		✓		✓				✓
Suggestion: Phased exclusion traditional equipment		✓								✓	✓	
Suggestion: Use of the two-stage model		✓	✓		✓			✓		✓	✓	

6.2 Project suitability to the two-stage model

During the semi-structured interviews, the professionals were asked questions on topics such as their satisfaction of the tender process, design process, the price-quality ratio and if they noticed cost and/or time efficiency. In addition, it was asked what collaboration form they would choose instead of a two-stage model for their project that they worked on. These questions were asked to validate the information from literature on the suitability of the two-stage model. Table 5 shows an overview of the responses of the interviewed professionals.

According to the interviewees, the rationale for choosing the two-stage model was mainly because of technical complexity and environmental complexity. The two-stage model was also used for projects in which the client or the advisory firm had too little technical knowledge, resulting in a demand for the contractor's knowledge and skills. For example, in the project of advisor A^{B1}, default solutions were not able to be applied, therefore there was a demand for

the contractor's knowledge and skills. In the project of contractor A[A1], the public client and the advisory firm needed the expertise of the contractor for the phasing of the project. On the other hand, three professionals indicated that the two-stage model was used for their projects in order to challenge the market to come up with suitable solutions for their projects. Nevertheless, the costs of the projects range from 1.2 million to 300 million euros.

From the interviews it can be concluded that most of the professionals were satisfied with the tender procedure. As an example, public client B[C2] was satisfied with the tender procedure since it is based on 100% quality, which resulted in the most suitable partner. In addition, the lead time is shorter with this tender procedure according to public client C[C3], because a tender for the exploratory phase is omitted. Eleven out of the twelve professionals are satisfied with how the design process came about. In general, the design has been developed in an integrated manner, taking into account factors such as cooperation, trust, a good atmosphere, and equality. The design process has resulted in a feasible design through the input of knowledge and expertise from all parties involved.

The contractor's input is used directly, which saves time and money in the design and the realization. Although, in some cases the design stage took a lot of time, but that paid off in the realization phase. This way they knew what to do if a party encountered something unexpected. Also, as an example, advisor B[B2] described that in a traditional approach where an engineering firm is first called in, the manufacturability of the design would have to be checked again, which takes time and costs.

The professionals were also extremely satisfied with the price-quality ratio. According to contractor A[A1], there is fair work for which is in line with the market price with a better distribution of the risks. The design is jointly established, whereby the client receives timely insight into the price.

Most professionals found it difficult when asked which form of collaboration they would choose instead of the two-stage model. Due to the complexity of the work, the two-stage model was considered to fit their projects so well that they could not opt for another form of collaboration. In two cases, the choice was made for an alliance because they considered collaboration within a project team necessary for the project. In other two cases, technical specifications were preferred because of the simplicity of the project.

Table 5: Responses on project suitability

	Interviewed professional											
Aspect	A1	A2	A3	A4	B1	B2	B3	B4	C1	C2	C3	C4
Rationale: Technical complexity				✓	✓	✓			✓	✓	✓	✓
Rationale: Environmental complexity		✓		✓	✓	✓			✓	✓	✓	✓
Rationale: Too little technical knowledge	✓		✓	✓	✓	✓				✓	✓	

public client and advisory firm												
Rationale: Challenge the market		✓	✓	✓			✓	✓	✓			
Satisfied tender procedure	✓	✓	N.A.	✓	N.A.	✓		N.A.	✓	✓	✓	
Satisfied design process	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
Cost efficiency		✓		N.A.		✓		✓			✓	
Time efficiency	✓	✓	✓	N.A.	✓	✓	✓	✓	✓			✓
Satisfied price-quality ratio	✓	✓	✓	N.A.		N.A.	✓	✓	✓	N.A.	✓	✓
The two-stage model was suitable for the project	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓

6.3 Implementation of sustainability in Dutch two-stage infrastructure projects

Professionals that were interviewed for this research were asked questions on how sustainability is implemented Dutch two-stage infrastructure projects. An overview of the responses is given in table 6.

From the interviews it emerges that sustainability has been implemented in different ways in the two-stage infrastructure projects. In most cases, there are joint sustainability objectives that are pursued as a project team during the project. These sustainability objectives can be established because the client can ask about sustainability opportunities during the tender, or how the contractor will implement the client's sustainability objectives.

However, there are various incentives for the contractor to implement sustainable solutions in two-stage projects. Most of the contractors described that their incentive to implement sustainable solutions is market driven or from internal motivation of the organization. For example, contractor B^{A2} indicated that his organization strived to set up a project that fits within their quality frameworks. Contractor C^{A3} described an additional different incentive. This contractor explained that when the public client is not satisfied with the design, they would not gain the right to execute the project. Therefore, this contractor did their best by showing commitment in stage 1. Public client B^{C2} expressed that the incentive for the contractor to use a sustainable solution came from practical reasons. The project team of this project was confronted with environmental complexity where the solution indirectly made a positive contribution in terms of sustainability. The joint sustainability objectives mentioned earlier also helped to incentivize contractors to implement sustainable solutions. Public client

C^{C3} described that after awarding the contract of stage 1, a project team is set up and if one of the objectives is sustainability, then this goal will be pursued as a collective. The Ambitieweb, which is described in chapter 3 of this report, has been used extensively to draw up joint sustainability objectives. Nevertheless, sustainability hardly plays a role when there is a certain time pressure in advance on a two-stage project, in the cases of advisor A^{B1} and public client A^{C1}.

The professionals also mentioned that MKI scores were usually used in their two-stage projects. With the help of DuboCalc, indicative MKI values were delivered to certain solutions. These values are indicative because the design is not yet fixed in the tender of two-stage projects. Public client B^{C2} used MKI scores by calculating the scores per phase and looking at optimization possibilities. Then, using monitoring and clear dashboards, progress was measured in terms of sustainability and emissions compared to what was promised by the contractor. If it turned out that the project team was lagging behind, it would be discussed internally in order to still achieve the sustainability objectives. However, contractor B^{A2} criticized the use of MKI in the Dutch construction industry. According to this contractor, who is the director of a small sized contracting firm, small and medium-sized contracting firms are completely excluded when MKI is being used for engineering projects. This is because sometimes these companies do not receive the required MKI mixtures of recipes from, for example, asphalt plants that are required for a tender. This means that these companies must register with general MKI scores, which is why contractor B^{A2} finds unfair competition. In addition, contractor B^{A2} indicated that clients cannot check certain MKI scores. In short, this contractor thinks that MKI is not a good mechanism when focussing on sustainability in the Dutch construction industry.

Table 6: Implementation of sustainability in Dutch two-stage infrastructure projects

	Interviewed professional											
Aspect	A1	A2	A3	A4	B1	B2	B3	B4	C1	C2	C3	C4
Use of joint sustainability objectives	✓	✓	✓	✓	N.A			✓	N.A.	✓	✓	✓
Incentive contractor: winning stage 1 / stage 2			✓	✓	N.A.			✓	N.A.			
Incentive contractor: internal motivation / the market	✓	✓	✓		N.A.				N.A.			✓
Incentive contractor: practical solution					N.A	✓			N.A	✓		
Incentive contractor: Joint					N.A.			✓	N.A.	✓	✓	

sustainability objectives												
No incentive contractor							✓					
Use Ambitieweb	✓		✓		N.A.				N.A.	✓	✓	✓
Use MKI scores	✓		✓		N.A.	✓		✓	N.A.	✓		✓
Monitoring sustainability	✓				N.A.				N.A.	✓		

6.4 Comparison two-stage and one-stage infrastructure projects

The question was asked to what extent the professionals notice a difference when implementing sustainable solutions within one-stage projects and two-stage projects. For the interview questions, technical specifications were used as a one-stage collaboration model for the comparison. The rationale for this is that technical specifications are used very often in the Dutch construction industry. This is a set of legal, administrative, and technical conditions for drawing up contracts and it forms the basis for making specifications according to a standardized, uniform method. The technical specification is regarded as the most important standard specification in the Dutch construction industry and has been used in the Netherlands for over thirty years (Pianoo, n.d.-e). One of the few differences between a technical specification and the two-stage model is that with the two-stage model, the public client works with the contractor on the design first and then decides whether the contractor will execute the project or not. In contrast with a technical specification, where the contractor will only perform the realization.

From the results it can be concluded that a technical specification prescribes what must be done. In other words, there is less creativity for sustainable solutions. With a technical specification there is a lack of input on the design, implementation methods and type of equipment. With the two-stage model, an integral approach is taken at the implementation of sustainable and innovative solutions in the design and realization. This is because there is more freedom for discussions between the involved parties, which leads to the best solution, socially and financially. There is room for this freedom because collaboration plays a major role, resulting in a supported solution, in contrast to a technical specification.

There is also a remarkable difference in the risk distribution of both collaboration models. With a technical specification the risks are mostly allocated to the contractor. According to contractor A^{A1}, contractor C^{A3} and public client A^{C1} this risk distribution results in not taking the initiative of contractors to implement sustainable solutions because they do not want to be responsible for the risk of implementing the solution. Most respondents believe that the two-stage model has a fairer risk distribution. By means of joint risk sessions, the risks are allocated to the party that is the most suitable to manage them. Because this is done early, there is more room to apply sustainable solutions according to contractors A^{A1} and C^{A3}. Moreover, because the design is not yet established with a two-stage approach, the project team gains insight into the costs at an early stage, which reduces the financial risks according to advisors A^{B1} and C^{B3}.

6.5 Stimulation of sustainability in two-stage infrastructure projects

Subsequently, the professionals were asked which factor they consider the most crucial for the implementation of sustainable solutions within infrastructure projects, including two-stage projects, and how this factor can be stimulated. In chapter 4 of this report, it is described that scientific literature shows that the following drivers are crucial for the implementation of sustainable solutions in infrastructure projects: organizational integration, social utility, project economy, and environmental implication. The professionals chose one of these drivers and described why the driver is important and how it can be stimulated within two-stage infrastructure projects.

6.5.1 Organizational integration

The most chosen driver is organizational integration, 6 professionals (50%) opted for this. The results of the interviews show that cooperation within an organization must be established in such a way that parties must deploy the right employees who are open to cooperation and sustainability in combination with common objectives. Some employees are still traditionally minded and not open to innovations and sustainability, which hinders the process of implementing sustainable solutions. Contractor D^{A4} indicated that when good cooperation takes place, there is room to discuss sustainable ideas with each other which leads to more concrete ambitions. According to advisor D^{B4}, sustainable initiatives are less likely to be chosen if collaboration does not work within a team. To stimulate organizational integration within two-stage projects, evaluation moments should be planned to see whether everyone still knows their role, what the expectations in the project team are and whether everyone is satisfied with the collaboration and each other's performances.

6.5.2 Social utility

The driver of social utility has been chosen by three professionals (25%), who link social utility with time and cost efficiency and having less impact on the environment. According to contractor A^{A1} and public client C^{C3}, this driver could be stimulated with the help of having concrete goals in the project team. In addition, public client C^{C3} indicated that more future prospects should be offered by public clients by, for example, making sustainability a fixed award criterion in future two-stage projects.

6.5.3 Project economy

Project economy was chosen by three professionals (25%). Public client A^{C1} indicated that contractors are commercial organizations, and their primary goal is to make profit, therefore sustainable solutions must also be financially attractive. According to advisor B^{B2}, this driver can be stimulated by showing that sustainability contributes to the financial incentives. Advisor C^{B2} suggested that the project team should look more to the long term (realization phase and maintenance phase). That is because often sustainable solutions are cheaper and more efficient than traditional solutions in the long term. As mentioned by advisor B^{B2}, more subsidies would also help to stimulate financial attractiveness and thus the use of sustainable solutions within two-stage projects.

6.5.4 Environmental implication

None of the professionals chose environmental implication as the most crucial driver for the implementation of sustainable solutions in infrastructure projects. The main reason for this is because according to the other interviewees the other drivers tackle environmental implication.

6.6 Barriers of the two-stage model

The interviewed professionals mentioned a number of barriers that they experienced during their two-stage projects. The mentioned barriers are shown in the table below. Most of these barriers are linked to inexperience with the two-stage model in the infrastructure sector. Because of this inexperience, some parties may not know what their exact role is within the collaboration form which can lead to falling back to old behaviour or the traditional division of roles. Clients still find the model exciting because it is unfamiliar, and they find it difficult to make final decisions. This may lead to mistrusting contractors which eventually affects the collaboration negatively.

On the other hand, contractor A^{A1}, Public clients, B^{C2} , C^{C3} , D^{C4} see a part of the pricing process as a barrier of the two-stage model. For example, public client B^{C3} mentioned that there is a lack of trust during the pricing process since this process is not established in competition, which results in a risk of not having a price which is in line with the market. The reason for this is because there has been hassle around the pricing in the past and current clients take this with them into the two-stage collaboration model. Public client B^{C2} described that the contractor could switch quickly with the prices while the clients need time to make decisions that are in line with their organisation. This complicates the collaboration between the contractor and the public client.

Also, according to contractor D^{A4} it is difficult to find the right people that are open for working with collaborative contracts such as the two-stage contracts. The two-stage model requires these kinds of people instead of the standard contractor or public client who are not that open to intensive collaboration between the parties.

Table 7: Experienced barriers of the two-stage model

	Interviewed professional											
Mentioned barrier	A1	A2	A3	A4	B1	B2	B3	B4	C1	C2	C3	C4
Price forming	✓									✓	✓	✓
Deploying the right people that are open for collaborative contracts				✓								

Clients have little understanding of the two-stage model		✓										
Fall back to old behaviour / traditional roles			✓	✓							✓	
Mistrust between the client and contractor					✓	✓	✓	✓	✓			

7. Discussion

This chapter starts with section 7.1, which compares the results from the research with literature. Section 7.2 describes the research limitations and the assumptions.

7.1 Comparison research findings with literature

This comparison is mainly focused on the results from the semi-structured interviews, compared to findings from scientific literature regarding the Dutch Climate Agreement, the project suitability of the two-stage model, how sustainability is implemented in Dutch two-stage infrastructure projects, how it can be improved and what the barriers of the two-stage model are.

7.1.1 The Dutch Climate Agreement

The interviewed professionals indicated that the transition to a climate neutral civil engineering sector is unfeasible with the current measures and not enough progress is being made. To check whether the progress of the transition is indeed too slow compared to the original planning of the Dutch Climate Agreement, the Climate Monitor which was drawn up by the Dutch government was explored. This report describes the progress of the policy and the agreements in the national climate agreement. Since 2020, the emissions of mobility in construction and sustainability in the construction sector have been tracked annually in the Climate Monitor. The 2021 Climate Monitor states that based on current data, it has been calculated that CO_2 emissions from mobile equipment was approximately 1.5 M ton in 2020 (Rijksoverheid, 2021). This, despite the goal in the Climate Agreement is to reduce it by 0.4 M ton (approximately 30%) by 2030. Because no information is available on the emissions of mobility in construction from the year that the policies of the Dutch Climate Agreement for the Dutch construction industry started, it is not possible to give an indication of whether these policies express sufficient progress to achieve the goal of the Dutch Climate Agreement before 2030.

7.1.2 Project suitability

The results of the interviews indicate that the rationale for choosing a two-stage model is mainly related to the technical and environmental complexity of the projects. The interviewed professionals also indicated that the contractor's expertise was needed in the early stages of the project for complex works. This corresponds with what is described in the literature, high-risk complex projects with many uncertainties are thoroughly linked to the two-stage model (Rijkswaterstaat, 2020b; Ma & Xin, 2011). The two-stage model is also linked to projects where designers want the contractor's expertise for more complex and innovative design solutions (Bouwend Nederland, 2019). In addition, the interviewed professionals were satisfied with this form of collaboration for their project. Most of them could not choose for an alternative collaboration method for their project, only two respondents hesitated for an alliance and two others chose for technical specifications.

In order to validate the anticipated benefits of the two-stage model described in literature (see Appendix B), the professionals were asked questions on topics such as their satisfaction

of the risk allocation, the design process, the price-quality ratio and if they noticed cost and/or time efficiency. The experienced benefits of the two-stage model by the professionals can be seen in table 8.

The two-stage model leads to an improved risk allocation since the risks are allocated to the party that is the most suited to manage them instead of traditionally where most of the risks are allocated to the contractor. Contractor C^{A3} described that environmental risks, such as angry inhabitants, belong more to the public clients, while the realization risks belong more to the contractors. There is also the possibility in the two-stage model to split the risks between the public client and the contractor. Therefore, this contractor finds the risk allocation process in the two-stage model fairer than the traditional model. The traditional model is rather characterized with risk-averse behaviour from the contractor and the public client (Economisch Instituut voor de Bouw, 2017). According to Bouwend Nederland (2019), the two-stage model leads to an improved distribution of risks and responsibilities than a classic client-contractor relationship. This risk management is improved because of contributions from parties involved in the process where they identify, mitigate, and eliminate risks. Rijkswaterstaat mentions that the client and contractor can jointly determine how they will allocate (part of) the risks, or the client can prescribe this unilaterally. This, while the discussions about the risk are conducted transparently (Rijkswaterstaat, 2020b). Rijkswaterstaat (2020b) also mentioned that in other countries where the two-stage model has been implemented, a shift to a more balanced risk distribution was created between the client and contractor. This was also mentioned by Eadie & Graham (2014) where Early Contractor Involvement was used in construction projects located in the United Kingdom. They state that the appropriate risk allocation led to satisfaction of clients and contractors. It also appears that cooperation has changed in other countries, that contractors are more likely to be involved in the process these days and that there is more focus on (long-term) performance (Rijkswaterstaat, 2019).

Because construction knowledge and experience of the contractor are available in the project front-end, these aspects lead to a satisfied design process, time efficiency, financial benefits, and a satisfied price quality ratio. The contractor's expertise on costs of materials and execution techniques in the design process result in a feasible, executable and a quality design since there is predictability on (the costs for and risks during) the execution, while the client receives timely insight into the price which results in less risk of indirect costs.

Table 8: Experienced benefits of the two-stage model by the interviewed professionals

	Interviewed professional											
Benefit	A1	A2	A3	A4	B1	B2	B3	B4	C1	C2	C3	C4
Improved risk allocation	✓	✓	✓	✓	✓	✓	N.A.	✓	✓	✓	N.A.	✓
Satisfied design process	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
Time efficiency	✓	✓	✓	N.A.	✓	✓	✓	✓	✓			✓

Financial benefits		✓		N.A.		✓	✓	✓	✓		✓	✓
Satisfied price-quality ratio	✓	✓	✓	N.A.		N.A.	✓	✓	✓	N.A.	✓	✓

All in all, the benefits of the two-stage model which were described in scientific literature were largely experienced by the interviewed professionals.

7.1.3 Cooperation

Organizational integration is seen as the most crucial driver for implementing sustainable solutions in infrastructure projects by 6 of the interviewed professionals (50%). According to the results of the interviews, employees that are open to cooperation should be deployed in two-stage infrastructure projects in order to stimulate sustainable ideas because this creates room to discuss these ideas, while traditionally minded employees are less open to innovations and sustainability. According to Xue et al. (2018) an integrated relationship maintained among the project team could help strengthen common infrastructure sustainability objectives. Moreover, Jacobson & Ok Choi (2008) mentioned that willingness to compromise and collaborate are important factors for successful delivery of projects. Additionally, joint sustainability objectives were used often by the interviewed professionals in the two-stage infrastructure projects, which is also correlated to cooperation within a project team. This benefit of having sustainability ambitions in two-stage infrastructure projects can be validated by the indication of Munyasya & Chileshe (2018), they described that the sustainability needs of the projects are adequately communicated through close interaction and networking among the involved stakeholders which help to stimulate sustainability in infrastructure projects. Also, according to Adetola et al. (2011) an appropriate allocation of risks is considered as an important factor of sustainable infrastructure development falling under organizational integration. Relating this aspect back to the characteristic of the two-stage model, the risks are allocated to the party that is the most suitable to manage them.

7.1.4 Difference in risk distribution between two-stage and one-stage infrastructure projects

One of the main differences between two-stage and one-stage infrastructure projects is the risk distribution. As mentioned in chapter 6.4, respondents indicated that with a technical specification the risks are mostly allocated to contractors, which leads to contractors not taking the initiative of implementing sustainable solutions because they do not want to be responsible for the risk of implementing the solution. Economisch Instituut voor de Bouw (2017) confirms that this form of collaboration is characterized by risk-averse behaviour: in the case of the application of new or previously untested materials and products, public clients perceive a disproportionately high risk when implementing an innovation in their project. This leads to implementation of already known solutions. Risk-averse behaviour is further enhanced by a number of recent (bad) experiences, for example with the widening of the A15 in the Netherlands. Examples are also mentioned at municipal level of renovations with

negative financial consequences, for the contractor or for the client. The risk-averse behaviour of contractors is reinforced by the fear of claims. The consequence of this fear is that contractors also mainly go for 'proven technologies' and common processes.

According to Economisch Instituut voor de Bouw (2017), risk-averse behavior can be tackled through proper agreements between parties about risk distribution, and about the application and supervision of innovations. This mechanism can be seen in the two-stage model. According to Bouwend Nederland (2019), the two-stage model leads to an improved distribution of risks and responsibilities than a classic client-contractor relationship. Respondents of the interviews mentioned the same aspect about the two-stage model. This risk management is improved because of contributions from parties involved in the process where they identify, mitigate, and eliminate risks. Rijkswaterstaat mentions that the client and contractor can jointly determine how they will allocate (part of) the risks, or the client can prescribe this unilaterally. This, while the discussions about the risk should be conducted transparently (Rijkswaterstaat, 2020b). Rijkswaterstaat (2020b) also mentioned that in other countries where the two-stage model has been implemented, a shift to a more balanced risk distribution was created between the client and contractor. This was also mentioned by Eadie & Graham (2014) where Early Contractor Involvement was used in construction projects located in the United Kingdom. They state that the appropriate risk allocation led to satisfaction of clients and contractors. It also appears that cooperation has changed in other countries, that contractors are more likely to be involved in the process these days and that there is more focus on (long-term) performance (Rijkswaterstaat, 2019).

Rijkswaterstaat (2019) mentioned that the risks should be allocated to the party best capable of carrying that risk in two-stage projects. This will lead to having a balanced risk distribution which may eventually increase the chances of implementing sustainable solutions. Additionally, the two-stage model has proven to work well when the client has high circularity ambitions because of the improved distribution of risks (PIANOo, n.d.-f). All in all, a fair distribution of risks should be implemented in order to influence sustainability within two-stage projects.

7.1.5 Barriers of the two-stage model

The barriers of the two-stage model were described in chapter 6.6 of this report. As mentioned in this chapter, most of these barriers are linked to inexperience with the two-stage model in the infrastructure sector which resulted in a disfunction in cooperation which eventually leads to falling back to old behaviour and even mistrust between the involved parties. The consequences of the lack of experience with the two-stage model has also been noticed in Australia and Norway. In these countries it was confirmed that private and public parties lack either experience, initiative, or both with the early involvement of the contractor. Because of their inexperience, they experience difficulty with the concept which makes it hard for them to reach the benefits of the two-stage model (Love et al., 2014; Wondimu et al., 2016). However, these papers do not mention if the lack of experience with the two-stage model in these countries led to falling back to old behaviour or mistrust between the involved parties.
Also, the literature research of chapter 5.3 showed that there are organizational barriers to sustainable infrastructure development. Mentioned examples of organizational barriers in

this chapter are problems in the communication and management between members of the project team (Mills & Glass, 2009; Häkkinen & Belloni, 2011), and a lack of cooperation and networking (Häkkinen & Belloni, 2011; Agarchand & Laishram, 2017; Munyasya & Chileshe, 2018). Because collaboration has not been smooth in the projects of the respondents while it is linked to sustainability, collaboration should be improved in two-stage projects. Recommendations on improving collaboration in two-stage projects are described in chapter 8.2.

7.2 Research limitations and assumptions

First and foremost, during the semi-structured interviews the professionals were asked on topics such as the implementation of sustainable solutions and how the process took place in making their two-stage projects more sustainable. These interview questions can be interpreted in different ways because of the wide characterization of the terminology of sustainability. This has led to a variety of answers since a concrete definition of a sustainable construction was not given during the interview. As mentioned before, Goh et al. (2019) described sustainable construction as the delivery of environmentally friendly, socially acceptable, and economically efficient projects without any dimension dominating the others. This description should have been given before asking the questions on sustainable solutions during the interview.

Also, because of a change later in the study when the semi-structured interviews were already performed, it was not asked to what extent the professionals made use of subsidies and tax benefits in their two-stage infrastructure projects. For example, it would have been possible to investigate whether it might be easier to make use of subsidies when there is more intensive cooperation between the client and the contractor, so that the client could be more open to subsidies. This would further increase the contrast between the two-stage model and one-stage collaboration forms and thus also show more of the impact of the two-stage model on sustainability.

Moreover, in Appendix C of this research, four project delivery methods are described from existing literature. Most of these project delivery methods came from expert reviews who try frame standardizations of the two-stage model. However, it should be indicated that there are many more two-stage project delivery methods.

Finally, the number of interviewees for this research is limited. The validity of this research can be increased by increasing the number of interviews of professionals that worked on different two-stage infrastructure projects in the Netherlands. The higher the number of interviews, the more reliable the results.

8. Conclusions and recommendations

Before this research, it was unknown how sustainability is implemented in the two-stage model and what the impact of the two-stage model is on the sustainability of infrastructure projects. Making the Dutch construction more sustainable contributes to the transition of Rijkswaterstaat and the Paris Climate Agreement. Therefore, the objective of this research is to fill the gap of knowledge by giving insight in experiences of Dutch market parties and public parties with two-stage infrastructure projects, and the implementation of sustainable solutions in this form of collaboration. In this chapter, each sub question and the main question of this study is answered, recommendations are made for future Dutch two-stage infrastructure projects and for further research.

8.1 Conclusions

This study aimed at exploring the impact of the two-stage model on sustainability of infrastructure projects. The following sub questions can now be answered through the research study, which contributes to answering the main research question. The sub questions SQ1-SQ5 composing the main research question are answered first before the main research question is answered.

SQ 1: What does the two-stage model procedure look like in the Dutch infrastructure sector?

With the aim of understanding what the two-stage model is, it is crucial to give a description of this collaboration form. Different kinds of delivery models can be classified under the two-stage model. Generally, the client tenders a two-stage contract where the design phase and the realization phase are separated from each other (van Kruining, 2021). The client will award the tender by using the qualitative award criteria and the price related criteria (CROW, 2020). In the first stage, the design phase, the client, the contractor, subcontractors, and suppliers take decisions on the design based on the costs and the practical consequences for the methods of execution (Bleeker, 2021). In the end of stage one, parties must have developed an execution design and reached an agreement on the execution in order to carry out stage two (Huith, 2021). If the client and contractor cannot come to an agreement on the price for the execution, the parties will part their ways. The second stage is called the realization phase, where the more execution-oriented parties take the lead. This stage is about the efficient use of equipment and people in order to realize a project with a healthy financial return (Boogaart, 2021).

SQ 2: Which tools can be implemented in two-stage infrastructure projects in order to meet the sustainability conditions of the Paris Climate Agreement, and how are they currently implemented?

In order to gain an understanding on the effects of the two-stage model on sustainability, it is important to know which sustainability tools can be implemented in two-stage projects. According to literature, sustainability tools that are often used for current Dutch infrastructure projects are subsidies, tax benefits, targeted socially responsible procurement (MVI), the Ambitieweb and the Omgevingswijzer (Ministerie van Infrastructuur en Milieu, 2016). The use

of these tools were asked in the interviews. The results indicate that joint sustainability objectives are used the most often in Dutch two-stage infrastructure projects, which mostly result from the use of the Ambitieweb. Looking at MVI, indicative MKI scores were used with the help of DuboCalc to determine the impact of solutions on the environment. Calculating the MKI scores per phase, looking at optimization possibilities and monitoring progress in terms of sustainability and emissions is another method where MKI scores were used.

SQ 3: Which drivers and barriers explained in scientific literature may influence sustainability in two-stage infrastructure projects?

For the purpose of shaping the interviews and asking the respondents questions on sustainability within two-stage infrastructure projects, research has been conducted on the drivers and barriers explained in scientific literature that influence sustainability in infrastructure projects. An overview of the found factors that explain the drivers and barriers can be seen in table 2 and table 3. The drivers for sustainable infrastructure development are the result from the three dimensions of sustainability (economic, social, and environmental sustainability) with an addition of an organizational component. In order to deliver sustainable two-stage infrastructure projects, these drivers should be appropriately captured, managed, and aligned to existing business models. In addition, awareness for the found barriers should be created so sustainability will not be hindered in two-stage infrastructure projects.

Table 2: Drivers for sustainable infrastructure development that fall under the pillars operationalizing sustainability

Pillar operationalizing sustainability (driver)	**Factors for sustainable infrastructure development**
Project economy	Financial performance; management of the company's relationship with customers; business expansion.
Social utility	Enhancement of safety and health for the public during construction and operation stages; labour practices; adaptability of the infrastructure to withstand external environmental disturbances and public requirement changes; the infrastructure should be in harmonious relationship with the local community; the infrastructure sets an example and provokes sustainable policies.
Environmental implication	Innovation: consideration of adopting environmentally friendly materials and technologies where the output of the construction should not contain a large amount of waste which contaminates the air, soil, and water; mitigation policies.

Organizational integration	Integration of precise estimation, timely allocation, and reasonable use of resources; close interaction and networking among involved stakeholders; open communication; trust; willingness to compromise and collaborate; relational contract approaches; fostering cooperation between the project team members with a longer-term mind-set and focussing on team efforts on whole-lifecycle performance and sustainable infrastructure; risk allocation.

Table 3: Barriers of sustainable infrastructure development

Barrier	**Factors that explain the barrier**
Financial	Higher investment costs compared with traditional building; risks of unforeseen costs; financial benefits of sustainable innovation adoption are marked by uncertainty; the need for assurance for the rate of return of clients; dilemma between the realization of sustainability objectives and investments.
Steering mechanism	The lack or the wrong type of steering mechanism; not implementing sustainability requirements in regulatory frameworks.
Innovation	Risk averse attitude of private parties; the need for platforms between designers and user groups.
Underpinning knowledge	Knowledge and awareness of the concept of sustainability; the wide content of sustainable construction; failure to describe sustainability requirements during the initiation stage of infrastructure projects.
Organizational	Lack of cooperation and networking; lack of stakeholder and local participation; problems in the communication and management between members of the project team; complex supply chain where parties may have competing interests.

SQ 4: How could the implementation of sustainability in Dutch two-stage infrastructure projects be improved?

From the interviews it can be concluded that organizational integration is the most important driver among the respondents for implementing sustainability in Dutch infrastructure

projects, including two-stage projects. In order to strive for organizational integration, respondents indicated that it is important to deploy employees that are open to cooperation and sustainability from the involved parties in combination with common objectives. The interviewed professionals see evaluation moments during the project as an aspect to improve organizational integration. Planning these evaluation moments will help to check progress on collaboration and satisfaction with each other's performances. Implementation of these initiatives may help to improve sustainability in two-stage infrastructure projects.

SQ 5: What are the barriers of the one-stage collaboration model which influence the implementation of sustainability?

The respondents see various barriers for the implementation of sustainability in one stage collaboration models. For the sake of this sub question, working with technical specifications were used as an example in the interviews because this collaboration form is regarded as the most important standard specification in the Dutch construction industry (Pianoo, n.d.-e). Technical specifications are characterized by prescription by the public client on what must be done, unilateral risk distribution and risk-avoiding behaviour on the part of the contractor. These aspects lead to a lack of sustainable input on the design, execution methods and the type of equipment.

Finally, with the sub questions being answered, the main question is answered accordingly. The main research question is defined as follows:

"What is the impact of the two-stage model on sustainability of Dutch infrastructure projects?"

The impact of the two-stage model on sustainability can be seen by comparing its characteristics to the one-stage collaboration model. The two-stage model is characterized by integral collaboration between the public client and the contractor with freedom for discussions between the parties. The results of the interviews show that working with jointly determined sustainability objectives with the help of tools as the Ambitieweb, guide to achieving sustainability in two-stage infrastructure projects. In addition, the two-stage model is characterized with a risk distribution that is jointly determined, while early risks of solutions are discussable at an early stage. This leads to the best solution, socially, financially and supported by the project team. In brief, the two-stage model is characterized by many factors that are linked to collaboration between the project team that falls under organizational integration. This, while organizational integration was also the most chosen driver for implementing sustainability in Dutch infrastructure projects among the respondents.

On the other hand, a technical specification which is a form of a one-stage collaboration model, is characterized by factors that in contrast to the two-stage model. According to the respondents, there is a lack of sustainable input since the public client prescribes what must be done without the help of the contractor. The risk distribution also differs from the two-stage model, where the risks of a technical specification are mainly allocated to the contractor. This results in risk-avoiding behaviour on the part of the contractor, which can lead to not implementing sustainable solutions in infrastructure projects since they can be too risky.

Based on the factors resulting from the interviews, technical specifications are characterized by having a lack of organizational integration while the two-stage model focusses more on this driver. Therefore, the two-stage model has more influence on sustainability of Dutch infrastructure projects.

With the answer to the main research question in hand, the main objective of this research study has been reached. An exploration of the impact of the two-stage model on sustainability of infrastructure projects has been performed.

8.2 Recommendations for future practice

This research concludes that organizational integration is the most important driver that influences sustainability in Dutch two-stage infrastructure projects and cooperation, which falls under organizational integration, is one of the main factors that differs from two-stage and one-stage collaboration models. However, the respondents of the interviews for this research indicated that they encountered problems of cooperation during the Dutch two-stage infrastructure projects. For example, problems such as falling back into old behaviour and the emergence of mistrust between the involved parties. Therefore, public and market parties are advised to give collaboration a prominent role in future two-stage infrastructure projects by implementing certain aspects in the projects. Beforehand, it is advised to deploy employees from the involved parties that are open to cooperation and sustainability. Some employees are still traditionally minded and not open to innovations and sustainability, which hinders the process of implementing sustainable solutions. If sustainability is one of the objectives of the two-stage project, the implementation of shared sustainability goals that are going to be pursued throughout the project is advised. Most of the respondents were satisfied with the use of these shared sustainability goals in their two-stage projects. Drawing up these shared sustainability goals can be done with the use of the Ambitieweb and the Omgevingswijzer for example. It is also recommended to use periodic meetings in which the satisfaction of soft skills such as collaboration and communication with the involved parties is measured. This could be done with surveys based on shared core values, where the results are shared in a transparent manner. From this it can follow whether there are factors that can be improved within the process that leads to development of the project team. All these aspects will not only speed up the process since it will improve cooperation between the involved parties but will also create an environment in which sustainable opportunities can be exploited.

In addition, it is advised to take into account that the two-stage model is not suitable for every type of project. Advisor C^{B3} indicated that the two-stage model was not suitable for the project that she worked on because of the simplicity of the project. This, while literature explain that the two-stage model should be used for high-risk complex projects with many uncertainties where construction knowledge of the contractor is needed (Rijkswaterstaat, 2020; Ma & Xin, 2011). In other words, the two-stage model should not always be applied. If the client already knows what he wants, then a technical specification would be more suitable because of the simplicity of what needs to be executed in the given time period.

Another barrier that most of the professionals encountered is that there is a lack of experience with the two-stage model which leads to falling back to the traditional roles of the involved

parties. In order to stimulate the implementation of the two-stage model in the Dutch construction industry, more experience is needed. Therefore, contractors B[A2], C[A3] and advisor D[B4] directly suggested that public parties should tender two-stage projects more often in order to gain more experience with the model. Van Wijck (2018) described the same indication that more two-stage projects have to be tendered by (public) clients in order to gain momentum with the two-stage model (van Wijck, 2018).

Also, Rijkswaterstaat should publish more evaluations of two-stage projects for further implementation of the two-stage model in the Netherlands. Parties in the construction industry will learn from the made mistakes and possible improvements mentioned in these evaluations. According to some of the respondents, when the two-stage model is proven to work, forward momentum will carry the development and use of the model further. These evaluations of Rijkswaterstaat will stimulate smaller public parties to choose for the two-stage model more often if it proves success. This, while experience is lacking with the two-stage model in the Netherlands as described above. More knowledge on the two-stage model is needed in the Dutch construction industry, which is needed to attract public parties to choose more often for the two-stage model.

Lastly, the interviewed professionals proposed certain solutions to accelerate the transition to a climate neutral construction sector. For example, it was indicated that sustainability should be a fixed criterion in the tender. Although, a similarity has been noticed in the 2021 Climate Monitor, in which it is established that governments stimulate the transition by tightening the criteria in purchasing processes and agreements on standardization of emission-free procurement (Rijksoverheid, 2021). Another recommendation by the respondents is the phased exclusion of traditional construction equipment, which may eventually result in an innovation push and stimulation to purchase zero-emission construction equipment. Moreover, public parties should make use of market surveys or market consultations. The interviewed professionals recommended this, because this action will give an understanding of what exactly is needed from the market parties and public parties to stimulate the transition to a zero-emission construction industry.

8.3 Recommendations for further research

Firstly, this research mainly focussed on the client-contractor relationship in two-stage infrastructure projects in the Netherlands. However, subcontractors also play a role in the two-stage model. As mentioned in chapter three, subcontracts are involved in the design phase as well since they are more involved in the execution than the contractor. It is rather unknown what the subcontractors think of the two-stage model, what their input is on sustainability in two-stage projects, their experiences, barriers and how they behave within two-stage projects. Further research could be conducted on these aspects within Dutch two-stage infrastructure projects.

Besides, the number of interviewees for this research is limited. The validity of this research can be increased by increasing the number of interviews of professionals that worked on different Dutch two-stage infrastructure projects. Future research could identify more (reliable) results.

Furthermore, this research described four variants of the two-stage model in Appendix C. However, there are many more project delivery methods of the two-stage model than described in this research. Future research could be conducted on how each two-stage project delivery method has contributed to two-stage projects in the Netherlands, sustainability, the transition goals of Rijkswaterstaat, the advantages and disadvantages. This would create a great foundation (for handbooks) that could be used by parties in the Dutch infrastructure sector.

9. Bibliography

Adetola, A., Goulding, J., & Liyanage, C. (2011). Collaborative engagement approaches for delivering sustainable infrastructure projects in the AEC sector: A review. *International Journal of Construction Supply Chain Management*, *1*(1), 1–24. https://doi.org/10.14424/ijcscm101011-01-24

Agarchand, N., & Laishram, B. (2017). Sustainable infrastructure development challenges through PPP procurement process. *International Journal of Managing Projects in Business*, *10*(3), 642–662. https://doi.org/10.1108/ijmpb-10-2016-0078

Ambitieweb. (n.d.). Werken aan Duurzaamheid. Retrieved 21 March 2022, from https://www.werkenaanduurzaamheid.nl/tools/ambitieweb/

Antea Group. (2021). *Closing the loop: in 2050 circulair en klimaatneutraal werken*. Retrieved 2 March 2022 from Antea Group: https://anteagroup.nl/nieuws-media/nieuws/closing-the-loop-in-2050-circulair-en-klimaatneutraal-werken

Bakhtawar, B., Thaheem, M. J., & Arshad, H. (2019). Integrating sustainability into project risk management; an application in PPP projects*, in CSCE 2019 : Proceedings of the Canadian Society for Civil Engineering Annual Conference*, CSCE, Laval, Quebec, pp. 1-14.

Bamgbade, J., Kamaruddeen, A., & Nawi, M. (2017). Malaysian construction firms' social sustainability via organizational innovativeness and government support: The mediating role of market culture. *Journal of Cleaner Production*, *154*, 114–124. https://doi.org/10.1016/j.jclepro.2017.03.187

Bergen, M., & Mountford, H. (2020). *6 Signs of progress since the adoption of the Paris Agreement*. World Resources Institute. Retrieved 27 February 2022, from https://www.wri.org/insights/6-signs-progress-adoption-paris-agreement

Bleeker, R. G. T. (2021). Een bouwcontract en geen juristencontract. *Tijdschrift Voor Bouwrecht*, *14*(8). https://www-ibrtracker-nl.tudelft.idm.oclc.org/docs/articles/2021/augustus/a~document.pdf

Boes, H., & Fijneman, J. (2021). *De meerwaarde van tweefasen-contracten: kies de juiste invalshoek.* Cobouw article, retrieved from: https://www.linkedin.com/posts/joost-fijneman-2815a8_tweefasencontracten-innovatie-activity-6775024106678050816-TxBT/

Boogaart, E. (2021). *Dynamieken in een 2 fasen contract*. https://courageousteaming.com/wp-content/uploads/2021/04/2021_Ct_ebook_V01_Dynamieken_in_2_fasen_contract.pdf

Bouwend Nederland. (2019). *Handreiking gefaseerd aanbesteden*. https://www.pianoo.nl/sites/default/files/media/documents/Handreiking%20gefaseerd%20aanbesteden-juli2019.pdf

Bouwend Nederland. (2020). *Bouwteam en andere samenwerkingsvormen groeien in populariteit*. Retrieved 16 March 2022, from https://www.bouwendnederland.nl/actueel/nieuws/15435/bouwteam-en-andere-samenwerkingsvormen-groeien-in-populariteit

BRODIES. (2020). *Two stage tenders: A means of managing risk for contractors?* https://brodies.com/insights/construction-and-engineering/two-stage-tenders-a-means-of-managing-risk-for-contractors/

Bundgaard, K., Klazinga, D., & Visser, M. (2011). Traditional Procurement Methods Are Broken : Can Early Contractor Involvement Be the Cure? *Terra et Aqua, 11*(1), 8.

Retrieved from https://www.iadc-dredging.com/ul/cms/terraetaqua/document/2/9/9/299/299/1/articletraditional-procurement-methods-are-broken-can-early-contractor-involvement-be-the-cureterra-et-aqua-124-4.pdf

Chao-Duivis, M. (2012). Het bouwteam model: Een studie naar de juridische vormgeving en het functioneren in de praktijk. Instituut voor Bouwrecht (IBR).

Chao-Duivis, M. A. B., Koning, A. Z. R., & Ubink, A. M. (2018). *A practical guide to Dutch building contracts* (4th ed.). Stichting Instituut Voor Bouwrecht.

Clemens, D. (2021). *A practical guideline for riskmanagement processes in two-phase delivery models.* [Master's thesis, TU Delft].

Construction Executive. (2017). *Working Backward From a Construction Budget With Target Value Design*. Retrieved 20 March 2022, from http://constructionexec.com/article/working-backward-from-a-construction-budget-with-target-value-design

CROW. (2019). *Bouwteams: wat en waarom - een introductie* [Slides]. CROW. https://www.crow.nl/downloads/pdf/aanbesteden/accongres2019/presentatie-sessie-1-5.aspx#:~:text=Een%20bouwteam%20is%20een%20samenwerkingsmodel,mag%20doen%20voor%20de%20uitvoering

CROW. (2020). *Handreiking 'Aanbesteden van twee fasen contracten'*. https://www-crow-nl.tudelft.idm.oclc.org/getmedia/145ca750-e10f-4e8f-b609-536643553c48/Handreiking-Aanbesteden-van-twee-fasen-contracten.pdf.aspx?ext=.pdf

Davis, P., Love, P., & Baccarini, D. (2008). Building Procurement Methods. Retrieved from http://www.construction-innovation.info/images/pdfs/Research_library/ResearchLibraryC/2006- 034-C/reports/Report_-_Building_Procurement_Methods.pdf

Deane, M. (2008). The builder's role in delivering sustainable tall buildings. *The Structural Design of Tall and Special Buildings*, *17*(5), 869–880. https://doi.org/10.1002/tal.470

Designing Buildings. (2020). *Two-stage tender*. https://www.designingbuildings.co.uk/wiki/Two-stage_tender

Diaz-Sarachaga, J. M., Jato-Espino, D., Alsulami, B., & Castro-Fresno, D. (2016). Evaluation of existing sustainable infrastructure rating systems for their application in developing countries. *Ecological Indicators*, *71*, 491–502. https://doi.org/10.1016/j.ecolind.2016.07.033

Duurzaam Gebouwd. (2020). *Model overeenkomst bouwteam DG 2020*. https://duurzaamgebouwd.lingacms.nl/upload/dg_8fd9sluf/Model_Bouwovereenkomst_DG-2020.pdf

Duurzame-Infra. (n.d.). *Transitiepad bouwplaats en bouwlogistiek*. Retrieved 1 March 2022, from https://www.duurzame-infra.nl/roadmaps/transitiepad-bouwplaats-en-bouwlogistiek

Eadie, R., & Graham, M. (2014). Analysing the advantages of early contractor involvement. *International Journal of Procurement Management*, *7*(6), 661. https://doi.org/10.1504/ijpm.2014.064971

Economisch Instituut voor de Bouw. (2017). *Innovatie in de bouw*. https://www.eib.nl/pdf/Rapport_Innovatie_in_de_bouw_web.pdf

European Commission. (n.d.-a). *2030 Climate Target Plan*. Europa. Retrieved 26 February 2022, from https://ec.europa.eu/clima/eu-action/european-green-deal/2030-climate-target-plan_en

European Commission. (n.d.-b). *Emissions monitoring & reporting*. Europa. Retrieved 27 February 2022, from https://ec.europa.eu/clima/eu-action/climate-strategies-targets/progress-made-cutting-emissions/emissions-monitoring-reporting_en

European Commission. (2020). *Stepping up Europe's 2030 climate ambition*. Europa. https://eur-lex.europa.eu/resource.html?uri=cellar:749e04bb-f8c5-11ea-991b-01aa75ed71a1.0001.02/DOC_1&format=PDF

European Commission. (2021). *EU climate action: Progress reports show 2020 emissions down 31% from 1990, 76% of ETS revenues used for green transition*. Retrieved 27 February 2022, from https://ec.europa.eu/commission/presscorner/detail/en/IP_21_5555

Finnie, D. A. (2020). *A contractual framework for two-stage early contractor involvement (2S-ECI) in New Zealand commercial construction projects*. https://mro.massey.ac.nz/bitstream/handle/10179/16327/FinniePhdThesis.pdf?sequence=&isAllowed=y

Gan, X., Zuo, J., Ye, K., Skitmore, M., & Xiong, B. (2015). Why sustainable construction? Why not? An owner's perspective. *Habitat International*, *47*, 61–68. https://doi.org/10.1016/j.habitatint.2015.01.005

Gauthier, J., & Wooldridge, B. (2011). Influences on Sustainable Innovation Adoption: Evidence from Leadership in Energy and Environmental Design. *Business Strategy and the Environment*, *21*(2), 98–110. https://doi.org/10.1002/bse.716

Geurts, E. (2022). *Veldtest met waterstofaggregaat op emissieloze bouwplaats succesvol verlopen*. Alles over Waterstof. Retrieved 1 March 2022, from https://allesoverwaterstof.nl/veldtest-met-waterstofaggregaat-op-emissieloze-bouwplaats-succesvol-verlopen/

Goh, C. S. (2017). *Towards an integrated approach for assessing triple bottom line in the built environment*. International Conference on Advances on Sustainable Cities and Buildings Development. https://www.researchgate.net/publication/322386717_Towards_an_Integrated_Approach_for_Assessing_Triple_Bottom_Line_in_the_Built_Environment

Goh, C. S., Chong, H. Y., Jack, L., & Faris, A. M. (2019). Revisiting triple bottom line within the context of sustainable construction: A systematic review. *Journal of Cleaner Production.*

Grierson, D. (2009). *Towards a sustainable built environment*. CIC Start Online. https://www.researchgate.net/publication/311933331_Towards_a_Sustainable_Built_Environment

Häkkinen, T., & Belloni, K. (2011). Barriers and drivers for sustainable building. *Building Research & Information*, *39*(3), 239–255. https://doi.org/10.1080/09613218.2011.561948

Heuvelhof, E. T., & de Jong, M. (2009). *Strategic Behaviour in Network Industries - A Multidisciplinary Approach*. Edward Elgar Publishing.

Hinge, G., Surampalli, R. Y., & Goyal, M. K. (2020). Sustainable Infrastructure. *Sustainability*, 295–311. https://doi.org/10.1002/9781119434016.ch14

Huith, G. J. (2021). Eerlijk werk voor eerlijk geld? *Tijdschrift Voor Bouwrecht*, *14*(8). https://www-ibrtracker-nl.tudelft.idm.oclc.org/docs/articles/2021/augustus/a~document.pdf

Jacobson, C., & Ok Choi, S. (2008). Success factors: public works and public-private partnerships. *International Journal of Public Sector Management*, *21*(6), 637–657. https://doi.org/10.1108/09513550810896514

Jilcha Sileyew, K. (2020). Research design and methodology. *Cyberspace*. Published. https://doi.org/10.5772/intechopen.85731

Ke, Y., Wang, S., & Chan, A. P. C. (2013). Risk Misallocation in Public–Private Partnership Projects in China. *International Public Management Journal*, *16*(3), 438–460. https://doi.org/10.1080/10967494.2013.825508

Klimaatverbond Nederland. (2020). *Rekenen met de toekomst*. https://klimaatverbond.nl/wp-content/uploads/2020/09/Rekenen-met-de-Toekomst-Publicatie-CO2-beprijzing-Klimaatverbond-Nederland.pdf

Koninklijke Bouwend Nederland. (2021). *Model bouwteamovereenkomst 2021*. https://www.bouwendnederland.nl/media/10351/2021-05-01-kbnl-model-bouwteamcontract-2021.pdf

Koppenjan, J. F. (2015). Public–Private Partnerships for green infrastructures. Tensions and challenges. *Current Opinion in Environmental Sustainability*, *12*, 30–34. https://doi.org/10.1016/j.cosust.2014.08.010

Köppel, S. & Ürge-Vorsatz, D. (2007) *Assessment of Policy Instruments for Reducing Greenhouse Emissions from Buildings*. Report for UNEP SBCI. Central European University, Budapest.

Kuh, K. (2018). The Law of Climate Change Mitigation: An Overview. *Encyclopedia of the Anthropocene*, 505–510. https://doi.org/10.1016/b978-0-12-809665-9.10027-8

Kumaraswamy, M. M., & Zhang, X. Q. (2008). Risk Assessment and Management in BOT-Type Public-Private Partnership Projects in China - with Special Reference to Hong Kong. *Public-Private Partnerships*, 263–283. https://doi.org/10.1002/9780470690703.ch12

Laedre, O., & Svalestuen, F. (2014). *Early contractor involvement: Advantages and disadvantages for the design team*. https://www.researchgate.net/publication/267210780_Early_Contractor_Involvement_Advantages_and_Disadvantages_for_the_Design_Team/stats

Leendertse, W., Lenferink, S., & Arts, J. (2012). Public-Private Collaboration: How Private Involvement can Contribute to Network Performance. *Procedia - Social and Behavioral Sciences, 48*, 2917– 2929. https://doi.org/10.1016/j.sbspro.2012.06.1260

Lenferink, S., Arts, J., Tillema, T., van Valkenburg, M., & Nijsten, R. (2012). Early Contractor Involvement in Dutch Infrastructure Development: Initial Experiences with Parallel Procedures for Planning and Procurement. *Journal of Public Procurement, 12*(1), 1–42. Retrieved from https://search.proquest.com/docview/1002352955?pq-origsite=gscholar

Liu, X., Schraven, D., de Bruijne, M., de Jong, M., & Hertogh, M. (2019). Navigating Transitions for Sustainable Infrastructures - The Case of a New High-Speed Railway Station in Jingmen, China. *Sustainability 11 (15), 4197.*

Love, P., Edwards, D. J., & Irani, Z. (2012). Moving beyond optimism bias and strategic misrepresentation: An explanation for social infrastructure project cost overruns. *IEEE Transactions on Engineering Management, 59*(4), 560–571. https://doi.org/10.1109/TEM.2011.2163628

Love, P., O'Donoghue, D., R. Davis, P., & Smith, J. (2014). Procurement of public sector facilities. *Facilities*, *32*(9/10), 460–471. https://doi.org/10.1108/f-03-2012-0020

Ma, Tony., & Xin, Hee. (2011). Early contractor involvement - South Australian experience. 36th Australasian University Building Educators Association (AUBEA) Conference. Paper 7. Retrieved from: http://epublications.bond.edu.au/aubea_2011/7

Martens, M. L., & Carvalho, M. M. (2017). Key factors of sustainability in project management context: A survey exploring the project managers' perspective. *International Journal of Project Management*, *35*(6), 1084–1102. https://doi.org/10.1016/j.ijproman.2016.04.004

Matemilola, S., Fadeyi, O., & Sijuade, T. (2020). Paris Agreement. *Encyclopedia of Sustainable Management*, 1–5. https://doi.org/10.1007/978-3-030-02006-4_516-1

Mills, F. T., & Glass, J. (2009). The Construction Design Manager's Role in Delivering Sustainable Buildings. *Architectural Engineering and Design Management*, *5*(1–2), 75–90. https://doi.org/10.3763/aedm.2009.0908

Ministerie van Binnenlandse Zaken en Koninkrijksrelaties. (2012). *Aanbestedingswet 2012*. https://wetten.overheid.nl/BWBR0032203/2019-04-18

Ministerie van Economische Zaken. (2016). *Aanbestedingsreglement werken 2016*. https://www.pianoo.nl/sites/default/files/documents/documents/arw2016staatscourant17juni.pdf

Ministerie van Infrastructuur en Milieu. (2016). *Handreiking Aanpak Duurzaam GWW*. Duurzaam GWW. https://www.duurzaamgww.nl/?file=304&m=1645517268&action=file.download

Ministerie van Infrastructuur en Waterstaat. (n.d.). *Opbouw omgevingswijzer*. Omgevingswijzer. Retrieved 21 March 2022, from https://www.omgevingswijzer.org/toelichting/opbouw/

Ministerie van Infrastructuur en Waterstaat. (2021a). *Circulaire economie*. Rijkswaterstaat. Retrieved 2 March 2022, from https://www.rijkswaterstaat.nl/zakelijk/duurzame-leefomgeving/circulaire-economie

Ministerie van Infrastructuur en Waterstaat. (2021b). *Circulaire viaducten en bruggen*. Rijkswaterstaat. Retrieved 2 March 2022, from https://www.rijkswaterstaat.nl/zakelijk/duurzame-leefomgeving/circulaire-economie/strategic-business-innovation-research-circulaire-viaducten

Ministerie van Infrastructuur en Waterstaat. (2021c). *CO2-prestatieladder*. Rijkswaterstaat. Retrieved 2 March 2022, from https://www.rijkswaterstaat.nl/zakelijk/zakendoen-met-rijkswaterstaat/inkoopbeleid/duurzaam-inkopen/co2-prestatieladder

Ministerie van Infrastructuur en Waterstaat. (2021d). *Emissieloze bouwplaats*. Magazine Rijkswaterstaat. Retrieved 1 March 2022, from https://www.magazinesrijkswaterstaat.nl/zakelijkeninnovatie/2021/01/emissieloze-bouwplaats

Munyasya, B., & Chileshe, N. (2018). Towards sustainable infrastructure development: Drivers, barriers, strategies, and coping mechanisms. *Sustainability*, *10*(12), 4341. https://doi.org/10.3390/su10124341

Nader, A. (2019). *Success factors to the client-contractor collaboration in the Dutch infrastructure sector*. [Master's thesis, TU Delft]. TU Delft Repository. https://repository.tudelft.nl/islandora/object/uuid%3Af2aeb134-8acd-4076-bdce-e7ddedc74558

Natuur en Milieu. (2019). *Belemmeringen bij de inzet van elektrische mobiele werktuigen*. https://www.natuurenmilieu.nl/wp-content/uploads/2019/09/Belemmeringen-bij-de-inzet-van-elektrische-mobiele-werktuigen.pdf

NEBEST. (n.d.). *Closing the Loop*. Retrieved 2 March 2022, from https://www.nebest.nl/producten/closing-loop

Oakland, J. S., & Morris, P. (1995). *Total Quality Management.* Taylor & Francis.

Pianoo. (N.d.-a). *Aanbestedingsreglement Werken 2016 (ARW 2016)*. Retrieved 4 April 2022, from https://www.pianoo.nl/nl/regelgeving/aanbestedingsreglement-werken-2016-arw-2016

Pianoo. (n.d.-b). *Aanbestedingswet 2012*. Retrieved 4 April 2022, from https://www.pianoo.nl/nl/regelgeving/aanbestedingswet-2012

Pianoo. (n.d.-c). *Selectiecriteria*. Retrieved 4 April 2022, from https://www.pianoo.nl/nl/metrokaart/selectiecriteria

Pianoo. (n.d.-d). *Maatschappelijk Verantwoord Inkopen*. Retrieved 2 March 2022, from https://www.pianoo.nl/nl/themas/maatschappelijk-verantwoord-inkopen

Pianoo. (n.d.-e). *Traditionele contractvormen GWW (RAW en Bouwteam)*. PIANOo - Expertisecentrum Aanbesteden. Retrieved 10 May 2022, from https://www.pianoo.nl/nl/sectoren/gww/contractvormen/traditionele-contractvormen-gww-raw-en-bouwteam

PIANOo. (n.d.-f). *Twee-fasen-contract past perfect bij de circulaire ambities van It Swettehûs*. PIANOo - Expertisecentrum Aanbesteden. Retrieved 14 June 2022, from https://www.pianoo.nl/nl/twee-fasen-contract-past-perfect-bij-de-circulaire-ambities-van-it-swettehus

Plumer, B., & Popovich, N. (2021). *Yes, there has been progress on climate. No, it's not nearly enough.* The New York Times. Retrieved 27 February 2022, from https://www.nytimes.com/interactive/2021/10/25/climate/world-climate-pledges-cop26.html

PPS Netwerk NL. (2021). *Twee-fasen aanbesteding: Theorie en praktijkervaring 1,5 jaar na gunning*. PPS Netwerk. https://www.ppsnetwerk.nl/twee-fasen-aanbesteding-theorie-en-praktijkervaringen-van-project-15-jaar-na-gunning/

Rahmani, F., Khalfan, M. M. A., & Maqsood, T. (2013). The use of early contractor involvement in different countries. *AUBEA Proceeding Conference*, 1–10. Retrieved from https://www.library.auckland.ac.nz/external/finalproceeding/Files/Papers/46530final00139.pdf

Rijksoverheid. (2019). *Klimaatakkoord*. https://www.rijksoverheid.nl/documenten/rapporten/2019/06/28/klimaatakkoord

Rijksoverheid. (2021). *Monitor Klimaatbeleid 2021*. https://www.rijksoverheid.nl/documenten/publicaties/2021/10/28/monitor-klimaatbeleid-2021

Rijkswaterstaat. (2019). *Toekomstige opgave Rijkswaterstaat: Perspectief op de uitdagingen en verbetermogelijkheden in de GWW-sector*. https://www.rijksoverheid.nl/binaries/rijksoverheid/documenten/rapporten/2019/06/11/toekomstige-opgave-rijkswaterstaat/toekomstige-opgave-rijkswaterstaat.pdf

Rijkswaterstaat. (2020a). *Op weg naar een vitale infrasector*. https://www.rijksoverheid.nl/ministeries/ministerie-van-infrastructuur-en-

waterstaat/documenten/rapporten/2020/03/03/bijlage-1-definitief-pva-transitie-naar-een-vitale-infrasector
Rijkswaterstaat. (2020b). *Evaluatie 2-fasen proces*. https://www.rijkswaterstaat.nl/formulieren/contactformulier-servicedesk-zakelijk
Ritchie, H. (2020). *Future greenhouse gas emissions*. Our World in Data. Retrieved 27 February 2022, from https://ourworldindata.org/future-emissions
RIVM. (2015). *Circular economy in the Dutch construction sector*. https://www.rivm.nl/bibliotheek/rapporten/2016-0024.pdf
RIVM. (2020a). *Effect meten van circulair inkopen*. https://www.rivm.nl/bibliotheek/rapporten/2020-0002.pdf
RIVM. (2020b). *Effecten van de impuls klimaatneutraal en circulair inkopen in 2019*. https://www.rivm.nl/bibliotheek/rapporten/2020-0074.pdf
Robinson, H., Carrillo, P., Anumba, C. J., & Patel, M. (2010). *Governance and Knowledge Management for Public-Private Partnerships*. Wiley.
RVO. (2022a). *DEI+: Circulaire economie*. Retrieved 2 March 2022, from https://www.rvo.nl/subsidie-en-financieringswijzer/demonstratie-energie-en-klimaatinnovatie-dei/circulaire-economie
RVO. (2022b). *Energie-investeringsaftrek (EIA) voor ondernemers*. Retrieved 2 March 2022, from https://www.rvo.nl/subsidie-en-financieringswijzer/energie-investeringsaftrek/ondernemers
RVO. (2022c). *MIA en Vamil voor ondernemers*. Retrieved 2 March 2022, from https://www.rvo.nl/subsidie-en-financieringswijzer/miavamil/ondernemers
RVO. (2022d). *Subsidieregeling Schoon en Emissieloos Bouwmaterieel (SSEB)*. Retrieved 2 March 2022, from https://www.rvo.nl/subsidie-en-financieringswijzer/subsidieregeling-schoon-en-emissieloos-bouwmaterieel
RVO. (2022e). *Thema's Demonstratie Energie- en Klimaatinnovatie (DEI+)*. Retrieved 2 March 2022, from https://www.rvo.nl/subsidie-en-financieringswijzer/demonstratie-energie-en-klimaatinnovatie-dei/themas-dei-2021
RVO. (2022f). *Voorwaarden Energie-investeringsaftrek (EIA)*. Retrieved 2 March 2022, from https://www.rvo.nl/subsidie-en-financieringswijzer/energie-investeringsaftrek/ondernemers/voorwaarden
RVO. (2022g). *Voorwaarden MIA\Vamil*. Retrieved 2 March 2022, from https://www.rvo.nl/subsidie-en-financieringswijzer/miavamil/ondernemers/voorwaarden
Saldana, J. (2009). *The Coding Manual for Qualitative Researchers*. SAGE Publications.
Sewalt, A. (2019). *Business opportunities in bouwteam projects*. University of Twente.
Shen, L. Y., Tam, V. W., Tam, L., & Ji, Y. B. (2010). Project feasibility study: the key to successful implementation of sustainable and socially responsible construction management practice. *Journal of Cleaner Production*, *18*(3), 254–259. https://doi.org/10.1016/j.jclepro.2009.10.014
Shen, L., Wu, Y., & Zhang, X. (2011). Key Assessment Indicators for the Sustainability of Infrastructure Projects. *Journal of Construction Engineering and Management*, *137*(6), 441–451. https://doi.org/10.1061/(asce)co.1943-7862.0000315
Shrestha, A., Chan, T. K., Aibinu, A. A., Chen, C., & Martek, I. (2018). Risk Allocation Inefficiencies in Chinese PPP Water Projects. *Journal of Construction Engineering and*

Management, *144*(4), 04018013. https://doi.org/10.1061/(asce)co.1943-7862.0001457
Snyder, H. (2019). Literature review as a research methodology: An overview and guidelines. *Journal of Business Research*, *104*, 333–339 https://doi.org/10.1016/j.jbusres.2019.07.039
Soliño, A. S., & Gago De Santos, P. (2010). Transaction Costs in Transport Public–Private Partnerships: Comparing Procurement Procedures. *Transport Reviews*, *30*(3), 389–406. https://doi.org/10.1080/01441640903037941
Song, L., Mohamed, Y., & AbouRizk, S. M. (2009). Early Contractor Involvement in Design and Its Impact on Construction Schedule Performance. *Journal of Management in Engineering, 25*(1), 12–20. https://doi.org/10.1061/(ASCE)0742-597X(2009)25:1(12)
Srivastava, V. (2017). Project finance bank loans and PPP funding in India: A risk management perspective. *Journal of Banking Regulation*, *18*(1), 14–27. https://doi.org/10.1057/jbr.2015.7
Streck, C., Keenlyside, P., & von Unger, M. (2016). The Paris Agreement: A New Beginning. *Journal for European Environmental & Planning Law*, *13*(1), 3–29. https://doi.org/10.1163/18760104-01301002
Tafazzoli, M. (2018). *Accelerating the green movement: Major barriers to sustainable construction*. http://ascpro0.ascweb.org/archives/cd/2018/paper/CPGT120002018.pdf
TNO. (2021). *Kwantitatieve evaluatie Green Deal Duurzaam GWW 2.0*. http://resolver.tudelft.nl/uuid:dfd885d5-5cd4-4505-8348-689b3e6a2661
UNFCCC. (n.d.-a). *Biennial update reports*. Retrieved 27 February 2022, from https://unfccc.int/process/transparency-and-reporting/reporting-and-review-under-the-convention/biennial-update-reports-and-international-consultation-and-analysis-non-annex-i-parties/biennial-update-reports
UNFCCC. (n.d.-b). *Preparation of NCs and BRs*. Retrieved 27 February 2022, from https://unfccc.int/preparation-of-ncs-and-brs#eq-1
UNFCCC. (n.d.-c). *The Paris Agreement*. Retrieved 26 February 2022, from https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement
UNFCCC. (1992). *United Nations framework convention on climate change*. https://unfccc.int/resource/docs/convkp/conveng.pdf
UNFCCC. (2011). *Report of the Conference of the Parties on its seventeenth session, held in Durban from 28 November to 11 December 2011*. https://unfccc.int/sites/default/files/resource/docs/2011/cop17/eng/09a01.pdf
UNFCCC. (2015a). *Paris Agreement*. https://unfccc.int/sites/default/files/english_paris_agreement.pdf
UNFCCC. (2015b). *Historic Paris Agreement on climate change: 195 nations set path to keep temperature rise well below 2 degrees celsius*. Retrieved 26 February 2022, from https://unfccc.int/news/finale-cop21
UNFCCC. (2021a). *"Climate commitments not on track to meet Paris Agreement goals" as NDC synthesis report is published | UNFCCC*. Retrieved 27 February 2022, from https://unfccc.int/news/climate-commitments-not-on-track-to-meet-paris-agreement-goals-as-ndc-synthesis-report-is-published
UNFCCC. (2021b). *Updated NDC synthesis report: Worrying trends confirmed*. Retrieved 27 February 2022, from https://unfccc.int/news/updated-ndc-synthesis-report-worrying-trends-confirmed

United Nations. (2019). *Report of the United Nations commission on international trade law* (No. 74).

Valdes-Vasquez, R., & Klotz, L. E. (2013). Social Sustainability Considerations during Planning and Design: Framework of Processes for Construction Projects. *Journal of Construction Engineering and Management*, *139*(1), 80–89. https://doi.org/10.1061/(asce)co.1943-7862.0000566

van den Berg, M. A. M. C. (2007). *Mr. C. Asser's Handleiding tot beoefening van het Nederlands burgerlijk recht. Bijzondere overeenkomsten. Deel IIIC Aanneming van Werk.* Kluwer. https://uncitral.un.org/sites/uncitral.un.org/files/advance_edited_version_in_e.pdf

van Kruining, F. (2021). *Twee-fasen-contract*. Tenderteam. https://www.tenderteam.nl/kennisbank/twee-fasen-contract/

van Valkenburg, M., Lenferink, S., Nijsten, R., & Arts, J. (2008). Early Contractor Involvement: A New Strategy for 'Buying The Best' in Infrastructure Development in The Netherlands. In *Third International Public Procurement Conference* (pp. 1–31). Retrieved from http://www.ippa.org/IPPC3/Proceedings/Chaper 22.pdf

van Wijck, D. J. A. (2018). *Early contractor involvement in the Netherlands*. [Master's thesis, TU Delft]. TU Delft Repository. https://repository.tudelft.nl/islandora/object/uuid:d72e722f-fd17-4645-8e5d-821ce5520f39/datastream/OBJ/download

VGBouw. (1992). *Model Bouwteamovereenkomst 1992*. https://www.bouwendnederland.nl/media/3328/vgbouw-model-bouwteamovereenkomst-1992.doc

Wondimu, P. A., Hosseini, A., Lohne, J., Hailemichael, E., & Lædre, O. (2016). Early Contractor Involvement in Public Infrastructure Projects. In *24th Annual Conference of the International Group for Lean Construction* (pp. 13–22). Boston. Retrieved from https://www.researchgate.net/profile/Ali_Hosseini39/publication/305699322_Early_Contractor_Involvment_In_Public_Infrastructure_ProRjects/links/581ad87e08ae3c82664c3da3/EarlyContractor-Involvment-In-Public-Infrastructure-Projects.pdf

Xiong, W., Yuan, J. F., Li, Q., & Skibniewski, M. J. (2015). Performance objective-based dynamic adjustment model to balance the stakeholders' satisfaction in PPP projects. *Journal of Civil Engineering and Management*, *21*(5), 539–547. https://doi.org/10.3846/13923730.2014.895409

Xue, B., Liu, B., & Sun, T. (2018). What matters in achieving infrastructure sustainability through project management practices: A preliminary study of critical factors. *Sustainability*, *10*(12), 4421. https://doi.org/10.3390/su10124421

Yılmaz, M., & Bakış, A. (2015). Sustainability in Construction Sector. *Procedia - Social and Behavioral Sciences*, *195*, 2253–2262. https://doi.org/10.1016/j.sbspro.2015.06.312

Zainul Abidin, N. (2010). Investigating the awareness and application of sustainable construction concept by Malaysian developers. *Habitat International*, *34*(4), 421–426. https://doi.org/10.1016/j.habitatint.2009.11.011

A. Brief summary Rijkswaterstaat's evaluation

In May 2020, Rijkswaterstaat published an evaluation on six two-stage infrastructure projects within the Netherlands, where the aim of the evaluation is to unlock as much information as possible from these projects so future projects can learn from them. The evaluation points out the first signs on whether the two-stage model contributes to the vital infrastructure sector (Rijkswaterstaat, 2020b).

The most important similarities and differences have been identified from all the projects in the evaluation, so future projects can gain inspiration for the control variables that are going to be applied by them. Rijkswaterstaat described the following topics in their evaluation:

1. The uncertainties that must be captured in the two-stage model.
2. The impact that the formulated uncertainties have on the further elaboration of the (final) design and the price.
3. The necessary effort of the market during and after the tender.
4. The exit strategy if the parties cannot agree on design and/or price.

Each project has been evaluated on the following aspects:

- Scope: apart from the uncertainties to be determined with regard to, for example, the further design and/or condition of the acreage, the plan elaboration can also be included in this.
- Pricing: ceiling price combined with unit prices, direct costs with surcharge or a fixed tender amount for parts for which a fixed price can be issued, combined with a recalibration of those parts that are too uncertain for a fixed price at the tender. Possibly supplemented with checks and balances such as an accountant's statement on direct costs (if use is made of surcharge percentages), cost commissions or access to quotations from subcontractors and suppliers. Options chosen must be in accordance with the Aanbestedingswet 2012.
- Degree of importance of price during award: it must be indicated how the price is taken into account in the award decision.
- Moment of price formation: final price formation can take place prior to the award or afterwards (with the consequence that a clear exit strategy must be established);
- Risk distribution: the client and the contractor can jointly determine how they allocate (part of) the risks, or the client can prescribe this unilaterally.
- Exit: the variants of a possible exit (or go/no-go) differ depending on which conditions have been laid down for an exit if there is no agreement on, for example, the price, design and/or permit.
- Degree of design freedom: the number of requirements varies between collecting the requirements together with the contractor, setting three top requirements or the standard package of requirements with a certain degree of freedom.
- Integration teams and systems: from total integration of teams and systems in the same location to mirrored IPM teams, and everything in between.
- Combination formation: free combination formation, or a client who selects an engineering firm and a contractor itself.

In brief, Rijkswaterstaat concluded that their research results shows that not all projects are suitable for using a two-stage model. For regular (straightforward) projects, the two-stage model within the investigated case studies in the Netherlands has no added value. A two-stage model can be especially of added value where multiple and/or larger uncertainties make it difficult, if not impossible, to give a reasonable price in a regular tender procedure. In addition, a two-stage model in projects should contribute to Rijkswaterstaat's transition objectives for a vital infrastructure sector in the Netherlands. Given the limited number of two-stage projects completed in the Netherlands, it is still too early to draw that conclusion according to Rijkswaterstaat. However, the first signs are positive (Rijkswaterstaat, 2020b).

B. Advantages and areas of concern of the two-stage model

Anticipated benefits of the two-stage model

- Construction knowledge and experience are available in the project front-end: An advantage is the timely acquisition and optimal use of construction knowledge and experience in the early stages of the project. This improves the quality of the project because parties with practical knowledge are allowed to contribute ideas to the drawing board (Bouwend Nederland, 2019). In addition, by discussing what and how the tasks within a project can be tackled in the early stages, misunderstandings and ambiguities can be discovered faster. This creates the possibility to work faster towards solutions that lead to the desired end result (Bouwend Nederland, 2019). The experience of the contractor also plays a huge role in the certainty of the costs and planning. The contractor is aware of where the (most important) risks lie during the realization. This expertise is important for the early stages of the process in order to mitigate these risks (Love et al., 2014; Rahmani et al., 2013).

- Improved risk allocation**:** The two-stage model leads to a better distribution of risks and responsibilities than a classic client-contractor relationship (Bouwend Nederland, 2019). This risk management is improved because of contributions from parties involved in the process where they identify, mitigate, and eliminate risks. Rijkswaterstaat mentions that the client and contractor can jointly determine how they will allocate (part of) the risks, or the client can prescribe this unilaterally. This, while the discussions about the risk are conducted transparently (Rijkswaterstaat, 2020b).

- Time saving: Since the client and the contractor are able to work together in the earliest stages of a project, the preparation of the final work usually takes a little longer. But a shorter period of realization, and thus a quicker project delivery outweighs this. Especially the expertise of the contractor in technical aspects and costing speeds up the designing and realization of the project (Bundgaard et al., 2011; Leendertse et al., 2012; Lenferink et al., 2012; Love et al., 2014; Rahmani et al., 2013; Song et al., 2009; van Valkenburg et al., 2008; Bouwend Nederland, 2019).

- Financial benefits (lower costs and higher cost certainty): Early involvement of the contractor in the process leads to an overall cost reduction of the project and the risk of project cost overruns: the initial estimate, the construction costs, the maintenance costs. This is not only because of the reduced delivery time of a project, but there is also general cost reduction of the works. The contractor has expertise in the

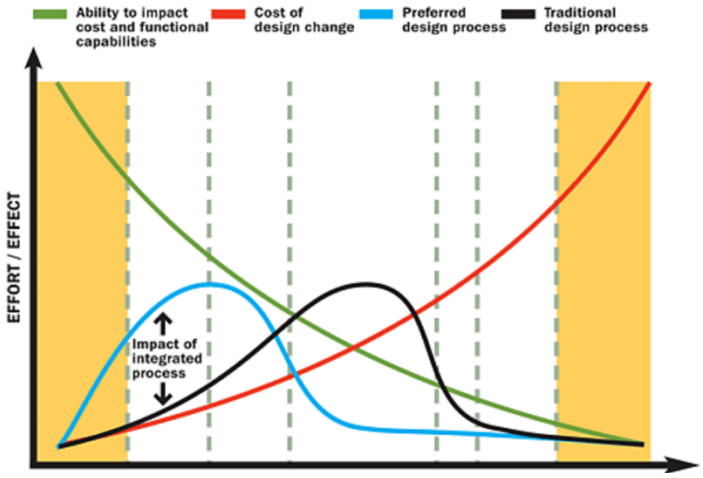

Figure 5: Preferred design process versus traditional design process (Laedre & Svalestuen, 2014)

costs of materials and execution techniques, which benefit the reduction of the costs in the end. (Bundgaard et al., 2011; Eadie & Graham, 2014; Leendertse et al., 2012; Lenferink
et al., 2012; Love et al., 2014; Rahmani et al., 2013; van Valkenburg et al., 2008). Besides the general costs, the two-stage model leads to less additional work and lower failure costs. Research states that changes made in the early design phases cause less costly rework than changes made later. Later in the project, changes will cost significantly more, and the level of influence is smaller. Figure 5 suggests how an optimal design process should be executed. An increased effort in a front-end loaded design will reduce the cost of changes (Laedre & Svalestuen, 2014). But many practical examples show that the financial aspect is not decisive for the decision to have a close cooperation between the contractor and the client in the early stages of a project. The collaboration is often aimed at maximum quality for the available budget (Bouwend Nederland, 2019). In addition, there is greater cost certainty, as contractors price a project with an informed understanding of it. This can also potentially lead to cost savings for the client (Brodies, 2020). Also, Rijkswaterstaat mentioned that agreements on the price are adaptive until realization starts and there is predictability on the (costs for the) execution. The latter results in less failure and indirect costs (Rijkswaterstaat, 2020b).

- Improve the quality of the design: Since the contractor is also involved in the design phase of the two-stage model, they are able to improve the quality of the design of the project. A better-quality design means a better constructability in design by instilling specialised construction expertise, such as in-depth knowledge of construction materials, methods, and local practice into design. By discussing innovative solutions during the design phase, sustainable, circular and / or climate-adaptive solutions are more likely to be executed. (Leendertse et al., 2012; Lenferink et al., 2012; Rahmani et al., 2013; van Valkenburg et al., 2008; Bouwend Nederland, 2019).

- More preparation time: According to Bouwend Nederland (2019), the two-stage model gives the contractor more time to prepare the work, purchase materials and contract the necessary parties when he is involved early in the project.

Downsides of the two-stage model

- Uncertainty of the exact outcome and costs: The main disadvantage of working as a team together in the early stages of a project is that there is uncertainty for a long period of time about the exact outcome of the project and the exact costs of the final result. The earlier the contractor is appointed, the greater the potential benefits they are able to bring to the project. But the less able they are to provide accurate pricing information for the second-tender process. Since the contractor becomes involved in the project before it has been designed in detail, they are unable to give an accurate price for the construction works. While contracts generally provide some element of transparency and competition in the second state appointment, the reality is that other tenderers may have lost interest in the project and the embedded contractor will have a significant competitive advantage. This contrasts with a well-defined

project where a regular tender procedure is used. An effective solution is to work with the “target value design approach”. With this approach, a ceiling price or a target budget is set for certain pre-defined targets in the project which allows the entire preconstruction team to begin with a validated, estimated cost in mind. Imposing a (limited) budget has a disciplining effect on making choices with cost consequences. It also lets design drive the budget since it becomes a challenge for the contractor to spend the available budget as usefully as possible. This, while the cost of a construction contract can generally be estimated well in advance: the price of asphalt, concrete and equipment are fairly standard, with a modest bandwidth. Besides, according to the Procurement Directive 2014/24/EU recital 90, a price element must be part of the award system and thus prior to the final award. (Bouwend Nederland, 2019; Construction Executive, 2017; Designing Buildings, 2020; Rijkswaterstaat, 2020b).

- Dominating parties: A general downside of teamwork such as in a two-stage model, is that it is possible that a party within the team has a dominant attitude towards other parties of the team. This may result in one-sided solutions for the realization of the design. A possible solution for this issue is to give the competence of working together a place in the procurement. Another solution is to hire an external consultant for the team (Bouwend Nederland, 2019).

- Unbalanced liability: Another area of concern is that the division of legal liability can be unbalanced. The allocation of risks and liability must be fair in line with the responsibilities that the parties bring to the collaboration. It is important to arrive at an appropriate proportional framework in consultation with the entire team (Bouwend Nederland, 2019).

- Lack of experience with early contractor involvement: In Australia and Norway, it was confirmed that private and public parties lack either experience, initiative, or both with the early involvement of the contractor. Because of their inexperience, they experience difficulty with the concept which makes it hard for them to reach the benefits of the two-stage model (Davis et al., 2008; Love et al., 2014; Wondimu et al., 2016). The same problem may occur in the Netherlands, since the development of the two-stage model for complex projects in the Netherlands is very recent and the experience of market parties is limited (PPS Netwerk NL, 2021).

C. Variants of the two-stage model

Variants of two-stage models
The concept of Early Contractor Involvement has already been implemented in various countries. According to literature, the United Kingdom, Australia, Sweden, Norway, New Zealand, the United States, and the Netherlands already implemented this concept. These countries use different types of contracts for their two-stage projects (Rahmani et al., 2013). In order to get an understanding of which variants of the two-stage model are used in Dutch construction industry, this paragraph has been drawn up.

Pre-award model
The first variant was used for the renovation of the Nijkerkerbrug of Rijkswaterstaat in 2017. This was a project where the lifespan of a bridge had to be extended by thirty years (Huith, 2021). The pre-award model is a variant of the two-stage model that runs during the tender procedure. After a (regular) selection of market parties in the registration phase of the tender, a dialogue phase will start which works as a funnelling method to get to one single party. This funnelling takes place on the basis of single qualitative award criteria. The price for the realization is not fixed at that moment. The project is granted 'provisionally' to the selected contractor. Then stage one (design phase) of the two-stage model starts for the contractor and the client. This design phase must result in a design that it is able to determine a final price for (e.g., final design and realization design). After the design phase, the selected contractor can be invited to register himself. If the selected contractor meets the expectations of the client and a price agreement has been reached, a 'final award' takes place, and the agreement can be concluded. The (winning) contractor will be subsequently commissioned for stage two (see figure 6). Depending on the execution, the UAV-GC 2005 or the UAV 2012 can be applied (Huith, 2021).

This process has the characteristics of Best Value Procurement (BVP), in which a concretization phase is completed with one tenderer prior to the award and commissioning. However, in the case of the BVP the price is fixed during the provisional award and only the design should be concretised during the concretization phase. While for this variant of the two-stage model the design and the price have not been determined yet (Huith, 2021).
This variant is not suitable for every project, especially when the selected contractor after provisional award has a lot of design work to do. On the other hand, this variant seems suitable for relatively simple projects where a contractor can confirm his offer with limited risks. The

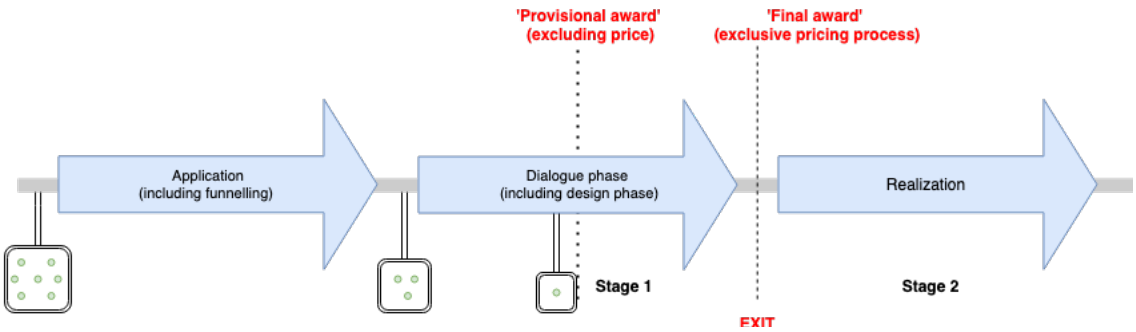

Figure 6: The Pre-award model (Huith, 2021)

risks should be investigated by the contractor himself after selection depending on the best price-quality ratio. Then the risks can be identified better (Huith, 2021).

Exit-model after award

The second variant was used successfully for the renovation of the Maastunnel in Rotterdam in 2017 (Huith, 2021). First, the procurer goes through a complete tender procedure with several market parties (for example 3 or 5) and awards the Design & Construct (D&C) contract to the winning tenderer. This goes based on the award criteria which are included in the tender documents. There is no fixed price established during the awarding of the contract to the winning tenderer. In this variant, the agreement to be concluded with the winning tenderer refers to going through stage one and stage two. Agreements are therefore made for both stages. At the end of stage one, the pricing process takes place between the procurer and the winning tenderer, without involvement of competing tenderers. If at the end of stage one no agreement is reached on the price in relation to the design draft, there is a possibility to terminate the agreement (the so-called 'exit'). This variant is called the ‘exit model’ since legal binding arises for all stages of the project and ‘the exit’ requires a separate decision from one of the parties (see figure 7) (Huith, 2021).

The process design for this variant does not have to deviate substantially from that of a regular D&C contract, this variant can be applied with a slight deviation compared to the UAV-GC 2005. In addition, after the contract has been awarded, the parties can carry out the work from their traditional roles. This means that the contractor will primarily focus on the design and execution work. In this way, he can further investigate the risks that were difficult or impossible to estimate during the tender procedure and, if desired, take mitigation measures or adjust his design choices. In its traditional role, the client can test the contractor's design proposals and accept them if they are suited. Moreover, in this variant, the division of responsibility does not have to deviate from that of a regular D&C contract. The contractor remains responsible for the design work that it carries out during stage 1, on the understanding that during this phase the consequences of certain choices in the design process can be better coordinated with the client (Huith, 2021).

This variant is not suitable for all projects. It seems more suitable for projects where a (limited) number of design activities depend on risks that are already known at the time of tender, but the exact effect of these risks on the design is difficult to estimate / give price to. After commissioning the tender with the best price-quality ratio, risks can be better identified and assessed based on insights obtained from studies and, if possible, discounted within pre-announced margins on the basis of unit prices (Huith, 2021).

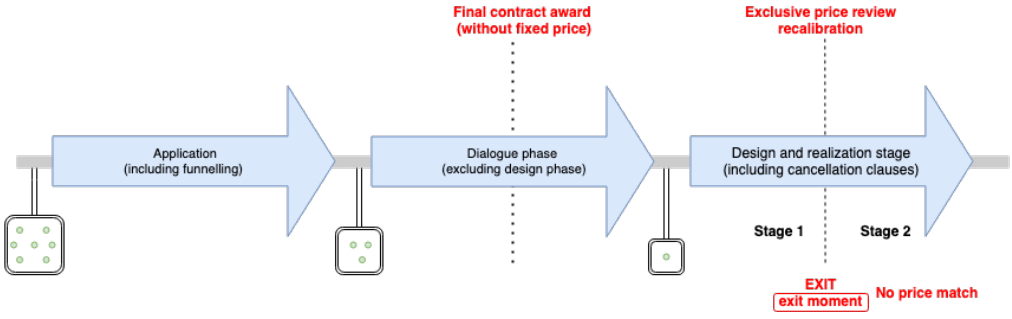

Figure 7: The 'Exit-Model' after award (Huith, 2021)

Entry-model after award

The third variant is very similar to the second variant and has been used at various water boards in dike improvement projects for the Dutch flood protection program (e.g., project Krachtige Ijsseldijken Krimpenerwaard) (Huith, 2021). In this variant too, the two-stage model takes place after the completion of a tender procedure with more than one tenderer. The award decision is taken without the price for which the entire work must be realized. However, unlike the exit model, after awarding there is commitment between the client and the tenderer for the first stage. This does not mean that nothing at all is fixed for the second phase. However, the commitments for the second phase are made subject to a suspensive condition (in Dutch: 'Opschortende voorwaarden'). This means that stage two will only be carried out if the parties come to an agreement on the price (Huith, 2021). In other words, this condition has to be fulfilled outside of other agreements in order to let the contractor execute the project.

The essential difference between the entry-model and the exit-model is therefore the legal consequence of the absence of price agreement on the execution at the end of stage one. In the case of the entry-level model, the legal relationship ends after stage one if no price agreement is reached. In the exit model, a legal act still has to take place in order to get released from the commitments for stage two, while with the entry model a legal act has to be performed in order to become bound for that phase (Huith, 2021).

This variant is suitable for projects in which optimizations to the preferred design can be made during the planning phase and the design process. This means that compared to the other variants, the entry-model (theoretically) has the greatest potential for collaboration and risk management (Huith, 2021). A representation of the model is shown below.

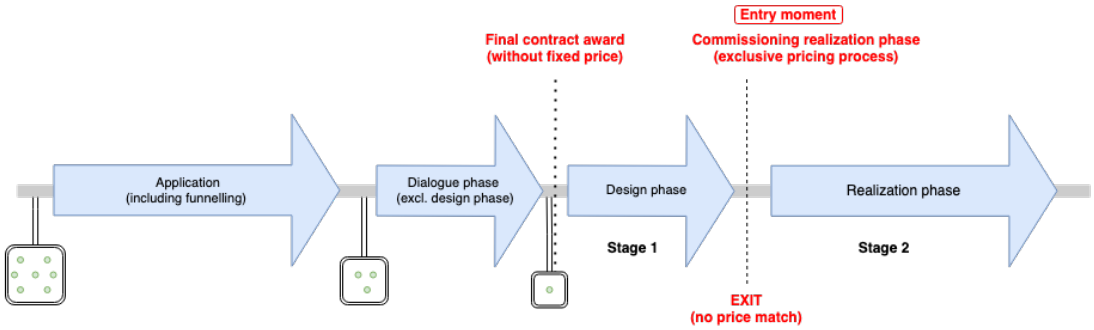

Figure 8: The 'Entry-model' after award (Huith, 2021)

According to Huith (2021), the Bouwteam can be seen as an application of the entry-model because of similarities in the processes described in the next section. The phenomenon of Bouwteams are becoming more and more popular in the Netherlands (Bouwend Nederland, 2020) and can be described as follows (Chao-Duivis, 2012):

The Bouwteam model is characterised by the fact that the contractor is involved in the design. This has the advantage that he can contribute his knowledge of execution at this early stage, and this can be taken into account in the design. Liability within the Bouwteam is organised in such a way that liability for a particular idea rest with the person in whose province that idea lies, or who adopted it if it was not his own. The contractor takes part at the design stage in

the hope of being awarded the contract for the works. Whether he will get it is not certain; it will depend on the price he quotes. The construction phase is separate from the design phase and is governed by its own conditions, and it may be a different contractor who carries out the works. The client may possibly take part at the design stage; in the construction phase he is the traditional client with all the liabilities that entails.

The Bouwteam has a multidisciplinary nature, bringing the expertise of the different parties (contractor, designer, and the client) together in consultancy roles (van den Berg, 2007). The goal of the Bouwteam is to jointly arrive at an execution-oriented design that can be realized (CROW, 2019). Sewalt (2019) mentioned that most of the time when using the Bouwteam model, the price negotiations happen in a parallel process with the first phase of the model. This prevents late cost estimations that make price negotiations difficult. The two most common variants of the Bouwteam are elaborated in this paragraph (Chao-Duivis, 2012):

- Bouwteam agreement that consists of a second stage execution based on the UAV contract (Bouwteam UAV).
- Bouwteam agreement that consists of a second stage execution based on the UAV-GC contract (Bouwteam UAV-GC).

The process of both variants is visualized in figure 9, where the difference between the variants is the roles of the parties. With the Bouwteam UAV, the contractor has to assist the client in drawing up the execution designs and the execution itself (neglecting some exceptions). While in the Bouwteam UAV-GC, the contractor is involved in the Bouwteam until the definitive design, then the contractor has the responsibility to finish the execution design and the execution itself.

The set of general conditions for the Bouwteam can be either the old Bouwteam model: VGBouw model 1992, one of the new revised Bouwteam versions: Duurzaam gebouwd 2020 model (DG2020) or Model Bouwteamovereenkomst 2021 (BN2021) from Bouwend

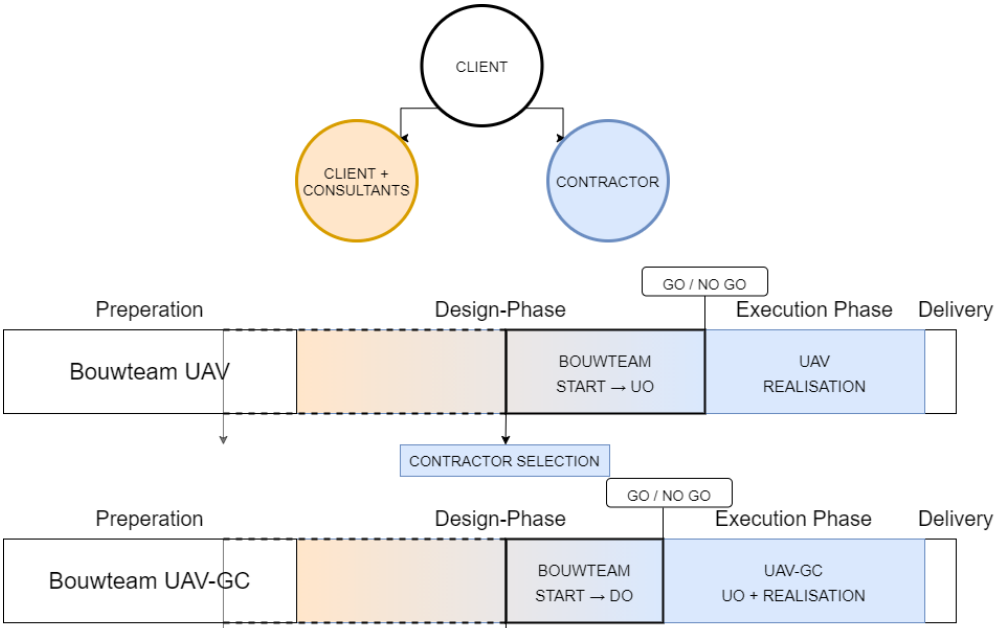

Figure 9: Main variants of the Bouwteam model (Clemens, 2021)

Nederland, or a variation on one of the models. These general conditions form the guiding framework for the design phase and are also known as the Bouwteam agreement.
The Bouwteam can be set up in two ways. The first possibility is that the client enters separate contracts with all members and enters a 'coordination agreement'. The second possibility is to enter separate contracts with all the members and stipulate that they shall work with third parties (Chao-Duivis et al., 2018).

The scope, price and risks are included in the process by creating an execution agreement. But there is no collective responsibility for the design and there is also no collective liability for mistakes in the design. Therefore, it is important to make clear agreements regarding the responsibilities and liabilities. The liabilities of the contractor towards the client are controlled by Article 13 till 15 from the DNR2011. According to the BN2021 agreement for example, responsibility for advice and designs rest with the person on the Bouwteam to whose particular area that advice and those designs relate, provided that person has accepted and adopted that advice and those designs (Koninklijke Bouwend Nederland, 2021).

Hybrid model
The hybrid model has been used by Rijkswaterstaat voor the A27 Everdingen-Hooipolder project, this project is still ongoing (Huith, 2021). In this variant, one agreement is made for a project in which a distinction is created between a 'regular part' and a two-stage part. The regular part contains geographically defined (more or less) standard parts of the project, it is expected that the risks are to be well priced in a tendering procedure. Tenderers must offer a fixed price for these components in a 'regular' manner. This agreement also contains some risky elements, whereby the pricing takes place in phases after the contract has been awarded (see figure 10) (Huith, 2021).

Rijkswaterstaat used this model for the A27 Everdingen-Hooipolder project and commissioned a Basic Agreement ('Basisovereenkomst') to which the UAV-GCI 2019 was applied. The UAV-GCI 2019 contains amendments and additions to the UAV-GC 2005 and are the result of Rijkswaterstaat's need for a contract form for contracts in which existing acreage is maintained, while parts of that existing acreage are replaced and/or renovated to a greater or lesser extent (Huith, 2021). This strategy ensures the early involvement of the integrated contractor. Nevertheless, the parties do take up the roles that they are familiar with as described in the UAV-GCI 2019. So Rijkswaterstaat therefore limited itself to a testing and accepting role and did not participate in co-designing. Certain aspects have been added to both the Basic Agreement and the other contract documents in which the two-stage model is implemented. Those are, among other things, the price for which the work must be realized. This price is divided into a fixed part and a two-stage part, giving the whole an 'initial contract value' (Huith, 2021).

It follows from this that during stage one - which lasts a maximum of 27 months - the contractor must go through a number of steps with regard to the two-stage components and must carry out the design work. The contractor must make every effort to ensure that the costs of realization remain within predetermined budgets (Huith, 2021).

Based on the draft Basic Agreement, stage one of the two-stage model is completed with the signature of the client of a two-stage certificate. Stage two is then defined as: "The phase of

the agreement that enters per two-stage element upon issuance of the two-stage certificate of the relevant two-stage element and ends on the date of completion." This means an obligation has been entered in regard to the second stage (the realization phase) under the conditions of Article 6:22 of the Dutch Civil Code (Huith, 2021).

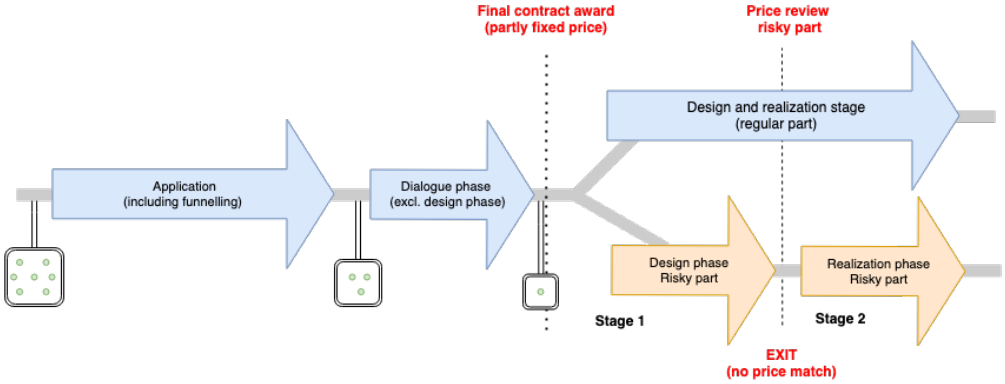

Figure 10: Hybrid model (Huith, 2021)

D. Pricing process of the two-stage model

In the case of the two-stage contract, the moment of commissioning the project does not coincide with the realization agreement. The price for realization naturally depends on the scope agreed in the realization agreement. This means that pricing is also part of the design phase and therefore takes place after the tender has been awarded. This creates a dependency that parties are not used to and which they do not recognize from other tender forms. For both parties, uncertainty about the price in the internal decision-making process can be a deal breaker. A client cannot cope with a 'carte blanche', but a contractor would not like to put energy into a process that can lose him money just before the finish line. In order to cope with this uncertainty, CROW (2020) described three steps in the pricing process that can be found in many two-stage contracts in the Netherlands. They lead to an increasing process of working towards the final price in clarity and transparency, aimed at preventing mutual surprise. The three steps of the CROW are described below which are in accordance with the DG2020 Bouwteam agreement, but it should be mentioned that the pricing process may differ per project depending on the nature and scope of the project (Huith, 2021).

Step 1: Laying the foundation of the tender
Choosing for a two-stage contract means choosing for a process of collaboration. This collaboration only gets a chance if there is clarity about the scope and the available budget, as mentioned in Article 7 of the DG2020 Bouwteam agreement (Duurzaam Gebouwd, 2020). The clarity is important for two reasons (CROW, 2020):

- Tenderers can immediately make an estimation whether the scope and budget are in balance. If the tenderer believes that there is no balance between the scope and the budget, he can report this to the client. If the client does not want to make any changes, the tenderer can decide to not put any energy into this tender.
- Tenderers who do participate assume that the scope can be achieved within the budget. The risk of opportunistic behaviour (I will participate to the tender and see how it goes in the end) is mitigated due to the offered clarity but can be further mitigated by the way of price control as an award criterion. So, the tenderer has to show how he is going to ensure that the price will always stay within the budget during the design phase.

For this step it is important to clarify that (a part of) the budget is reserved for the design phase and / or how the design phase is going to be paid for. A fixed price as a budget should be avoided, because when that amount is 'used up', further collaboration may come under pressure. Rijkswaterstaat used a target price for one of their projects, which was used to give tenderers insight in the estimation of the costs for the total project (i.e., including costs of the client) and served as a price component in the determination of the 'BPKV' (Best Price Quality Ratio). The target price is not intended as a fixed price or ceiling price but serves as a reference that can be used to help to validate the final offer at the end of stage one (CROW, 2020).

The foundation of the pricing can be expanded further with, for example, (hourly) rates, unit prices and fixed surcharge percentages as mentioned in Article 10 of the DG2020 Bouwteam agreement (Duurzaam Gebouwd, 2020). This offers the client a little bit of price certainty that he needs to get started with a two-stage contract. It seems more effective to determine any

rates or percentages after consultation with the market, so that they are the same for everyone. Competition on these rates increases the chance of strategic tenders, which does not benefit the collaboration. The budget and any additional financial frameworks form the basis for further pricing during the design phase (CROW, 2020).

Step 2: Clarifying the effect on the price at every step in the design phase
In the past, Bouwteams have regularly come under tension or broke down because parties within a Bouwteam first established a suitable design together and then the contractor came up with a price for it. This price was (much) higher than expected, which led to disappointment and mistrust on both sides. The classic Bouwteam agreement (VGB 1992) usually focuses on this sequence: after the design is ready, the contractor makes a price offer. The new model agreement Bouwteam DG2020 pays explicit attention to outlined problems, which is elaborated in the next section (Duurzaam Gebouwd, 2020). To this end, the contractor is obliged to make an interim estimate at certain moments in the design process of the costs for carrying out the work (CROW, 2020; (Duurzaam Gebouwd, 2020).

In step 2, the parties discuss the various technical solutions with each other, whereby the contractor also shows what the financial consequences are. In its purest form, an open book budget is used. This is also mentioned in Article 12.4 of the DG2020 Bouwteam agreement (Duurzaam Gebouwd, 2020). The contractor and any other partners show exactly how the base price is built up. With each design choice, it becomes clear which topics will be dropped and which will be added, so that the price implications become completely transparent. The pricing at the end will then have the character of a final check but should no longer produce any surprises (CROW, 2020).

Step 3: The go / no go decision
After the parties have agreed on the content (and on the confidence in further collaboration), the contractor is given a term in which to make the corresponding price offer which is also elaborated in Article 12 of the DG2020 Bouwteam agreement (Duurzaam Gebouwd, 2020). If this price offer does not immediately lead to an agreement, the parties will enter negotiations. If the negotiations do not lead to an agreement, the ultimate consequence may be that the parties must part their ways. The pricing procedure aims to serve both parties: for the client it prevents a vendor lock-in, an excessive dependence on one party. If no agreement is reached on the price, the client can work with another party. For the tenderer, this procedure offers protection against a decision by the client to refrain from entering into the realization agreement (CROW, 2020).

Since the intention of two-stage contracts is to achieve better results on the basis of collaboration, in many cases extra attention is paid to an escalation model. Especially if the collaboration continues over several (sub) projects for a longer period. Disagreements (e.g., about pricing) are then quickly diverted from the operational level, so that they have as little effect as possible on the mutual cooperation in the other (sub) projects.

Steps that regularly return are (CROW, 2020):

- Enabling a higher management layer in both organizations
- Engaging the director in both organizations

- Engaging an independent, external (cost) expert

In Article 14 of the DG2020 Bouwteam agreement it is mentioned that the consequences of an exit scenario must be described in detail in the agreement, including aspects of intellectual property, any liability for the realized design and the possibility or impossibility for the two-stage contractor to participate (again) in the event of re-tendering (Duurzaam Gebouwd, 2020). In particular, attention will also have to be paid to the compensation if the decision has been made to part ways with the contractor (CROW, 2020). According to Article 10 and 13 of the DG2020 Bouwteam agreement, this compensation is based on the performed work (Duurzaam Gebouwd, 2020).

The principles for the reimbursement differ per variant. In the pre-award model, one can think of a tender fee that covers the costs of investigations made during the tender. With regard to the exit-model after award, a cancellation fee is obvious, but not based on par. 16-10 UAV-GC 2005. This section is based on the execution of the entire project and the profit to be realized from it, while the main part of this profit flows in during stage two. The full application of par. 16-10 under UAV-GC 2005 is also not appropriate. Here, the contractor is entitled to reimbursement of costs arising from obligations that the contractor has already entered into at the time of termination with the view to the execution of the project. Huith (2021) believes that there is no basis for reimbursement of costs arising from obligations that a contractor has already entered into for stage two, while stage one has not yet been completed.

With the entry-model after award**,** the contractor will be reimbursed for work at the end of stage one, as provided for in the agreement for that stage. Since there is no agreement for stage two, there is no title for an additional compensation (Huith, 2021).

E. Details of the two-stage model in the Dutch construction industry context

Limited appointment
For the first stage of the two-stage model it is key to bring interests from the different parties together in a definitive or executive design (Boogaart, 2021). Therefore, It is important that the first stage's limited appointment is based on as much information as possible and that requirements are well defined, as subsequent changes could prove expensive. The first stage's limited appointment may include (Designing Buildings, 2020):

- A pre-construction and construction programme
- Method statements
- Detailed preliminaries including staff costs
- Agreed overheads and profit
- A schedule of rates to be applied to the second-stage tender
- Agreed fees for design and other pre-construction services
- Tendering of any packages that can be broken out and defined
- Agreed contract conditions to be applied to the second-stage constructions contract
- Price of the execution of stage two

Joint risk management methods
A common way to control project risks is by making use of the RISMAN method and the Joint Risk Management (JRM). The following methods are identified as subjects of joint risk management (Clemens, 2021):

- Early risk identification
- Cooperative risk identification between the design-team parties
- Open-book risk register
- Full transparent knowledge sharing
- Risk sharing (optional)

Negotiation on the price of execution based on Article 12 of the DG2020 Bouwteam agreement (Duurzaam Gebouwd, 2020)
As soon as the client has established that the documents as referred to in Article 3.2 (among others preliminary design, execution design, execution planning) comply with his requirements, he shall notify the contractor of this finding in writing. During a period of [2 weeks] from the date of the observation, the parties will negotiate with the aim of establishing these in the draft contract for work:

- The assignment to the contractor of specific risks included in the risk file.
- Provisions regarding liability and compensation for damage (including costs) to the extent that the draft contract of work does not already provide for this.
- Any suspensive or resolutive conditions in the draft contract of contracting from work.
- Other provisions that are relevant to the Parties insofar as the draft contract.

As soon as the Client has established that the parties have reached agreement, the client will notify the contractor of this finding in writing. He then invites the contractor to submit an offer

for the execution work. By [2 weeks] at the latest, the contractor will provide insight into the substantiation of the price on the basis of an open budget if included in his offer. After assessment of the offer, the client will decide to accept this offer or enter into negotiations with the contractor regarding this offer. The contractor communicates its decision to the contractor in writing no later than [2 weeks] after receipt of the offer.

The negotiations referred to in Article 12.5 take place on an exclusive basis between the parties. On exclusive basis means that the client with regard to the (preparation of the) execution work of the project does not maintain contact with other persons during the period mentioned in the following sentence parties that may be interested in entering into a contract of work contract with related to the project. The period of the negotiations lasts [8 weeks], calculated from the moment of the date of the Client's decision to enter into negotiations.

During the negotiations regarding the contract of contract of work, the Parties negotiate exclusively on the following topics:

- The price and / or the various components in the substantiation thereof.
- The allocation of the risks included in the risk file, insofar as allocated to the contractor, the pricing of those risks and / or of the associated risk management measures.
- Liability and compensation for damage (including costs) insofar as the draft agreement of contracting work does not already provide for this.

At any time during the period as referred to in Article 12.6, the client may decide to accept in writing the contractor's offer applicable at the time, as a result of which the contract for the contracting of work is concluded between the Parties.

After the term of exclusivity has expired, the client can enter into an agreement with a third party for contract work for the execution activities of the project. The commissioner is in that case no compensation owed to the contractor other than as referred to in Article 10.1. In that case, the contractor will in no way hinder the client from entering into an agreement for the contracting of work with a third party on the basis of the DG2020 agreement.

Tendering procedures of two-stage contracts in accordance with the Aanbestedingswet 2012 (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2012) and Aanbestedingsregelement Werken 2016 (Ministerie van Economische Zaken, 2016):

- Up to €1.5 M: Selective Tendering (in Dutch: ‘Meervoudig onderhandse procedure') in accordance with chapter 7.1.1 ARW 2016, with three (max. five) candidates.
- Between €1.5 M and the European Threshold (2020/2021: € 5.35 M): the national restricted procedure in accordance with chapter 3.5.5 ARW 2016 and Article 2.99 of the Aanbestedingswet 2012 on the selection of candidates with three (max. five) candidates.
- Above the European Threshold: The European restricted procedure in accordance with chapter 3.5.4 ARW 2016, with five candidates.

Qualitative award criterium: Opportunities
By 'opportunities' the possibilities that a tenderer sees to realize the project goals as well as possible are meant (CROW, 2020). Examples are technical innovations, circularity, CO_2 savings, environmental management, safety, or limitation of nuisance. Opportunities such as criteria for Circular Building or Climate Proof Building can be named in advance by the client as separate award criteria. Basically, any subject that is also used in regular tenders is possible, but there are differences in interpretation and implementation with two-stage tenders.

An example is the MKI score, which expresses the sustainability of a technical solution. In a two-stage contract, a technical solution is determined in the first phase of the contract, right after tendering. If sustainability is the main goal of the project, MKI can play an important role. But if this criterion would be implemented for a two-stage project, the design should already be fixed at that point which is not the case in a two-stage model. Therefore, in a two-stage model it can be asked about possibilities to reduce the MKI of the technical solution within the budget. Then the assessment will proceed by comparing the different possibilities of tenderers to determine which offer is the best in terms of sustainability. Each tenderer will be asked what steps he envisions for their opportunities and what form of collaboration he needs (CROW, 2020).

Submitting an opportunity file is an option for the two-stage tender. Then each tenderer will be asked to provide, for example, a top three of opportunities that they see to generate as much added value as possible for the project, based on the project goals. The assessment on this award criterion takes place by determining the added value of each top three. The advantage of this method is that the parties can show that they understand the request well enough (CROW, 2020).

Qualitative award criterium: Risks
A fixed part of the tendering process for two-stage contracts is the risk file (CROW, 2020). A lot can go wrong during the design phase as well as during the realization phase. Properly recognizing these risks and indicating which measures can be taken to that end, gives the client a good picture of the extent to which the tenderer understands the specification. A market party that thoroughly understands the project and that knows how to mitigate risks will deliver better results.

Qualitative award criterium: Collaboration
Two-stage contracts are mainly aimed at the joint design phase, that is why the vision and the way of collaboration between the client and the tenderer are important award criteria (CROW, 2020). The way of working together is of great importance for achieving the project objectives with two-stage contracts.

In the case of large projects, it is advised to include collaboration in the supply chain as an award criterion (CROW, 2020). A large part of the work is often performed by the chain of specialized (sub)contractors and suppliers. And the quality of the work is therefore determined to a large extent by this chain. Transparency and clarity about the way in which and the conditions under which the chain is involved can thus provide a useful award criterion.

Qualitative award criterium: Team composition
An element that plays a role in awarding two-stage contracts is getting to know (some members of) the market parties (CROW, 2020). This introduction can be in the form of a highly regulated interview or a presentation. Nowadays, there is more often an interactive, substantive conversation that in terms of setting resembles a construction meeting, in which questions are asked about the plans that have been submitted.

Such a conversation can be taken into account in the awarding process in two ways (CROW, 2020):

- Supportive: The purpose of the conversation is to explain the submitted plans and ideas. Thus, the conversation contributes to the score of the submitted plans but does not receive its own score.
- Independent: The way in which the tenderer demonstrates on how he understands the assignment and how he manages the desired way of working together during the meeting, can count as a separate criterion in determining the offer with the best price-quality ratio.

Ultimately, it is important that the tenderers have confidence that the chosen approach will yield the most suitable partner for the client.

Price related criterium: Price for fixed parts (CROW, 2020)
Advantages:
- Provides a simple and objective award criterion
- Provides the certainty of a realistic price for the relevant components
- Because components that do not play a role in the design phase are discounted, there is little chance that strategic behaviour will occur that negatively influences the collaboration.

Disadvantage:
- Even if the weighting of this price component is limited, it can become decisive if the qualitative scores are close to each other. By going through a number of scenarios, the client can determine in advance whether the chosen system will lead to acceptable results.

Price related criterium: Unit prices, rates, and hourly wages (CROW, 2020)
Advantages:
- Provides a simple and objective award criterion
- Prices and rates have been established through direct market forces (insofar as they have been requested).

Disadvantages:
- Because the quantities are not fixed, strategic behaviour can take place. This can put the collaboration under pressure.
- Prices and rates provide less certainty than a fixed sum for a component because it is always possible for discussions about the quantity. The chance that discussions will occur is smaller when rates have been set for specific work packages and when it can be objectively determined how often such a work package has been performed.

Price related criterium: Surcharge percentages (CROW, 2020)

Advantages:

- Provides a simple and objective award criterion.
- Surcharge percentages are clear in advance and have been established through direct market forces.

Disadvantages:

- Surcharge percentages differ substantially between large and small companies where the small companies have a disadvantage.
- Clarity about the surcharge percentage does not necessarily provide clarity about the final price.
- Strategic registration behaviour can lead to registration with very low percentages. This can lead to an incentive to make up for this 'loss' elsewhere in the work, which puts pressure on open and transparent collaboration.

Price related criterium: Price control methods (CROW, 2020)

Advantages:

- Very small risk on strategic behaviour and associated negative consequences on collaboration.
- Transparency on the part of the contractor ensures fair prices.

Disadvantages:

- There is no clarity in advance about prices when awarding. On the other hand, there are guarantees that the work will remain within the financial frameworks.
- Prices are not formed through direct competition and therefore can be higher than when there is direct competition. Due to the small risk of strategic behaviour and the certainty that work is carried out within the financial frameworks, the risk of budget overruns and additional work is low and the chance that the most optimal solution will be realized is high.

F. Main content of the Paris Agreement

The Paris Agreement contains (Streck et al., 2016; UNFCCC, 2015a):

- An ambitious collective goal to hold warming well below 2 degrees with efforts to limit warming to 1.5 degrees.
- An aim for greenhouse gas emissions to peak as soon as possible, and to achieve net-zero emissions in the second half of this century.
- A requirement for mitigation measures of individual countries to be expressed in nationally determined contributions (NDCs).
- A process that demands a revision of NDCs at least every 5-years representing progression beyond the last NDCs.
- A mechanism for countries to achieve NDCs jointly, sharing mitigation targets, and a mechanism for countries to cooperate in achieving NDCs. Countries can meet their NDC targets by transferring 'mitigation outcomes' internationally – either in the context of emission trading, or to allow results-based payments.
- A mechanism for private and public entities to support sustainable development projects that generate transferrable emission reductions.
- A framework for enhanced transparency and an expert review of NDCs.
- A global stocktake from 2023 and every 5 years thereafter to review progress.
- A global goal of enhancing adaptive capacity, strengthening resilience, and reducing vulnerability to climate change, and commitment to providing enhanced support for adaptation.
- A decision to adopt the Warsaw International Mechanism for Loss and Damage, noting that the agreement does not involve or provide a basis for any liability or compensation.
- A commitment to a collective goal of providing USD 100 billion per year to 2025, and beyond 2025 with USD 100 billion as a floor. Developing countries are encouraged to provide voluntary support. Public funds will play a 'significant role' in finance and developed countries must report twice a year on levels of support provided.
- An enhanced transparency framework for action and support with built-in flexibility which takes into account Parties' different capacities with the goal to understand climate change action in the light of the objective of the UNFCCC and the PA.
- A non-punitive compliance mechanism that is expert based and facilitative in nature.

G. Strategy and progress of the Paris Agreement

Strategy

The Paris Agreement works on a 5-year cycle of climate action carried out by countries so rapid reductions of global emissions can take place in order to achieve a balance between emissions and removals in the second half of the century (European Commission, n.d.-c). In 2020, countries submitted their plans for climate action known as nationally determined contributions (NDCs). In these NDCs, countries communicate actions they will take to reduce their greenhouse gas emissions in order to reach the goals of the Paris Agreement. Countries also communicate in the NDCs actions they will take to build resilience to adapt to the impacts of rising temperatures (UNFCCC, n.d.-c). In addition to the Paris Agreement, the Katowice climate package was adopted at the UN climate conference (COP24) in December 2018. This package contains common and detailed rules, procedures and guidelines that operationalise the Paris Agreement. It covers all key areas including transparency, finance, mitigation, and adaptation, and provides flexibility to countries that need it in light of their capacities, while enabling them to implement and report on their commitments in a transparent, complete, comparable, and consistent manner (European Commission, n.d.-c).

As for the EU, the initial NDC was the commitment to reduce greenhouse gas emissions by at least 40% by 2030 compared to 1990 under the 2030 climate and energy framework. All key EU legislation for implementing this target was adopted by the end of 2018 (European Commission, n.d.-c). However, an updated and enhanced NDC was submitted to reduce emissions by at least 55% by 2030 from 1990 levels, which also included information to facilitate clarity, transparency and understanding of the NDC in December 2020. The reason for this update was to have a more reasonable path to becoming climate neutral by 2050 which was based on an impact assessment by the European Commission. This would give policymakers, investors, and citizens certainty so decisions made in the coming years do not lock in emission levels inconsistent with the EU's goal to become climate-neutral by 2050. In addition, the objective of this updated ambition is to prepare ground for the necessary adaptation of the climate and energy legislation playing a key role in the decarbonisation of the European economy, including determining the future role and application of carbon pricing and its interaction with other policies. The impact assessment confirms that an ambition increase within the range of 50% to 55% greenhouse gas reductions is possible in a responsible and socially fair manner, that it can spur sustainable economic growth and employment, and accelerate the clean energy transition, particularly when combined with adequate enabling policies and use of carbon revenues. Economic risks of increasing ambition to 55% greenhouse gas reductions are limited, while it increases investor certainty and reduces the risk of carbon lock in, and accomplishes significant overall environmental benefits (European Commission, n.d.-a; European Commission, 2020). Nonetheless, the new proposal is in line with the Paris Agreement objective to keep global temperature increase well below 2, preferably to 1.5 degrees Celsius, compared to pre-industrial levels (European Commission, n.d.-c).

However, not all countries have sufficient capacities to deal with many of the challenges brought by climate change. As a result, the Paris Agreement provides a framework for financial, technical, and capacity building support to developing countries and requests all developed countries to enhance support for capacity-building actions in developing countries.

The Paris Agreement reaffirms that developed countries should take the lead in providing financial assistance to countries that are less endowed and more vulnerable, while for the first time also encouraging voluntary contributions by other parties. Climate finance is needed for mitigation because large-scale investments are required to significantly reduce emissions. Climate finance is equally important for adaptation, as significant financial resources are needed to adapt to the adverse effects and reduce the impacts of a changing climate (European Commission, n.d.-c; UNFCCC, n.d.-c).

Measuring progress

Article 13 under the Paris Agreement describes that the involved parties established an enhanced transparency framework (ETF) in order to build mutual trust and confidence and to promote effective implementation (UNFCCC, 2015a). Under ETF, starting in 2024, countries will report transparently on actions taken and progress in climate change mitigation, adaptation measures and support provided or received (UNFCCC, n.d.-c). For example, parties should hand in a national inventory report of anthropogenic emissions by sources and removals by sinks of greenhouse gases, prepared using good practice methodologies accepted by the Intergovernmental Panel on Climate Change and agreed upon by the Conference of the parties serving as the meeting of the parties to this Agreement (UNFCCC, 2015a). The information gathered through the ETF will feed into the Global stocktake which will assess the collective progress towards the long-term climate goals. This will lead to recommendations for countries to set more ambitious plans in the next round (UNFCCC, n.d.-c).

The ETF also functions as a mechanism for accountability to promote compliance since there are no penalties for noncompliance in the Paris Agreement. Article 15 of the Paris Agreement describes that an expert-based and facilitative committee shall pay particular attention to the respective national capabilities and circumstances of parties. The committee shall operate under the modalities and procedures adopted by the Conference of the Parties serving as the meeting of the parties to the Paris Agreement at its first session and report annually to the Conference of the Parties (UNFCCC, 2015a). This action will help to get countries falling behind on their commitments and get back on track.

Besides the ETFs, developed and developing parties are required to submit national communications every four years and biennial reports every two years. According to the UNFCCC (2011), a national communication is a report that each party to the Convention prepares to provide among others the following elements of information to the Conference of the Parties:

- Summary information from the national greenhouse gas inventory on emissions and emission trends.
- Quantified economy-wide emission reduction target taking into consideration any relevant decisions of the Conference of the Parties (e.g., base year, gases and sectors covered).
- Progress in achievement of quantified economy-wide emission reduction targets (e.g., mitigation actions and their effects, future projections).

The biennial reports provide an update of the most recently submitted national communication and to provide additional information in relation to mitigation actions taken

or envisaged to undertake and their effects as well as support needed and received (UNFCCC, n.d.-a). According to the UNFCCC (n.d.-b), these reports form essential components of the Convention as promoting consistent, transparent, comparable, accurate and complete information indispensable in enabling a thorough review and assessment of the implementation of the Convention and monitoring progress. International assessment and review for the biennial reports is conducted every two years independently or in conjunction with a national communication (UNFCCC, 2011).

However, all EU countries are required to monitor their emissions under the EU's Climate Monitoring Mechanism, which sets the EU's own internal reporting rules based on internationally agreed obligations. The European Commission is required to produce an annual report on progress of the EU targets, covering actual (historic) emissions and projected future emissions for every country.

In order to get more complete data, EU Member States also report annually on the following aspects to the UN (European Commission, n.d.-b):

- Emissions of seven greenhouse gases (the greenhouse gas inventory) from all sectors: energy, industrial processes, land use, land use change & forestry, waste, agriculture.
- Projections, policies & measures to cut greenhouse gas emissions.
- National measures to adapt to climate change.
- Low-carbon development strategies.
- Financial & technical support to developing countries, and similar commitments.
- National governments' use of revenues from the auctioning of allowances in the EU emissions trading system.

Current state of progress

According to the UNFCCC (n.d.-c), the Paris Agreement sparked trends in various sectors where it is becoming noticeable that low-carbon solutions are being implemented. Moreover, zero-carbon solutions are becoming competitive across economic sectors representing 25% of emissions. For instance, over 1,000 major companies have committed to set emissions reduction targets based on science, and more than 340 have committed to set net-zero targets across their operations and value chains. Private sector leaders increasingly recognize that transitioning the high-carbon economy to one built on low-carbon activities is not only essential to limit dangerous climate change impacts; it is also good for companies' bottom lines (Bergen & Mountford, 2020). In addition to these companies, the following points of progress have been made (Bergen & Mountford, 2020; European Commission, 2021; Plumber & Popovich, 2021).

- The European Union tightened caps on industrial emissions, China and India ramped up renewable energy, Indonesia began cracking down on illegal deforestation.
- Cities have committed to reaching net-zero emissions by 2050, and many individual cities worldwide are also taking commendable action to reduce emissions and create better lives for their residents.
- The European Investment Bank aims to align its strategy with the Paris Agreement's objectives and stopped funding oil, gas, and coal projects at the end of 2021. This, while about 30% of the European Union's €750 billion ($891 billion) stimulus plan and

its €1.1 trillion ($1.3 trillion) 2021-2027 budget will be dedicated to climate-friendly investments.
- More than 130 private banks signed onto the Principles for Responsible Banking which seeks to align banking practices with the Paris Agreement.
- Technological advances make renewable energy more attainable. For instance, electric vehicle technology improved so quickly that an increasing number of major automakers are planning to stop making internal combustion engines. But also, clean energy advanced far more quickly than predicted while the costs have plummeted.
- Coal power, a major source of emissions, has begun to wane.
- Compared to 2019, emissions in sectors covered by the EU Emission Trading System fell sharply in 2020, by 11.4% from power generation and the bulk of industrial production, and by 63.5% from aviation. Non-ETS emissions, such as those from non-ETS industry, transport, buildings, agriculture, and waste, fell by 6%.

Nevertheless, the climate commitments are not on track to meet the Paris Agreement goals and worrying trends have been confirmed by the UNFCCC (UNFCCC, 2021a; UNFCCC, 2021b). Based on the NDCs sent by the parties that fall under the UNFCCC, these parties must double their climate efforts to reach the Paris Agreement's goal of limiting global temperature rise by 2°C —ideally 1.5°C —by the end of the century. The level of ambition communicated through these NDCs indicates that changes in these countries' total emissions would be small, less than -1%, in 2030 compared to 2010 (UNFCCC, 2021a). An updated report of the NDCs even confirmed that for all available NDCs of all 192 Parties taken together, a sizable increase, of about 16%, in global greenhouse gas emissions in 2030 compared to 2010 is anticipated. Comparison to the latest findings by the Intergovernmental Panel on Climate Change shows that such an increase, unless changed quickly, may lead to a temperature rise of about 2.7°C by the end of the century (UNFCCC, 2021b).

A visualization of potential future scenarios of global greenhouse gas emissions can be seen in figure 11. According to Ritchie (2020), these are the five possible future scenarios:

- No climate policies: projected future emissions if no climate policies were implemented; this would result in an estimated 4.1 to 4.8°C warming by 2100 (relative to pre-industrial temperatures).
- Current climate policies: projected warming of 2.8 to 3.2°C by 2100 based on current implemented climate policies.
- National pledges: if all countries achieve their current targets set within the Paris climate agreement, its estimated average warming by 2100 will be 2.5 to 2.8°C. This will go well beyond the overall target of the Paris Agreement to keep warming “well below 2°C”.
- 2°C consistent: there are a range of emissions pathways that would be compatible with limiting average warming to 2°C by 2100. This would require a significant increase in ambition of the current pledges within the Paris Agreement.
- 1.5°C consistent: there are a range of emissions pathways that would be compatible with limiting average warming to 1.5°C by 2100. However, all would require a very urgent and rapid reduction in global greenhouse gas emissions.

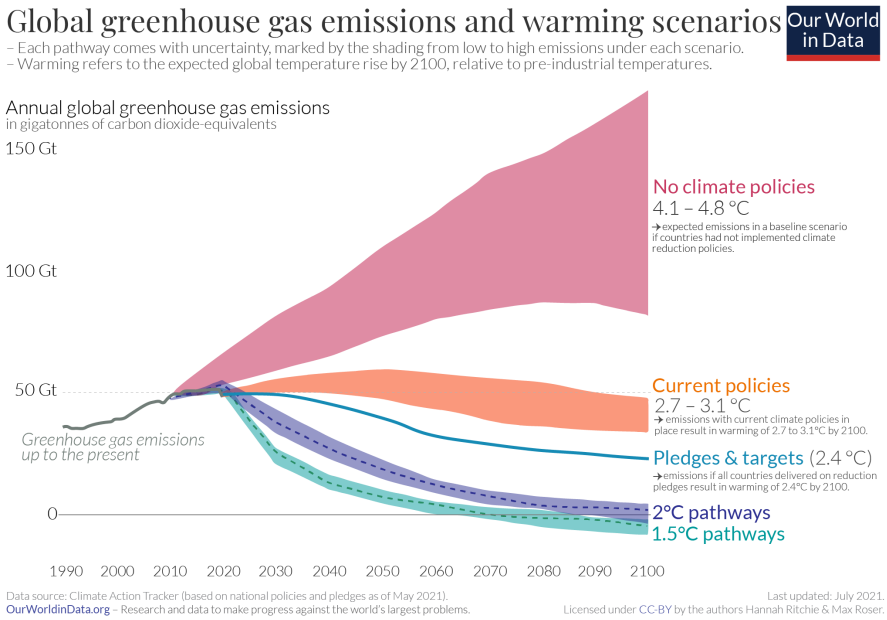

Figure 11: Global greenhouse gas emissions and warming scenarios (Ritchie, 2020)

According to the European Commission (2021), greater efforts are required to reach the 2030 goal of cutting net emissions by at least 55% and achieving climate neutrality by 2050. To ensure that the EU policy framework is fit for its new 2030 climate target, the European Commission proposed in July 2021 a package of climate and energy legislation. Moreover, the EU's €800 billion recovery plan will provide significant support to Member States' climate projects (European Commission, 2021).

H. The Dutch Climate Agreement and the Dutch infrastructure sector

The following agreements were mentioned in the Dutch Climate Agreement regarding zero-emissions construction traffic and mobile machinery (Rijksoverheid, 2019):

- In 2019, Dutch businesses, working alongside public authorities, knowledge institutes, and Natuur & Milieu, will undertake the "Climate-neutral Construction Site Challenge" in order to identify knowledge and experiences, opportunities and possible obstacles surrounding zero-emissions mobile machinery, in order to accelerate the growth and incorporation of zero-emissions mobile machinery and advance knowledge exchange and to facilitate public authorities in this transition.
- Public authorities will take the initiative to include the use of zero-emissions mobile machinery and the principles of the HND Green Deal in procurement processes, such as for construction works and landscaping activities. In this regard, the national government and other public authorities will aim to achieve agreements on the standardisation of invitations to tender for zero-emissions machinery. Agricultural machinery will be added to the Green Deal for Mobile Machinery (HND Green Deal). The national government will enable the relevant top sectors to develop autonomous vehicles, via crossovers before 2023, that carry out transport and field operations sources for precision applications and run-on renewable energy sources.
- The national government will create framework conditions within the regulations to allow cities to steer toward green construction traffic and the use of zero-emissions construction machinery, for example by imposing a monitoring obligation for emissions and load factor.
- The national government will be committed to putting carbon dioxide labelling and standardisation of mobile machinery on the agenda of the European Commission.
- If the agreements above have not yet led to an expected reduction of carbon dioxide emissions by mobile machinery of 0.4 Mt by 2030 (to be determined in consultation with local and regional authorities), the national government will impose zero-emissions green construction traffic and the use of zero-emissions mobile machinery by 2026. The government will already begin the preparation of legislation to allow rapid introduction of a legal obligation to take place.

Regarding climate neutral and circular ground, road and water works, the following agreements were mentioned in the Dutch Climate Agreement (Rijksoverheid, 2019):

- In relation to ground, road and water works (GWW), the national government alongside regional authorities will increase purchasing power and will make commitments by no later than 2020 regarding the application of climate-neutral and circular methods wherever possible by 2030 (machinery, material supply chains), including procurement and standardisation of the invitation to tender. The national government and other public authorities will encourage measures within their own construction and maintenance processes and by establishing supply chain agreements and Green Deals aimed at product and material supply chains (such as asphalt, concrete, soil, and steel). Among other things, the measures will focus on maintenance works that prolong lifespans, on sustainability (low carbon improvements) and on

harmonisation of material use. This will involve making use of tools from the Sustainable GWW approach, such as DuboCalc, the CO_2 ladder and additional procurement criteria. Where possible, the national government and provincial authorities will use their infrastructure to generate energy and for multi-purpose use of space.

- The national government and local and regional authorities will make their experience with sustainable civil works available (innovations for climate adaptation, climate mitigation and the circular economy) and will share knowledge aimed at making the material supply chains more sustainable and at energy savings and generation in the construction sector in order to learn more quickly and save costs in implementation.
- In tenders, the national government will score based on carbon dioxide emissions, where contractors with lower emissions will be more likely to receive the contract. In 2019, the national government will be developing a strategy and action programme aimed at achieving fully circular and climate-neutral status in the construction sector by 2030, in relation to which it will formulate specific carbon dioxide reduction targets in projects that contribute to acceleration of the developments toward zero-emissions vehicles and logistics optimisation formulated in this Agreement.

I. Interview questions

Allereerst bedankt dat u wilt deelnemen aan de interviews. Ik zal mezelf eerst voorstellen, mijn naam is Altan Ceylan en ik ben een tweedejaars master-student aan de TU Delft. Op dit moment voer ik vanuit Boskalis Nederland een onderzoek uit naar de implementatie van duurzaamheid binnen twee-fasen projecten. Met behulp van interviews wil ik een aantal sub vragen beantwoorden zodat ik de impact van het twee-fasen model op duurzaamheid kan bepalen.

Verder zal dit interview volledig anoniem worden vastgelegd in mijn scriptie. Voordat we beginnen wil ik u vragen of ik ons interview mag opnemen, de opname zal worden verwijderd nadat ik mijn onderzoek heb afgerond.

A: Introductie			Code
Vraag	1	Zou u uzelf willen introduceren? (Naam, functie, aantal jaar ervaring in de GWW-sector).	GQ1
B: Introductie twee-fasen project			
Vraag	2	Zou u in het kort algemene informatie willen geven over het project waar een twee-fasen proces is toegepast? (Naam project, omschrijving, grootte, complexiteit, (schatting) van de kosten).	GQ1
Vraag	3	Wat was de reden voor het gebruik van het twee-fasen proces?	GQ2
C: Aanbestedingsfase			
Vraag	4	Welke type contract werd er aanbesteed (voor het ontwerp / uitvoering)?	GQ1
Vraag	5	Vanuit literatuur komt naar voren dat het twee-fasen model een kort en goedkoop aanbestedingsproces heeft, komt dit overeen met uw ervaring met dit project?	GQ2
Vraag	6	Hoe groot speelde maatschappelijk verantwoord inkopen een rol bij de aanbesteding van dit project? (Omgevingswijzer, Ambitieweb, DuboCalc, de CO_2 prestatieladder).	SQ2
D: Ontwerp- en uitvoeringsfase			
Vraag	7	Hoe is in het hele proces het project verduurzaamd?	SQ2
Vraag	8	Welke incentives werden er aan de aannemer aangeboden om gebruik te maken van duurzame oplossingen/innovaties?	SQ2
Vraag	9	Hoe tevreden bent u over hoe het ontwerp tot stand is gekomen?	GQ2
Vraag	10	Op basis waren de risico's verdeeld en waren de risico's ook eerlijk verdeeld?	GQ2
Vraag	11	Terugkijkend naar het project, in welke mate heeft u gemerkt dat er kosten en/of tijd efficiënt is gewerkt? Heeft dit volgens u een correlatie met het twee-fasen proces?	GQ2
Vraag	12	Hoe tevreden bent u over de prijs-kwaliteitsverhouding?	GQ2
Vraag	13	Welke van de volgende factoren acht u het meest cruciaal bij het implementeren van duurzame oplossingen binnen infrastructuurprojecten? En waarom? - Financiële aantrekkelijkheid	SQ4

		- Maatschappelijk nut - Aandacht voor het milieu en ecologie - Samenwerking binnen een projectteam en met stakeholders	
Vraag	14	Hoe zou de door u gekozen drijfveer gestimuleerd kunnen worden in een twee-fasen project?	SQ4
E: Samenwerking			
Vraag	15	Stel dat u de keuze zou hebben om voor een andere samenwerkingsvorm te kiezen in plaats van een twee-fase proces, waar zou u dan voor kiezen? En waarom specifiek voor deze vorm?	GQ2
Vraag	16	In welke mate merkt u het verschil qua implementatie van duurzame oplossingen met een samenwerkingsvorm als een RAW-bestek?	SQ5
Vraag	17	Welke barrières ziet u voor verdere implementatie van het twee-fasen proces? Bijvoorbeeld: Waar lopen opdrachtnemers en opdrachtgevers tegenaan in deze nieuwe contractvorm?	GQ2
F: Klimaatakkoord			
Vraag	18	Volgens het Nederlandse Klimaatakkoord zal er een transitie plaats vinden naar emissieloos materieel / emissieloze bouwplaats en een klimaat neutraal GWW-sector. In welke mate merkt u deze transitie?	GQ3
Vraag	19	Vindt u deze transitie noodzakelijk en haalbaar? En waarom?	GQ3
Vraag	20	Vindt u dat er genoeg aandacht wordt besteed aan deze transitie in infra-projecten of wat zou er moeten worden veranderd in de GWW-sector? Denk aan: incentives voor marktpartijen, bepaalde factoren in de samenwerking met partijen, meer subsidies, initiaties vanuit Rijkswaterstaat.	GQ3
Vraag	21	Hoe zouden publieke opdrachtgevers een nog actievere bijdrage kunnen leveren aan het versnellen van de transitie naar een duurzame GWW-sector?	GQ3
Vraag	22	Heeft u nog vragen en / of opmerkingen?	GQ