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ORIGINAL ARTICLE

Sustainability requirements in public tenders - an embedded case study at the Dutch Department of Public Works

Requisitos de sustentabilidade em licitações públicas - um estudo de caso incorporado no Departamento de Obras Públicas da Holanda

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Abstract: The construction industry is under pressure to work much more sustainably. The government is the largest client and has a lot of potential to contribute to sustainability. However, little is known about the effectiveness of sustainability requirements in public procurement for construction projects. This study examines three Rijkswaterstaat road construction projects to understand the role of sustainability requirements. One striking finding is that contractors often adopt additional sustainability measures during construction. This research shows that agreements can evolve flexibly, which highlights the importance of contractual flexibility. This flexibility is essential for effective collaboration and achieving sustainability performance. Contractual adjustments can lead to improved environmental performance by allowing contractors to incorporate innovative and sustainable solutions as the project progresses. It is therefore important that public contracts allow for such adjustments to promote sustainability in the construction sector. Contractual flexibility appears to play a key role in the successful implementation of sustainable practices in construction projects.

Keywords: Public works; Sustainability requirements; Construction industry; Contractual flexibility; Incomplete contracts.

Resumo: O setor de construção está sob pressão para trabalhar de forma muito mais sustentável. O governo é o maior cliente e tem muito potencial para contribuir com a sustentabilidade. No entanto, pouco se sabe sobre a eficácia dos requisitos de sustentabilidade nos contratos públicos para projetos de construção. Este estudo examina três projetos de construção de estradas da Rijkswaterstaat para entender o papel dos requisitos de sustentabilidade. Uma descoberta surpreendente é que as empreiteiras geralmente adotam medidas adicionais de sustentabilidade durante a construção. Esta pesquisa mostra que os acordos podem evoluir de forma flexível, o que destaca a importância da flexibilidade contratual. Essa flexibilidade é essencial para uma colaboração eficaz e para a obtenção de um desempenho sustentável. Os ajustes contratuais podem levar a um melhor desempenho ambiental, permitindo que as empreiteiras incorporem soluções inovadoras e sustentáveis à

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medida que o projeto avança. Portanto, é importante que os contratos públicos permitam tais ajustes para promover a sustentabilidade no setor de construção. A flexibilidade contratual parece desempenhar um papel fundamental na implementação bem-sucedida de práticas sustentáveis em projetos de construção.

Palavras-chave: Obras públicas; Requisitos de sustentabilidade; Setor de construção; Flexibilidade contratual; Contratos incompletos.

1 Introduction

Sustainability has been high on the agenda of organizations in recent years (e.g. AlNuaimi et al., 2021). Many countries agreed in the Paris Agreement that there should be more focus on sustainability, resulting in an international treaty to curb global warming. This requires that every country dies its part and reduces nitrogen emissions. There is little difference of opinion on the priority that should be given to sustainability. The world is faced with major problems and challenges regarding our natural environment. In 2017 European governments have set ambitious climate goals for 2030 to 2050. The European Green Deal, as proposed by the European Commission, aims for a climate-neutral economy by 2050.

In recent decades, the pursuit of environmental impact through government procurement has shifted from allowing the use of green criteria to recommending their use (Halonen, 2021). Public procurement has been studied by many scolars and is considered an effective tool to encourage both public and private organizations to work sustainably (Halonen, 2021). Public procurement can also be used to develop innovative activities and projects in which sustainability plays an important role (Ntsonde & Aggeri, 2021). Public authorities can encourage innovation and sustainability by emphasizing it in tenders (Lingegård et al., 2021). There are high expectations about the possibilities and possible effects of green public procurement to tackle environmental problems (Yu et al., 2020), also since government organizations represent large volumes of public spending (Montalbán-Domingo et al., 2023).

Sustainability is receiving increasing attention, although its effects are difficult to monitor. Problematic is that many public agencies experience little to no legal pressure and enforcement to actually procure sustainably (Vluggen et al., 2019; Palmujoki et al., 2010). Researchers conclude that with few exceptions, legal and financial accountability still seem to prevail over performance accountability to achieve sustainable procurement (Vluggen et al., 2019). It is important that procurement legislation allows sustainability to play a greater role within public procurement (Giorgi et al., 2022).

The construction industry is an area to be prioritized for achieving climate goals (Giorgi et al., 2022). This industry accounts for 9% of European countries' gross domestic product (European Commission, 2022). In addition, the construction industry uses a relatively large amount of raw materials and produces a relatively large amount of waste (Uil, 2022). The construction industry causes many environmental problems, "ranging from excessive energy consumption to pollution of the surrounding environment" (Pero et al., 2017, p. 3). A recent systematic literature review identified many challenges, potentials and research questions related to sustainable supply chain management in construction (Cataldo et al., 2022). Green construction is gradually adopted, albeit rather slowly (Goh et al., 2020). Both in construction, use, management, maintenance and end-of-life, a project can have a positive impact on the carbon footprint. This is why the civil engineering sector is pre-eminently an important sector to set high standards to achieve

climate goals. Public procurement is a decisive factor when it comes to achieving sustainability goals (Miller et al., 2009), since the government is the most important and largest customer and client of the construction industry (Lenderink et al., 2022). Green public procurement has much potential to contribute to sustainability, where “more than half of this potential is related to investment in infrastructure” (Chiappinelli et al., 2019, p. 436). There is little knowledge about the effect of sustainable procurement on the environment, the pricing of contracts and the ability to bring about a green transformation (Halonen, 2021). More specific, we lack insights into the actual inclusion of sustainability requirements in public works procurement (Montalbán-Domingo et al., 2023. The research questions of this study are: how are sustainability requirements handled in public works contracts? Which requirements are included in these contracts and how are these contracts implemented and monitored?

In this study we explore and investigate the role of sustainability requirements in three major road construction projects as commissioned by the Dutch Department of Public Works, with a focus on environmental sustainability. It was also investigated how the contractual agreements were fulfilled and adjusted during the implementation of the projects. The investigated projects have been tendered at European level, and the specifications also include sustainability requirements. Contractors have made additional commitments in the field of sustainability in the action plan.

The remainder of this paper is as follows. The literature review summarizes the current understanding of sustainability and contracting within the context of infrastructure maintenance. The methodology section introduces the in-depth case study at Rijkswaterstaat (RWS), the Dutch public agency responsible for roads and waterways in the Netherlands. The results of a cross case analysis are presented, summarizing the main findings and conclusions. The results are discussed and interpreted in the discussion section The paper is completed with recommendations for practitioners and recommendations for further research.

2 Literature review

2.1 Sustainability in public procurement

In 1977, Cambridge scholar and economist Joan Robinson posed an important economic question: “what is growth for?”. When economic growth does not lead to increased human welfare, economic growth can not be seen as success, but as failure (Robinson, 1977). Scholars are increasingly coming to realize that economics is disconnected from social progress (Chataway et al., 2014). Public procurement, which accounts for about 12-16% of gross domestic product, is shifting from a focus on competition and low prices to social and sustainable aspects (OECD, 2020).

The Bruntland Commission provided the well-known definition of sustainable development as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (United Nations General Assembly, 1987, p. 43). The term “sustainability” is read and interpreted in different ways, with a philosophical point of view on the one hand to a container term in the business sphere on the other. Already published studies show that there is a wide range of definitions when it comes to sustainability in procurement. This study uses the definition of green public procurement (GPP). Green public procurement can be seen as “practices that take into account the environmental quality of offers when awarding public contracts (Chiappinelli et al., 2019, p. 434). This descriptions

corresponds with the conceptualization of the European Commission which emphasizes the balance between the three pillars of sustainable development - economic, social and environmental (European Commission, 2022).

Green and sustainable procurement policies have caused contracting authorities to become risk averse rather than open to new ways of sustainable procurement. Many public purchasers tend to rely on past experiences to avoid potential legal conflicts (Palmujoki et al., 2010). In order to encourage purchasers to buy sustainably, knowledge about sustainability, the environment and procurement is very important. Procurement organizations would therefore do well to increase buyers' knowledge about sustainable procurement and encourage buyers' affective involvement in sustainable procurement (Grandia, 2016).

2.2 Sustainability and public works tendering

Roads, railways, airports, water systems, and electricity networks are most commonly provided by national governments. The public infrastructure is at the base of all economic activities (Gelderman et al., 2019). The construction industry can be characterized as a high-risk, complex business in which many parties are involved (Rahman & Kumaraswamy, 2002). Projects have a long lead time, while customers sometimes want to see the design adjusted (Eriksson, 2008). This customization contributes to the complexity of the construction industry. The sustainable capabilities of contractors are of critical importance for the implementation of green construction activities (Gu et al., 2023; Ershadi et al., 2021). Practice shows that relationships are governed by competition, while cooperation will lead to better results (Lenderink et al., 2022). The achievement of sustainable goals requires collaboration, common understanding of sustainability principles, and the integration of procedures and processes (Pero et al., 2017; Ershadi et al., 2021).

It is generally known and accepted that the construction industry faces the important, challenging task of significantly contributing to improving sustainability within all work processes (Lenderink et al., 2022; Chiappinelli et al., 2019). The complexity of sustainability in public constructions is illustrated by an extensive bibliographic research that resulted in a structure of nine categories that add 214 criteria (Perlingeiro et al., 2021). However, little is known about the inclusion of sustainability criteria in infrastructure construction projects (Yu et al.,2020; Montalbán-Domingo et al., 2023). There are also serious questions about the actual effectiveness of these sustainability requirements. Main barriers refer to a lack of knowledge and effective procurement methods, the technical complexity of projects, financial constraints, poor design practices, and a low administrative capacity (e.g. Montalbán-Domingo et al., 2023; Lenderink et al., 2022; Fitriani & Ajayi, 2023).

To give substance to sustainability, the Dutch central government has written socially responsible procurement (SRI) criteria. With these criteria, the central government is committed to promoting socially responsible procurement (SRI). SRI means that procurement is used to achieve greater sustainability and avoid negative effects on environmental and social aspects. The central government has formulated standard sustainability and environmental requirements that can be used by government bodies in tenders and contracts. Using the SRI criteria tool, it is possible to select specific requirements by topic and add them to the contract. Therefore, it is up to the public authority itself to add these requirements on a project-specific basis. Including sustainability requirements in contract is not an obligation. Contracting out

the sustainability criteria gives the public authority the ability to react quickly and steer when disruptions occur in execution (Palmujoki et al., 2010). Sustainability requirements and criteria are included, to encourage market players to differentiate on sustainability. PIANOo, the Dutch Public Procurement Expertise Centre, has made a distinction between three ambition levels, see Table 1. PIANOo is part of the Dutch Ministry of Economic Affairs and Climate Policy (PIANOo, 2020).

Table 1. Ambition levels of SRI criteria.

Ambition level of SRI criteria	Type of criteria	Purpose
Basic	Eligibility requirements	Exclude unsustainable products, services and works.
	Selection criteria	
	Minimum requirements	
	Contract provisions	
Significantly	Eligibility requirements	Encourage sustainable products, services and works to make significant sustainability gains.
	Selection criteria	
	Enhanced award criteria	
	Enhanced minimum requirements	
	Contract clauses enhanced	
Ambitious	Ambitious award criteria	Encourage new solutions and innovation to make the lowest possible negative burden or positive contribution
	Functional and ambitious minimum requirements	
	Ambitious contract clauses	
	Suggestions for greater impact	

2.3 Sustainability requirements in contracts

Like most business contracts the contractual arrangements between (public) client and contractors are, in practice, incomplete. The Incomplete Contract Theory posits that completeness is hard to achieve (Bolton & Dewatripont, 2004), which implies that unforeseen divergences in performance require negotiation or dispute resolution (Hart & Moore, 1988). Unexpected events and developments require a certain flexibility in contracts. Flexible contract mechanisms enable an effective response to continuously changing circumstances (Demirel et al., 2017). Contractual flexibility is a considered a necessary condition to foster collaborative relationships between clients and contractors (Simons & Nijhof, 2021). The advantages of incomplete contracts are offset by the disadvantages of additional costs and possible opportunistic behavior of contractors (e.g. Hart & Moore, 1988; Zhang & Xi, 2023; Domingues et al., 2014), which is likely to negatively impact sustainability performance.

Literature is not clear about the actual inclusion and use of the sustainable requirements in public works tendering (Yu et al., 2020; Montalbán-Domingo et al., 2023). The uptake of sustainability requirements in public contracting remains difficult to discern (Yu et al., 2020). Minimum requirements are requirements that are included by the contracting authority and must be implemented as a minimum. These minimum requirements are included in the contract as contract clauses. In public procurement with a sustainable character, it is important to include environmental criteria and sustainability aspects. Public agencies must comply with basic principles:

- Non-discrimination: Governments should not discriminate on the basis of nationality.

- Equal treatment of entrepreneurs: governments should treat everyone in the same way.

- Transparency: entrepreneurs are given insight and information about tenders.

- Proportionality: requirements are proportionate to the work and scope of the contract.

With appropriate requirements, the contracting authority tests whether a tenderer is suitable to perform in accordance to the contract. Suitability requirements can be set to test a party's technical and professional ability and economic standing. The suitability requirements are functional in nature. Selection criteria gives the opportunity to rank candidate parties during the tender process. This is done to compare and rank parties that meet the suitability requirements. This is a relative valuation process in which the selection criteria are strongly determined by the complexity and scope of the contract. Sustainability can be an important selection criteria in this (Sloots et al., 2022).

Award criteria aim to contract the party that submitted the most economically advantageous tender. This can be done in three ways:

best value for money,

lowest cost calculated on cost-effectiveness, such as life-cycle costs and

lowest price.

The Dutch legislator leaves the choice on how to apply the most economically advantageous criteria to the contracting authority, but does give a caveat in this. If the contracting authority wishes to exploit innovation from the market, it is also desirable to award on the basis of best price-quality (Sloots et al., 2022).

2.4 Measuring and monitoring sustainability requirements

The contract management process is becoming increasingly important as the size and volume of procurement in public agencies continues to increase and suppliers/contractors become an extension of the organization (Coleman et al., 2020; Meredith & Mantel, 2002). With this, contract management is also changing. Where previously a more traditional method of contract management was used, building a constructive relationship with contractors is increasingly becoming the norm (Garrett & Rendon, 2005). Parties may have won a contract by offering more quality than requested. Documents from the Public Procurement Regulatory Authority show that resources are wasted and contract requirements are not always implemented, resulting in the party that won the tender not fulfilling the contract (Mchopa, 2015).

The main activities of contract management are monitoring, enforcement, coordination and collaboration (Nullmeier et al., 2016). In many theories of contract management, assurance is the most prominent function of contract management with the aim of minimizing opportunism and protecting investments(Yin, 2013). Public institutions in the Netherlands apply System – oriented Contract management (SOCM). Central to SOCM is that contractors have the responsibility to monitor the quality of delivered products and manage risks. To ensure this, Rijkswaterstaat requires that parties apply quality management. Quality management is often shaped according to established guidelines. When the required quality is not met, it is possible to impose fines.

3 Methodology

3.1 Research design

An embedded case study was used, allowing for an in-depth analysis of the phenomenon of sustainability in an actual context. To develop a thorough understanding, similar cases are studied to investigate the role and the impact of sustainability requirements in public procurement. Appendix 1 shows the methodological path, followed in this study.

We selected three comparable cases from the civil engineering sector. Cases should be comparable and meet the following requirements:

1. The contracts have a comparable contract form.
2. The works should not be older than 20 years.
3. The projects should be European tendered.
4. Sustainability requirements are included in the tender and the contractor has made additional sustainability commitments in the qualitative plan of work.

In addition to the criteria mentioned above, the case studies were selected based on their leading role in Dutch civil engineering. The projects are complex and multidisciplinary in nature, of similar duration and started in the same period. In addition, they are located in different parts of the Netherlands and include partnerships of several large, leading contractors. These selection criteria ensure that the case studies are representative of a wide range of conditions and challenges within the sector.

3.2 Data collection

For this study, two primary data collection methods were applied. Semi-structured interviews: the research included 3 cases (projects) of Rijkswaterstaat, for each case, a minimum of 3 interviews have been conducted. The interviews took place with IPM role holders, sustainability or procurement advisors of the following projects:

Project A16 Rotterdam

Project Afsluitdijk

Project Blankenburgverbinding

The projects are leading for the Dutch civil engineering sector and are very large in size. The projects have the following similarities: Same contract form,not older than 20 years, European tendered and have sustainability requirements in the contract. On the point of generalizability/representativeness, we would like to emphasize that the way in which Rijkswaterstaat tenders for and carries out large, public works should be seen as the standard way in which all major construction works in the Netherlands are carried out under the direction of Rijkswaterstaat. To this end, this organization has developed extensive manuals, procedures and regulations that employees adhere to during implementation. We conclude that the three major projects examined in this study provide a good picture of public works in the Netherlands. The Rijkswaterstaat way of working has always been the way the government in the Netherlands approaches public works. If we take a closer look at the 3 projects studied, it gives a good picture of public works in the Netherlands.

Table 2 provides an overview of the main character properties of the selected cases. The table summarizes the main characteristiscs of the cases used in the study.

Table 2. Characteristics of the cases.

Characteristics	Project A16 Rotterdam	Project Blankenburgverbinding	Project Afsluitdijk
Location	Rotterdam, Netherlands	Between Vlaardingen en Maassluis, Netherland	Between Friesland and North Holland, Netherlands
Start date	2016	2018	2018
Duration	Expected to be completed in 2024	Expected to be completed in 2024	Expected to be completed in 2024
Complexity	High	High	High
Multidisciplinary	Yes, includes road construction, civil engineering, and environmental management	Yes, includes tunnel construction, road construction, and water management	Yes, includes water barrier reinforcement, road construction, and nature management
Leading contractors	Consortium of major contractors such as BAM, Heijmans, and Boskalis	Consortium of major contractors such as Ballast Nedam, DEME, and Macquarie	Consortium of major contractors such as BAM, Van Oord, and Rebel Group
Objective	Improve Rotterdam's accessibility and reduce traffic congestion	Improve the connection between the A20 and A15 and reduce traffic congestion	Strengthen the water barrier, improve traffic safety and sustainability of the Afsluitdijk
Main challenges	Managing urban environment, technical complexity of tunnel construction	Technical complexity of tunnel and bridge construction, environmental management	Managing water control, preserving natural habitats, and reinforcing an existing water barrier
Geographical spread	South Holland	South Holland	Friesland and North Holland
Value (in Euros)	<500 Millions	<500 Millions	>500 Millions
Contract form	Design Build Finance and Maintain	Design Build Finance and Maintain	Design Build Finance and Maintain

Table 3 lists the interview respondents and data collection approach for each of the three projects.

The standard contract form is DBFM (Design, Build, Finance and Maintain) sometimes called DBFMO (Design, Build, Finance, Maintain, Operate). A DBFM contract is a specific type of public private partnership where the private partner is integrally responsible for designing, building, financing and maintaining the infrastructure (Lenferink et al., 2013). These contracts are used in many countries around the world, mainly for infrastructure and construction projects (Verweij, 2015). For instance, the United Kingdom, Australia, the Netherlands, Belgium and the United States have used DBFM and DBFMO contracts for projects such as roads, bridges, tunnels, airports, schools, hospitals and prisons. These contract forms are often used when governments want to share risk and leverage private sector expertise to make projects more efficient. They also provide long-term private sector involvement in infrastructure management and maintenance, which can result in better performance and lower costs in the long run.

Table 3. Data collection and respondents of the cases.

Characteristics	Project A16 Rotterdam	Project Blankenburg Connection	Project Afsluitdijk
Respondents	• Contract Manager	• Project Manager	• Former Project Manager
	• Procurement Adviser	• Procurement Adviser	.
		.	• Current Project Manager
		• Sustainability Advisor	.
	• Advisor system-oriented contract management	.	• Contract Manager
	.	.	• Procurement Advisor

From the late 1990s, DBFM was introduced as a form of contract in the Netherlands. From 2004, RWS embraced the motto “the market unless” which refers to a procurement strategy aimed at contracting as much as possible from specialized suppliers. RWS specifically preferred buy options to make options. Initially projects over 112.5 million euros were subjected to DBFM contracting. In 2007 this threshold was lowered to 60 million. Government-wide model agreements for this form of contract have been drawn up by the State Property Agency, Rijkswaterstaat and the Ministry of Finance. Between 2003 and 2020, 21 projects in the Netherlands were tendered using a DBFM contract form. In a DBFM contract, the contractor is responsible for the design and construction of the project as well as the financing and overall maintenance. It is thus an integrated form of contract. This gives the contractor maximum scope to apply his knowledge and creativity .In the period from 2003 to 2020, 21 major infrastructure and construction projects were tendered with a DBFM contract (see Appendix 2).

Different sources of evidence are used to complement each other and to ensure the validity of the study (Yin, 2013). The case study involved in-depth semi-structured interviews with key respondents, as well as an analysis of documentation and archival records, including Policy documents, Tender file, Plan of Action. The purpose of the semi-structured interviews is to gain insight into the respondents' perceptions and experiences relative to the research topics. Semi-structured interviews were chosen for this study because even though the different cases are similar the nature or scope of the work may be different. Also, the interviewees differ in function which makes it possible to ask more in-depth questions based on the respondents' answers to enhance data collection. Respondents were selected based on their role and involvement in the selected cases. Respondents must have been actively involved in the project for an extended period of time in the following roles: Project Manager, Contract Manager, Procurement Consultant or Sustainability Consultant. A minimum of 4 interviews were conducted per case until saturation occurred. We conducted interviews within the focus organizations. An interview typically lasted 60 to 90 minutes. All interviews were recorded and transcribed.

The operationalization explains the key terms to be used in the process of data collection (see Appendix 3), aimed at clarifying, defining and standardizing the data. The interview protocol contained the following themes:

1. Introduction and background information
2. Role and involvement of the respondent in the project
3. Selection and inclusion of sustainability requirements in the tender file
4. Sustainability requirements in the final contract
5. Governance and coordination
6. Performance monitoring
7. Contract compliance and reinforcement

3.3 Data analysis

During the collection of the data (interviews) there was already a partial data analysis, which is also not unusual for qualitative research. The literature search yielded key concepts and points of interest that we could use when drawing up the interview guide and at a later stage when analyzing and interpreting the results. During the interviews we gain new insights that could be used in the following interviews. The outcome of the interviews was displayed and summarized in a data matrix. The transcripts were submitted to the respondent for information to increase reliability.

A data matrix has the advantage that a structured representation of data can be created, which ensures that the information becomes comparable and insightful. After coding the transcripts, a within case analysis was conducted, followed by a cross-case analysis in which the outcomes of the different cases were compared and contrasted.

4 Results

4.1 Background information about the case organization

Rijkswaterstaat was founded in 1798 as the Bureau of Waterways and in 1848 it was renamed Rijkswaterstaat. On behalf of the Ministry of Infrastructure and Water Management, the agency manages national highways, main waterways and waterworks like the delta works. Rijkswaterstaat is primarily a political management organization with much technical knowledge. However, the construction and maintenance of the national highways, main waterways and waterworks is not done in-house but is outsourced to the market. Large organizations cooperate extensively with Rijkswaterstaat. Rijkswaterstaat has the coordinating and steering role in this cooperation. As a government body, Rijkswaterstaat is accountable to the minister and the House of Representatives. Politics therefore plays a major role at Rijkswaterstaat.

Sustainability requirements are often included as award criteria at Rijkswaterstaat. Sustainability requirements can be divided into two categories namely, 'social' sustainability requirements and 'green' sustainability requirements. Social sustainability requirements contribute to improving the welfare of people in current and future generations. Social sustainability requirements are often referred to as social return. Green sustainability requirements focus on environmental aspects.

The award criterion best price-quality ratio allows tenderers to distinguish themselves. The criteria used as award criteria are the quality criterion, performance criterion and price criterion. The quality and performance criterion are scored which creates a notional discount on the price criterion. Quality is converted into a discount on the tender price to distinguish the bidder with the best price, quality ratio. Tendering

parties are challenged with quality criteria to offer higher quality than what is required in the contract. This approach increases distinctiveness, implying that a tender with higher quality can be preferred to a less costly tender of lower quality.

The purpose of the quality criteria is to select a tender that not only meets the requirements set, but also offers the best value for the client. This approach encourages bidders to compete not only on price, but also on other aspects that add value to the project or contract. The quality criteria are determined in advance by the contracting authority and are included in the tender documents. These criteria are given monetary weight, the amount depending on their importance to the client. An able evaluation committee reviews the submitted plans and gives scores. The party offering the best value for money wins the contract.

Quality criteria can vary in form. The most important feature of a quality criterion is that the quality of the tender is difficult to measure by a yardstick. There will always be a (subjective) assessment. This makes these criteria more difficult to test in implementation. Performance criteria are quantitative by nature and can therefore be measured and assessed. Rijkswaterstaat frequently uses the performance criteria Environmental Cost Indicator (ECI) and the CO2 performance ladder. The CO2 Performance Ladder is an instrument used in the Netherlands to encourage companies and organizations to reduce CO2 in their operations and projects. The CO2 Performance Ladder works on the basis of a certification system that includes five levels (ladders) ranging from level 1 to level 5. The higher the level at which a company is certified, the more efforts it has made in terms of CO2 reduction. The certificate relates to the organization and projects already carried out, and is not about the project at issue in the tender. The performance criteria Environmental Cost Indicator (ECI) is used to reduce the environmental impact of the project being tendered for. The tendering parties must use the ECI to calculate how much energy consumption, raw materials and greenhouse gas emissions their design will cost or emit. The CO2 performance ladder is about the past, the ECI is about the future project.

The environmental cost indicator is a means of objectively comparing the various CO2 reduction initiatives of tenderers. For this calculation we use the calculation program Dubocalc (Sustainable Construction Calculator), designed by Rijkswaterstaat. The DuboCalc calculation program allows tenderers to calculate the environmental impact resulting from the choice of materials, working methods and energy consumption. The calculation program calculates the magnitude of the environmental cost indicator (ECI) value of civil engineering. The more CO2 reduction the market party offers the higher the notional reduction in the tender price. The ECI thereby makes it possible to objectively compare different CO2 reduction initiatives that market players can offer.

> *We use the Environmental Cost Indicator, which translates CO2 reduction into fictitious euros. These euros used as a reduction of the price. The winning contractor's bids are included as fixed requirements in the contract* (Sustainability Consultant).

4.2 The cases investigated

Case 1 Blankenburg connection project

The purpose of the Blankenburg connection is to ensure that the Rotterdam region has an attractive long-term business climate and becomes a pleasant place to live. The Blankenburg connection (A24) consists of the construction of a freeway, a land tunnel,

a water tunnel, a sunken connection to the A20 and a high connection to the A15. The A20 will be widened. The new national highway A24 will open in 2024. In addition to design and construction, the contract includes 20 years of maintenance.

Case 2 Afsluitdijk project

The purpose of the Afsluitdijk is to protect the Netherlands from the force of water. In its current form, the Afsluitdijk has been doing this for 90 years, but raising and widening the Afsluitdijk is crucial to maintaining its function in the future. An important ambition in the project is the use of renewable energy and protection of ecology. The contract includes reinforcing the dike, increasing water drainage, improving the road surface, replacing and widening bridges and locks. In addition to design and construction, the contract includes 20 years of maintenance.

Case 3 Project A16 Rotterdam

The purpose of the A16 project is to improve accessibility and livability in the northeastern part of Rotterdam. To achieve this goal, ground walls, a semi-sunken tunnel through the Lage Bergse Bos, noise barriers and noise-reducing asphalt will be built. This will make the energy-neutral A16 Rotterdam one of the best fitted national highways in the Netherlands. In addition to design and construction, the contract includes 20 years of maintenance.

4.3 Results case 1: construction of blankenburgverbinding

No sustainability requirements were set for the suitability and selection criteria. In order to challenge the market players and provide an extra incentive to sustainability, two performance criteria were included: Environmental Cost and the CO2 performance ladder. The environmental cost indicator (ECI) value offered will be converted into a fixed requirement in the contract. The CO2 performance ladder certificate must be delivered at the start of work. The Blankenburg contract was drawn up in 2015, approved in 2016 with construction starting in 2018. Contracts are often written with a particular task in mind, but the task can change over time. The project team finds it important to deliver a project that is not outdated:

> *Contracts are set up for a particular task, although this task can change over time. We want to deliver a state-of-the-art project that is not completely specified at the start. The project must not be obsolete upon delivery* (Project manager).

From this motivation, the possibility of making the tunnels in the route energy-neutral is being examined. The construction of a solar park is being investigated in the immediate vicinity. In addition, additional budget (subsidy) has been requested by the sustainability consultant (Sustainability Consultant, BBV). This sustainability budget will be used to examine whether additional sustainability requirements can be applied. The sustainability budget is mainly used so that the contractor will use more electric equipment, the additional costs being paid by Rijkswaterstaat.

> *The contractor is using the sustainability budget for making energy-neutral tunnels and including more electric equipment. Additional costs are paid by the client organization, as agreed in the contract* (Contract manager).

4.4 Results case 2: Project Afsluitdijk

The tender for the Afsluitdijk project did not set sustainability requirements for eligibility and selection criteria. In fact, the size of the project was such that the project knew that the parties who would tender had much knowledge in the field of sustainability. The strategy was to challenge the market to build an energy-neutral dike. The focus was on the energy-neutral dike, but social return was also an important part of the award criteria. Tenderers were challenged to write a social return approach plan. Performance Criteria Environmental Cost calculation was focused on all quantities of materials to be supplied, removed and/or used in the Work with respect to the object Dikes road.

The strategy to approach the market resulted in the following award criteria: Risk and opportunity plan, sustainability plan with sub-criteria: energy dike plan, social return plan, CO2 performance ladder and the performance criteria environmental cost (PCE). The offered CO2 ambition level and PCE will be converted into hard contract requirements at profit tender. The energy dike plan and the social return plan will be translated into the project management plan and the preliminary design after being awarded. This makes it more difficult to test. The award criteria are thus part of a larger whole and cannot always be tested individually.

The combination Levvel won the tender. Levvel designed Levvel blocks which are used as dike revetment. Due to the smart design, 200,000 M3 less concrete is needed than when traditional dike revetment is used. This is a saving of 40,000 tons of CO2 (a 56% reduction). To avoid having to transport the 75 thousand Levvel blocks over long distances, a temporary concrete plant was built next to the project, resulting in (much) fewer emissions. In doing so, the contractor fulfilled the EQI, among other things. During realisation, further research into the offered Levvelblocks was carried out by means of a living lab. The trial garden was initiated by the project itself and was not an initiative by the contractor

The sustainability plan and the social return plan were converted into specific requirements in the project management plan. Among other things, the building of spuds, the construction of a solar park, and the creation of around 100 placements for people covered by the sheltered employment act have been converted into requirements. These requirements are tested with a system of targeted contract management. The CO2 performance ladder was successfully tested at the start of construction The contractor demonstrates each year that the CO2 ambition level was met and certified. So far, the contractor has always successfully demonstrated this in accordance with the tender. On the basis of validation and verification, Rijkswaterstaat checks whether the environmental cost indicator (ECI) has been achieved. Because the Afsluitdijk project has not yet been completed and delivered, it is not yet possible to make a definitive judgment on whether the environmental cost indicator (ECI) value offered in the tender will be met. However, it was tested and established that the Levvelblocks were applied in accordance with the approved design.

Governance:

The Afsluitdijk became a loss-making project for the contractor and for Rijkswaterstaat. This did not benefit cooperation:

> *The greater the financial pressure, the more exciting the cooperation* (Project Manager, Afsluitdijk).

The total additional cost for the contractor is some €435 million, according to recent estimates. Some of it was reimbursed following a dispute with Rijkswaterstaat, but

some remained at the contractor's expense. Due to previous loss-making projects and the huge additional costs on the Afsluitdijk project, the party BAM (part of the combination of contractors) is at risk of bankruptcy. This has caused a shift in the market. Due to the high financial risks a contractor faces on a large project like the Afsluitdijk and the likelihood of a loss-making project, fewer and fewer contractors want to do projects over 250 million.

4.5 Results case 3: Project A16

The highway A16 improves accessibility and livability in the north-eastern part of Rotterdam and the surrounding regions. The project team aims to ensure that the A16 fits in well with its surroundings. The project also has the ambition to work sustainably and promote noise reduction. Besides the construction of the A16, the contract includes 20 years of maintenance.

The main objective of the project was to increase the accessibility of the ring road and the livability of the area north of Rotterdam. From the aspect of livability, the objective of sustainability was brought into the project. The project team indicated that sustainability was important to them.

> *We wanted to do more than was usual at the time* (Procurement consultant, A16).

Energy consumption played an important role in this. Tunnels use much energy. To reduce costs, the project team chose to split the standard environmental cost indicator (ECI) award criteria into material use and energy consumption. This is a departure from Rijkswaterstaat's standard policy. The project did not choose to make sustainability part of the suitability requirements and selection criteria. This is because the suitability requirements and selection criteria are requirements in terms of organisation (suitability requirements) and previous experience (selection criteria). Sustainability requirements were therefore not proportionate to be included in the suitability requirements and selection criteria. During the tender, the contractor offered an EMAE (economically most advantageous execution) as part of the award criteria. The EMAE consists of a pot of money available to both the project team and the contractor.

> *The project team and the contractor can take initiatives during project realization to contribute to project objectives, such as sustainability. About one-third of the budget is set aside for sustainability. During the realization of the project we can spend it on additional sustainability initiatives* (Procurement consultant, A16).

In the period after the contract was awarded, Rijkswaterstaat's policy changed and the goal was set to be emission-free by 2030. The A16 project was asked to contribute ideas on how to reduce CO2 emissions, together with the contractor, we looked at whether this was possible. The result was that it was possible by using HVO fuel, among other things:

> *HVO fuel is a particular type of fuel that reduces CO2 by 90%* (Contract manager, A16).

This made the project a pilot project in the field of emission-free construction. The additional costs incurred for this by the contractor were mainly reimbursed by subsidies and the use of the EMAE.

Green Bow's winning combination. The Green Arc has offered a motorway with tunnel that runs entirely on direct current and is energy-neutral. This will make the A16 Rotterdam the first energy-neutral motorway with tunnel in the world. With this design, the tenderer meets the award criteria of sustainability, noise pollution and EQI. On the award criterion 'positive experience', the contractor offered 50 FTE social return, while the project did not ask for this. The project team 'didn't dare' make any demands on this.

> *Because you notice that at the time of the tender we did not get clarity within the team about what exactly we wanted with it* (Contract manager, A16).

The CO2 performance ladder was successfully tested at the start of construction The contractor demonstrates each year with certificates that the CO2 ambition level has been achieved. So far, the contractor has always successfully demonstrated this. The contractor reports the achieved value of the EQI every quarter. Based on validation and verification, he then checks whether the environmental cost indicator (ECI) has been achieved. Because the A16 Rotterdam project has not yet been completed and delivered, it is not yet possible to make a final assessment of whether the EQI value offered in the tender will be achieved. The contract manager has indicated that the EQI value is well on track.

Governance:

During tender preparation, the project had a desire to project sustainability and act sustainably. To achieve this, sustainability was focused on during the tender and much attention was paid to the Most economically advantageous tender.

4.6 Cross case analysis

The cases examined show that no selection or suitability requirements were applied in terms of sustainability. The performance criteria CO2 performance ladder and environmental cost (EQI) were used. In all three cases, the winning tenderer achieved the highest level of EQI and the highest ambition on the CO2 performance ladder. In addition, the Afsluitdijk and A16 project cases chose to use the award criteria to ask for more sustainability and to challenge market players to come up with a sustainable and innovative design. Both the Afsluitdijk project and the A16 project received sustainable and innovative tenders. Both projects were offered energy-neutral designs that save and generate energy in a smart way. The remaining energy required is generated by solar parks. The Afsluitdijk project had asked for a social return plan by award criteria, the A16 project had not, but the contractor offered it under a general theme. This solution was welcomed by the client. The Blankenburgverbinding project did not do anything with social return.

Remarkably, contractors were able to achieve additional sustainability during project implementation. The Blankenburgverbinding project developed from a 'normal' tunnel into an energy-neutral tunnel during realisation, with a solar park, in addition to which more and more electric equipment and equipment running on HVO fuel was used. In the other cases, the original design was already based on an energy-neutral final situation, with a focus on low consumption. In these cases, during realisation, much effort was put into further developing the sustainability of the current design and additional deployment of electric vehicles and equipment on HVO fuel. For monitoring award criteria, it is important to distinguish between performance criteria and award criteria. Performance criteria are easily measurable. The CO2 performance ladder is

tested before realization begins. This test is repeated every year. In all three cases, the contractor has demonstrated that the CO2 ambition levels are met. The environmental costs (EQI) are reported monthly and are tested by validation and verification. During the realization of the projects, the environmental costs (EQI) were closely monitored, although it was not established if the contractor met the environmental costs until project delivery. If the contractor has exceeded the offered environmental costs, a penalty can be given, depending on the amount of the excess. The award criteria are tested by system-oriented contract management (SCB). SCB is risk-driven and is based on the contractor's quality system. The relationship between the contracting authority and the contractor is considered important in monitoring and enforcing the contract, which is why high emphasis is placed on relationship management. Award criteria are more difficult to test individually because they are often part of the design. As a result, the entire design is often tested and evaluated. The final requirements test is done when the project is delivered. At that time, all requirements are reviewed for compliance. Interim results are not shared due to corporate confidentiality.

During the preparation, the Blankenburgverbinding project had the ambition to become a sustainability pilot project and ask for more sustainability. The board/ministry stopped this, stating that the task facing the project team is complex enough. During realization, the Afsluitdijk project came into discussion with the contractor about the hydraulic boundary condition. Due to an error by the project, the contract value was increased by 238 million euros. This discussion put pressure on the cooperation between the project and the contractor. Even though the project was allowed additional costs, the project remains loss-making for the contractor. So loss-making that if the contract value had not been increased there was a chance that BAM would have gone bankrupt. The situation with the Afsluitdijk and previous projects such as the Zee toegang IJmond has made market parties decide not to take on projects with a value of 250 million or more, because the financial risks are very high. This decision may have a major impact on the work of Rijkswaterstaat.

Table 4 provides systematic insight into the results of the cross-case analysis. The horizontal row names the cases. The vertical column represents variables and important aspects from the study. The table aims to provide a systematic and structured analysis of the data, which contributes to a comparative interpretation of the results.

Table 4. Results and insights from the cross-case analysis.

Regarding sustainability	Case 1 Blankenburgverbinding	Case 2 Afsluitdijk	Case 3 A16 Rotterdam
Project objective	Promote attractive business climate, pleasant living environment and good incorporation.	Strengthen and renew Afsluitdijk in a sustainable and ecological manner.	Increase livability Rotterdam. Ambition to reduce nuisance and promote sustainability.
Eligibility requirements and selection criteria in procurement	No selection requirements and eligibility criteria in the tender.	No selection requirements and eligibility criteria in the tender.	No selection requirements and eligibility criteria in the tender.
Performance criteria in the contract	Environmental cost indicator (ECI) and CO2 performance ladder	Environmental cost indicator (ECI) and CO2 performance ladder	Environmental cost indicator (ECI) and CO2 performance ladder divided into energy and material

Table 4. Continued...

Regarding sustainability	Case 1 Blankenburgverbinding	Case 2 Afsluitdijk	Case 3 A16 Rotterdam
Award criteria	None	- Plan energy dike aimed at making the Afsluitdijk energy neutral.	- Energy-neutral highway with tunnel on direct current (first in the world).
		- Social return	- Social return
Offering winning bid	No additional sustainability and social return offered	- Energy-neutral dike	- First DC-powered energy-neutral highway with tunnel in the world.
		- Low emissions during construction of dike due to Levvelblocks, among other things	- 50 fté social return
		- 100 fté social return	- EMAE
Additional sustainability	- Realize tunnel energy-neutral through solar park.	Testing ground to make Levvelblocks more sustainable	Emission-free construction site by deploying additional electric equipment and applying HVO fuel.
	- Deployment of electric equipment		
Monitoring contract	- CO2 performance ladder: successfully tested at start of contract. Reassessed each year	- CO2 performance ladder was successfully tested at the start of realization. This is done again every year.	- CO2 performance ladder: successfully tested at start of contract. Reassessed each year
	- environmental cost indicator (ECI), tested with reporting contractor. Testing by validation and verification.	- environmental cost indicator (ECI) validation and verification every quarter with a monitor.	- Environmental cost indicator (ECI), tested by reporting contractor. Testing by validation and verification.
		The energy dike plan is included in the design and the social return plan is included in the project management plan and are tested by contract management.	- Annoyance reduction plan is included in the project management plan.
			- Sustainability plan is included in the design.
Contract enforcement	To date, the contractor has successfully achieved the offered CO2 performance level and EQI. Final testing will take place upon project delivery.	- The design of the Levvelblocks were reviewed and found to be good.	- So far, the contractor has successfully demonstrated meeting the offered CO2 ambition level and Environmental cost indicator (ECI), .
		- A discussion of the hydraulic boundary condition led to an increase of 238 million euros in the contract.	- The energy-neutral tunnel and highway is tested by system-oriented contract management.
	Interim results will not be shared due to corporate confidentiality.	- Final testing of requirements will be done upon completion. Interim results are not shared due to corporate confidentiality	AMEA is tested and settled per offer.
Governance	Reticence on the part of the board regarding sustainability. The project team's desire to become a sustainability pilot project was not honored by the board.	The Afsluitdijk is a loss-making project for the contractor. Because of the high risks, contractors are now unwilling to bid on projects worth more than €250 million.	A major shared focus on sustainability.

5 Discussion

Public procurement is generally seen as an effective tool to encourage both public and private organizations to work sustainably, provided that emphasis is placed on it (Halonen, 2021; Lingegård et al., 2021). Our investigation shows that in terms of contract suitability and selection there were actually no sustainability requirements imposed. In the awarding process, we see a very different picture. The CO2 performance ladder and control of environmental costs play an important role in the awarding process. There is also varying attention to Social Return and the use of certain materials. The winning bidders submitted extensive sustainability plans with an innovative character, such as an energy neutral Afsluitdijk, and an energy neutral tunnel (Blankenburg). It appears that both sustainability and innovation can be stimulated when emphasized together. Our study shows the willingness of contractors to embrace sustainability. However, sustainability was not the salient criteria when the contracts were first awarded; rather, sustainability emerged during the life of the contract. In one of our cases (Blankenburg) the contractor was more enthusiastic and ambitious about it than the public authority (Rijkswaterstaat). In another case (Afsluitdijk) the inclusion of many additional requirements led to the near bankruptcy of the main contractor (BAM), with ensuing litigation. In the third case (A16) the sustainability goals of both sides matched closely. When the public procurer seeks innovation from the market, it seems desirable to award on the basis of best value for money (Sloots et al., 2022). These long term projects have yet to reach their end date, hence it is unclear whether the sustainability requirements are being met; the yearly reports on environmental costs (EQI) paint a positive picture of the outcome.

Contracts evolve during the term and contractual flexibility is important. Collaboration appears to be a key driver of performance and innovation (Koppenjan et al., 2022). The contract can play an important role in delivering significantly higher value (De Neufville & Scholtes, 2011). Introducing flexibility in contracts can lead to better integration of the commercial, personal and business relationships that are important in contract management (Nuottila et al., 2015). Our interviews revealed that contractual flexibility is important to continue meeting the moving and changing sustainability goals during project implementation. Our results are in line with studies examining relationships and contractual flexibility between public client and private contractors in the infrastructure sector (e.g. Zhang & Xi, 2023; Domingues et al., 2014; Song et al., 2021). Our results confirm the main finding of Tian et al. (2022), i.e. that contractual flexibility has a positive impact on sustainability performance.

In all three cases contract monitoring relied on building and maintaining strong relationships between the parties. Cooperation, open communication, trust, flexibility, adaptability and continuous improvement are important pillars. These findings are consistent with relational contract theory (Coleman et al., 2020; Nwajei, 2021). In cases 1 and 3 (Blankenburg and A16) these shared values resulted in satisfaction with the negotiated contracts and their evolvement over time. In case 2 (Afsluitdijk) it also caused major financial losses for the main contractor.

6 Conclusions and recommendations

Our findings show that contracts evolve over time, contractual flexibility being key to making public projects successful. Sustainability appears to be an important award criterion, encouraging tenderers to submit innovative and sustainable bids. Contract

management plays an important role in monitoring progress and compliance with sustainability requirements during project implementation. Our first contribution concerns an addition and refinement of the existing theory in which an emphasis on sustainability is crucial in procurement. Our second contribution focuses on the “blind spot” in our knowledge about the importance of contractual flexibility on sustainability in contracts. Our third contribution addresses the role of relational contract management on sustainability requirements in contracts. Overall, the conclusion seems justified that paying attention to sustainability requirements in the tendering phase has a positive effect. Contractors can be encouraged to develop sustainable solutions that reduce the impact of projects on the environment.

6.1 Recommendations

1. In the cases studied, sustainability was always part of the tender. However, not in every case was sustainability emphasized equally. Contractors will be encouraged to offer sustainable solutions if the tender explicitly includes and values sustainability requirements in the award criteria.
2. Contract flexibility is important. Contracts are made for large projects at an early stage as innovative developments are piling up. Using a rigid contract in which it is not possible to scale up or extend sustainability does not do contribute or stimulate innovation and sustainability. Opt for a contract where sustainability can be scaled up or expanded, so that the contracts continue to encourage the contractor to work sustainably.
3. Relational contract management should be made an important part of contract management.

The interviews indicate that building and maintaining strong relationships between the contracting parties is important to a successful project and crucial to applying contractual flexibility.

4. Social return. The study shows that social return is handled differently for each project and that respondents were unsure how to handle it. It is important that social return is included in public tenders

At the start of the study, the thought was that respondents could be more open about the current status of sustainability requirements in the contract. During the interviews, this turned out to be different than expected. Because the projects had not yet been delivered, it was not yet possible to make a “final judgment” as to whether the sustainability requirements had been met. However, it was possible to obtain an intermediate judgement on environmental costs (EQI) because the environmental costs are reported periodically. It is therefore important that further research is conducted on infrastructural projects that have been completed and delivered on the results of the sustainability requirements in the contract and to what extent the sustainability requirements have been implemented.

The study has several methodological limitations. For example, the study was conducted at a single organization in the civil engineering sector. In addition, the projects studied had the same tendering procedure and contract form. Finally, projects used for the study are very large in size and icons in the field. As a result, the results cannot be generalized to other public tenders. After all, tenders in the field of works are different from tenders in the field of hiring, services or supplies. Multiple case studies over time may give interesting insights in changing contexts. Quantitative analysis

methods can contribute to the persuasiveness of the results of research into the use and effectiveness of sustainable requirements in public work contracts.

The results of this study also provide grounds for further research. Contractual flexibility emerged as an important factor in achieving sustainability. The question, however, is how and under what conditions this effect exists. Future studies can also further investigate the distinction and interaction between content flexibility (in contracts) and executing flexibility. The construction industry simply works with long-term projects and incomplete contracts, which leads to a tension between achieving sustainability goals and potential opportunistic behavior of contractors.

Statement on Data Availability

Data are available after publication of the paper (on request).

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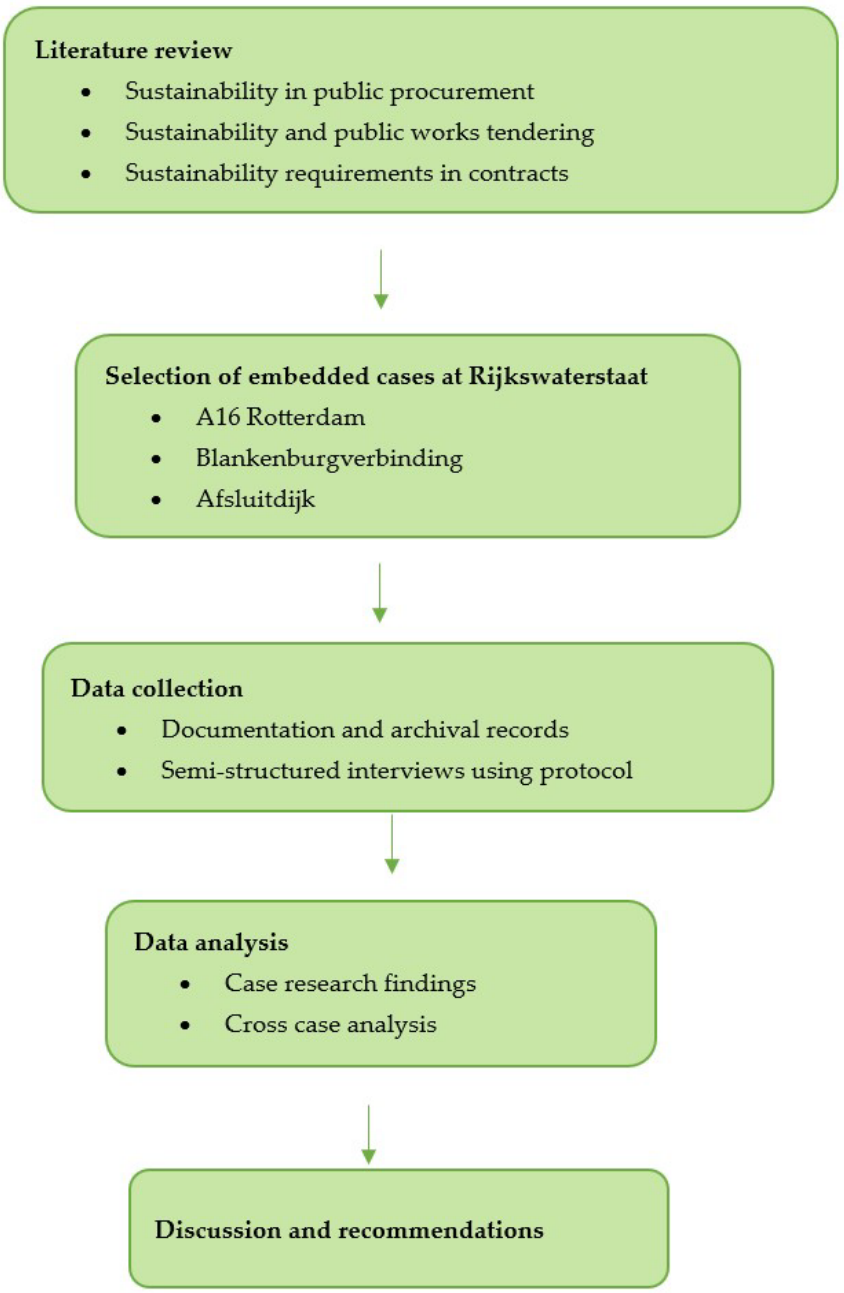
Authors contribution

Each author had significant contribution to this project and authorship is limited to the mentioned researchers. Each authors individual contribution: Mart-Jan Roos (collecting data/investigation, data curation, formal analysis, resources, writing original draft preparation, validation, visualization), Cees Johannes Gelderman (conceptualization, formal analysis, methodology, project administration, supervision, reviewing and editing), Janjaap Semeijn (conceptualization, formal analysis, methodology, project administration, supervision, reviewing).

Appendix 1. Methodology flow chart.

This flowchart illustrates the steps for collecting and analyzing data for the three specific projects at Rijkswaterstaat.



Appendix 2. DBFM-contracts from 2003 to 2020.

Project Name	Type	Contract close/financial close	Contract duration	Value in millions of euros
N31 Wäldwei	Road	2003	15 year	<100
A59 Den Bosch- Oss/ Rosmalen - Geffen	Road	2003	15 year	100 – 250
Tweede Coentunnel	Road, Tunnel	2008	25 year	>500
A12 Lunetten-Veenendaal	Road	2010	20	250 – 500
A15 Maasvlakte Vaanplein	Road	2015	20 years	> 500
SAA: A1/A6	Road	2012-2013	25 years	> 500
N33 Assen - Zuidbroek	Road	2012	20 years	100 – 250
A12 VEG	Road	2014	16 years	<100
Keersluis Limmel	Water	2014/2015	30 years	<100
SAA: A9 Gaasperdammerweg	Road & Tunnel	2014	20 years	>500
Lekkanaal/Derde Kolk Beatrixsluis	Water	2016	27 years	100 – 250
Zeetoegang IJmond	Water	2015	26 years	> 500
SAA: A6 Almere	Road	2020	20 years	100 – 250
A27/A1	Road	2016	25 years	100 – 250
N18 Varsseveld Enschede	Road	2016	25 years	100 – 250
Sluis bij Eefde	Water	2016/2017	27 years	< 100
A24 Rotterdam (Blankenburgverbinding)	Road & Tunnel	2017/2018	20 years	< 500
A16 Rotterdam	Road & Tunnel	2018	20 years	< 500
HWS Afsluitdijk	Water	2018	25 years	> 500
SAA: A9 Badhoeve-dorp - Holendrecht	Road	2019	14 years	> 500
ViA15	Road	2020	20 years	> 500

Appendix 3. Key concepts and their operationalization.

Theoretical concept	Definition	Dimension	Indicators (measurements)	Sources
Environmental sustainability	Meet the needs of the present without compromising the ability of future generations to meet their own needs	Key performance indicators (KPI)	- Emissions (CO2)	United Nations General Assembly (1987), Grandia (2016), Cheng et al. (2018)
			- particulate matter emissions	
			- energy consumption	
			- environmentally conscious product process	
			- percent sustainability (recycled) material.	
Sustainability requirements	Contractual requirements to be met by the Contractor.	Requirement	- emissions (CO2)	United Nations General Assembly (1987), Grandia (2016), Cheng et al. (2018)
		- Measurable	- particulate matter emissions	
		- Specific	- energy consumption	
		- System-oriented contract management	- environmentally conscious product process	
			- percentage of sustainability (recycled) material.	
Contract management	Overseeing, enforcing, coordinating and collaborating. With the goal of minimizing opportunism and protecting investments	- Supervision	System oriented contract management (SOCM)	Schepker et al. (2014)
		- Enforcement		
		- Coordination		
Eligibility Requirements	Test criteria by which the procurer tests the tenderer's suitability to perform the contract.	Review	- Requirements for technical and professional competence.	Sloots et al. (2022)
			- requirements to demonstrate financial and economic standing.	
			- requirements for professional competence.	
Selection criteria	Distinctive criteria that further limit the number of applicants.	Measurable	- Criteria to technical and professional competence	Sloots et al. (2022)
			- criteria to demonstrate financial and economic standing	
			- criteria on professional competence.	
Award criteria	Distinctive criteria aimed at contracting the party that submitted the most economically advantageous bid (MEAT).	- Quality versus price	- Quality	Sloots et al. (2022)
			- Sustainability	
		- Investment	- Risks	