# The Cost of Honest Competition: Analyzing Public Tendering for Non-Residential Facilities

An Academic Perspective on the Current System of Public Tendering Procedures using Game Theory Analysis

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# Preface

Before you lies the master thesis “The Cost of Honest Competition: Analyzing Public Tendering for Non-Residential Facilities.” With this thesis, the requirements for the master’s degree in Construction Management & Engineering at the Eindhoven University of Technology have been met. This research introduces the cost of honest competition as a way to view economic waste in public tendering.

At the start of my masters, I took a course simulating a tender for the construction of a high-rise building in the center of Rotterdam. During my bachelor’s studies, I had grown used to archiving each project after completion, and rarely looking back much. But when the winner of that simulation was announced – and it wasn’t our team – it stung a little. To close the book on a project we had genuinely hoped to win felt unexpectedly disappointing.

While winning or losing had no real consequences in that setting, that moment stuck with me and sparked two questions: “Is this really the way most efficient way to divide public work?,” and “how much money actually goes into trying to win a tender?” The former question I do not know the answer to (yet); the answer on the latter is presented to you, the reader, in this thesis.

I would first like to thank Willem van Dijk, who was instrumental in helping me frame and structure this research and played a key role in setting up this graduation project at Heijmans.

Secondly, I have to thank Néomie Raassens for her contribution to composing the proposal and thesis, in addition to the readability of this thesis with her many very useful comments (some of the most prevalent being: “Why?”, “How?”, and “What do you mean?”). It helped me stay focused on the research.

Thirdly, I would also like to thank Qi Han, as chair of my graduation committee for her feedback on my work, and helping me with what is and isn’t game theory.

I would also like to thank Rob Janssens, who has been very helpful with practical insights into tendering, explaining how things usually work, and ensuring a very important question is always asked: “Can you make a figure for that?” Although Rob would probably like to see my thesis being one large infographic, I hope it contains enough visuals for your liking!

Thank you to everyone at Heijmans Verwerving & Advies for the warm welcome and the many enjoyable days at the office!

I would like to thank my partner Jennifer, who helped me greatly in academically setting up this research, and I would like to thank my friends and family (especially my parents) for the support and relaxation during the graduation project.

Thanks to everyone who supported me during this journey! Here is the result.

Philip Canoy
Best, June 2025

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# Summary

This graduation project investigates the inefficiencies in the Dutch public tendering system for (semi-)public non-residential buildings. Although public procurement is designed to ensure fairness, transparency, and equal competition, the current system leads to a significant amount of capacity and cost being spent on unsuccessful bids. Contractors invest heavily in tenders they may not win, and these sunk costs are not (sufficiently) compensated. These costs represent a collective burden that affects the overall efficiency of the construction sector. This research aims to analyze and quantify these inefficiencies using game theory, introducing the **cost of honest competition**.

**Framing the Challenge: Inefficiencies in Tendering**
Dutch procurement law (Aanbestedingswet) implements EU directives and mandates public tendering for government-funded construction projects above a certain threshold (5.5 million euros). Procedures must adhere to principles such as transparency, equal treatment, competition, and proportionality. The underlying goal is to stimulate creativity, prevent favoritism, and ensure that the most economically advantageous proposal is selected in an open and transparent way.
However, despite these positive intentions, the practical implementation of public tendering causes inefficiencies. Contractors often invest substantial time, money, and human capacity into tender submissions without any guarantee of return. Since only one party can win a tender, all other participants end up with unrewarded and non-refundable expenses. These sunk costs do not disappear; they are either absorbed by the contractors, or reflected in higher bid prices in future tenders.
Given labor shortages, and desire to build quickly, current public procurement practices result in sector-wide economic inefficiencies. The collective effect of these inefficiencies often stays under the surface, as the tendering system appears to function "as intended" in terms of fairness and legal compliance.
The main goal of this research is to quantify that which can be referred to as the cost of honest competition – in other words, the collective and cumulative sunk costs incurred by losing bidders ((sub-)contractors) and the contracting authority in a single tender procedure. By modeling this system using game theory, the project provides a structured analysis of how different actors behave during the tendering process and how their individual choices affect the total cost of acquiring a contract from a broader societal perspective.

The following research question, as well as sub-questions guide this thesis:
*How do collective costs contribute to the economic inefficiencies in the Dutch tendering process for (semi-)public non-residential buildings, and how can game theory be applied to quantify these inefficiencies?*

*How does the judicial and regulatory context guide the tendering process and influence inefficiencies?*
*What are the key steps in the Dutch tendering process, and how do these steps contribute to collective costs?*
*In what way can game theory be used to model and quantify these inefficiencies?*

**Determining the Cost of Honest Competition**
The research was conducted in three phases. First, a literature review was conducted to understand the foundations of procurement law and game theory. Key procurement

law principles—such as transparency, equal treatment, and competition—were reviewed alongside game theory concepts like Nash equilibrium, Pareto efficiency, and decision trees. Additionally, the different procurement procedures were mapped using BPMN (Business Process Model and Notation) diagrams to provide a clear visual overview of key decision points and outcomes.
Next, seven tenders were analyzed in depth using internal documentation from a major Dutch contractor. These cases were selected based on project size (greater than €20 million), contract type (DB or DBM), and the availability of detailed data on time investments and cost breakdowns. In addition, semi-structured interviews were held with key stakeholders in the sector: one representative from a contracting authority, one general contractor, and five subcontractors. These interviews served to validate the assumptions around cost structures, internal decision-making, and perceived risks in the tendering phase.

Based on the collected data and process maps, a sequential game theory model was developed. This model simulates the restricted procedure – by far the most commonly used tendering method in this market segment. The model incorporates real-world data on costs, decision-making preferences, and probabilistic outcomes. Contractors in the model must decide whether or not to participate, and contracting authorities must define selection and award criteria. Each decision leads to a cost, depending on the outcome of the game. The model concludes that the cost of honest competition is around 4.2% of the total contract price, increasing by ~1.3% for each additional non-winning bidder.

**Implications**
This research makes the collective economic cost of fairness in public tendering visible and quantifiable. Although equal access is an essential principle of procurement law, this thesis shows that the resulting competition, whilst legally compliant, can be economically suboptimal when viewed as a system. The collective cost of tenders, especially those lost, places an invisible but persistent financial burden on the sector. Applying game theory to this setting allows these effects to be modeled and understood in a structured way. The findings suggest that relatively modest adjustments to the current system, limiting the number of competitors, could reduce inefficiencies.

**Limitations and Further Research**
The research is limited to restricted procedures for non-residential construction and models only one contractor per tender. Open, negotiated, or design contests were not included, nor were infrastructure or residential projects. Additionally, access to internal company data was constrained by confidentiality, limiting the depth of financial insights. Future research could expand the model to other types of procedures, compare international compensation practices, or explore long-term behavioral shifts in contractor strategy due to structural tender losses.

**Conclusion**
Tendering remains crucial to transparent and fair public spending. However, this thesis shows that it also introduces hidden costs that cannot be ignored. By analyzing these inefficiencies through the lens of game theory, this research provides a basis for discussing more balanced procurement strategies that combine fairness with economic efficiency.

# Samenvatting

Dit afstudeeronderzoek richt zich op de inefficiënties binnen het Nederlandse aanbestedingssysteem voor (semi-)publieke utiliteitsbouw. Hoewel publieke aanbestedingen zijn ontworpen om eerlijkheid, transparantie en gelijke concurrentie te waarborgen, leidt het huidige systeem ertoe dat aanzienlijke hoeveelheden capaciteit en kosten worden besteed aan niet-winnende inschrijvingen. Aannemers investeren fors in aanbestedingen die zij mogelijk niet winnen, en deze gemaakte kosten worden niet (voldoende) gecompenseerd. Deze kosten vormen een collectieve last die de algehele efficiëntie van de bouwsector beïnvloedt. Dit onderzoek heeft als doel deze inefficiënties te analyseren en te kwantificeren met behulp van speltheorie, waarbij het begrip **prijs van eerlijke concurrentie** wordt geïntroduceerd.

**Probleemstelling: Inefficiënties in het Aanbestedingsproces**
De Aanbestedingswet implementeert Europese richtlijnen en verplicht openbare aanbestedingen voor bouwprojecten gefinancierd door publieke middelen. Het onderliggende doel is het stimuleren van creativiteit, het voorkomen van vriendjespolitiek en het waarborgen dat het economisch meest voordelige voorstel op een open en transparante wijze wordt geselecteerd.
Ondanks deze positieve bedoelingen leidt de praktische uitvoering van publieke aanbestedingen tot inefficiënties. Aannemers investeren vaak veel tijd, geld en menskracht in inschrijvingen zonder enige garantie op succes. Slechts één partij kan de opdracht winnen, en alle andere deelnemers blijven enkel achter met verzonken kosten. Deze verzonken kosten verdwijnen niet; ze worden óf geabsorbeerd door de aannemers, óf weerspiegeld in hogere biedprijzen bij toekomstige aanbestedingen. Gezien het tekort aan arbeidskrachten en de wens om snel te bouwen, leiden de huidige aanbestedingspraktijken tot economische verspilling op sectorniveau. Het collectieve effect van deze inefficiënties blijft vaak onder de radar, omdat het systeem juridisch gezien "functioneert zoals bedoeld".
Het hoofddoel van dit onderzoek is het kwantificeren van wat kan worden omschreven als de prijs van eerlijke concurrentie – oftewel de verzamelingen van verzonken kosten die worden gemaakt door verliezende inschrijvers ((onder-)aannemers) en de aanbestedende dienst in één enkele aanbestedingsprocedure. Door dit systeem te modelleren met speltheorie biedt dit project een gestructureerde analyse van hoe verschillende acteurs (aannemer, en aanbestedende dienst) zich gedragen tijdens het aanbestedingsproces, en hoe hun individuele keuzes de totale maatschappelijke kosten beïnvloeden.

De volgende hoofdvraag, net als de volgende sub-vragen, staan centraal in dit onderzoek:
*Hoe dragen collectieve kosten bij aan de economische inefficiënties in het Nederlandse aanbestedingsproces voor (semi-)publieke utiliteitsbouw, en hoe kan speltheorie worden toegepast om deze inefficiënties te kwantificeren.*

*Hoe beïnvloedt het juridische en regelgevende kader het aanbestedingsproces en de bijbehorende inefficiënties?*
*Wat zijn de belangrijkste stappen in het Nederlandse aanbestedingsproces, en hoe dragen deze bij aan collectieve kosten?*
*Op welke manier kan speltheorie worden gebruikt om deze inefficiënties te modelleren en kwantificeren?*

**Het Bepalen van de Prijs van Eerlijke Concurrentie**
Het onderzoek werd uitgevoerd in drie fasen. In de eerste fase is een literatuurstudie uitgevoerd om inzicht te krijgen in de fundamenten van aanbestedingsrecht en speltheorie.
Daarnaast werden de verschillende aanbestedingsprocedures in kaart gebracht met behulp van BPMN-diagrammen (*Business Process Model and Notation*), om een helder visueel overzicht te geven van belangrijke beslismomenten en uitkomsten.
In fase twee zijn zeven aanbestedingen (>€20 miljoen; met als vervolg een DB(M)-contract) geanalyseerd aan de hand van interne documentatie van een grote Nederlandse aannemer. Aanvullend zijn semigestructureerd interviews gehouden met een opdrachtgever, een hoofdaannemer en vijf onderaannemers. Deze dienden ter verificatie van aannames over kosten, keuzes en risico's tijdens het proces.
Op basis van deze gegevens is in de derde fase een speltheorie model ontwikkeld. Dit model simuleert de niet-openbare procedure, inclusief keuzes, kosten en verwachte uitkomsten. De conclusie van het model is dat de kosten van eerlijke concurrentie ongeveer 4,2% van de totale aanneemsom bedragen, met een toename van ongeveer 1,3% voor elke extra niet-winnende inschrijver.

**Implicaties**
Dit onderzoek maakt de collectieve economische kosten van eerlijkheid in publieke aanbestedingen zichtbaar en kwantificeerbaar. Hoewel gelijke toegang een essentieel principe is binnen het aanbestedingsrecht, laat deze thesis zien dat de daaruit voortvloeiende concurrentie, hoewel juridisch correct, economisch suboptimaal kan zijn. De collectieve kosten van aanbestedingen, vooral de verloren aanbestedingen, vormen een onzichtbare maar structurele financiële last voor de bouwsector.
Door speltheorie toe te passen, worden deze effecten inzichtelijk gemaakt op een manier die anders moeilijk te onderbouwen is. De bevindingen suggereren dat relatief kleine aanpassingen aan het systeem, zoals het beperken van het aantal concurrenten, kunnen bijdragen aan een efficiënter systeem.

**Beperkingen en Vervolgonderzoek**
Het onderzoek beperkt zich tot de beperkte procedure binnen de utiliteitsbouw en modelleert slechts één aannemer per aanbesteding. Andere vormen zoals openbare procedures, onderhandse aanbestedingen of prijsvragen zijn niet opgenomen, evenals infrastructuur- of woningbouwprojecten. Daarnaast was de toegang tot interne bedrijfsdata beperkt vanwege vertrouwelijkheid, wat de financiële diepgang beperkte.
Toekomstig onderzoek zou het model kunnen uitbreiden naar andere procedures en die kunnen vergelijken. Ook is het mogelijk om de langetermijneffecten van structurele aanbestedingsverliezen op het strategisch gedrag van aannemers te onderzoeken.

**Conclusie**
Aanbesteden blijft essentieel voor een transparante en eerlijke besteding van publieke middelen. Dit onderzoek toont echter aan dat het systeem ook verborgen kosten met zich meebrengt die niet genegeerd mogen worden. Door deze inefficiënties te analyseren met behulp van speltheorie, biedt dit onderzoek een onderbouwde basis voor de discussie over evenwichtigere aanbestedingsstrategieën die eerlijkheid combineren met economische efficiëntie.

# Abstract

Public tendering (of (semi-)public non-residential buildings in the Netherlands) is designed to ensure fairness, transparency, and equal opportunity in the allocation of publicly funded construction contracts. However, this system also leads to economic inefficiencies. Contractors often invest considerable resources in preparing a bid, knowing only one bid can win. The remaining bidders incur unrewarded sunk costs. . These sunk costs do not disappear; they are either absorbed by the contractors, or reflected in higher bid prices in future tenders.
These cumulative losses, in addition to the costs made by the contracting authority in order to set up the tender contribute to what this research defines as the **cost of honest competition**.

This thesis aims to quantify these inefficiencies by modeling the Dutch public procurement system using game theory. The study is structured in three phases: (1) a literature review on procurement law and game theory; (2) qualitative pre-research including a document analysis of seven tender cases (project > €20 million, and DB(M) contract) and interviews with key stakeholders (contracting authorities, general contractors, and subcontractors); and (3) development of a game theory model simulating the restricted procedure – the most prevalent procurement method in the Dutch construction sector.

The model integrates real-world data, including cost estimates and actor decision-making logic. Results show that the cost of honest competition averages approximately 4.2% of the total contract price, with each additional non-winning bidder increasing this cost by roughly 1.3%.
The findings highlight a systemic inefficiency in the current procurement model; while legal principles of fairness and transparency are upheld, they come at a measurable cost to the sector. This insight opens a policy discussion on the balance between open competition and economic efficiency. Modest adjustments, such as reducing the number of invited bidders, could significantly mitigate these losses without compromising legal integrity.

This research shows that fairness in public procurement comes with measurable economic costs. By quantifying these through game theory, this research offers evidence-based insights for policymakers seeking to optimize public tendering.

Keywords: Tendering, Public Procurement, Sunk Costs, Game Theory, Economic Inefficiency

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# List of Abbreviations/Glossary

| | |
|---|---|
| AanbW | Aanbestedingswet<br>(Procurement Law) |
| ARW | Aanbestedingsreglement Werken<br>(Works Procurement Regulations) |
| BPMN | Business Process Model Notation |
| CV | Coefficient of Variation |
| DB | Design & Build |
| DBM | Design Build & Maintain |
| DNR | De Nieuwe Regels<br>(The New Rules) |
| EMVI | Economisch Meest Voordelige Inschrijving<br>(MEAT, most economically advantageous tender) |
| ESPD | European Single Procurement Document |
| EU | European Union |
| KPI | Key performance indicators |
| PEC | Parlementaire enquête commissie<br>(Parliamentary Inquiry Committee) |
| PQ | Pre-qualification |
| R# | Result # |
| SQ | Sub question |
| UAV | Uniforme Administratieve Voorwaarden<br>(Standard administrative conditions) |
| UAV-GC | Uniforme Administratieve Voorwaarden – Geïntegreerd Contract<br>(Standard administrative conditions for integrated contracts) |
| UEA | Uniform Europees Aanbestedingsdocument<br>(European Single Procurement Document) |

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# 1. Framing the Challenge: Inefficiencies in Tendering

This chapter outlines the problem definition (1.1), the research question (1.2) and research approach (1.3). It also explains the motives for undertaking this research are discussed (1.4) and provides a reading guide (1.5) to assist the reader navigate this thesis.

## 1.1. Problem Definition

The current system of public procurement of (semi-)public non-residential buildings *(*utiliteitsgebouwen) in the Netherlands is resource-intensive (Boes & Dorée, 2013). To ensure fairness, tenders are (mostly) publicly advertised, prompting multiple contractors to prepare a bid, explaining why their proposal is the best possible option for the tender. Multiple proposals competing for a single contract results in significant capacity – and therefore cost – lost on unsuccessful bids. This inefficiency does not align with the current labor shortage felt in the construction sector.

Tendering – also called (public) procurement – of construction contracts for non-residential (semi-)public facilities in the Netherlands is mandated by law for all (semi-)governmental bodies relying on public finding and is almost exclusively managed through formal tendering procedures. Figure 01 shows which (semi-)public parties are obligated to legally tender under procurement law. Projects exceeding the threshold value of €5,538,000 (Expertisecentrum Europees Recht, 2023) must be be tendered.

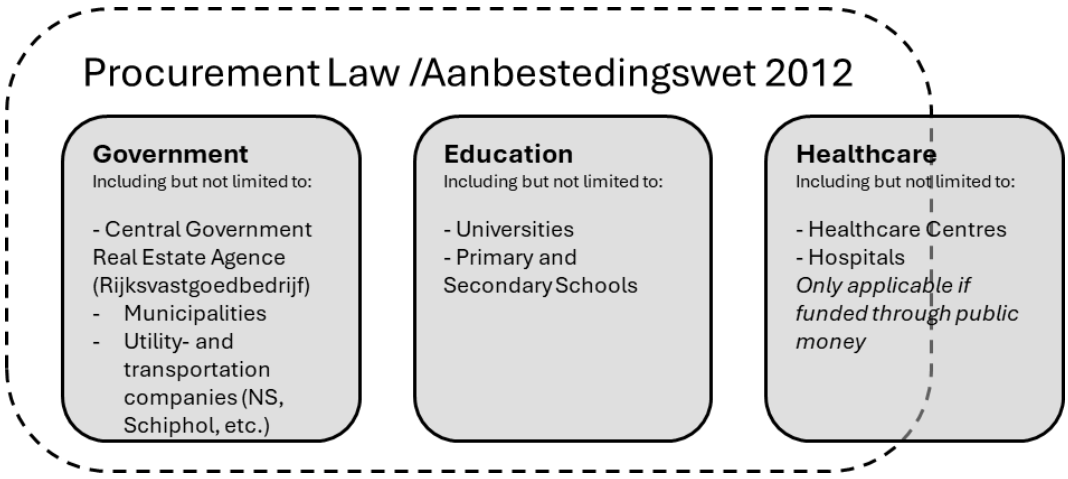


*Figure 01: Parties obligated to follow procurement law*

From the contracting authority's perspective, public tendering is often considered beneficial. It aims to provoke equal and creative competition between private sector parties, unlike direct one-on-one procurement (Hobma & Jong, 2022). Tendering is less susceptible to nepotism (i.e., favoring connections over quality), protectionism (preferential purchasing by governments, i.e., 'buying national' policies) and aims to result in the highest overall value (Heijboer & Telgen, 2002).
Tendering also allows contracting authorities the opportunity to set a precedent within the built environment (Schotanus, 2022). By adopting innovative policies, they can lead an industry-wide chance in the construction sector (Janssen, 2024). Encouraging

innovation through procurement can help achieve policy goals, and address broader societal challenges (Lenderink, Halman, Boes, & Voordijk, 2019)

Actors choose to bid in a tender in order to gain public works. From the perspective of a contractor taking a tender (aannemer), the procurement procedure itself – before any contract is signed – often incurs a high (collective) cost placed on losing bidders. These contractors invest substantial resources without any financial guarantee. As only one bidder is successful, the majority must absorb these sunk costs of losing tenders, which over time can lead to higher bid prices in the future tenders, as tenderers adjust their bids to account for the risk of not covering their investments (Blomgren-Hansen, 2019).

These tender procedures are based on judicial and regulatory frameworks based on Dutch and European directives. These procedures are regulated through procurement law (aanbestedingswet (AanbW, 2012)) and aim to ensure fairness, transparency, and cost-effectiveness in the allocation of a contract (Chao-Duivis, Bruggeman, Koning, & Ubink, 2018).
There are sixteen different forms of procurement procedures that are mentioned in the Aanbestedingsreglement Werken (Works Procurement Regulations (ARW, 2016)). Contracting authorities must use one of the specific award procedures set out in the directive. Common procedures are:

- **Open procedure**
  The contract is openly advertised, and all interested parties have the opportunity to tender, there is no limit to the amount of bidders.
- **Restricted procedure**
  The contract is advertised to invite potential tenderers, a selection of possible tenderers based on pre-qualifications is made to limit the amount of bidders.
- **Competitive dialogue**
  The contract is advertised, and all interested parties can enter the procedure. A selection of tenderers are invited for more dialogue, in which feedback is given on the bid. It is possible to iteratively reduce the number of tenderers.
- **Negotiated procedure**
  The contract can be advertised to a (selection of) tenderer(s) without publication. It can be used if there are no other suitable tenderers, or information is sensitive.

Procurement law also offers guidance for selection of a winning tender. It is possible to select on the lowest price principle, where all requirements have to be met. This approach ensures cost efficiency and transparency. However, contractors may try to minimize costs by providing inadequate work, and the lowest price principle is susceptible to opportunistic behavior with client-contractor relationships (Johnston & Lawrence, 1998). Thus, whilst this may lead to short-term financial gain, it can result in long-term costs due to potential construction issues (Klotz, Horman, Riley, & Bechtel, 2009).
The EMVI award criteria (economisch meest voordelige inschrijving, MEAT, most economically advantageous tender) are selection criteria that integrate factors like price, quality, and sustainability. EMVI weighs all factors and thus encourages bidders to offer possibly creative or innovative solutions, rather than focusing on minimization

of costs. This approach aims to deliver better overall outcomes by considering the quality of the building in addition to the price (Hazen, 2014).

The sequential nature of the client-contractor relationship in tendering and actor-based nature of the tender process lends itself to the use of game theory. Game theory is a framework used to analyze interactions between actors, maximizing outcome in any way. It helps to explain the behavior of actors and shows the outcome had the game been performed differently (Myerson, 1991). In Game Theory, a game is a set of circumstances that has a result dependent on the actions of multiple decision-makers; players (Hayes & Kelly, 2024).

## 1.2. Research Questions

In the current system of tendering collective costs are high. Losing bidders incur high sunk costs and capacity-loss which is an economically inefficient way to operate. It is important to understand the tender procedures of (semi-)public buildings since the type of procedure greatly influences the collective costs. The procedures lead to a high investment from the bidding party, and repeated tendering without winning places a large burden on a tendering company. However, tendering is required to divide up public works, guaranteeing equal competition.
In order to gain insight in the economic inefficiencies (i.e., the collective costs made because of the current tender procedure), the collective costs need to be quantified and validated; putting a price to equal competition. The main research question can be described as follows.

*RQ: How do collective costs contribute to the economic inefficiencies in the Dutch tendering process for (semi-)public non-residential buildings, and how can game theory be applied to quantify these inefficiencies?*

To answer this question, multiple sub-questions have been defined. The tender process is completely governed by judicial and regulatory frameworks of these procedures. It is important to create a coherent understanding of these laws and policies.
In addition to this, it is crucial to understand the key steps and define these clearly in order to better define the game of public tendering which results in a better understanding and application of game theory. The sub-questions can thus be defined as follows:

*Q1: How does judicial and regulatory context guide the public tender processes in the Netherlands and influence economic inefficiencies?*

*Q2: What are the key steps in the Dutch tender process, and how do these steps contribute to economic inefficiencies and collective costs?*

*Q3: In what ways can game theory be used to model the economic inefficiencies in the Dutch tendering process for (semi-)public non-residential buildings, and what insights can these models provide about collective costs?*

The aim of this research is to analyze the tender process and define the cost of honest competition – in other words, the collective and cumulative sunk costs incurred by losing bidders ((sub-)contractors) and the contracting authority in a single tender procedure.
By mapping out all key steps in the process through analysis of judicial and regulatory context, the basis of game theory is formed. In this way, the collective costs will be quantified through game theory.
This research only focusses on non-residential buildings in the public procurement process, which excludes infrastructure or residential projects.
Data on the side of the contractor (tenderer) is available through company involvement. General data on tendering in the Netherlands is available through collaboration with Bouwend Nederland.

## 1.3. Research Design

The design of this research consisted of multiple steps in order to gain insight into the main objective. In Table 01, an overview of aspects can be found including type of data and research method, and which sub-question it answers. It is important to first create an understanding of the current situation, in the Dutch Construction sector. This will be done in phase 1 through a review of existing literature and judicial documents, and process mapping.
Phase 2 will focus on qualitative pre-research performing document analyses, interviews, and creating case narratives. This phase is important to validate later models. Applicable pre-qualitative research to be used for validation of a model are available through company involvement.
In the final phase, a mathematical model will be created of the most prevalent tender procedure in the Netherlands. This model will be used in a generalized case to show cumulatively the collective costs made by the construction sector. Most importantly, the model will be used in order to calculate the cost of honest competition.

*Table 01: Overview of research design*

| Research Method | Type of data | Outcome | SQ |
|---|---|---|---|
| Context Analysis | Qualitative | analysis of tendering and game theory through a literature review | 1 |
| Process Mapping | Qualitative | visualization of tendering-steps | 2 |
| Document Analysis | Qualitative/ Quantitative | examining tender documents, contracts, and results | 2 |
| Interviews | Qualitative/ Quantitative | performing interviews in order to collect data from stakeholders and validate existing theories through triangulation that can be used in the case model | 2 |

| | | | |
|---|---|---|---|
| Case Narrative | Qualitative | developing a chronological and detailed account based on documents and interviews. | 2 |
| Mathematical Model | Qualitative | creating a generally applicable mathematical model | 3 |
| Creation of Case Model(s) | Qualitative/ Quantitative | creating case model(s), applicable to the situation as studied in the cases to quantify economic inefficiencies. | 3 |

In Figure 02, a schematic overview of the graduation project can be found, outlining the steps needed to start a new part of the research.

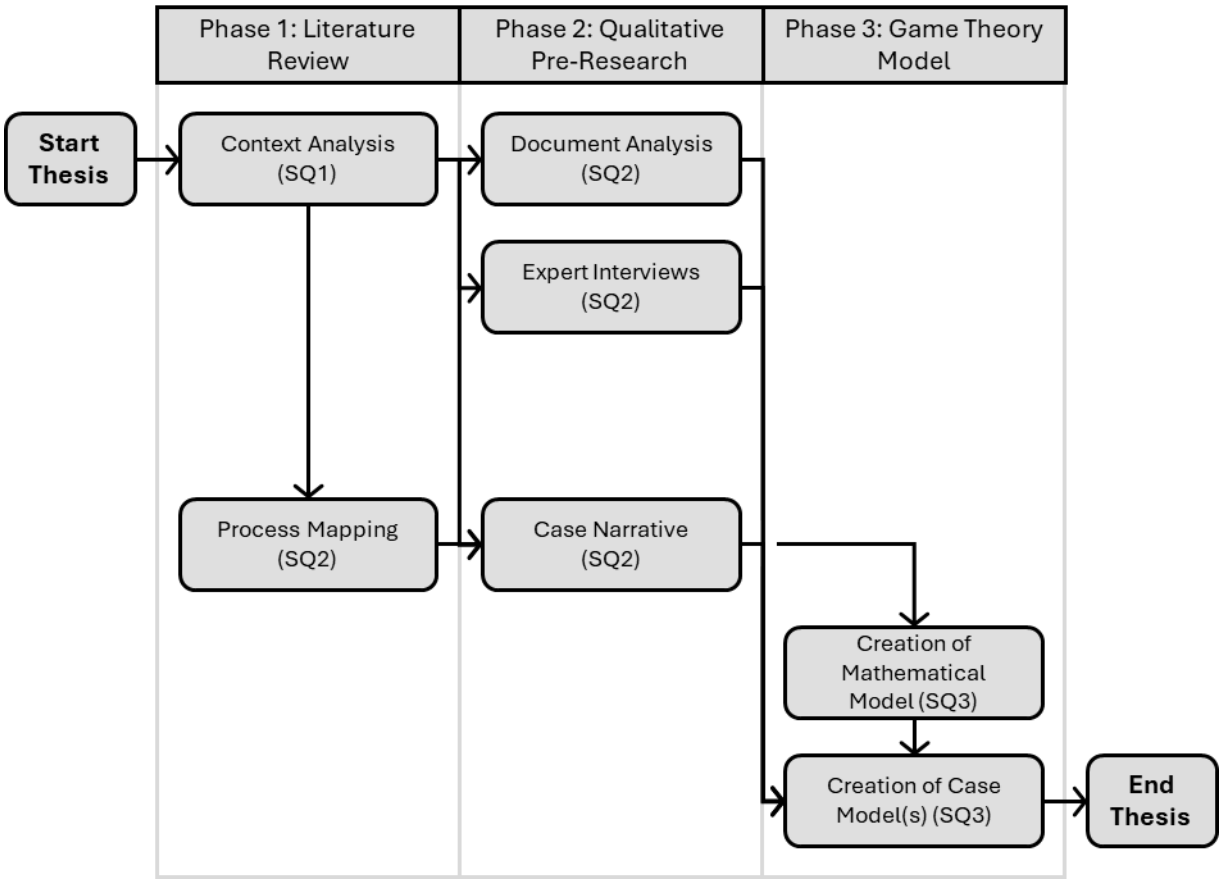


*Figure 02: Schematic overview of graduation project*

## 1.4. Research Motivation

When tendering was only based on the lowest-price principle, this could create opportunistic behavior with client-contractor relationships often being distrustful (Johnston & Lawrence, 1998). This fear turned out to be well-founded, in 2002 allegations were made of a sector-wide collusion scandal (Bouwfraude) trough bid-rigging among construction companies and civil servants (Rijt, Hompes, & Santema, 2010). Client-contractor relationships were often recurrent (Dorée A. , 1997) with only 2-3% of projects forming new client-contractor relationships. Close and recurrent

client-contractor relationships were vulnerable to collusion. The media suggested that this collusion robbed the taxpayer of about 500 million euros each year (Dorée A. , 2004). To investigate the allegations of collusion, a Parliamentary Inquiry Committee (parlementaire enquête commissie, PEC) was set up. The final report drafted confirmed the structural nature of cartels and bid rigging. It also concluded that the government had failed to create a consistent policy for the construction sector (PEC, 2002).

This collusion had a major impact on the trust in the relationship between public sector clients and the construction industry (Dorée A. , 2004). Because of this, the PEC adopted a vision based on the 'competition is good'-ethos and urged the restauration of proper functioning of the market. A tougher competitive environment will lead to healthy market dynamics (PEC, 2002).

The improved rules for tendering were defined in the Procurement Law (AanbW, 2012) and the Procurement Regulation (ARW, 2016). These laws and regulations aim to bring out creative competition and provide a fair way to divide public works (Hobma & Jong, 2022).
However, tendering is also expensive and takes up a lot of capacity. The sunk costs and capacity of losing bidders is an inefficient way to operate (Blomgren-Hansen, 2019). In order to quantify the cumulative sunk costs game theory can be used. Game theory allows for a stepped approach clearly visualizing all costs of acquiring a contract (Trienekens & Beulens, 2001).

While the existing literature has analyzed the principles and legal frameworks of procurement law (Arrowsmith, Treumer, Fejø, & Jiang, 2011; Chao-Duivis, Bruggeman, Koning, & Ubink, 2018), relatively limited research has been devoted to the quantitative economic inefficiencies inherent in public tendering procedures. Notably, there is a lack of studies that empirically assess the cost of tendering from the contractor's perspective (Collins, Blondel, Sarfo, & Emmanuel, 2021). Futhermore, accurately and empirically quantifying costs remains a methodological challenge (Thomassen, Vassbø, Solheim-Kile, & Lohne, 2016). Current procurement models fail to capture the full cost implications of the tendering process (Fazekas & Blum, 2021).
This thesis makes a unique contribution by introducing 'cost of honest competition' – in other words, a game theory-based principle to quantify the collective and cumulative sunk costs incurred by losing bidders and the contracting authority in a single tender procedure.

Since the tender procedures form the basis of the challenges in tendering, the question arises on how these collective costs contribute to the economic inefficiencies in the Dutch tendering procedures, and how these costs can be quantified.

## 1.5. Reading Guide

This thesis is structured to guide the reader through an investigation into the inefficiencies of the current Dutch public tendering process for (semi-)public non-residential buildings, focusing on the collective cost of honest competition.

Firstly, Chapter 1 provides an introduction to the challenge that is researched and shows how this research will be tackled in and the underlying motive for this research.
Chapter 2 provides the theoretical framework for this thesis. Part A explains fundamental concepts in game theory, and part B translates the procedural structures of public procurement into a process map (BPMN).
Chapter 3 outlines the research strategy. It discusses the qualitative pre-research phase – including tender documents and expert interviews – and the translation of the process map into a game theory model. The chapter also defines the scope of the model.
Chapter 4 creates the theoretical game theory model that can determine the cost of honest competition and builds upon the game theory model using real-life data and insights gathered from the qualitative pre-research. This chapter presents a step-by-step quantification of the collective costs incurred by both contractors and contracting authorities during the tendering process ending with a validated cost of honest competition.
Chapter 5 concludes the outcomes of the model. It reflects on the theoretical and practical implications and discusses the limitations of the study. In addition to this, it proposes direction for future research.

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# 2. Foundations in Procurement Law and Game Theory

In the literature review, part A will be used to elaborate upon game theory, wherein important factors are explained. In part B, tendering laws and policies will be further elaborated on, translating these procedures and processes to game theory. In addition to this, these procedures will be shown clearly through process maps.

## Part A: Game Theory

In order to gain insight into the collective costs, it is important to understand decision-making during the tendering process. In this way, the costs leading from those decisions can be quantified. To understand these decisions, game theory will be used. The sequential nature of the client-contractor relationship in tendering and the simultaneous nature between contractors, paired with the clearly defined start- and endpoint of the process lends itself to the use of game theory (Carmichael, 2005).

Game theory can be defined as the study of mathematical models of conflict and cooperation between intelligent rational decision-makers. Game theory provides general mathematical techniques for analyzing a situation in which two or more individuals make decisions that will influence each other's welfare (Myerson, 1991). Unlike traditional decision theory, which only considers individual decision making, game theory is concerned with the interaction between different decision-makers each of whom is trying to make the best decision (Osborne & Rubinstein, 1994).

Game theory is applied in this study because it offers a structured framework for analyzing decision making among actors with potentially conflicting motives. The sequential nature of tendering can be easily translated to the structured framework of game theory. The advantage of game theory lies in the ability to simulate realistic scenarios, account for asymmetric information, and quantify potential outcomes making it fitting to this research (Carmichael, 2005). However, a key limitation is its reliance on the assumption that an actor acts rationally, which may not fully reflect the nuanced motivations of real-world actors.
Key concepts crucial to game theory will be explained in later sections.

### 2.1. Games

A game is a description of strategic interaction that includes the constraints on the actions that the players can take and the players' interests (Osborne & Rubinstein, 1994).

A game can be set up sequentially, or simultaneously. In a sequential game, players make moves in order. This means that the other players can respond to another players' move. In a simultaneous game, players make moves at the same time. Players need to formulate their strategies based on what they think the others will do (Carmichael, 2005).

Games can be played cooperatively, where all players are allowed to communicate and make enforceable agreements on how to play the game. Because these

agreements are enforceable, each player has an incentive to agree on a mutually beneficial outcome (Carmichael, 2005). In noncooperative games, it is assumed that players act only in their own self-interest. Cooperation can take place in noncooperative games, but this cooperation is not enforceable.
In addition to this, the number of players defines the type of game. There is a distinction between a 2-player game, or an N-player game, with N>2 (Carmichael, 2005).
A game can be played once by the same players (single-stage, or unrepeated games), or more than once (multi-shot, or repeated games). In a repeated game, the strategy might be different every time the game is played. This meta-strategy takes into account each repetition of the game. Over time people can switch between strategies but they will only do so if they expect to make a higher return by doing so (Carmichael, 2005).

Several types of games can be categorized (Osborne & Rubinstein, 1994):

- **Strategic games**
  A strategic game is noncooperative, and simultaneous. All individuals aim for their own optimal outcome, and cooperation cannot be enforced. All players make their decisions at the same time.
- **Extensive games**
  An extensive game is non-cooperative and simultaneous. All individuals aim for their own optimal outcomes, and decisions are made after previous players have made their decisions.
- **Coalitional games**
  It is important to coalitional games that these games will always be played cooperatively, and cooperation can thus be enforced.

## 2.2. Players

A game is played between different players. A set of players can be described by $N = \{1, \dots, n\}$. The players are decision-makers and will react (in an extensive game) to other players' decisions (Veen, 2014). Fundamental to game theory is the assumption that all players act rationally, maximizing their own objectives given their knowledge of the game (Myerson, 1991).
Each player uses his own strategy to pursue and maximize his interests (Veen, 2014). This strategy can also be called the behavior of a player. Game theory is based on independent selection of a strategy of a player, whilst the overall outcome is determined by the combined decisions of all participants (Myerson, 1991).

A distinction can be made between games with perfect information and imperfect information. In a game with perfect information, all players are fully informed about the moves of all other players, whereas games are played with imperfect information if this is not the case (Osborne & Rubinstein, 1994). In games with imperfect information, often only a player's own move is known, but could also mean in an n-player game that the moves of other parties are partially known. Games with imperfect information are called Bayesian games (Myerson, 1991).

In addition to this, a game could be played with asymmetric information (Carmichael, 2005). This means that not all players have the same information, instead some players have private information. This could influence the way a game is played.

## 2.3. Solution

When all players have made their decisions, the game is finished. The outcome is decided by the behavior of all players during these games. The value of an outcome for an individual player is called the payoff. This is a number or value that represents the interests of the player within the given outcome (Osborne & Rubinstein, 1994). In a multi-actor environment, the values of the payoffs of the involved players may differ when the players have different preferences over the set of outcomes (Veen, 2014).
It is important to define what the payoff represents. The payoff can be determined in the form of money, defining the amount of money spent or gained in the game. This is a quantifiable method, with cardinal values (i.e., €10 is twice as much as €5).
A payoff could also be determined in a less quantifiable manner (Cruz & Simaan, 2000). A way to quantify this type of payoff is to define ordinality can be how satisfied an actor is with the final result (i.e., a ranking of results based on the preferences of the actor). This does not explicitly imply cardinality (i.e., result 1 is not two times as good as result 2). This method of ordinally defining outcomes can be used to solve the game theory model when the actors have different motives.

A game can be considered zero-sum if the sum of the players' payoff is a constant (e.g., division of €10 for two players always results in a total sum of each players' payoff of €10). In a zero-sum game, strengthening a player's own position will always weaken the position of other players (Carmichael, 2005). In a non-zero-sum game, this is not the case, and collaboration could be beneficial to all parties. It is important to know what type of game is being played, because the strategies and outcomes differ significantly.

There are often many solutions to a game, with players often having different preferred solutions (Carmichael, 2005). Although not considered in this thesis, preferred strategies can be based upon the behavior of players (e.g., risk-taking vs. risk averse). It is important to find the optimal Nash-equilibrium. When this equilibrium is reached, no actor can improve their own outcome (payoff) by changing strategies unilaterally (Carmichael, 2005). A situation is Pareto efficient if no player can be made better off, without making someone else worse off. There can be multiple Pareto-efficient outcomes (Carmichael, 2005).
The Nash-equilibrium could be Pareto efficient, but it does not have to. Reaching the Nash-equilibrium does not mean that this is the best collective outcome.

By introducing game theory as a mathematical model to analyze the tender process, the quantification of the cumulative costs are enabled. Section 2.10 will conclude the literature review in its totality. The next section, part B, will elaborate on the principles, objectives, and procedures of procurement.

# Part B: Tendering

Since 2012, Procurement Law (Aanbw2012) is based on European Directives on public procurement. In this part of the report, the principles and objectives of procurement law will be elaborated upon. By defining all different actors, their goals, the start point and end point of the tendering process, and selection criteria; a translation to game theory can be made clear.
In addition to this, the different procedures allowed under the Procurement Regulation (ARW2016) are visualized through process maps.

## 2.4. Procurement Law

In order to create a level playing field for business across Europe, EU law sets out minimum harmonized public procurement rules. These rules govern public authorities and certain public utility operators purchasing goods, works and services. The European directive on public procurement (Directive 2014/24/EU) is transposed into national legislation. (European Commission, sd) and governs all procurement of goods above the threshold value of €5.538.000 (Expertisecentrum Europees Recht, 2023).
The total yearly tendering market in every sector in the Netherlands is good for €85 to €100 billion per year (TenderNED, 2024). Whilst the exact portion is not given, an estimation can be made combining the average contract price (€11.7 million) and the amount of awarded tenders in the built environment (2,500) per year (TenderApp, 2024). This gives an estimate of around €29 billion each year.

There is an obligation to tender if the contracting party is mostly funded through public funding or if they are established for the specific purpose of meeting needs in the general interest, not having an industrial or commercial character (Chao-Duivis, Bruggeman, Koning, & Ubink, 2018). It is important to understand the objectives and principles of tendering law, and thus the objectives the contracting authority has to follow whilst playing the game.

### 2.4.1. Principles

The European directive and Dutch Procurement Law are based on adherence of six principles, these are (Chao-Duivis, Bruggeman, Koning, & Ubink, 2018):

- **Principle of equal treatment and non-discrimination:**
  This is the most important principle, obliging the contracting authorities to treat each citizen and tender equally.
- **Principle of transparency:**
  Contracting authorities must give clear information to possible contractors about the given assignment and allows monitoring of contracting authorities.
- **Principle of proportionality:**
  Requirements and conditions to enter/win procurement must be proportional to the nature and extent of a contract that is to be awarded.
- **Principle of competition:**
  This principle ensures that the call for tenders must invite competition, although the extent of competition is allowed to be limited.

- **Principle to state reasons:**
  This principle ensures an obligation to state adequate grounds for any reason made by a public contracting authority.
- **Principle of protection of legitimate expectations and legal certainty:**
  Justified beliefs merit protection.

These principles of procurement law guide the party through the tendering process and must be adhered too throughout the entire process. Two of these principles are generally considered most important; transparency, and competition (Arrowsmith, Treumer, Fejø, & Jiang, 2011). If conflicting, European courts have final say on how these principles should be interpreted.

### 2.4.2. Objectives

There are eight objectives that are important to public procurement law. These objectives, and an elaboration can be found in Table 02. Within different procurement systems (e.g., construction work, computing services), importance to different objectives can differ greatly (Arrowsmith, Treumer, Fejø, & Jiang, 2011).

*Table 02: Elaboration on objectives of European procurement directive*

| Objective | Elaboration |
|---|---|
| Value for money (efficiency) | A major objective to procurement systems is to successfully acquire the goods, works or services concerned on the best possible. This does not necessarily mean the lowest price.<br>In order to ensure this objective, the principle of transparency and competition is essential. |
| Integrity – avoiding corruption and conflicts of interest | The objective of integrity is important to the tendering process, preventing collusion, nepotism, and self-interest.<br>There is a close and complementary connection between this objective and the objective aiming to achieve the best value for money. Corruption and collusion may prevent the best value for money in acquisition. Reducing corruption will often have the result of improving the value for money obtained when acquiring the goods, works, or services.<br>The principles of transparency, equal treatment, and stating reasons are fundamental principles in order to achieve integrity in the tendering process. |
| Accountability | It is important to ensure accountability in the tendering process. It is important to ensure that the objectives and rules can be monitored and enforced.<br>The principle to state reasons is most essential in order to achieve this objective. In addition to this, |

| | |
|---|---|
| | the principle of transparency ensures trust in the system. |
| Equal opportunities and equal treatment of providers | This objective is important in providing fair access to work paid for by the taxpayer.<br>There is a close connection between this objective, and the objective of integrity. By not allowing integrity, confidence in the process is created encouraging all firms to participate. |
| Fair treatment of providers | This objective can be important from a point of view of procedural fairness. More generally fair treatment will encourage firms to participate in the competition |
| Efficient implementation of industrial, social, and environmental objectives | Procurement can be used to achieve benefits that go beyond the acquisition of goods, works or services. Governmental contracting authorities can use tendering to set an example. |
| Opening up public markets to international trade | Important to the new European directives is opening up international trade. Public procurement had often been rather closed.<br>This objective closely aligns with the objective of equal treatment, where an international supplier may not be treated differently to a national one. In addition to this, the principle of transparency is essential, since lack of transparency can be a barrier to trade.<br>To achieve this objective, standardization of procedures for awarding tendering contracts has taken place. |
| Efficiency in the procurement process | This objective aims to ensure that the procurement process is conducted without unnecessary or disproportionate delay, or a waste of resources. Important to this objective is the principle of proportionality, where the condition to enter must be proportional to the nature of the contract. |

The European objectives lead to trust in the client-contractor relationship. Through tendering (in comparison to initial client solutions) a better cooperation-focused process is created (Boes & Dorée, 2013), leading to a more successful collaboration through improved trust (Challender, 2017).

It is important to understand that these objectives might create conflicts with other objectives, leading to economic inefficiencies.
The objective of value for money can clash with the objective of equal treatment, e.g., a bid that is handed in too late, might be the best bid. A contracting authority can

prioritize the objective for best value for money (the late bid) or priorities equal treatment (i.e., a late bid is not considered). This potential for conflict is always present between objectives and must be judged on a case basis considering the most important principles.
It is important to understand these conflicts, in order to judge the results from the perspective of the contracting authority.

It is crucial that the principles and objectives of public tendering are clearly elaborated upon in order to understand the goals of different actors, and the choices that these actors will make during the tender process.

## 2.5. Actors & their Goals

The tendering process can be understood as a game in extensive form with two types of players, where the contracting authority (a governmental party that is legally obliged to tender) and multiple contractors (private companies) interact in a structured framework.

A contracting authority aims to procure a new facility. In this procurement process, it aims to achieve all objectives under the European directive. The contracting authority must also follow the principles of equal treatment, non-discrimination, and transparency (Chao-Duivis, Bruggeman, Koning, & Ubink, 2018). Contractors aim to win the contract. It must keep profitability and tries to win under the most profitable terms.
The interaction between contracting authorities and contractors has been defined and structured in the procurement regulations (ARW, 2016). In addition to this, contractors are not allowed to communicate or discuss any part of the tender among themselves (Jansen, 2009). Within the extensive game, a simultaneous sub-game between contractors can be found. Information between actors is imperfect (as communication is forbidden)

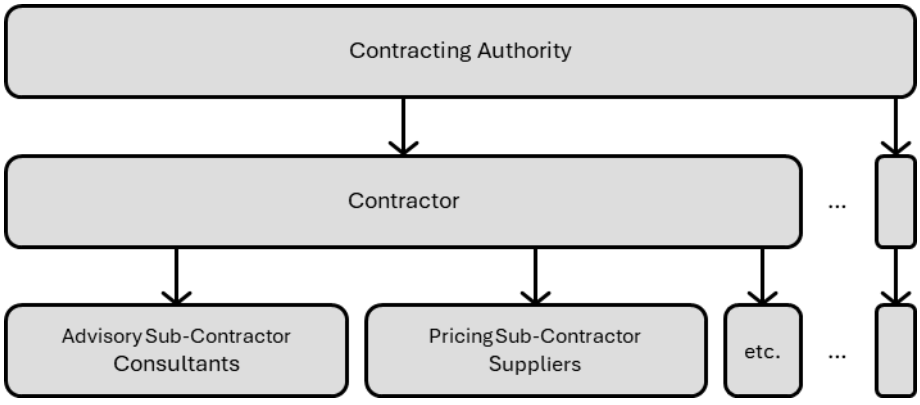


*Figure 03: Schematic overview of the relationship between contracting authorities, contractors, and sub-contractors*

In addition to this, contractors work with multiple subcontractors in order to submit a tender (schematically shown in Figure 03). These contractors work together with subcontractors under DNR (*De Nieuwe Regels*, Section 2.8) (Hobma & Jong, 2022). It

is important to make a distinction between subcontractors. Working together with the contractor, the advisory subcontractors (e.g., architects, construction consultants). These subcontractors get paid for the work they perform. However, this paid subcontractor takes on financial risks as well, often including success fees in the contract (i.e., if lost, only paid 50%, if won 110%).
Another type of subcontractor is the pricing subcontractor (i.e., supplier, e.g., concrete supplier, vendors). These actor often only provide a quote, and do not get paid to perform this work. Whilst the work is often significantly less then advisory subcontractors, there are many more pricing subcontractors that offer a quote.

The actions of these actors will be elaborated upon in later sections and will be used in process mapping of the different type of procedures.

## 2.6. Pre-procurement Phase

It is important to understand and define the starting point of the tendering process. For this graduation project, the start of this process is defined as the moment the contracting authority opens the tender. In addition to this, it is crucial to get an overview of the decision-making process on the side of the contractor on whether or not to join the tender (bid/no-bid decision).

In the pre-procurement phase, a contracting authority chooses which type of tender procedure to use. In this phase, a contractor must decide whether to participate based on the potential return, in comparison to the cost of bidding (Carmichael, 2005) (Blomgren-Hansen, 2019). The decision is assessed based on competition, project risks and long term strategic benefits. If the potential return is considered to be too low, a contractor does not bid. Using a feasibility study, the best procurement approach is identified and is performed during the decision to join the tender (McCue & Pier, 2008).

## 2.7. Selection Criteria

It is also important to define the endpoint of the game, which for this project is the moment the contractor authority selects a bid from one of the competing tenderers.
The selection phase can be based on either the lowest price principle or the EMVI principles (Most Economically Advantageous Tender). The advantages and disadvantages of these two principles have already been discussed in earlier sections.

The choice of selection criteria influences the amount and type of work to be performed during the tendering process. Since procedures with selection criteria based on EMVI are most prevalent, these types of procedures will be analyzed.

## 2.8. Post-procurement Phase

After the winning tender is selected, the post-procurement phase starts. The contract offered at the end may influence the invitation to tender, as well as the willingness of contractors to join. It is thus important to understand which building methods correspond with which contract form. In Table 03, an overview of contract forms are introduced (Hobma & Jong, 2022).

*Table 03: Elaboration of contract forms*

| Type | Name | Elaboration |
|---|---|---|
| UAV | Uniforme Administratieve Voorwaarden | Standard administrative conditions used in the Dutch construction sector regulating contracts between clients and contractors. They establish clear rules and obligations for both parties ensuring legal clarity. |
| UAV-GC | *Uniforme Administratieve Voorwaarden – Geïntegreerd Contract* | Standard administrative conditions used in the Dutch Construction sector for integrated contracts. It establishes clear rules and covers design in addition to construction, |
| DNR | *De Nieuwe Regels* | Updated regulations aimed at improving standardized contracts. The rules focus on the responsibilities of a contractor's obligations for design and construction. |

In Figure 04, an overview can be found of the process after a tender is won and the contract is formed. This figure shows the entry point of the contractor (after the contractor has won the tender) and shows the point at which a final price is determined.

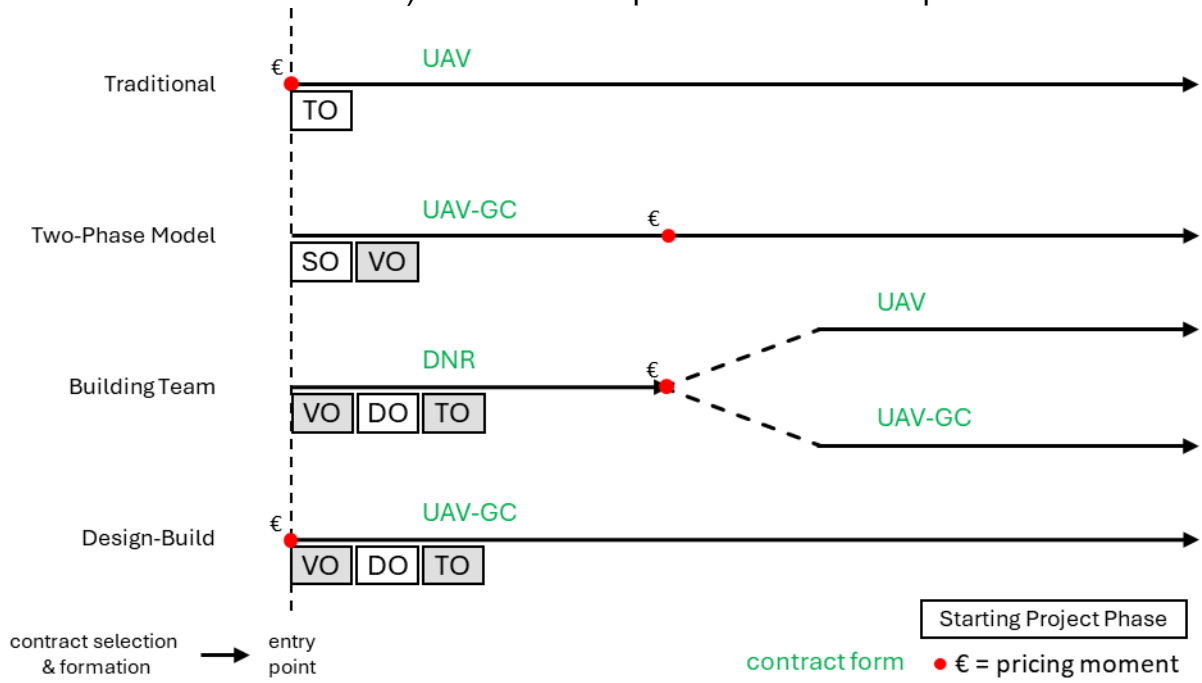


*Figure 04: Schematic overview of contract formation and forms after selection of a tender*

## 2.9. Procedures

The tendering procedures defined in procurement law (ARW, 2016) (AanbW, 2012) regulate how contracts are awarded. These distinct types of procedures influence the strategic behavior of contractors. There are four main types of procedures prevalent in Dutch public tendering (Chao-Duivis, Bruggeman, Koning, & Ubink, 2018): Open procedures, restricted procedures, competitive dialogues, and negotiated procedures. Each type of procedure also has an implication on economic efficiency, and the amount of competition.
In the next section, these four tendering procedures will be analyzed, understanding the implications of the type of procedure on tendering. In addition to this, process maps have been made in order to clearly define these procedures.

In order to map and illustrate each procedure, a business process model and notation diagram (BPMN-diagram) has been created per procedure. These four diagrams will explain the role and actions of each actor in each procedure. A BPMN-diagram is used to express complex processes simplifying it to be easier to understand (Owen & Raj, 2003). One key feature of BPMN-diagrams is the use of “swimlanes” to separate tasks, decisions (gateways) and responsibilities, showing the interaction between actors.
It clearly separates tasks, events and decisions (gateways) placing them in (swimming) lanes specifying which actor is responsible (Corradini, Muzi, Re, Rossi, & Tiezzi, 2022).

For all procedures, the process maps examines the relationship between the contracting authority and the contractor. The subcontractor’s role will be schematically reduced to a simple transactional role only with the contractor and will not be included as an acting party in the diagram. Even though tendering typically involves multiple contractors, the process map simplifies this only including one. The BPMN diagram accounts for multiple possible outcomes. Later in the report (Section 4.1), the possibility of reaching each result will be quantified, and the expected pay-off for each contractor will be calculated.
This approach is similar to how businesses map interactions with customers - where each costumer can experience multiple results (purchasing, quote rejection, etc.). Despite the presence of multiple costumers, the costumer is represented as a singular actor in the BPMN for clarity and simplification (Corradini, Muzi, Re, Rossi, & Tiezzi, 2022).

In all procedures, the process starts with the contracting authority opening the tender procedure and ends with the selection of a winning bid.

### *2.9.1. Open Procedure*

The open procedure forms the essence of tendering; a contracting authority aims to procure a new facility, sets up a tender and invites all interested parties to join (Heijboer & Telgen, 2002). There is no minimum or maximum number of contractors, and there is no pre-selection (He, Milne, & Ataullah). All bids are evaluated at the same time and the contracting authority will select a bid based on pre-communicated selection criteria (Heijboer & Telgen, 2002). During and after the tendering process, no discussion

between the contracting authority and contractor, or amongst contractors is allowed (He, Milne, & Ataullah).

Figure 05 shows the open procedure in a BPMN-diagram developed for this analysis. Three different results (R1-R3) can be found in the diagram. After starting the tender, the contractor can decide not to join (R1), or can join, submit its bid and lose (R2) or win (R3).

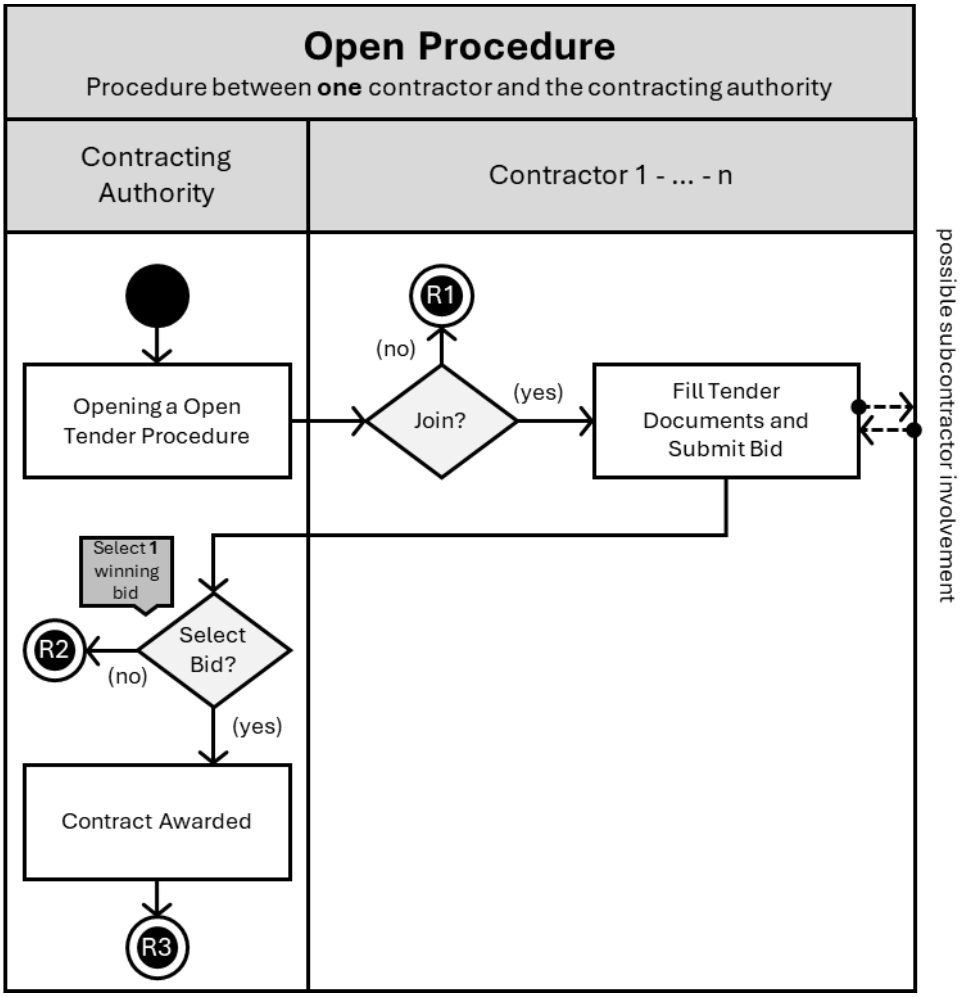


*Figure 05: BPMN-diagram of an open procedure*

This procedure ensures the objective of transparency and equal treatment since it opens the bidding process to all potential bidders. It encourages broad participation, which leads to competitive pricing. However, competitive pricing could also lead to potential quality or execution issues, which may result in long-term costs due to potential construction issues (Klotz, Horman, Riley, & Bechtel, 2009)
In addition to this, the number of tenderers is unknown beforehand, and authorities must evaluate many bids, which is time consuming and leads to high evaluation costs. (Heijboer & Telgen, 2002).

### *2.9.2. Restricted Procedure*

In a restricted procedure, the tender procedure is closed, meaning that the contract is not publicly advertised. The contracting authority starts the procedure by inviting all

potentially interested contractors to submit pre-qualifications showing the contractor is capable to do the work. This means that the number of invited bidders is limited to (a minimum of) three parties (Arrowsmith, Treumer, Fejø, & Jiang, 2011). The contracting authority will select a bid based on pre-communicated selection criteria. During and after the tendering process, no discussion between the contracting authority and contractor, or amongst contractors is allowed (He, Milne, & Ataullah).

Figure 06 shows the restricted procedure in a BPMN-diagram, with five different results (R1-R5) depicted within. After starting the tender, the contractor can decide not to join (R1) or submit a prequalification which may be rejected (R2) or accepted. If invited to the tender, it can decide to withdraw (R3) or submit its bid leading to a loss (R4) or a win (R5).

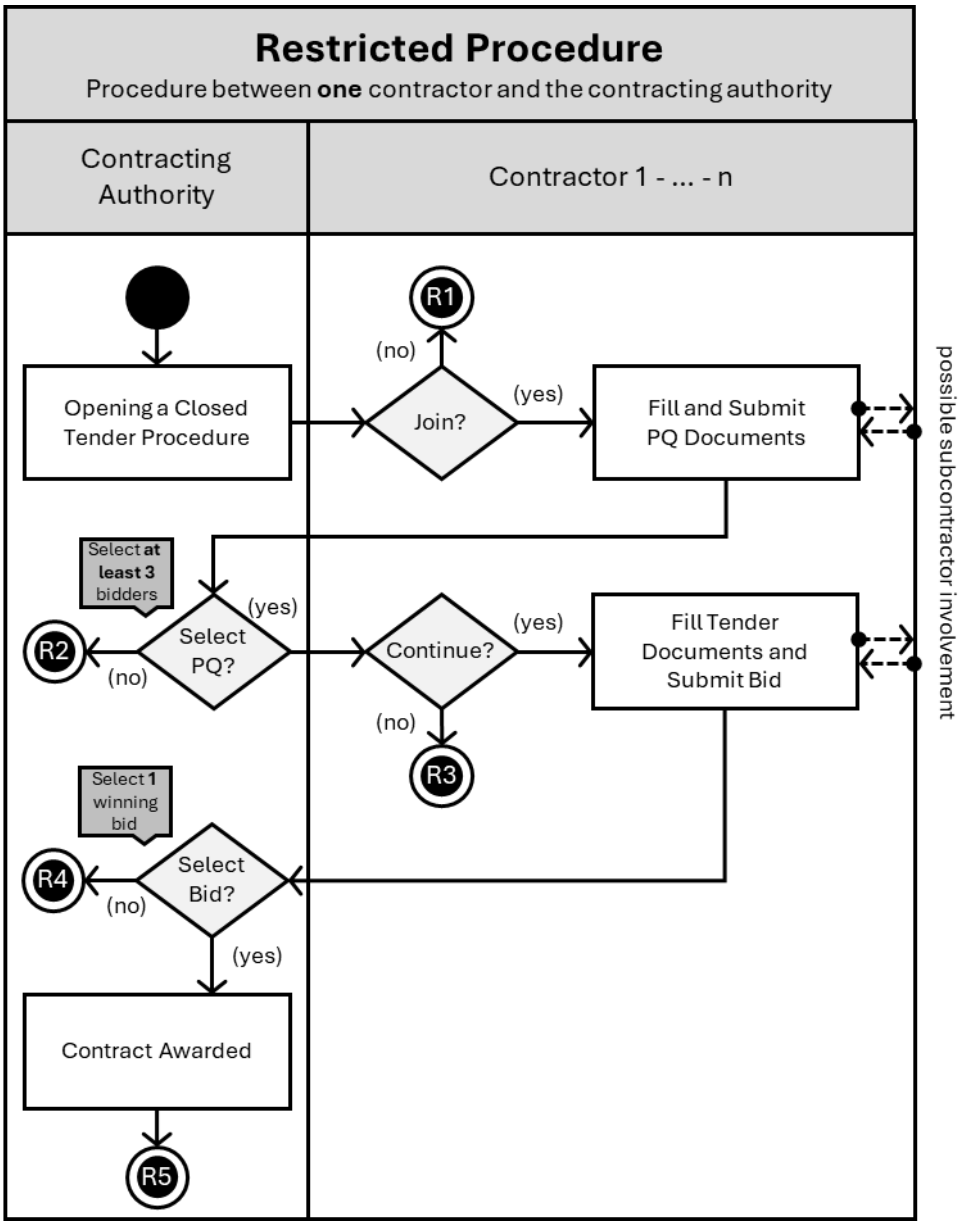


*Figure 06: BPMN-diagram of a restricted procedure*

A restricted procedure reduces administrative work of the contracting authority, by having to evaluate fewer bids and provides more certainty to possible bidders (Heijboer & Telgen, 2002). It ensures the objective of efficiency, and results in higher quality bids. However, fewer bidders mean less competition, which could lead to increased prices (Klotz, Horman, Riley, & Bechtel, 2009).

### *2.9.3. Competitive Dialogue*

When using competitive dialogue, the procedure starts with an open call. Instead of immediate bidding, bidders engage in a dialogue with the contracting authority. Discussion is allowed before submission of the bids (He, Milne, & Ataullah). During the discussion, requirements and solutions are refined, since at the start, the contracting authority does not exactly know what it wants (He, Milne, & Ataullah). In each round of discussions the contracting authority could decide to drop bidders, but a minimum of three bidders are necessary to ensure competition (Arrowsmith, Treumer, Fejø, & Jiang, 2011). In the end, final bids are submitted and the best offer is selected.

Figure 07 visualizes the BPMN diagram developed for this analysis of this procedure and shows five different outcomes can be found (R1-R5). After the tender begins, the contractor may choose not to participate (R1). The process then becomes iterative, with the contractor submitting interim deliverables to the contracting authority. At each cycle, the contracting authority may drop the contractor (R2), or the contractor may withdraw (R3). If a final tender is submitted, the authority determines whether the contractor loses (R4) or wins (R5) the bid.

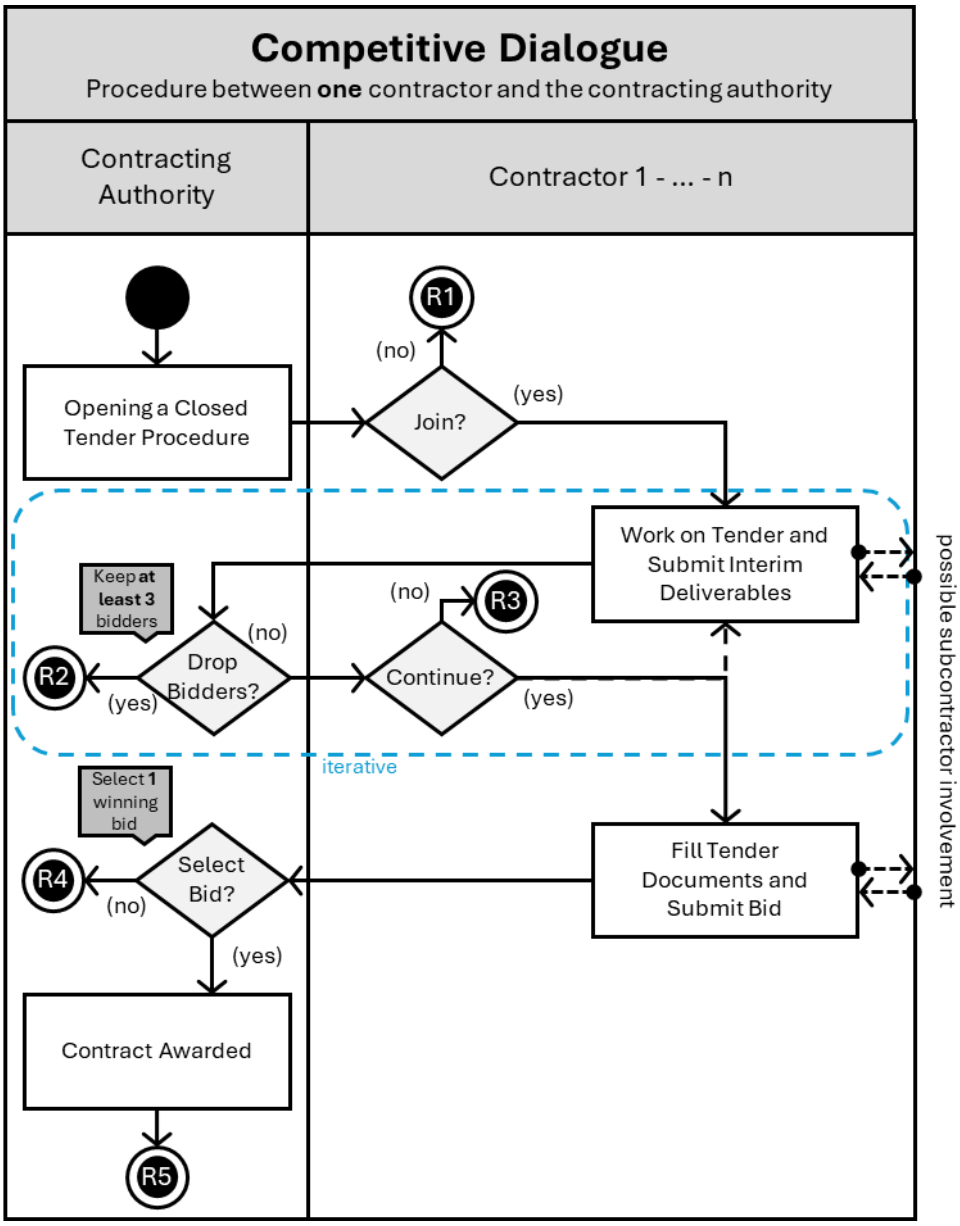


*Figure 07: BPMN-diagram of a competitive dialogue*

This procedure allows for complex projects, since the contracting authority is able to better define project details and integrate solutions brought forward in the dialogue (He, Milne, & Ataullah). In addition to this, it encourages high value for money. However, this procedure is time-intensive and could risk unequal treatment through information asymmetry.

### *2.9.4. Negotiated Procedure*

In a negotiated procedure, the contracting authority directly negotiates with only one selected bidder (He, Milne, & Ataullah). This procedure can be used if there are no (suitable) tenderers or there are technical or secrecy aspects that are exceptional. Only in these cases can a contracting authority opt for a negotiated procedure (Chao-Duivis, Bruggeman, Koning, & Ubink, 2018). The contracting authority could further define the scope during negotiations (He, Milne, & Ataullah).

Figure 08 shows the BPMN-diagram of a negotiated procedure and shows five different outcomes that can be found (R1-R4). This procedure shows only one contractor that can decide not to participate in negotiations (R1). The process then becomes iterative, with the contractor submitting interim deliverables to the contracting authority. At each cycle, the contracting authority may withdraw (R2), or the contractor may withdraw (R3). When submitting the final documents, the contracting authority can decide to accept (R4) or reject. If rejected, the contracting authority can decide to continue the negotiations or stop (again R2).

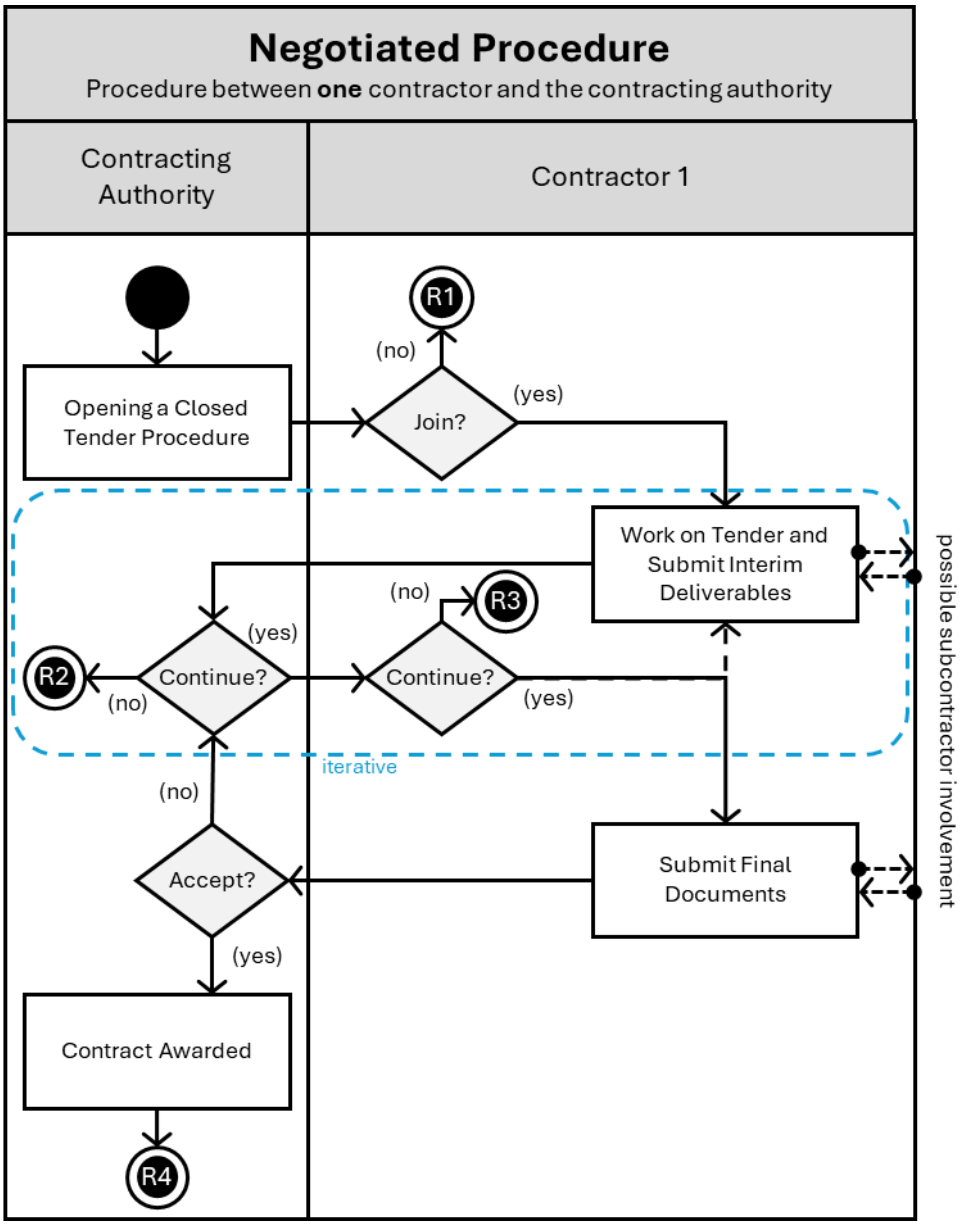


*Figure 08: BPMN-diagram of a negotiated procedure*

A consequence of choosing this procedure is a decrease in transparency (Arrowsmith & Treumer, 2009). There is less (i.e., little to no) competitive pressure, which can lead to higher prices. Although it allows for a faster process, it is crucial to ensure it is only

used in specific legally justifiable cases. These restrictions are important since they directly go against the objective of equal opportunity.

## 2.10. Conclusion

The chapter has provided an elaboration on game theory and its application to the tendering process.

Game theory is introduced as a mathematical model used to analyze decision-making in the tender process. Within the tendering process, the game between contracting authorities and contractors can be considered sequential, and the game amongst competing contractors can be considered simultaneous.
Game theory enables quantification of the collective costs resulting from the current economic inefficiencies in the tendering process.

The second part of this chapter explains the legal framework surrounding tendering, outlining the rules that a contracting authority has to follow.
Through the creation of process diagrams of each procedure, a clear and coherent overview has been created, illustrating and simplifying the tender process.

The application of game theory to the tendering process provides a structured way to visualize and evaluate strategic interactions between clients and contractors. By framing tendering as an extensive game, an overview can be created of the preferred strategies of each actor, the utility per result, as well as the probability of reaching each result.

# 3. Conceptual Modeling Approach

This research employed a mixed-method approach to investigate how collective costs contribute to the economic inefficiencies in the Dutch tendering process for (semi-)public non-residential buildings. The methodology is separated into three phases (as can be found in Section *1.3. Research Design*) In the first stage, a literature review was performed in order to provide the necessary context and investigate academic articles on this subject (and can be found in chapter *2. Literature Review*).
The second phase of this graduation project consists of qualitative pre-research. Through combining a document analysis on relevant tenders and expert interviews, practical, financial, and organizational matters will be identified influencing tendering choices.
The third and final phase of this research applies game theory to model the interaction between stakeholders during the tendering process, building on the empirical insights from the qualitative pre-research, as well as the process maps created in the first phase. This approach ensures an in-depth practical understanding of tendering procedures and a structured theoretical understanding of the client-contractor relationships, resulting in a quantified price of equal competition.

In order to scope the graduation project, work with limitations in available data and experience of available interviewees, and finish this project in time, the focus will be placed on one type of procedure.
In the (semi-)public non-residential sector, the restricted procedure is most prevalent. Figure 09 shows this prevalence, providing a percentage overview of each procedural type (BouwendNederland, 2025).

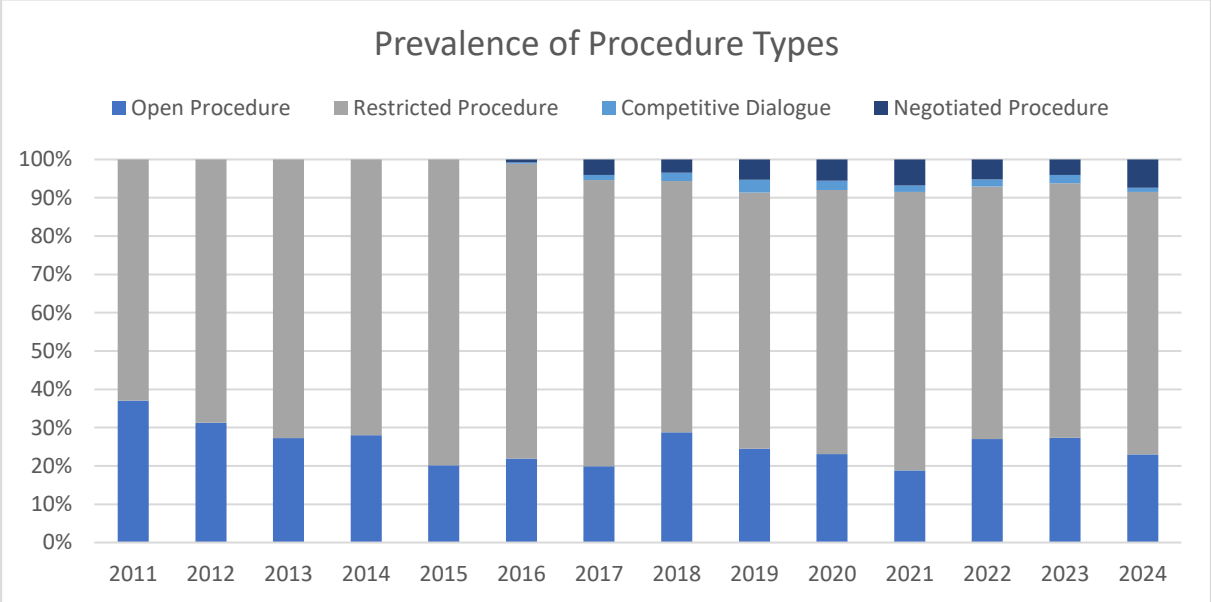


*Figure 09: Prevalence of procedure types in tendering in the Netherlands*

This procedure will be analyzed and used for the game theory model.

## 3.1. Qualitative Pre-Research

In order to create sufficient context and validate financial and procedural matters in the game theory model, qualitative pre-research is performed. It focuses on two sources of data:

- Tender documents; publicly available tender documents, as well as internal submission documents, documents on assessment of the tender, and information on spending during the procedure and cost estimations on final given prices.
- Semi-structured interviews; interviews with practitioners and experts involved in the tendering process.

In the following sections, these data sources and the inherent methods used to analyze the available data will be elaborated upon.

### 3.1.1. Document/Tender Analysis

To understand and find financial information on the tender procedure, multiple tenders have been investigated based on public and internal documents. The selection of tender cases is based on pragmatic grounds (availability of data at a representative contractor in the Netherlands), which is necessary if the amount of cases is limited (Aken, Berends, & Bij, 2007). The tender cases were selected based on the following criteria:

- **Contracting authority: (Semi-)public entity**
  Only tenders issued by public or semi-public contracting authorities were included in the document analysis. These entities are obliged to tender and subject to the Dutch Public Procurement Act, ensuring a standardized and transparent tendering process governed through the legal procedures (Hobma & Jong, 2022).
- **Procurement procedure: Procedure with Pre-Qualification**
  The selected tenders include a pre-qualification phase. These procedures are most prevalent in the sector (BouwendNederland, 2025) and are used to limit participation to only those candidates who meet predefined qualifications, ensuring that only capable and experienced participants are invited to submit full tenders (Heijboer & Telgen, 2002). This criterion means only restricted procedures, and competitive dialogues will be part of the analysis.
- **Project Size: Major Projects**
  The analysis was limited to tenders of major projects (>€20.000.000). This amount of money is based on the internal classification of projects. These projects involve substantial financial investment, making them relevant for this research.
- **Contract type: Design & Build (DB) or Design, Build & Maintain (DBM)**
  Only tenders resulting in a DB or DBM contract were considered. These integrated contract types (UAV-GC) transfer design responsibility to the contractor and significantly influences the tender submission. By ensuring uniformity in the post-procurement phase, the impact of this phase is equal.

- **Project status: Tender concluded and contract awarded**
  Inclusion was limited only to tenders for which the procedure has been completed and a contractor has been officially selected. This ensures full documentation and allows for analysis of the whole tender. In addition to this, the information is less business sensitive.
- **Participation: No contractor withdrawal during the procedure**
  Tenders in which the contractor has withdrawn were not considered. This criterion guarantees that the entire tender process was conducted as intended. When a contractor withdraws, this is often due to feasibility concerns between the PQ and tender submissions or due to available work capacity (Bohari, Ikau, Budin, Hadi, & Chan, 2021).

Before selection, there were 365 possible tenders to analyze at this representative contractor on the construction of non-residential facilities. After filtering on the type of contracting authority, only 322 were left. Filtering on the type of procedure left 186. Filtering on project size left 20 tenders, filtering on contract type left 9. The other criteria left out 2 more. Thus, these selection criteria resulted in 7 tenders between 2019 (start of the database) and 2025.
Due to the sensitivity of the data, descriptive data has been rounded or blacked out in the report or appendices. No rounded data is used in calculation. Relevant descriptive statistics of these tender cases can be found in Table 04.

*Table 04: Descriptive statistics of chosen tenders*

| | |
|---|---|
| minimum contract price | € 20.000.000 |
| maximum contract price | € 120.000.000 |
| average contract price | € 65.000,000 |
| # pre-qualifications joined | 7 |
| # pre-qualifications won | 5 |
| # tenders joined | 5 |
| # tenders won | 4 |
| contract type<br>DB (won)<br>DBM (won) | <br>1 (1)<br>6 (3) |

A total of 600+ documents are relevant to these seven tenders. A selection of key documents critical to this research has been made. Relevant information was extracted from each document by reviewing all pages. An overview of the analyzed documents is provided:

- **Tender guideline**
  The *leidraad*, received from the contracting authority, the tender guideline provides details on the scope of the project, evaluation criteria, submission deadlines, and legal, technical, or procedural specifications. In addition to this,

this document includes if and how much financial compensation has been given; and how many participants are allowed to enter the tender.
This document is used to create a general understanding of the project.

- **European Single Procurement Document (ESPD)**
  Also known in Dutch as the *Uniform Europees Aanbestedingsdocument (UEA)* the ESPD is used by contractors to declare that they meet the necessary conditions to participate in the prequalification phase of a public procurement procedure. This document is used in order to analyze the prequalification phase and possible partners in this phase.
- **Bid form**
  The *inschrijvingsbiljet* is a filled in template elaborating on the stated price. This bid form is submitted to the contracting authority and is used to create context on the contract price.
- **Pricing schedule**
  This *financieel eindblad* is an internal document and is used to better understand the final contract price and compare for irregularities between tenders.
- **Tender proposal**
  This is the main submission document detailing the contractor's offer. This document is used to find all partners and often includes (either in the document or separately submitted) an action plan on how the contractor plans to meet all requirements.
- **Notice of award decision**
  This decision document, received from the contracting authority, informs participating contractors on the outcome of the procedure, stating which bidder has won. It shows various amounts of transparency, sometimes showing scores from all participating contractors, to showing only the name of the winning contractor.
- **Internal notes**
  These documents, used for internal collaboration and a better transfer of knowledge internally, have been analyzed to find information that was not released in official documents, but has been written down during the process (e.g., amount of participants in the tender process that were present at the 'final presentation'; where the information on the number of participants has not been provided by the contracting authority).

In addition to this, for each tender, internal data on financial consequences (i.e., how much money/hours is spent on this tender) and on subcontractors (i.e., how many subcontractors have calculated and quoted a price, how much is paid to subcontractors advising in the tendering phase) was requested and analyzed. This data offered insight into the real-world costs and collaborative dynamics of the tendering process.

This document analysis resulted in crucial information necessary to translate the purely theoretical game theory model to a practical model.

### 3.1.2. Expert Interviews

In order to create a validated understanding of the tendering process, semi-structured interviews were conducted with seven professionals involved in public procurement. The interviews were conducted with professionals from governmental agencies (contracting authorities), and tenderers (i.e., the contractor submitting the tender) but will also focus on sub-contractors (e.g., an architect).

One tender has been chosen to find interviewees. Interviewees were selected via purposive sampling based. In a qualitative study, a relatively small and purposively selected sample may be employed, with the aim of increasing the depth (as opposed to breadth) of understanding (Campbell, et al., 2020). By using purposive sampling, interviewees that are most likely to yield appropriate and useful information are selected, using limited research capacity most effectively (Palinkas, et al., 2013).
There have been seven interviews. A generalized overview of interviewees has been created and can be found in Table 05.

*Table 05: Descriptive statistics of chosen interviewees*

| | |
|---|---|
| years of expertise | > 10 |
| # total interviewees | 7 |
| # interviewees contracting authority | 1 |
| # interviewees contractor | 1 |
| # interviewees subcontractor | 5 |

Diversity of information among subcontractors is achieved by interviewing several types, such as construction advisors, architects, and others. While only one individual from the contractor side was interviewed, diversity is introduced through the analysis of multiple tenders. However, there is no diversity among contracting authorities in this interview study, as no additional contracting authorities were contacted since the topic of tendering is business-sensitive and confidential. Only one contracting authority was interviewed; therefore, the results cannot be generalized.

Each interview starts with an ice breaker, through introduction of the study and conversation partners. In the core, information will be asked on the pre-procurement phase, tender costs, and the selection criteria. The main goal of the interview is validation. In addition to this, the interviews also aim to define which results are preferred by different actors (in order to be able to solve the game theory model). The interview guides can be found in appendix A.
Because the different role of all different actors (contracting authority, contractor, and subcontractor), different interview guides will be used.
For the contracting authority, the interview guide focused on the reasons for selecting a DB(M) contract, what type of work they performed, and if they tendered with internal or external expertise.

For a contractor, the focus was placed on the type of work that is performed trying to win the tender, their interactions with the contracting authority, and internal/strategic choices influencing the amount of money that they spent on the tender.
For a sub-contractor, it was important to understand if any (financial) risk was taken by these parties, in addition to their experiences with the selection process.

All interviews were recorded and transcribed, and the relevant data was extracted. Due to business sensitive information, these transcriptions will not be added in the appendix. All information is used anonymously and generalized.

Findings from the qualitative pre-research were used to validate assumptions underlying the game theory model.

## 3.2. Game Theory Modeling

By building on qualitative insights gained from the pre-research, theoretic models were created in the next phase of this research. In order to gain to such a model, a BPMN-diagram has been created. These BPMN-diagrams have already been shown in Section 2.9. Based upon the process map, a game theory model has been developed for the restricted procedure.

### 3.2.1. Process Mapping

Per procedure, a BPMN-diagram has been developed and shown in Section 2.9. A BPMN-diagram is a standardized graphical notation that depicts the steps in a business process from start to finish (Rosing von, White, Cummins, & Man, 2015). BPMN-diagrams break down complex processes into individual tasks, events, and decision points, providing clarity in order to understand the process (Debevoise & Taylor, 2014). It is a useful tool to simplify complex processes because it provides a clear visualization of the sequence of activities and the interactions between different actors (Owen & Raj, 2003).

The structured and detailed nature of BPMN-diagrams provide a solid foundation for developing game theory models. These diagrams help identify decision making moments (and events), that will be translated to game theory.

### 3.2.2. Game Theory Modeling

The application of game theory in this research aimed to analyze the interactions between key actors in the Dutch tendering process for (semi-)public non-residential buildings. Using game theory, this model quantifies the costs (pay-off) of one contracting authority and contractor.

Based on the process map, the theoretical model was created. This model is created as a sequential game between the contracting authority and a contractor. Each step in the process depends on the previous actions.
In addition to this, there is incomplete information in the model. A contracting authority may not have complete information about the contractor's capability. Contractors may

not have a clear overview of the evaluation. Since only one contractor is modelled, the incomplete information between contractors about each other's bid is not modelled.

Figure 10 shows a revised schematic overview of actor interaction in tendering highlighting the analyzed relationship. Because the relationship between contractor and subcontractors have is purely transactional, it has not been analyzed in the game theory model. However, the costs of subcontractors will be added in the game-theory phase to an individual contractors cost.
The subcontractors are either advisory (e.g., architects, construction consultants) or suppliers (i.e., pricing subcontractors, e.g. concrete supplier, vendors)

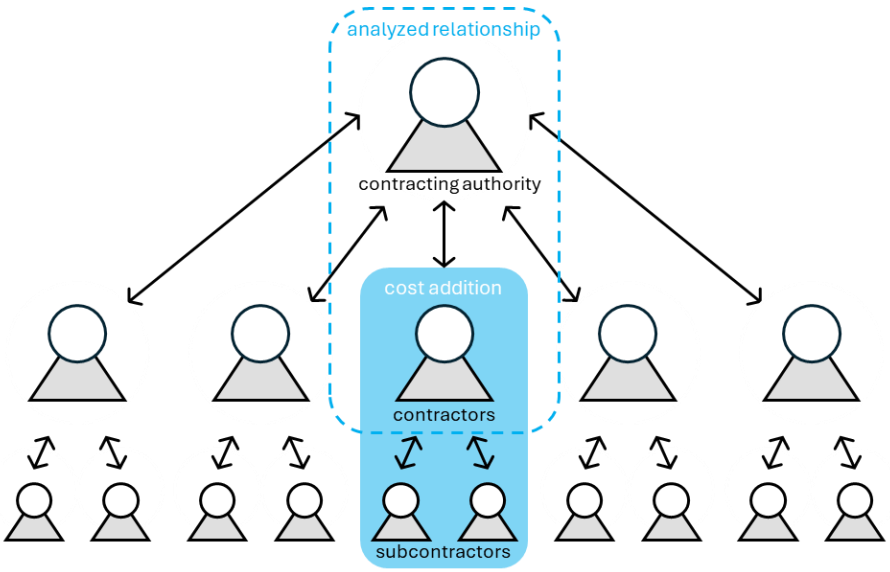


*Figure 10: Actor interaction in tendering highlighting the analyzed relationship*

The payoff structure is determined by the outcomes of the tendering process: a contractor can either win the bid, lose the bid, or lose the pre-qualification.
By feeding this model with data found in the qualitative pre-research, a complete and validated model has been made.
In order to solve the model, it is important to note the differences in motivation between two actors. Whilst the contractor aims to make a profit, the contracting authority aims to procure a new facility. In order to solve this model, it is important to create a value that means the same to the contracting authority as it does to the contractor. This value can be found in creating ordinality between the results (Cruz & Simaan, 2000).
By solving this model, the strategies of different parties have been defined resulting in a given outcome. This outcome defines the cost of honest competition.

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# 4. Determining the Cost of Honest Competition

This section will focus on answering the main research question and create an understanding of how the collective costs contribute to the economic inefficiencies in the Dutch tendering process. First, the theoretical foundation is presented (4.1), then, the results of the qualitative pre-research are shown (4.2), and finally, the price of equal competition quantified through a validated game theory model is given (4.3).

## 4.1. Translating BPMN-Diagram into a Game Theory Model

To come to a validated game theory model, it was important to simplify the complex tendering procedures in a BPMN-diagram. This diagram (Figure 11, earlier referred to as Figure 06) models the basic steps and decisions crucial to the client-contractor relationship.

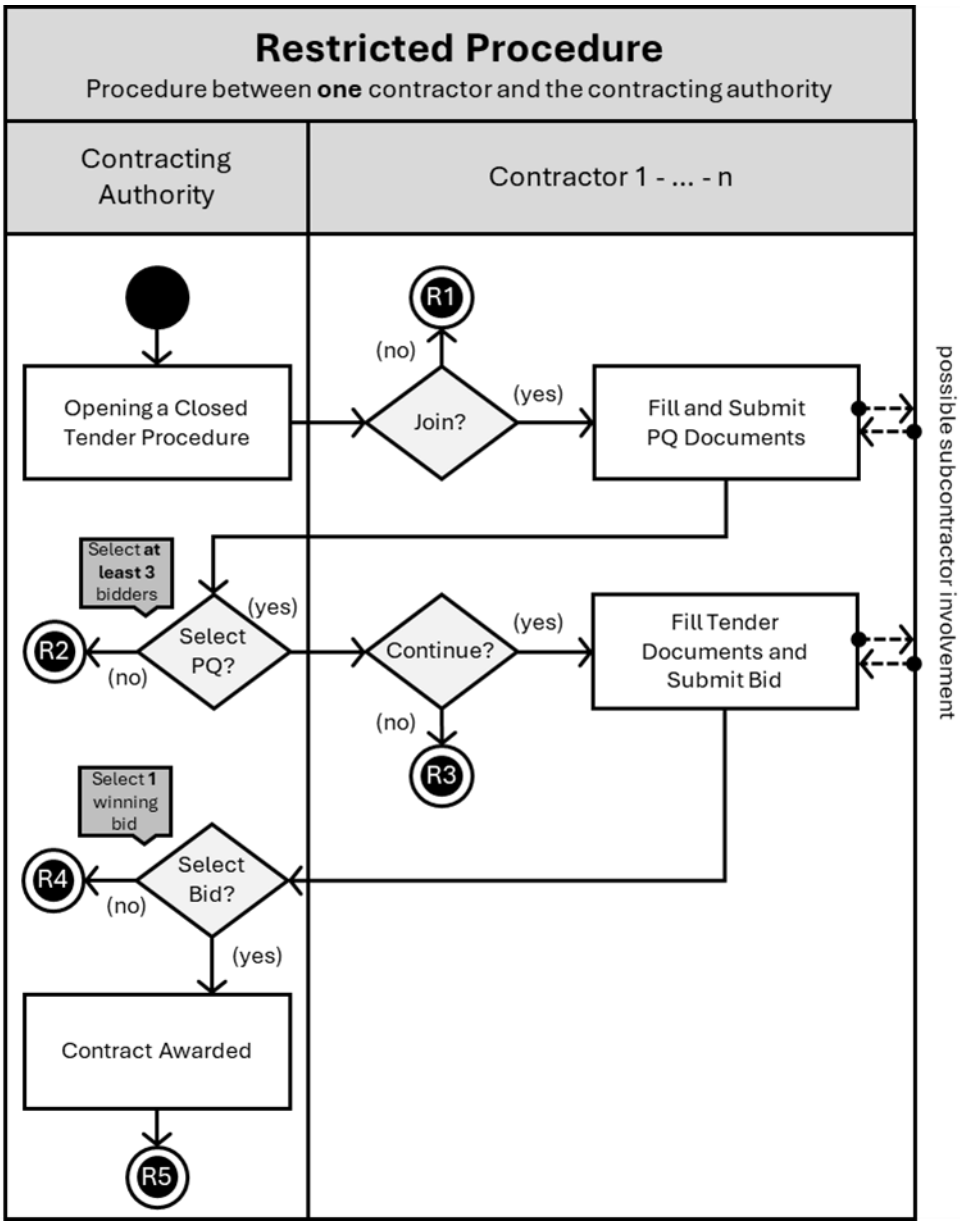


*Figure 11: (repeated) BPMN-diagram of a restricted procedure*

In Table 06, an overview of possible results can be found. Since only examples without contractor withdrawal have been selected there is no possibility of reaching R1 and R3.

*Table 06: Code elaboration*

| Code | Meaning |
|---|---|
| R1 | Contractor chooses not to join after the tendering procedure is opened |
| R2 | PQ application rejected; process stops here |
| R3 | Contractor withdraws after PQ |
| R4 | Tender submitted, not awarded |
| R5 | Tender submitted and awarded |

Based upon this BPMN-diagram, a game theory model (in the form of a decision tree) is created specifying actions of all parties, as well as the possible results. The model is shown in Figure 12. The models assume all contractors act rationally to minimize expected costs, bid preparation costs are known and fixed per contractor, and the likelihood of winning is equally distributed.

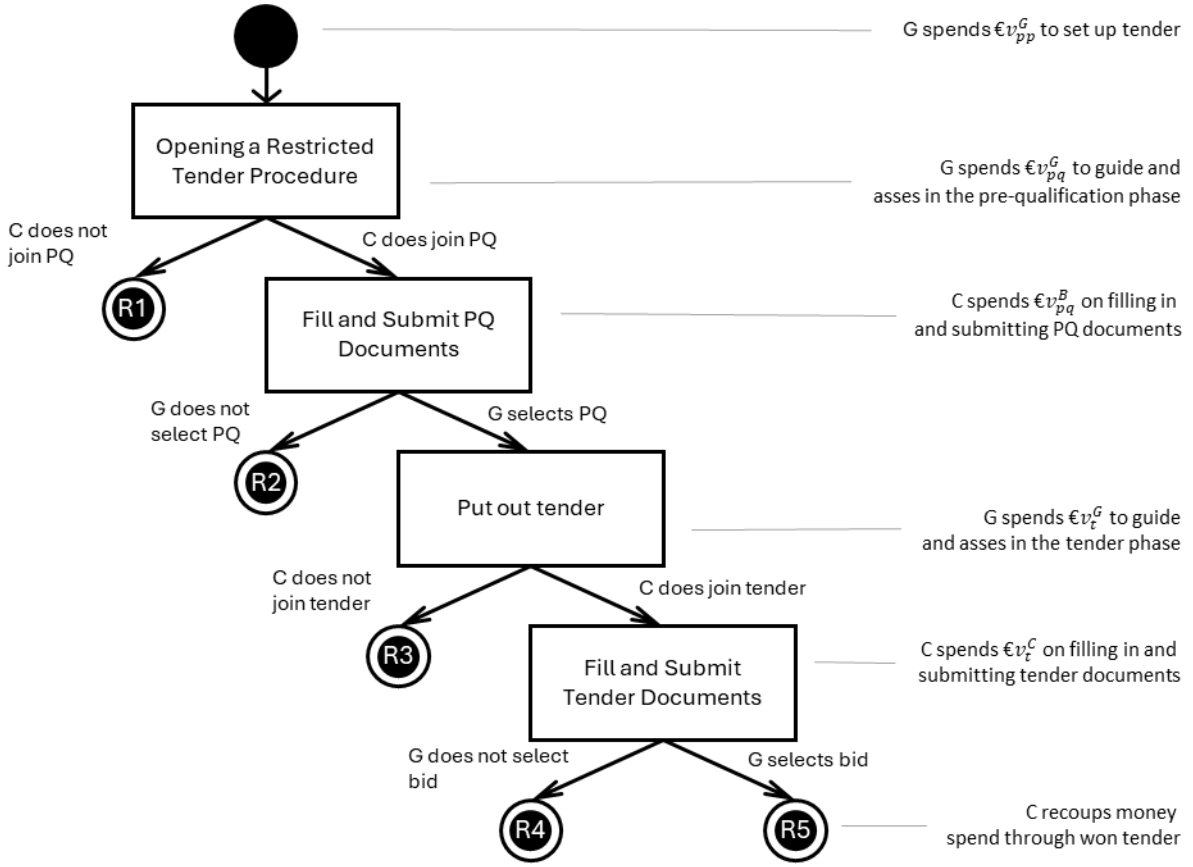


*Figure 12: Game theory model*

Based on this model, a set of calculations were created. The spending of subcontractors has been added to a participating contractor. In order to retain clarity, the superscript for the contracting authority has been defined as 'G' for (semi-)governmental party instead of 'CA' (being too similar close to 'C' contractor). Other definitions are 'C', for contractor, 'B' for bidders side (i.e., the contractor and subcontractor), 'SCa' for advisory subcontractors and 'SCp' for pricing subcontractors. The subscripts can be defined as ''pp' as pre-procurement phase, 'pq' as pre-qualification phase, 't' for tender phase, and 'co' for compensation.

For

| | |
|---|---|
| $n^C$ | amount of contractors in total procedure |
| $a^C$ | amount of contractors left after selection procedure |
| $v_{pp}^G$ | money spent by the contracting authority in the pre-procurement phase |
| $v_{pp}^G$ | money spent by the contracting authority in the pre-qualification phase |
| $v_{pp}^G$ | money spent by the contracting authority in the tender phase |
| $v_{co}^G$ | money spent by the contracting authority compensating losing bidders |
| $v_{pq}^B$ | money spent on the bidders side (contractor and subcontractors) in the pre-qualification phase |
| $v_t^B$ | money spent on the bidders side (contractor and subcontractors) in the tender phase |
| $E(C_{tot}^B)$ | expected costs on the government side |
| $E(C_{tot}^G)$ | expected costs on the contractor side. |

Using these formulas, the basic set of rules can be defined. All possible results (as defined in Table 06) are worked out. As can be seen, there is no difference in the results of R2 and R3, since no work is performed between publishing the results of the pre-qualification, and deciding to join the pre-qualification on both the contractors', and contracting authorities side.

$$(C^G, C^B) = (Costs\ of\ Government, Costs\ on\ the\ Bidders\ side)$$

| | |
|---|---|
| $R1: (v_{pp}^G, 0)$ | $p_1 = 0$ |
| $R2: (v_{pp}^G + v_{pq}^G, v_{pq}^B)$ | $p_2 = \frac{n^C - a^C}{n^C}$ |
| $R3: (v_{pp}^G + v_{pq}^G, v_{pq}^B)$ | $p_3 = 0$ |
| $R4: (v_{pp}^G + v_{pq}^G + v_t^G + v_{co}^G, v_{pq}^B + v_t^B)$ | $p_4 = \frac{a^C - 1}{n^C}$ |
| $R5: (v_{pp}^G + v_{pq}^G + v_t^G, v_{pq}^B + v_t^B)$ | $p_5 = \frac{1}{n^C}$ |

In order to calculate expected costs of the bidders based on these results, all possible outcomes are multiplied with their respective possibilities. To define the expected costs of the governmental party, all costs are added.

$$E(C_{tot}^{B}) = \sum_{i}(p_i * C_i^B) = \frac{n^C \times v_{pq}^B + a^C \times v_t}{n^C}$$
$$E(C_{tot}^{G}) = v_{pp}^G + v_{pq}^G + v_t^G + v_{co}^G \times (a^C - 1)$$

It is important to further define the costs made by contractors, since this often includes payment to advisory subcontractors. Advisory subcontractors often include a bonus/malus performance scheme dependent on winning the tender (e.g., if the tender is lost, -q%, if won, +q%). This thus affects how much is paid. In addition to this, many subcontractors are only asked to quote work to create a better overview of pricing. These contractors are not paid, and not part of the pre-qualification phase.

for

| | |
|---|---|
| $a^C$ | amount of contractors left after selection procedure |
| $n^{SCa}$ | amount of advisory subcontractors in the tender procedure |
| $n^{SCp}$ | amount of pricing subcontractors in the tender procedure |
| $v_{pq}^C$ | money spent by contractor in prequalification phase |
| $v_{pq}^{SCa}$ | money spent by advisory subcontractor in prequalification phase |
| $v_t^C$ | money spent by contractor in tender phase |
| $v_t^{SCa}$ | money spent by advisory subcontractor in tender phase |
| $v_t^{SCp}$ | money spent by pricing subcontractor in tender phase |
| $v_{co}^G$ | money compensated by the government to the contractor for tendering |
| $q$ | bonus/malus percentage |
| $C_{tot}^{B,win}$ | total cost of all parties in the winning bid ((sub-)contractors) |

$$v_{pq}^B = v_{pq}^C + n^{SCa} \times v_{pq}^{SCa}$$
$$v_t^B = v_t^C + n^{SCa} \times v_t^{SCa} \times \left(1 - \frac{q}{a^C}\right) + n^{SCp} \times v_t^{SCp} - v_{co}^G \times \frac{a^C - 1}{a^C}$$

Using the expected costs, an approximation of the cost of honest competition (in € and in a percentage) can be defined of a singular project. The percentual cost of honest competition is averaged out, and this average is stated (and given in Section 4.3) as the definitive cost of honest competition for the analysed tenders.

$$Cost\ of\ honest\ competition\ (CoHC) = E(C_{tot}^B) \times n_C + E(C_{tot}^G) - C_{tot}^{B,win}$$

$$\%(CoHC) = \frac{CoHC}{Total\ Contract\ Price}$$

All different variables will be defined in the qualitative pre-research. Section 4.3 will use the given method in order to calculate the cost of honest competition as a percentage of the total contract price.

## 4.2. Developing and Validating the Game Theory Model

To validate this model and ground it in real world practices, data from seven major tenders were analyzed. In this section, the theoretical game theory model will be developed further and will be validated by the use of internal document analysis and interviews. In Section 4.1, all variables necessary for defining the cost of honest competition have been determined. An overview of these variables can be found in Table 07, as well as the information sources where the necessary information sources can be found. The list of variables has been ordered alphabetically.

*Table 07: List of variables and elaboration on where these variables have been found, or derived*

| Variable | Elaboration | Source |
|---|---|---|
| $C_{tot}^{B,win}$ | total cost of all parties in the winning bid ((sub-)contractors) | calculated |
| $a^C$ | amount of contractors left after selection procedure | The amount of contractors left after selection can sometimes be found in the notice of award decision. If it is not there, it can often be found in the internal notes on the tender. |
| $n^C$ | amount of contractors in total procedure | The amount of contractors in the total procedure can sometimes be found in the notice of award decision. If it is not there, it can often be found in the internal notes on the tender. |
| $n^{SCa}$ | amount of advisory subcontractors in the tender procedure | The role of every advisory subcontractor can often be found in the tender proposal and can thus be found by counting. This variable is checked through records of payment in internally requested documents. |
| $n^{SCp}$ | amount of pricing subcontractors in the tender procedure | The amount of pricing subcontractors in the tender procedure can be found in internally requested documents on this subject. |
| $v_{co}^G$ | money compensated by the government to the contractor for tendering | This amount of money compensated by the government for the work that has been done in submitting a bid can be found in the tender guideline and validated in the internally requested financial documents. |
| $v_{pp}^G$ | money spent by the contracting authority in the pre-procurement phase | The amount of money that is spent by the contracting authority in the pre-procurement phase has been found in the interviews during the qualitative pre-research. |
| $v_{pp}^G$ | money spent by the contracting authority in the pre-qualification phase | The amount of money that is spent by the contracting authority in the prequalification phase has been found in the interviews during the qualitative pre-research. |

| | | |
|---|---|---|
| $v_{pp}^{G}$ | money spent by the contracting authority in the tender phase | The amount of money that is spent by the contracting authority in the tendering phase has been found in the interviews during the qualitative pre-research. |
| $v_{pq}^{B}$ | money spent on the bidders side (contractor and subcontractors) in the pre-qualification phase | Calculated |
| $v_{pq}^{C}$ | money spent by contractor in prequalification phase | The amount of money that is spent by the contractor in the tender phase has been found in internally requested documents and has been validated in the interviews during the qualitative pre-research. |
| $v_{pq}^{SCa}$ | money spent by advisory subcontractor in prequalification phase | The amount of money that is spent by the contractor in the PQ-phase has been found in internally requested documents and has been validated in the interviews during the qualitative pre-research. |
| $v_{t}^{B}$ | money spent on the bidders side (contractor and subcontractors) in the tender phase | Calculated |
| $v_{t}^{C}$ | money spent by contractor in tender phase | The amount of money that is spent by the contractor in the tender phase has been found in internally requested documents and has been validated in the interviews during the qualitative pre-research. |
| $v_{t}^{SCa}$ | money spent by advisory subcontractor in tender phase | The amount of money that is spent by advisory subcontractors in the tender phase can be found in the internally requested |
| $v_{t}^{SCp}$ | money spent by pricing subcontractor in tender phase | The amount of money that is spent by pricing subcontractors in the tender phase has been estimated based on internally requested documents on this subject. |
| $E(C_{tot}^{B})$ | expected costs on the bidders side. | Calculated |
| $E(C_{tot}^{G})$ | expected costs on the government side | Calculated |
| $q$ | bonus/malus percentage | This percentage can be found in internally requested tender agreements between the contractor and subcontractor. |

As stated in Section 3.1, the data received during this document analysis and interviews are business sensitive and will thus not be shown in this report. Section 4.4 includes illustrative quotes that reflect the overall consensus.

## 4.3. Collective Cost Quantification

By having validated data points, the developed game theory model in Section 4.1 can be filled. In order to keep all data secure, example data is used in the report. At the end of this section, the generalized results will show the actual price of honest competition that is found.

Based on the document analysis, an average of 6 participants joined the pre-qualification phase, and 3 participants each joined the tender phase.
These results populate a model that allows for the identification of an optimal strategy. To complete the game theory model, a fictitious case has been used. The data for this hypothetical project, with a contract price of €100,000,000, is presented in Table 08. This data is fictitious, randomly generated, yet remains plausible and representative of real-world scenarios.
A detailed overview of the work performed is also available. It is important to note that only costs directly related to the tendering process have been considered. Other expenditures – such as feasibility studies – have been excluded, as they would have been incurred regardless of whether the project was subject to a tendering procedure.

*Table 08: Fictive spending data*

| Variable | Amount | Elaboration |
|---|---|---|
| Money spent by the governmental party (contracting authority) in the pre-procurement phase | € 500.000 | The contracting authority has costs to decide a procurement strategy (defining what type of procedure fits best), writing the contracts, preparing the prequalification documents (creating prequalification criteria), preparing the tender documents (guideline, award criteria), and a possible market consultation. |
| Money spent by the governmental party (contracting authority) in the prequalification phase | € 100.000 | The contracting authority has costs guiding the prequalification phase (e.g., answering questions), evaluating PQ's reviewing qualifications, financials, certifications, scoring these, and issue results |
| Money spent by the governmental party (contracting authority) in the tendering phase | € 200.000 | The contracting authority has costs in finalizing the tender documents, guiding the tender process (clarifications, issuing extra documents) evaluating each bid (scoring submissions), and issue results. |
| Money compensated by the governmental | € 100.000 | The contracting authority partially compensates a tendering contractor. It is |

| | | |
|---|---|---|
| party (contracting authority) to the contractor for losing tenders | | assumed in this fictive case the contracting authority only compensates losing contractors. |
| Money spent by contractor (and subcontractors) in pre-qualification phase | € 20.000 | The contractors spends money in the prequalification phase on selecting references, preparing proper documentation (financial statements, technical qualifications, and legal declarations). |
| Money spent by contractor (and subcontractors) in tender phase | €1.400.000 | The contractor spends money in the tendering phase on preliminary designs (architects, structural consultants), calculating construction costs, developing a construction schedule, writing an action plan, and legal review. |

It is important to note that this game is played simultaneously between the contracting authority and multiple contractors with result 5 being exclusive to 1 game. The spendings from the contracting authority are also counted only once. Figure 13 shows the filled in game theory.

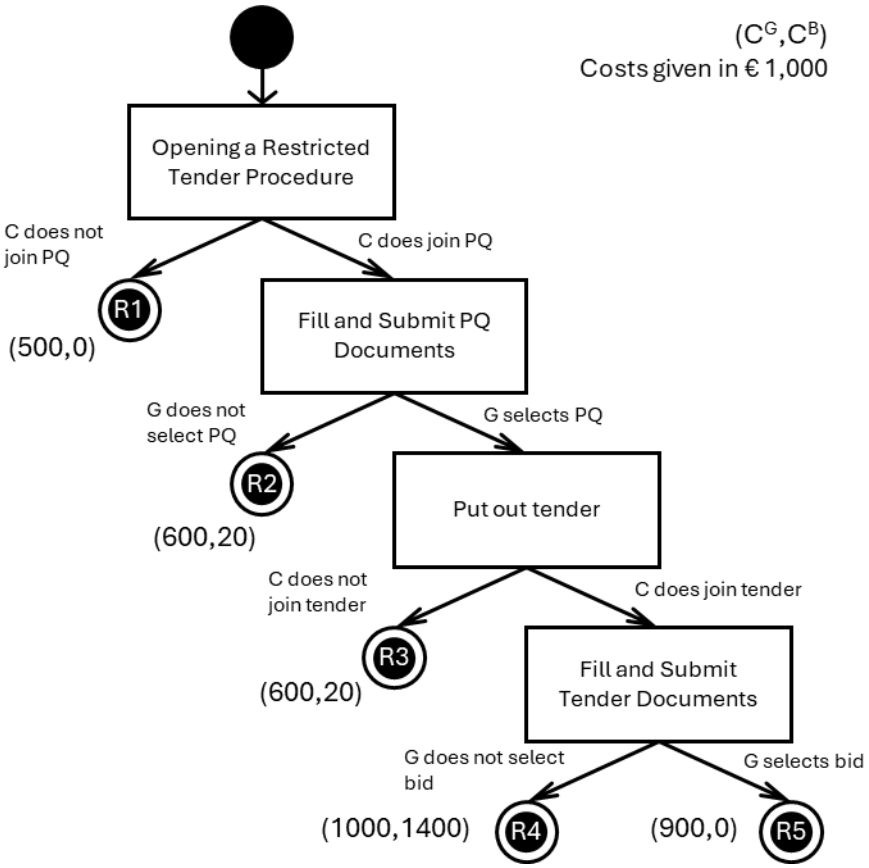


*Figure 13: Filled in game theory model*

Focusing only on financial motives, the results of the game can be found in Table 09. As stated in section 4.2, it is important to note the similarity in expenditure between result 2 and result 3. This is present since no work is performed between R2 (losing the prequalification) and R3 (choosing to withdraw after winning the prequalification).

*Table 09: Solving the game based on financial motives*

| | R1 | R2 | R3 | R4 | R5 |
|---|---|---|---|---|---|
| **Contracting Authority** | 500 | 600 | 600 | 1000 | 900 |
| **Contractor** | 0 | 20 | 20 | 1400 | 0 |
| **cumulative** | 500 | 620 | 620 | 2400 | 900 |

The table only considers financial motivation. The table has been colored to show which results are proffered (green, minimization of cost), and which results are not preferred (red, maximizes costs). When considering only financial motivation, the Nash equilibrium is to aim for outcome R1, as it represents the lowest cost and thus the most financially favorable option. For the contractor, whilst R5 may also yield a positive financial result, it cannot improve its own outcome once R1 is chosen. Similarly, for the contracting authority, R1 is the optimal choice as all other outcomes involve higher costs.
However, this leads to a paradoxical situation in which the Pareto-efficient action is to avoid procuring a new facility altogether – an outcome that does not reflect reality. This discrepancy arises because the contracting authority (i.e., the government) operates with broader motives beyond pure cost minimization, unlike the contractor.

To resolve this issue and make the model meaningful, it is necessary to define an ordinal ranking of the outcomes. All outcomes are ranked from a scale from 1 to 5, with 5 being the most preferred. These rankings are presented in Table 10.
The contractor's ordinal preferences are strictly based on financial considerations (even though in practice a contractor might value a lost tender for reputational or strategic reasons, e.g., demonstrating capability to the contracting authority). Such non-financial motivations are excluded from this analysis.
In contrast, the contracting authority's ordinal rankings are derived from a combination of the literature review, stakeholder interviews, and the completed game theory model.

*Table 10: Ordinality in results for different actors*

| Result | Actor | Order | Elaboration |
|---|---|---|---|
| R1 | Contracting Authority | 2 | It is preferred not to have no contractors joining the pre-qualification phase, since a new facility is then not able to be procured. If this happens, the invitation to tender might not be inviting. |
| | Contractor | 4 | If the contractor is not able to win the tender, a financial perspective prefers them not joining at all. |

| | | | |
|---|---|---|---|
| | | | When the contractor does not join the pre-qualification phase, it makes no unpaid costs. |
| R2 | Contracting Authority | 3 | To not select a contractor in the pre-qualification phase is a neutral result. The contracting authority prefers selecting contractors and having them submit a bid, but this result is better than having contractors withdraw. |
| | Contractor | 3 | To not be selected to tender is a neutral result. The contractor prefers winning the tender, or not having already made the costs in the pre-selection phase, but this result is better than having lost a tender (lot of costs) or deciding to withdraw |
| R3 | Contracting Authority | 1 | If the contracting authority has no contractors that accept the invitation to tender after having been selected for the tendering phase, a new facility is not able to be procured. In this case, the contracting authority has made more costs then in R1, hence this being the least preferred option. If this happens, the invitation to tender might not be inviting. |
| | Contractor | 2 | For a contractor it is not beneficial to spend money on a pre-qualification and then decide not to join after having been given the tender. |
| R4 | Contracting Authority | 4 | When having multiple contractors submit bids, the contracting authority ensures the most value for money by being able to choose. It prefers a winning bid (since this ensures procurement of a facility) but this winning bid can only be exclusive to one contractor. |
| | Contractor | 1 | Losing a tender, whilst having made a lot of costs, is the least beneficial option for a contractor from a financial perspective. It is lost money. |
| R5 | Contracting Authority | 5 | The contracting authority wants to procure a new facility and through this result, it completes that aim. |
| | Contractor | 5 | The contractors most preferred result is to win the tender, and thus be repaid their tender cost, in addition to a beneficial contract to build a new facility for the contracting authority. |

By ranking multiple results, the most beneficial option for both parties can be found in Table 12.

*Table 11: Solving the game with ulterior motives*

| | R1 | R2 | R3 | R4 | R5 |
|---|---|---|---|---|---|
| **Contracting Authority** | 2 | 3 | 1 | 4 | 5 |
| **Contractor** | 4 | 3 | 2 | 1 | 5 |
| **Cumulative** | 6 | 6 | 3 | 5 | 10 |

As can be seen in the table, the optimal strategy for both is winning the tender. However, as stated, a contracting authority plays this game simultaneously with multiple contractors, and only one contractor can win this tender.
A contractor benefits from early certainty (i.e., if it does not win, it rather makes no costs at all). For the contracting authority, in order to achieve the most value for money, it wants to be able to choose between different bids.
The Nash-equilibrium, the strategy all parties aim for, is to reach R5: winning the tender. This equilibrium is also Pareto efficient. Although losing multiple tenders successively, capacity issues, or other reasons, could lead to a strategy change – with the creation of a meta-strategy, one that considers this repetition – this is not taken into account in the calculation due to the unquantifiable nature of these reasons.

By defining the most optimal strategy, the amount of costs that are made following this strategy can be defined as well. For this research, multiple tenders have been analyzed and the method to determine the cost of honest competition has been used in the calculations. In this calculation, 6 interested parties aim to win the tender, and 3 parties get selected to submit a final offer. This is in line with the found average as stated in table 08. Example calculations with an elaboration can be found in appendix B. This appendix guides the reader to understand how the data has been found (since the true calculations cannot be given due to business sensitivity).

Since the contracting authority's spending is not cumulative across simultaneous games – unlike the contractors' costs, which must be considered cumulatively – its impact on the cost of honest competition is direct and linear. A percentual increase in the authority's spending results in a corresponding equal percentual increase in the overall cost of honest competition.
The current calculations assume that the contracting authority's costs amount to 1% of the contract price.

Based on the analysis of multiple tenders, the calculations (elaborated in Appendix B) indicate that the proportion of costs attributable to ensuring honest competition amounts to 4.222% of the total contract price (with a standard deviation of 0.711%).
The standard deviation, divided by the mean provides the coefficient of variation (CoV). For this research, the CoV is calculated to be 16.8%. A CoV of <10% is often strived for, where a CoV of 10-20% is often considered acceptable (Liu, Meerten, Declercq, & Gryllias, 2022). The CoV of 16.8% is considered acceptable. A high CoV (<20%) means the model must be used with caution (sample variability may be too high, and the model may not be considered valid (enough)).

As stated in Section 2.4, the total annual expenditure on tendered contracts in the Dutch built environment is estimated at €29 billion. Applying this ~4.2% benchmark to this figure suggests that approximately €1.218 billion (€1,218,000,000) per year is spent on facilitating honest competition – essentially as sunken costs.
Although this figure is admittedly reductive, and several caveats are present (procurement procedure varies across tenders, contract type differs, and many other contextual factors can influence the percentage). Nevertheless, this extrapolation offers valuable insight into the potential scale of resources invested in ensuring fair competition.

Using the calculations in the appendix, it is also possible to focus on the costs of a single contractor. This section provides an overview of the expected costs (defined as the average expenditure a bidder can anticipate. Table 12 also shows the costs incurred when winning the PQ stage but ultimately losing the tender. The findings indicate that participating in a tender after passing PQ results in an average expenditure of ~1.0% of the contract price.
In addition to the average percentage expenditure, the analysis also present the average absolute expenditure, based on the mean contract price of €65,000,000 across all examined tenders.

*Table 12: Percentage of contract price spent by a bidder to compete for a tender*

| | | Expected Costs | | Spendings if: Win PQ, Lose Tender | |
|---|---|---|---|---|---|
| **Contractor** | **% PQ** | 0.019% | €12,350 | 0.019% | €12,350 |
| | **% Tender** | 0.650% | €422,500 | 0.947% | €615,550 |
| | **%Total** | 0.669% | €434,850 | 0.966% | €627,900 |
| **Subcontractor** | **% PQ** | 0.005% | €3,250 | 0.005% | €3,250 |
| | **% Tender** | 0.012% | €7,800 | 0.029% | €18,850 |
| | **% Total** | 0.019% | €12,350 | 0.034% | €22,100 |

In addition, it is also important to analyze different scenarios. Table 13 shows different scenarios where a differentiation is made in amount of participants. For this scenario, the amount of contractors in the PQ-phase are exactly the same as the amount of contractors in the tender phase.
Calculating this (substituting the values in the calculations; appendix B) Each additional contractor thus results in an increase of 1,29% of the total price of honest competition.

*Table 13: Influence of the amount of contractors on the cost of honest competition*

| **N** | **1** | **2** | **3** | **4** | **5** |
|---|---|---|---|---|---|
| **Cost of Honest Competition (in %)** | 0,000% | 2,443% | 3,735% | 5,028% | 6,320% |

## 4.4. Additional Insights

The interviews have touched upon more information than only validation of the data found. This information has been anonymized and generalized if necessary to protect confidentiality. This section is used to illustrate a general idea on the tendering process and can be used in the next chapter.

The interviews focused on various stages of the tender process. In the interview with the contracting authority, several practical measures were discussed that aim to reduce inefficiencies. Importantly, this reduction is not viewed as a goal in itself, but as a necessity – without minimizing unnecessary effort and sunk costs, fewer contractors are willing to participate.
Additionally, the contracting authority increasingly applies a two-phase approach (with a later price determination point, even allowing adjustment after the tender has been awarded), separating qualitative and financial evaluations to further promote quality-based selection (in complex projects). The focus on quality is considered beneficial with (sub)contractors with one interviewee stating: “I’m positive about the tender format in which a complete design team – including the architect, structural engineer, contractor, cost consultant, and others – is selected based on an integrated vision.”, and “A tender process is much more pleasant to go through when there is a clear separation between the vision and the financial aspects. A two-phase contract is strongly preferred in this regard.”

On the (sub-)contractor’s side, it was noted that the workload on (advisory sub-)contractors is often very high, with DB(M) contracts asking for a worked out preliminary design. One interviewee stated: “These days, when tendering, they include a guideline and attach dozens of appendices to the report.” Another interviewee stated: “The European tender has become a kind of an administrative machine that we are compelled to participate in, because it generates a significant portion of our revenue.” This shows a perceived view that the amount of work has become too much, and also a bit redundant. The interviews reported that this preliminary design is too detailed for the phase of the project.
In the post-selection phase, multiple interviewees preferred a two-phase contract and consider the current shift from the contracting authority to be beneficial.

These additional insights from industry professionals and the contracting authority offer a practical lens through which the earlier findings can be interpreted. They underscore how certain procedural choices and tendering strategies directly influence the economic inefficiencies. The implications of these insights are further explored in the next chapter.

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# 5. Conclusion and Discussion

This thesis set out to investigate the collective costs embedded in the Dutch public tendering process for (semi-)public non-residential buildings, and to explore how game theory could be used to quantify these economic inefficiencies. Through a combination of a literature review, legal analysis, empirical data collection and game theory modeling, this research presents a framework for evaluating the cost of honest competition. This chapter concludes the study by discussing the theoretical and practical implications of the findings, reflecting on the study's limitations and suggesting directions for future research.

## 5.1. Theoretical Implications

The most significant theoretical contribution of this research lies in the integration of the tendering process in the construction industry with game theory. While existing literature has extensively examined the legal and procedural dimensions of procurement (answering sub-question one), a clear research gap remains in quantifying the actual costs incurred by losing bidders – particularly from the contractor's perspective. This gap, identified in the research motivation (Section 1.4), highlights the lack of empirical models that account for the collective sunk costs embedded in public tendering systems. To address this, the study introduces the 'cost of honest competition' and applies a game theory-based approach to capture these hidden inefficiencies.

By conceptualizing the tendering process in a BPMN-model between the contracting authority and the contractor (thus answering sub-question two; what are the key steps in the tender procedure; see Section 2.9), this research develops a structured framework for understanding how these costs accumulate. By answering sub-question three (what way can game theory be used to quantify the inefficiencies), the resulting model (see Section 4.1) provides a way to define these collective costs, the cost of honest competition, which can be used to evaluate (in)efficiency in public procurement (see Section 4.3).

The theoretical model shows that while winning a tender is a Pareto-optimal outcome, the structure of the game makes it inevitable that some actors will incur unrecoverable costs. This concept is grounded in empirical data from seven tenders and interview insights (Section 4.3) which validated the model's assumptions and quantified these inefficiencies.
As stated in Section 3.2.2, The thesis distinguishes between sequential decision-making (between the contracting authority and contractor) and simultaneous competition (among contractors) in order to illustrate how losing adds to the societal costs (this thesis does not delve into the simultaneous competition as from a societal-cost perspective, this is irrelevant).

To develop the game theory model, this thesis translates different motivations into quantifiable outcomes by introducing ordinal payoffs. This framework can be extended in future research to assess other forms of inefficiencies, such as those arising from

policy trade-offs (e.g., value for money vs equal treatment) or those present in different tender procedures (open procedure, etc.).
Importantly, the model underscores that competitive procedures – while effective at preventing corruption and ensuring fairness – can generate wasteful spending of money and capacity. This research highlights a policy tension: more competition does not necessarily inherently lead to a better societal outcome.

## 5.2. Practical Implications

The model calculated that the average cost of honest competition was 4.2% of the total contract price, with each additional losing contractor contributing roughly 1.3% to this cost (Section 4.3). Although admittedly reductive, applying this ~4.2% benchmark to this figure suggests that approximately €1.218 billion (€1,218,000,000) per year is spent on facilitating honest competition – essentially as sunken costs.
These findings hold important implications for both contracting authorities and contractors.

For contracting authorities, the insights suggest a need to balance transparency and fairness with economic efficiency. Since they control the number of tender participants and required work, they can directly influence the cost of honest competitions.
Based on the findings from interviewees (Section 4.4), changes reducing design requirements in early phases (e.g., from detailed to a conceptual level), limiting the amount of participants, and aiming towards two-phased contracts appear promising in reducing the economic inefficiencies within the tendering process, as emphasized by (sub)contractors.
For contractors, the results emphasize the importance of a bid/no-bid analysis (as can be found in Section 4.3, Figure 13). The finding shows that joining a tender after passing PQ leads to an average expenditure of ~1.0% of the contract price (and these costs are typically unrecoverable). Understanding the cost structure of tendering, and the low probability of success in (crowded) tenders can help contractors allocate resource more strategically.
The decision to (mostly) only join tenders that include a pre-selection phase is in line with the aim to minimize sunk costs and avoid repeated sunk costs over time.

The thesis also introduces the concept of a price of honest competition and provides a game-theory model that could guide decision making by policymakers to stimulate various tendering strategies. This has value beyond academic interest – and can directly inform procurement policy and contractor strategy.

## 5.3. Limitations and Future Research

While this study offers valuable insights, it is important to acknowledge its limitations. First, the analysis focuses on the restricted procedure in the Dutch tendering procedure. Whilst this procedure is prevalent, the exclusion of other procedural forms limits the generalizability of these findings. Each different procedure introduces different strategies, and levels of cost for the participants (e.g., an open procedure is riskier to enter but often costs less). This should be explored in future research.

Secondly, the data is partially anonymized and abstracted due to business sensitive information. Although triangulated during interviews and internal documents, some financial values – particularly those of pricing subcontractors – had to be estimated. This introduces a degree of uncertainty in the final quantifications (which can also be found in the high standard deviation), and in addition with a small sample size (only seven tenders were analyzed), better and broader data collection could result in better validation of the final result and reduce the standard deviation.
In addition to this, there is no diversity among contracting authorities in this interview study, as no additional contracting authorities could be contacted since the topic is business-sensitive and confidential. Only one contracting authority was interviewed; therefore, the results cannot be generalized.
Furthermore, the model assumes rational decision-making and does not account for repeated games, or behavioral bias. Incorporating behavioral game theory could offer a richer and more realistic representation of the tendering ecosystem.

To add to this, the study does not explicitly address long-term market effects, such as market dominance of larger firms (due to high costs disproportionately affecting small and medium-sized enterprises who have limited resources to absorb repeated losses). Future research could include long-term strategies (with the possibility of repeated tender losses). This could have implications for innovation, market consolidation, and bid quality.
In addition to what is already stated, future research could build on this work by extending the model to infrastructure and residential projects of all procedural type. It could also incorporate multiple bidders in the game tree rather than focusing on only one, and it could compare outcomes across different (European) procurement regimes.

An alternate angle on future research could be to investigate how the cost of honest competition can be used across the tender landscape. It could be interesting to investigate which procedure, regions, or project types consistently generate disproportionate sunk costs. This provides empirical evidence that guides possible policy intervention (e.g., if healthcare consistently has a high cost of honest competition, why? Can that be changed?).

Lastly, an alternative research angle could be a complete redesign of the game (tender procedures) itself; proposing alternate rules for public tendering that reduce the collective sunk cost.

## 5.4. Closing

This thesis began with a deceptively simple question: What is the real cost of honest competition in tendering? The answer is less simple. While fairness, transparency, and equal opportunity are non-negotiable values in public procurement, they are not costless. Through this research it has become clear that behind every bid lies a hidden price – one paid not just by losing contractors but ultimately paid by society.
Understanding these hidden costs allows us to rethink how we structure tendering, not to weaken the principles and objectives of tendering, but to build on the opportunities that public tendering can provide.

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# Appendices

Appendix A: Interview Guide (13 pages)

Appendix B: Example Calculation (1 page)

# Appendix A: Interview Guides

## Master Thesis: The Price Honest Competition

PTM Canoy

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## NL: Interview Guide – Aanbestedende Partij

Als voorbereiding van dit interview is het noodzakelijk data (kosten en uren) te verzamelen van de partij die ik interview. Het interview is semigestructureerd en duurt een half uur.

| *Onderdeel* | Beschrijving/Vraag | Doel |
|---|---|---|
| *Introductie (5 min)* | Bedankt voor uw deelname aan dit onderzoek. Voordat ik verder ga wil ik toestemming vragen dit interview op te nemen? | Wachten op akkoord, als er geen akkoord kan worden bereikt moet ik mee gaan schrijven. |
| | Dit gesprek is onderdeel van mijn afstudeeronderzoek binnen de master Construction Management & Engineering aan de TU Eindhoven. Het onderzoek gaat over het aanbestedingsproces van (semi-)utiliteitbouw projecten.<br><br>De resultaten van die onderzoek worden uiteraard anoniem verwerkt en uitsluitend gebruikt voor academisch onderzoek. | Kort houden, geen richting in sturen. |
| | Mezelf voorstellen | IJs breken |
| | Gesprekspartner voor laten stellen:<br><br>Beschrijving van je rol binnen je organisatie?<br>Jaren ervaring met tenders? | Het is belangrijk om te weten hoeveel ervaring de geïnterviewde heeft om zo expertise te kunnen bepalen in het onderzoek. |
| *Kern (20 min)*<br><br>*Voortraject* | Wat zijn voor u de belangrijkste overwegingen bij de keuze voor een aanbestedingsprocedure (open, niet-openbaar, concurrentiegerichte dialoog, onderhandeling)?<br><br>En waarom zijn deze factoren belangrijk? | Tweede vraag gebruiken om door te vragen als de eerste vraag hier nog geen antwoord oplevert. |
| | Hoe schat een aanbestedende partij vooraf het aantal potentiële inschrijvers in? | Duidelijk krijgen hoe een aanbestedende dienst een beeld maakt van het aantal potentiële inschrijvers. Doorvragen! |
| *Tenderkosten* | Welke werkzaamheden voert de aanbestedende partij intern en extern uit tijdens een aanbestedingsprocedure? | Duidelijk krijgen welke werkzaamheden opgepakt worden door aanbestedende dienst. |

| | | |
|---|---|---|
| | Hoe verschilt het aantal werk per aanbestedingsprocedure? | Vragen naar verschillen. Vergelijken van varianten. |
| *Selectieprocedure* | Hoe wordt een aanbesteding die binnenkomt beoordeeld? | Duidelijk krijgen hoe dit in de praktijk gebeurt. Hoe veel tijd/geld kost dit, hoe worden punten toegekend. |
| | Hoe ervaren jullie de selectieprocedure? | Bevragen hoe zij het selecteren van een partij ervaren. Is dat regelmatig emotioneel; of zijn er regelmatig mogelijk juridisch complexe situaties? |
| *Bespreken van resultaten* | Mijn onderwerp introduceren.<br><br>De kosten van eerlijke concurrentie zijn nu gedefinieerd als ongeveer 3,5% van de totale aannemerssom. Dat zijn verzonken kosten die moeten worden geabsorbeerd of op andere projecten voor een hogere prijs zorgen. Komt zo'n percentage overeen met jullie inschatting? | Als de mogelijkheid hiervoor is bespreek ik graag de resultaten om te kijken of zij dit ook zo zien. |
| *Afsluiting (5 min)* | Wat vindt u van het aanbestedingsproces in termen van kostenefficiëntie? En tijdsefficiëntie?<br><br>Heeft u nog suggesties of verbeterpunten? | Ruimte geven voor overige opmerkingen, nabranders. |
| | Kort samenvatten | Meeschrijven tijdens interview.<br><br>Vragen of ik het zo goed heb samengevat. |
| | Bedanken | |

## NL: Interview Guide – Aannemer

Als voorbereiding van dit interview is het noodzakelijk data (kosten en uren) te verzamelen van de partij die ik interview. Het interview is semigestructureerd en duurt een half uur.

| *Onderdeel* | Beschrijving/Vraag | Doel |
|---|---|---|
| *Introductie (5 min)* | Bedankt voor uw deelname aan dit onderzoek. Voordat ik verder ga wil ik toestemming vragen dit interview op te nemen? | Wachten op akkoord, als er geen akkoord kan worden bereikt moet ik mee gaan schrijven. |
| | Dit gesprek is onderdeel van mijn afstudeeronderzoek binnen de master Construction Management & Engineering aan de TU Eindhoven. Het onderzoek gaat over het aanbestedingsproces van (semi-)utiliteitbouw projecten.<br>De resultaten van die onderzoek worden uiteraard anoniem verwerkt en uitsluitend gebruikt voor academisch onderzoek. | Kort houden, geen richting in sturen. |
| | Mezelf voorstellen | IJs breken |
| | Gesprekspartner voor laten stellen:<br>Beschrijving van je rol binnen je organisatie?<br>Jaren ervaring met tenders? | Het is belangrijk om te weten hoeveel ervaring de geïnterviewde heeft om zo expertise te kunnen bepalen in het onderzoek. |
| *Kern (20 min)*<br>*Voortraject* | Welke factoren (en waarom) wegen mee in een besluit om wel/niet in te schrijven op een aanbesteding?<br>En waarom zijn deze factoren belangrijk? | Tweede vraag gebruiken om door te vragen als de eerste vraag hier nog geen antwoord oplevert. |
| | Hoe balanceert een aannemer deze verschillende factoren? | Vragen naar conflict tussen deze factoren. Wie maakt keuzes en waarom? |
| | Hoe bepaal je welke onderaannemers meedoen? | Duidelijkheid krijgen in hoe een aannemer bepaalt met wie ze samen gaan/willen werken. |
| *Tenderkosten* | Welke werkzaamheden voert een aannemer intern en extern uit tijdens een aanbestedingsprocedure? | Duidelijk krijgen welke werkzaamheden opgepakt worden door aanbestedende dienst; ook wat ze precies door onderaannemers laten doen. |

| | | |
|---|---|---|
| *Selectieprocedure* | Als een partij geselecteerd is, op welke manier ervaren jullie de selectie?<br><br>Transparantie in selectiecriteria? | Achterhalen wanneer een selectie als prettig wordt ervaren. Heeft een aannemer graag veel transparantie, liever niks, geen mening? |
| *Afsluiting (5 min)* | Afsluitend, heeft u nog suggesties of verbeterpunten voor het aanbestedingsproces? | Ruimte geven voor overige opmerkingen, nabranders. |
| | Kort samenvatten | Meeschrijven tijdens interview.<br><br>Vragen of ik het zo goed heb samengevat. |
| | Bedanken | |

## NL: Interview Guide – Onderaannemer

Als voorbereiding van dit interview is het noodzakelijk data (kosten en uren) te verzamelen van de partij die ik interview. Het interview is semigestructureerd en duurt een half uur.

| *Onderdeel* | **Beschrijving/Vraag** | **Doel** |
|---|---|---|
| *Introductie (5 min)* | Bedankt voor uw deelname aan dit onderzoek. Voordat ik verder ga wil ik toestemming vragen dit interview op te nemen? | Wachten op akkoord, als er geen akkoord kan worden bereikt moet ik mee gaan schrijven. |
| | Dit gesprek is onderdeel van mijn afstudeeronderzoek binnen de master Construction Management & Engineering aan de TU Eindhoven. Het onderzoek gaat over het aanbestedingsproces van (semi-)utiliteitbouw projecten.<br><br>De resultaten van die onderzoek worden uiteraard anoniem verwerkt en uitsluitend gebruikt voor academisch onderzoek. | Kort houden, geen richting in sturen. |
| | Mezelf voorstellen | IJs breken |
| | Gesprekspartner voor laten stellen:<br><br>Beschrijving van je rol binnen je organisatie?<br>Jaren ervaring met tenders? | Het is belangrijk om te weten hoeveel ervaring de geïnterviewde heeft om zo expertise te kunnen bepalen in het onderzoek. |
| *Kern (20 min)*<br><br>*Voortraject* | Wordt u benaderd door aannemers, of zoekt u zelf actief naar samenwerkingen?<br><br>Hoe kiezen jullie met welke partij jullie in zee gaan?<br><br>Hoe kiezen jullie óf jullie meedoen? | Duidelijk beeld krijgen van het proces en wanneer een onderaannemer aansluit. Doorvragen, wat is de verhouding tussen deze twee? |
| *Tenderkosten* | Welke werkzaamheden voert een onderaannemer bij deze tender intern en extern uit tijdens een aanbestedingsprocedure? | Duidelijk krijgen welke werkzaamheden opgepakt worden door een onderaannemer. |
| | Wordt uw partij betaald door werkzaamheden tijdens de tenderfase voordat het contract gewonnen is? | Duidelijk beeld krijgen van financiële risico's die een onderaannemer neemt. Ook het verschil tussen verschillende onderaannemers. |

| | | |
|---|---|---|
| | Draagt u financieel risico als de hoofdaannemer de tender niet wint? | |
| *Selectieprocedure* | Als een partij geselecteerd is, op welke manier ervaren jullie de selectie?<br><br>Transparantie in selectiecriteria? | Achterhalen wanneer een selectie als prettig wordt ervaren. Heeft een onderaannemer graag veel transparantie, liever niks, geen mening? |
| *Afsluiting (5 min)* | Afsluitend, heeft u nog suggesties of verbeterpunten voor het aanbestedingsproces? | Ruimte geven voor overige opmerkingen, nabranders. |
| | Kort samenvatten | Meeschrijven tijdens interview.<br><br>Vragen of ik het zo goed heb samengevat. |
| | Bedanken | |

## ENG: Interview Guide – Contracting Authority

As preparation for this interview, it is necessary to collect data (costs and hours) from the party I am interviewing. The interview is semi-structured and lasts for half an hour.

| *Section* | **Description/Question** | **Purpose** |
|---|---|---|
| *Introduction (5 min)* | Thank you for participating in this research. Before we continue, may I ask for your permission to record this interview? | Wait for approval. If no permission is granted, I will need to take notes manually. |
| | This conversation is part of my graduation research within the Master's program Construction Management & Engineering at Eindhoven University of Technology. The research focuses on the tendering process of (semi-)utility building projects. The results of this research will be processed anonymously and used solely for academic purposes. | Keep it short, do not steer the conversation. |
| | Introduce myself | Break the Ice |
| | Let the interviewee introduce themselves:<br>What is your role within your organization?<br>How many years of experience do you have with tenders? | It is important to know the level of experience of the interviewee in order to determine their expertise for the study. |
| *Core (20 min)*<br>*Pre-procurement Phase* | What are the most important considerations for you when choosing a tendering procedure (open, restricted, competitive dialogue, negotiation)?<br>And why are these factors important? | Use the second question to follow up if the first does not yield a clear answer. |
| | How does a contracting authority estimate the number of potential bidders in advance? | Clarify how a contracting authority forms an idea of the number of potential bidders. Probe further if needed! |
| *Tender Costs* | What internal and external tasks does the contracting authority carry out during a tendering procedure? | Clarify which works are performed by the contracting authority and when. |

| | | |
|---|---|---|
| | How does the amount of work vary per tender procedure? | Ask about the differences. Compare the different types. |
| *Selection Procedure* | How is an incoming tender evaluated? | Clarify how this is done in practice. How much time/money does it take? How are points awarded? |
| | How do you experience the selection procedure? | Ask how they experience the process of selecting a contractor. Is it often emotional? Are there often legally complex situations? |
| *Discussing Results* | Introduce my research topic.<br><br>The cost of fair competition is currently defined as approximately 3.5% of the total contractor sum. These are sunk costs that must either be absorbed or passed on to other projects through higher prices. Does this percentage align with your estimation? | If possible, I would like to discuss the results to see whether they align with the interviewee's views. |
| *Conclusion (5 min)* | What is your opinion on the tendering process in terms of cost-efficiency and time-efficiency? Do you have any suggestions or points for improvement? | Gather feedback on the tendering process. |
| | Summarize briefly | Take notes during the interview. |
| | Thank them | |

## ENG: Interview Guide – Contractor

As preparation for this interview, it is necessary to collect data (costs and hours) from the party I am interviewing. The interview is semi-structured and lasts for half an hour.

| *Section* | Description/Question | Purpose |
|---|---|---|
| *Introduction (5 min)* | Thank you for participating in this research. Before we continue, may I ask for your permission to record this interview? | Wait for approval. If no permission is granted, I will need to take notes manually. |
| | This conversation is part of my graduation research within the Master's program Construction Management & Engineering at Eindhoven University of Technology. The research focuses on the tendering process of (semi-)utility building projects. The results of this research will be processed anonymously and used solely for academic purposes. | Keep it short, do not steer the conversation. |
| | Introduce myself | Break the Ice |
| | Let the interviewee introduce themselves:<br>What is your role within your organization?<br>How many years of experience do you have with tenders? | It is important to know the level of experience of the interviewee in order to determine their expertise for the study. |
| *Core (20 min)*<br>*Pre-procurement Phase* | Which factors (and why) play a role in the decision to participate or not in a tender?<br>And why are these factors important? | Use the second question as a follow-up if the first one doesn't yield a clear answer. |
| | How does a contractor balance these different factors? | Ask about potential conflicts between these factors. Who makes the decisions and why? |
| | How do you determine which subcontractors to involve? | |
| *Tender Costs* | What internal and external tasks does a contractor carry out during a tendering procedure? | Clarify which tasks are handled by the contractor themselves, and which are outsourced to subcontractors. |

| | | |
|---|---|---|
| *Selection Procedure* | Once a party is selected, how do you experience the selection process?<br><br>Transparency in selection criteria? | Explore when a selection process is perceived as fair or pleasant. Does a contractor prefer full transparency, none at all, or have no opinion? |
| *Closing (5 min)* | What is your opinion on the tendering process in terms of cost-efficiency and time-efficiency? Do you have any suggestions or points for improvement? | Gather feedback on the tendering process. |
| | Summarize briefly | Take notes during the interview. |
| | Thank them | |

## ENG: Interview Guide – Subcontractor

As preparation for this interview, it is necessary to collect data (costs and hours) from the party I am interviewing. The interview is semi-structured and lasts for half an hour.

| *Section* | Description/Question | Purpose |
|---|---|---|
| *Introduction (5 min)* | Thank you for participating in this research. Before we continue, may I ask for your permission to record this interview? | Wait for approval. If no permission is granted, I will need to take notes manually. |
| | This conversation is part of my graduation research within the Master's program Construction Management & Engineering at Eindhoven University of Technology. The research focuses on the tendering process of (semi-)utility building projects. The results of this research will be processed anonymously and used solely for academic purposes. | Keep it short, do not steer the conversation. |
| | Introduce myself | Break the Ice |
| | Let the interviewee introduce themselves:<br>What is your role within your organization?<br>How many years of experience do you have with tenders? | It is important to know the level of experience of the interviewee in order to determine their expertise for the study. |
| *Core (20 min)*<br>*Pre-procurement Phase* | Are you approached by contractors, or do you actively seek out collaborations?<br>How do you choose which party to work with?<br>How do you decide whether to participate? | Gain a clear understanding of the process and when a subcontractor joins. Follow up with questions—what is the balance between these two approaches? |
| *Tender Costs* | What internal and external tasks does a subcontractor perform during a tendering procedure? | Clarify which tasks are handled by the subcontractors. |
| | Is your company paid for work done during the tender phase before the contract is awarded? | Gain a clear understanding of the financial risks subcontractors take. Also, explore differences between various subcontractors. |

| | | |
|---|---|---|
| | Do you bear any financial risk if the main contractor does not win the tender? | |
| *Selection Procedure* | Once a party is selected, how do you experience the selection process?<br><br>Transparency in selection criteria? | Explore when a selection process is perceived as fair or pleasant. Does a subcontractor prefer full transparency, none at all, or have no opinion? |
| *Closing (5 min)* | What is your opinion on the tendering process in terms of cost-efficiency and time-efficiency? Do you have any suggestions or points for improvement? | Gather feedback on the tendering process. |
| | Summarize briefly | Take notes during the interview. |
| | Thank them | |

# Appendix B:
# Example Calculation

Let the numers guide you through the elaboration of the example calculation.
Every green cell is Fictive Starting Data

All data is plausible, but random. No conclusions should be drawn based on this data. This appendix is purely illustrative to elaborate on how the calculations are performed.

1

**3 scenarios are established**
possiblity to reach scenario based on # participants

**Cost of Honest Competition**
The cost of honest competition is calculated from the multiple scenarios. In the report, 7 tenders have been analysed and calculated where the result is given as a percentage.

$$Cost\ of\ honest\ competition\ (CoHC) = E(C_C) \times n_C + E(C_G) - C_{tot}^{C,win}$$

$$CoHC = €746{,}667 \times 6 + €1{,}000{,}000 - €1{,}535{,}000 = €3{,}945{,}000$$

$$\%(CoHC) = \frac{CoHC}{Total\ Contract\ Price} = \frac{€3{,}945{,}000}{€100{,}000{,}000} = 3.945\%$$

Note, the 3.9% is hypothetical and does not relect the real life value (calculated to be 4.2%)

**Elaboration on Variables**

| | |
|---|---|
| $C_{tot}^{B,win}$ | total cost of all parties in the winning bid ((sub-) contractors) |
| $n^C$ | amount of contractors in total procedure |
| $E(C_{tot}^B)$ | expected costs on the contractor side. |
| $E(C_{tot}^G)$ | expected costs on the government side |

| | Example | | | |
|---|---|---|---|---|
| **Contract Price** | € 100,000,000 | | | |
| **Participants** | | | | |
| PQ | 6 | | | |
| Tender | 3 | | | |
| **Possibilities** | | | | |
| p(lose PQ) | 0.500 | | | |
| p(win PQ, lose tender) | 0.333 | | | |
| p(win tender) | 0.167 | | | |
| **Costs made by client** | € 1,000,000 | | | |
| **Price of honest competition (in €)** | € 3,945,000 | | | |
| **Price of honest competition (in % of contract price)** | 3.945% | | | |
| **Scenario** | **lose pq** | **win pq, lose tender** | **win tender** | **expected costs** |
| **Contractor** | | | | |
| PQ | € 20,000 | € 20,000 | € 20,000 | € 20,000 |
| Tender | € 0 | € 1,320,000 | € 1,500,000 | € 690,000 |
| Total | € 20,000 | € 1,340,000 | € 1,520,000 | € 710,000 |
| %PQ | 0.020% | 0.020% | 0.020% | 0.020% |
| %Tender | 0.000% | 1.320% | 1.500% | 0.690% |
| %Total | 0.020% | 1.340% | 1.520% | 0.710% |
| **All subcontractors** | | | | |
| PQ | € 5,000 | € 5,000 | € 5,000 | € 5,000 |
| Tender | € 0 | € 90,000 | € 10,000 | € 31,667 |
| Total | € 5,000 | € 95,000 | € 15,000 | € 36,667 |
| %PQ | 0.005% | 0.005% | 0.005% | 0.005% |
| %Tender | 0.000% | 0.090% | 0.010% | 0.032% |
| %Total | 0.005% | 0.095% | 0.015% | 0.037% |
| **Total** | | | | |
| PQ costs | € 25,000 | € 25,000 | € 25,000 | € 25,000 |
| Tender costs | € 0 | € 1,410,000 | € 1,510,000 | € 721,667 |
| **Total costs** | € 25,000 | € 1,435,000 | € 1,535,000 | € 746,667 |
| **Cost Elaboration** | | | | |
| **Contractor** | | | | |
| PQ costs | € 20,000 | € 20,000 | € 20,000 | € 20,000 |
| Tender internal | € 0 | € 1,260,000 | € 1,260,000 | € 630,000 |
| Tender external | € 0 | € 160,000 | € 240,000 | € 93,333 |
| Tender costs compensated | € 0 | € 100,000 | € 0 | € 33,333 |
| Tender costs | € 0 | € 1,320,000 | € 1,500,000 | € 690,000 |
| | **Advisory Subcontractors** | | | |
| PQ costs | € 5,000 | € 5,000 | € 5,000 | € 5,000 |
| Tender internal | € 0 | € 200,000 | € 200,000 | € 100,000 |
| Compensation from contractor | € 0 | € 160,000 | € 240,000 | € 93,333 |
| Tender costs | € 0 | € 40,000 | -€ 40,000 | € 6,667 |
| | **Pricing Subcontractors** | | | |
| PQ costs | € 0 | € 0 | € 0 | € 0 |
| Tender internal | € 0 | € 50,000 | € 50,000 | € 25,000 |
| Compensation from contractor | € 0 | € 0 | € 0 | € 0 |
| Tender costs | € 0 | € 50,000 | € 50,000 | € 25,000 |

Amount of participants is based on the found averages (Section 4.3)

Percentage of total contract price

4

2

3

**Scenario Elaboration**

**Lose PQ:** If the PQ is lost, the contractor and advisory subcontractor has lost money on filling in the PQ, no pricing subcontractor has made costs (since no quotes have been asked).

**Win PQ; Lose Tender:** If the tender is lost, the contractor and both types of subcontractors have spent money aiming to win the tender. The payment to advisory subcontractors is often lower (bonus-malus fee). There is no payment to pricing subcontractors.

**Win tender:** If the tender is won, all advisory subcontractors get paid more then asking price (through a bonus fee). Pricing subcontractors do not get compensated for work during tendering, but could get the job.

**Expected Costs**
To calculate the expected costs, all scenarios are considered (possibility multiplied by the cost). One example has been elaborated in this example.

$$E(C_C) = \sum_i (p_i * C_i^B)$$

$$E(C^B) = €20.000 \times \frac{3}{6} + €1.320.000 \times \frac{2}{6} + €1.500.000 \times \frac{1}{6} = €710.000$$