Enhancing Target Cost Process under NEC4 in Large Infrastructure Projects: A Guideline bringing Theory into Practice

UNIVERSITY OF TWENTE.

Rinkoniên Oosterweelknoop

lantis bouwen aan verbinding

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Preface

This master's thesis represents the culmination of an enriching and challenging journey through the field of Construction Management Engineering. It has been an incredible opportunity to delve into the intricacies of the target costing process under the NEC4 framework, particularly within the context of large infrastructure projects, such as the Oosterweelknoop. The research presented in this thesis aims to bridge the gap between theoretical constructs and practical applications, offering valuable insights and guidelines that can enhance project management practices.

The focus on the NEC4 framework is timely and relevant, given its increasing adoption in the construction industry for its collaborative approach and robust risk management strategies. The Oosterweelknoop project in Belgium provided an exemplary case study, offering a real-world context to explore the complexities and dynamics of implementing the NEC4 contract. This project, with its unique challenges and scope, served as a fertile ground for understanding the nuances of target costing, risk allocation, and collaboration.

My sincere thanks go to my internal supervisors, Drs. Ing. Hans Boes, Dr. Mr. Ir. Marc van Buiten, and Prof. Dr. Ir. Leentje Volker for their guidance, support, and invaluable feedback throughout this journey. Their expertise and insights have been instrumental in shaping this thesis.

I would also like to extend my appreciation to my external supervisors and colleagues, Myron Feldmann and Geertjan Muijs from Mobilis B.V., for their practical insights and support. Their industry experience and perspectives enriched this research, making it more grounded and applicable. Special thanks to my colleagues at Rinkoniên and Lantis for their collaboration and support during the data collection phase. Their willingness to share their experiences and challenges provided a deeper understanding of the practical aspects of the NEC4 framework.

I would like to thank all my colleagues at Rinkoniên for their unwavering support and genuine interest throughout the course of my master's thesis. Your encouragement, insightful discussions, and collaborative spirit have been invaluable in shaping this research. Working alongside such a dedicated and knowledgeable team has not only enriched my understanding of the industry but also made this journey more enjoyable and fulfilling. Thank you for your patience, for sharing your expertise, and for creating an environment where innovation and learning thrive. Your contributions have been instrumental to the success of this thesis, and I am deeply grateful for your support.

Finally, I hope this research contributes to the ongoing efforts to improve project management practices in the construction industry. I look forward to seeing the insights and guidelines developed in this thesis being implemented in future projects, ultimately leading to more efficient, collaborative, and successful project outcomes.

Jurre Brinkman

Antwerpen, July 2024

Executive summary

In recent years, optimizing target costing processes in complex infrastructure projects under the NEC4 framework has gained significant attention. This research seeks to address the challenges inherent in these processes and improve efficiency and collaboration.

The NEC4 framework is favoured for its emphasis on fostering collaboration and effective risk management. Early contractor involvement in the design process under NEC4 ensures that substantial effort is invested when the design is still developing, and risks are at their highest. This approach offers numerous advantages, including enhanced risk and cost management, opportunities for innovation, and reduced fragmentation of expertise. However, the intricacies of the target costing process within NEC4 necessitate a cooperative approach to price development between clients and contractors. The objective of this research is to analyse and refine the target costing process in large-scale infrastructure projects, emphasizing insights drawn from the Oosterweelknoop project to inform future projects. The research aims to identify theoretical patterns, gain insights from practical situations, and compare them to explore how a guideline for the collaborative target costing process in Phase 1 of the NEC4 framework can be conceptualized to enhance project management practices and foster collaboration between contractors and clients. Eventually, how this can be effectively applied and adapted to improve the target costing process amidst concurrent activities, evolving project parameters, and associated risks.

To address this question, the research adopted a mixed-methods approach. Initially, a comprehensive literature review was conducted, examining existing knowledge on target costing, the NEC4 framework, and collaborative practices in construction. Recognizing gaps in the literature, the study then proceeded with an in-depth case study of the Oosterweelknoop project. This case study involved semi-structured interviews with key stakeholders and thematic analysis of the data collected. Key findings from the research highlighted several important aspects. Early contractor involvement (ECI) significantly enhanced the target costing process by improving communication, reducing risks, and fostering a collaborative environment. However, to fully leverage the benefits of ECI, clear guidelines and effective stakeholder management are essential. Effective risk management practices also emerged as crucial. Proactive identification and mitigation of risks early in the project lifecycle are necessary to prevent cost overruns and delays. Additionally, aligning prices during the project's early phases through transparent negotiations and continuous monitoring is vital to ensure that the target costing process remains effective and realistic.

The outcome of this research was a practical guideline for the target costing phase. This guideline integrates theoretical patterns from both literature and empirical findings, focusing on three main aspects: collaboration and communication, risk management, and cost monitoring. Establishing clear channels and protocols for stakeholder interaction enhances cooperation and understanding, while proactive risk identification and mitigation strategies address potential issues early in the project lifecycle. Utilizing tools and techniques for continuous cost assessment and adjustment ensures financial control throughout the project. Document analysis and interviews with representatives from both client and contractor sides who participated in the target costing process provided empirical support. Validation of the guideline was achieved through expert evaluation. Validation involved feedback from industry experts, assessing the completeness and applicability of the guideline in real-world scenarios.

The research concluded with a refined model comprising critical success factors for optimizing the target costing process in NEC4 projects. These factors were categorized into themes based on the identified obstacles and are essential at both the project initiation and during the design phase. The final model included critical success factors, essential for effective target costing, and indirect success factors that support other critical success factors, ensuring a comprehensive approach to optimization. Recommendations for practice include the adoption of the developed guideline by construction firms to enhance their target costing processes. Furthermore, the study suggests additional research to refine the guideline and explore its applicability in different project contexts and geographical regions.

This study provides a robust framework for improving target costing in complex infrastructure projects, contributing valuable insights to both academic literature and industry practice. By adopting the proposed guideline, construction firms can achieve better cost control, enhanced collaboration, and improved project outcomes under the NEC4 framework.

Executive summary (Dutch)

In de afgelopen jaren is het optimaliseren van doelkosten processen in complexe infrastructuurprojecten onder het NEC4-raamwerk steeds meer aandacht gaan krijgen. Dit onderzoek richt zich op het aanpakken van de uitdagingen die inherent zijn aan deze processen en het verbeteren van efficiëntie en samenwerking.

Het NEC4 raamwerk wordt geprezen om zijn nadruk op samenwerking en effectief risicomanagement. Vroege betrokkenheid van aannemers bij het ontwerpproces onder NEC4 zorgt ervoor dat er substantiële inspanningen worden geleverd wanneer het ontwerp zich nog ontwikkelt en de risico's het grootst zijn. Deze benadering biedt tal van voordelen, waaronder verbeterd risicobeheer en kostenbeheer, kansen voor innovatie en minder versnippering van expertise. Echter, de complexiteit van het doelkost proces binnen NEC4 vereist een coöperatieve aanpak bij het prijsontwikkelingsproces tussen opdrachtgevers en aannemers. Het doel van dit onderzoek is om het doelkost proces in grootschalige infrastructuurprojecten te analyseren en te verfijnen, met nadruk op inzichten uit het Oosterweelknoop-project om toekomstige projecten te informeren. Het onderzoek heeft tot doel theoretische patronen te identificeren, inzichten te verkrijgen uit praktische situaties en deze te vergelijken om te onderzoeken hoe een richtlijn voor het samenwerkingsgerichte doelkost proces in fase 1 van het NEC4-framework kan worden geconceptualiseerd om projectmanagementpraktijken te verbeteren en samenwerking tussen aannemers en opdrachtgevers te bevorderen. Uiteindelijk hoe dit effectief kan worden toegepast en aangepast om het doelkost proces te verbeteren te midden van gelijktijdige activiteiten, evoluerende projectparameters en bijbehorende risico's.

Om deze vraag te beantwoorden, hanteert het onderzoek een mixed-methods benadering. Aanvankelijk werd een uitgebreide literatuurstudie uitgevoerd, waarbij bestaande kennis over "target costing", het NEC4 raamwerk en samenwerkingspraktijken in de bouw werd onderzocht. Door lacunes in de literatuur te herkennen, ging de studie vervolgens verder met een diepgaande casestudy van het Oosterweelknoop-project. Deze casestudy omvatte semigestructureerde interviews met belangrijke belanghebbenden en thematische analyse van de verzamelde gegevens. Belangrijke bevindingen uit het onderzoek benadrukken verschillende belangrijke aspecten. Vroege betrokkenheid van aannemers verbetert het doelkost proces aanzienlijk door communicatie te verbeteren, risico's te verminderen en een samenwerkingsomgeving te bevorderen. Echter, om de voordelen van het vroegtijdig betrekken van de aannemer volledig te benutten, zijn duidelijke richtlijnen en effectief stakeholdermanagement essentieel. Ook effectieve risicomanagementpraktijken kwamen naar voren als cruciaal. Proactieve identificatie en mitigatie van risico's in een vroeg stadium van de projectlevenscyclus zijn noodzakelijk om kostenoverschrijdingen en vertragingen te voorkomen. Bovendien is het van vitaal belang om prijzen tijdens de vroege fasen van het project af te stemmen door middel van transparante onderhandelingen en continue monitoring om ervoor te zorgen dat het doelkost proces effectief en realistisch blijft.

Het resultaat van dit onderzoek was een praktische leidraad voor het doelkost proces. Deze leidraad integreert theoretische patronen uit zowel de literatuur als empirische bevindingen, met de nadruk op drie hoofdaspecten: samenwerking en communicatie, risicobeheer en kostenbewaking. Het opzetten van duidelijke kanalen en protocollen voor interactie tussen belanghebbenden verbetert de samenwerking en het begrip, terwijl proactieve risicobeoordelings- en mitigatiestrategieën mogelijke problemen vroeg in de projectlevenscyclus aanpakken. Het gebruik van tools en technieken voor continue kostenbeoordeling en -aanpassing zorgt voor financiële controle gedurende het hele project. Documentanalyse en interviews met vertegenwoordigers van zowel de klant- als de aannemerszijde die deelnamen aan het doelkost proces leverden empirische ondersteuning. Validatie van de leidraad werd bereikt door middel van evaluatie door deskundigen. Validatie omvatte feedback van experts uit de industrie, waarbij de volledigheid en toepasbaarheid van de leidraad in realistische scenario's werd beoordeeld.

Het onderzoek concludeert met een verfijnd model dat kritieke succesfactoren omvat voor het optimaliseren van het doelkost proces in NEC4-projecten. Deze factoren zijn gecategoriseerd in thema's op basis van de geïdentificeerde obstakels en zijn essentieel zowel bij de projectinitiatie als tijdens de ontwerpfase. Het uiteindelijke model omvat kritieke succesfactoren die essentieel zijn voor effectief "target costing", evenals indirecte succesfactoren die andere kritieke succesfactoren ondersteunen, wat zorgt voor een uitgebreide benadering van optimalisatie. Aanbevelingen voor de praktijk omvatten de adoptie van de ontwikkelde leidraad door bouwbedrijven om hun doelkost processen te verbeteren. Bovendien suggereert de studie aanvullend onderzoek om de leidraad verder te verfijnen en de toepasbaarheid ervan in verschillende projectcontexten en geografische regio's te verkennen.

Deze studie biedt een robuust kader voor het verbeteren van doelkosten in complexe infrastructuurprojecten, en levert waardevolle inzichten voor zowel de academische literatuur als de industriële praktijk. Door de voorgestelde leidraad te adopteren, kunnen bouwbedrijven beter kostenbeheer, verbeterde samenwerking en verbeterde projectresultaten bereiken onder het NEC4-raamwerk.

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1. Introduction

Large engineering projects without delays, cost overruns, or technical issues appear to be uncommon (Koppenjan, Veeneman, van der Voort, ten Heuvelhof, & Leijten, 2011). Such projects are typically unique, particularly in the realm of large engineering projects where the involved parties, including decision-makers, project managers, engineers, contractors, and operators, often encounter situations with no prior experience (Koppenjan, Veeneman, van der Voort, ten Heuvelhof, & Leijten, 2011). Fulfilling the promises made by these projects has proven to be a challenge.

The construction industry in most countries in the world is one of extreme competitiveness, with high risks, and margins of profit generally low when compared to other areas of the economy. Consequently, pricing is one of the most important aspects of marketing in construction (Mochtar & Arditi, 2000). In the conventional approach, procurement strategies typically centre around competitive tendering, relying on elaborate and stringent contracts, followed by rigorous monitoring and supervision (Eriksson, et al., 2019). Considering the inherent complexity and uniqueness of large engineering projects, the conventional approach may not be well-suited for addressing the dynamic nature of large engineering projects. Nevertheless, contemporary research suggests that intricate infrastructure projects necessitate innovative management approaches. These advocate for fostering flexibility in addressing change through collaborative teams, emphasizing adaptability over rigid planning and control (Eriksson, et al., 2019). The implementation of new integrated contracts, such as DC (Design and Construct), DBFM (Design-Build-Finance-Maintain) or the New Engineering Contract 4th edition (NEC4), is crucial to ensure effective project cost and risk management. These contracts are designed to address and mitigate common issues associated with large-scale projects, offering a structured framework that promotes collaboration, risk-sharing, and efficient management throughout the project lifecycle.

The New Engineering Contract (NEC) is known for its comprehensive set of tools that facilitate effective communication and cooperation between project stakeholders (nec, 2024). The NEC4 contract, short for New Engineering Contract 4th edition, is the latest iteration of a suite of contracts developed by the Institution of Civil Engineers (ICE) in the United Kingdom. The NEC contract series emerged in the 1990s as a response to the perceived shortcomings of traditional construction contracts, which often resulted in disputes, delays, and cost overruns in the UK. The NEC contracts were designed to promote collaboration, flexibility, and risk management throughout the project lifecycle. The first edition, NEC1, was published in 1993, followed by NEC2 in 1995, NEC3 in 2005 and NEC4 in 2017. These contracts have different pricing and procurement options, such as target costing or the traditional 'lump sum.' Each subsequent edition incorporated feedback from users and reflected evolving best practices in project management and procurement. NEC4, introduced in 2017, builds upon the principles of its predecessors while incorporating updates and enhancements to address contemporary challenges in the construction industry.

One of the key objectives of NEC4 was to further streamline and clarify the contract language, making it more accessible to a wider audience. NEC4 also introduced new contract forms and options, to better accommodate different project types and procurement strategies. For example, it includes contracts tailored for collaborative working (NEC4 Alliance Contract), as well as provisions for building information modelling (BIM) and early contractor involvement (ECI). One of the standout features of the NEC4 contract is its flexibility, allowing parties to cherry-pick contractual options that best suit the specific requirements of their project. This tailored approach enables stakeholders to create an ideal contractual framework that aligns with their objectives, mitigates risks, and promotes efficiency throughout the project lifecycle.

The introduction of NEC4 contracts represents a significant advancement in addressing the challenges inherent in large-scale infrastructure projects (nec, 2024). However, despite its structured framework and emphasis on collaboration and trust, the implementation of NEC4 may encounter certain challenges. These challenges could include difficulties in effectively integrating the target costing process with the dynamic landscape of design changes, execution works, and associated risks. Additionally, stakeholders may face hurdles in adapting to the novel contractual provisions and collaborative mechanisms introduced by NEC4. It is essential to acknowledge and address these challenges to ensure the successful implementation and utilization of NEC4 contracts in large engineering projects.

1.1. Problem context

In this section, a brief overview is provided of the Oosterweelknoop project in Belgium. Next to this, an overview of the use of the NEC4 contract and its intricacies at the Oosterweelknoop project is provided in this section. For a more detailed overview, please refer to Appendix A2.

The Oosterweelknoop project, located in Antwerp Belgium, is a transformative infrastructure initiative overseen by client Lantis. Spearheaded by a consortium of esteemed contractors including Mobilis | TBI, Boskalis, Artes Group, Stadsbader, and CIT Blaton, collectively known as Rinkoniên, the project aims to revolutionize the region's transportation network. This significant endeavour involves the development of multiple infrastructure components, notably the construction of the Oosterweelknoop at the northern edge of Antwerp, near the Oosterweel church on the right bank (Lantis, 2024). This interchange, situated below ground level, integrates the Scheldetunnel with the Canal Tunnels, forming a crucial link in completing the Antwerp Ring Road network. With on and off-ramps connecting to the port and the northern part of the city, the interchange facilitates access to key areas while minimizing its environmental footprint through compact design and a distinctive paperclip shape. Additionally, a covered portion of the interchange will accommodate the Ringpark Noordkasteel.

Introduction to NEC4 Use in Belgium:

In Belgium, groundbreaking strides are being made as these projects are executed for the first time under the NEC4 contract. For this project Lantis has selected the NEC4 Engineering and Construction Contract. Within this contract the main payment option C (Target contract with activity schedule) has been selected as well as the option of Early Contractor Involvement (X22, ECI). The NEC4 contract is an English contract which has been specially translated into Flemish to make it executable here.

Intended Use of NEC4:

Figure 1 - Overview of the Oosterweelverbinding.

The NEC4 contract, utilizing options C and X22, functions in two distinct phases. As a result of Lantis' selection of Option C: Target Cost and Option X22: Early Contractor Involvement, the contract effectively adopts a two-phase structure. In the initial contract/agreement, the contractor assumes the exclusive opportunity to submit the initial bid for the subsequent contract (van der Pas, 2021). Consequently, project pricing is segmented into distinct phases, each viewed independently (Uzun, 2022). Phase 1 involves collaborative target costing, where the client and contractor finalize project scope and agree on a target cost based on the Definitive Design. Phase 2 sees the contractor executing works based on the established design, with the client paying directly for costs incurred.

Use at Oosterweelknoop Project:

At the Oosterweelknoop project, the NEC4 Option C X22 contract, though novel in Belgium, is being employed. The project's unique circumstances, including ongoing design finalization, risk allocation negotiations, and outdoor conditioning works, complicate the target costing process. These simultaneous processes introduce uncertainties in cost estimation, risk assessment, and design adaptation, underscoring the need for adaptability and effective communication among stakeholders. Here, preliminary works are crucial for site readiness, yet their execution faces challenges due to the need for cost estimates prior to issuance of scope instructions by the client, Lantis. This reactive approach, driven by political and organizational factors, hampers collaboration envisioned by the NEC4 framework. By structuring the target costing process in this way, four critical processes are created.

1. The ongoing finalization and potential changes to the design pose a challenge as the project team attempts to establish a target cost based on a design that may still be evolving.
2. Simultaneous risk allocation negotiations, alongside other processes, can complicate risk identification and allocation, potentially resulting in oversights or misjudgements.
3. Effective risk allocation ensures accurate project cost estimation and fosters collaboration between clients and contractors. Addressing shared risks in projects adds complexity to the negotiation process regarding risk allocation.
4. Unforeseen factors in outdoor conditioning works impact target cost estimation, necessitating comprehensive risk allocation between clients and contractors. The dynamic nature of outdoor conditioning works underscores the importance of flexibility and contingency planning within the NEC4 framework.

1.2. Problem statement

The OosterweelKnoop project, operating under the NEC4 Engineering and Construction Contract (ECC) Option C (Target contract with activity schedule) as well as Early Contractor Involvement (X22, ECI), encounters difficulties in effectively executing the target costing process due to concurrent project activities and evolving project parameters. Challenges arise in aligning the target costing process with the dynamic landscape of design changes, execution works, and associated risks.

2. Research design

This section outlines the research design, which encompasses the research objective and the research questions formulated to achieve it. Subsequently, it delineates the research scope and the chosen research approach. The research approach encompasses the methods employed to gather data necessary for addressing the research questions.

2.1 Research objective

The objective of this research is to analyse and refine the target costing process in large-scale infrastructure projects, emphasizing insights drawn from the Oosterweelknoop project to inform future projects. This involved identifying theoretical patterns in the target costing process and testing these patterns against the dynamic and complex realities of the OosterweelKnoop project. The research aims to identify best practices, gain insights from practical situations, and compare them to explore how a guideline for the collaborative target costing process in Phase 1 of the NEC4 framework can be conceptualized to enhance project management practices and foster collaboration between contractors and clients. Eventually, how this can be effectively applied and adapted to improve the target costing process amidst concurrent activities, evolving project parameters, and associated risks.

As this master's thesis project focuses on analyzing the target costing process. The emphasis on NEC4 and the Oosterweelknoop project reflects the interests of the Belgian Government, which aims to improve the implementation of NEC4 in future large-scale infrastructure projects. Additionally, the partners of the Rinkoniên consortium (Boskalis, Mobilis, Artes Group, CIT Blaton, and Stadsbader) have a vested interest in this contract, as it is likely to be utilized more frequently in the future. Therefore, providing a possible guideline for shaping the target costing process efficiently and effectively could benefit both the Client and Contractor for future projects, facilitating cooperation and reducing planning and cost inefficiencies.

2.2 Research gap

The research gap includes the introduction of a new contract type in the Belgian and Dutch construction industries. While there exists theoretical understanding, particularly from experiences in England, practical implementation remains significantly limited. As a result, both contractors and clients are navigating through the complexities of the target costing process. This research aims to address these gaps by testing and evaluating theoretical patterns within the context of the Oosterweelknoop project. By assessing their effectiveness and adaptability, the study aims to develop practical insights and strategies. These insights are intended to enhance the target costing process in similar infrastructure projects seeking to implement the NEC4 contract framework.

2.3 Research goals

To achieve the main objective of this research, sub-goals were established to provide a structured approach. These goals were split into three categories: normative, descriptive, and prescriptive. Normative aims to establish standards or norms to evaluate or make judgments about certain phenomena. It is concerned with what ought to be, providing recommendations or guidelines based on established values, ethical principles, or theoretical frameworks. This type of questions often addresses what is ideal or desirable and seeks to identify theoretical patterns or optimal conditions (University of Twente, 2024). Descriptive, on the other hand, focuses on systematically describing phenomena as they are, without making value judgments or recommendations. It involves collecting data to present an accurate picture of the current state or characteristics of the subject under study, often using methods such as surveys, observations, and case studies. The goal of descriptive questions is to understand the "what" of a phenomenon by detailing its features, patterns, and underlying mechanisms (University of Twente, 2024). Prescriptive goes a step further by offering specific strategies or solutions to address issues identified through normative or descriptive questions. It is action-oriented, providing practical recommendations to achieve desired outcomes, often based on empirical evidence or best practices. Prescriptive questions aim to answer the "how" by suggesting interventions, policies, or practices that can effectively address identified problems or enhance desired outcomes (University of Twente, 2024). Together, these three goals offer a comprehensive approach to understanding and addressing complex issues from multiple angles, ensuring a well-rounded and actionable body of knowledge.

- *Normative*
  - Identifying key concepts and theories from literature relevant to project management and collaboration in infrastructure projects in relation to the target costing process, under the NEC4 framework.
  - Establishing theoretical patterns for target costing in complex infrastructure projects and assess their applicability and effectiveness in phase 1 of the NEC4 framework.
- *Descriptive*
  - Examine the current organization and management of the target costing process within the Oosterweelknoop project during phase 1.
  - Identify and document specific examples of successful practices and bottlenecks in the target costing process at Oosterweelknoop during Phase 1 that impact project management practices and collaboration between contractors and clients. Thus, establishing the empirical pattern.
- *Prescriptive*

  Guideline Conceptualization:

  - Synthesize insights from theoretical patterns and the case study findings to conceptualize a framework for a guideline on collaborative target costing in Phase 1 of infrastructure projects under the NEC4 framework.
  - Propose key components and strategies for the guideline that aim to improve project management practices and enhance collaboration between contractors and clients in the Belgian context.

By achieving these sub-goals, the research aims to provide a comprehensive analysis of current practices and challenges in the target costing process, as well as to propose a conceptual framework for a guideline. This framework will be tailored to optimize project management practices and foster collaboration in Phase 1 of infrastructure projects under the NEC4 framework, specifically addressing the unique context of the Belgian setting.

2.4 Research scope

This section outlines the parameters within which the research operates. Figure 2 visualises the research scope, which this subchapter explains.

This study aims to assess the effectiveness of implementing a collaborative target cost process during the design and target costing phase, distinguishing it from the earlier procurement phase and later execution phases. The focus is on the Engineering and Construction Contract (ECC) within the NEC4 suite, particularly emphasizing payment option C, Target Contract with Activity Schedule. The objective is to enhance project management practices and foster robust collaboration between contractors and clients. By closely examining the target cost process within the NEC4 framework, the research will explore its intricate components and foundational principles. It will cover the design and target costing phase up to the agreement on the initial target cost, excluding subsequent adjustments via compensation events and the final target cost. A key aspect of the study is to highlight the importance of early contractor involvement in both shaping and executing the process.

Through a detailed analysis of collaborative efforts between contractors and clients, the research aims to uncover insights into how such synergistic processes can improve project management efficiency and overall project success. Discussions about political pressures on the target costing process, commonly seen in large infrastructure projects, will be deliberately excluded. Additionally, while the study will consider perspectives from both clients and contractors, it will intentionally omit views from consultants and subcontractors.is research is poised to explore the effectiveness of implementing a collaborative target cost process within the design and target costing phase, delineating its parameters from the prior procurement phase and subsequent execution phases. Focused primarily on the Engineering and Construction Contract (ECC) within the NEC4 suite, particularly emphasizing payment option C, Target contract with activity schedule, this study aims to uplift project management practices and foster robust collaboration between contractors and clients. With a meticulous examination of the target cost process within the NEC4 framework, this research will delve into its intricate components and foundational principles. A pivotal aspect will be highlighting the importance of early contractor involvement in both shaping and executing this process. Through a comprehensive analysis of collaborative endeavors between contractors and clients, the research seeks to unveil insights into how such synergistic processes can enhance project management efficiency and overall project success. It's essential to clarify that discussions concerning political-driven pressures on the target costing process, often observed in large infrastructure projects, will intentionally be omitted from the research scope. Moreover, while considering perspectives from both clients and contractors, the perspectives of consultants and subcontractors will be excluded.

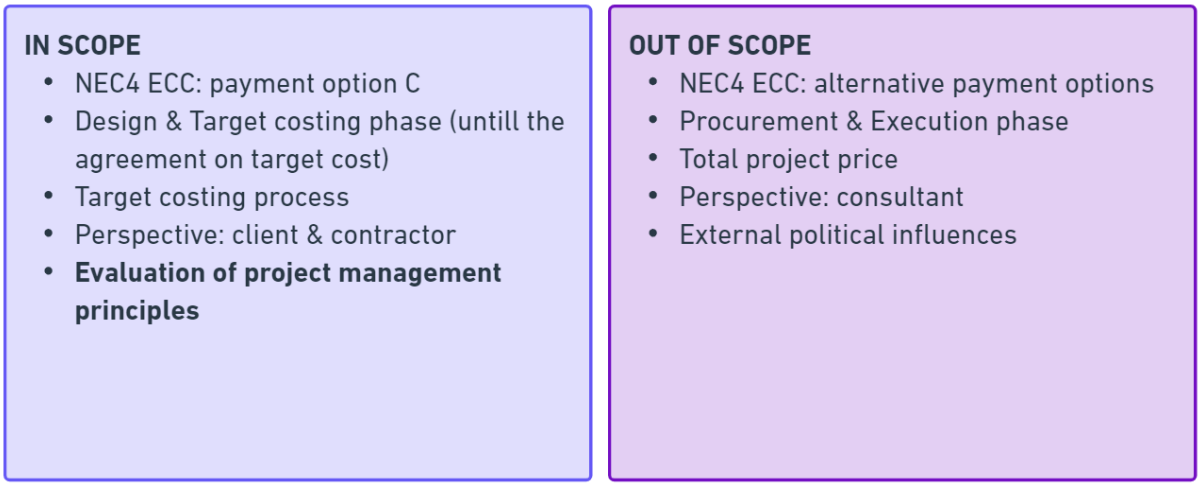

Figure 2 - Research scope

2.5 Research approach

This section presents the research approach that provides answers to the sub questions. In the figure below a schematic overview is given of the research approach. A more elaborated and detailed description of the research approach can be found in Appendix B1.

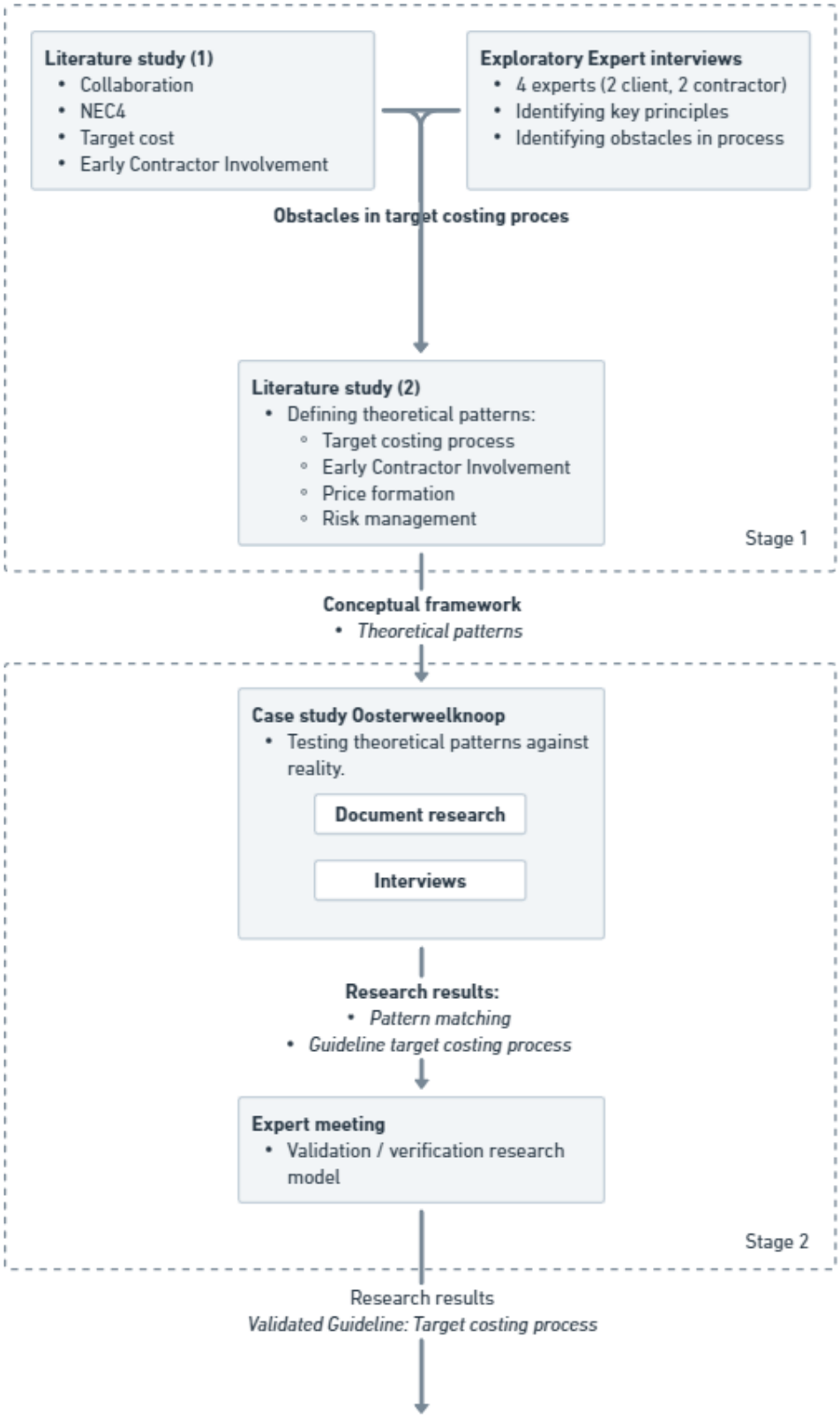

Figure 3 - Research approach

In this research, a qualitative approach will be employed to develop a guideline for a collaborative target costing process in Phase 1 of the NEC4 framework. The research will specifically focus on optimizing project management practices and enhancing collaboration between contractors and clients, with particular attention to the Belgian context. Pattern matching was a pivotal research technique in this study. According to Hak and Dul (2009), pattern matching is the core procedure of theory-testing with cases. This technique involves comparing two patterns to determine their similarities or differences. The patterns in question are the theoretical pattern derived from existing literature, and the empirical or observed pattern obtained from case studies and real-world observations.

The research follows these steps:

- Theoretical pattern development;
- Empirical pattern collection;
- Pattern comparison;
- Analysis and interpretation;
- Recommendations and guideline development.

By employing pattern matching, this research ensures a rigorous comparison between theory and practice, providing a robust basis for developing practical and theoretically sound guidelines. This method not only validates the theoretical framework but also adapts it to the nuances of real-world project environments, ensuring that the developed guidelines are both relevant and actionable.

Stage 1 – Creating conceptual framework

The research starts with an explorative part that consists of a literature review (1), empirical research by holding exploratory expert interviews and a second literature review (2). The literature (1) mainly focuses on providing relevant context information of how the NEC4 contract is built up and what the main options are that influence or have an impact on the target costing process. The exploratory expert interviews have the objective to identify key principles and obstacles in the target costing process within NEC4. With the second literature study, the aim is to describe the theoretical patterns within the NEC4 target costing process, based on the key principles established in literature study (1).

Literature study (1)

With the NEC4 contract, several aspects needed to be explored. Therefore, a literature review was conducted to identify crucial concepts within the NEC4 contract. These included the structure of the NEC contract itself (setup), payment options (e.g., Option C, Target contract with activity schedule), Early Contractor Involvement, risk management, and price formation within the NEC contract. Understanding these concepts was the initial focus of literature study (1).

The collected data was found on websites as Google scholar, Scopus, Web of Science and TU Delft and University of Twente repositories. The search terms that are used to find articles that may be related for this research are (‘Risk allocation OR ‘Risk mitigation’ OR ‘design’ OR ‘Early Contractor Involvement’) and (‘Collaboration’ OR ‘NEC4’ OR ‘Target cost’ OR ‘Compensation events’). In addition, the search term "Collab* " will be used. Also, construction related websites such as Bouwunie and the website of nec itself, proved to be useful sources.

Exploratory expert interviews

Following the exploratory expert interviews, a clear picture emerged regarding the fundamental principles and obstacles inherent in the target costing process within NEC4. These interviews, involving key stakeholders such as the project director, technical manager of Lantis, and counterparts at Rinkoniên, served as essential tools for data gathering. These interviews provided practical insights into the challenges faced. By swiftly amassing a diverse array of perspectives, these interviews enabled a deeper understanding of the obstacles encountered in the target costing process.

Literature study (2)

With the second literature study, the aim was to describe the theoretical patterns within the NEC4 target costing process, based on the key principles established in literature study (1). The results of this literature study are a conceptual framework of principles and tools to successfully complete the target costing process.

The theoretical patterns established are based on literature. To find theoretical patterns in literature certain criteria were formed: the first criterion was that the paper was not published before 2005. Secondly, the papers should be about the key principles which arose from literature study (1). Therefore, the search terms used for literature study (1) were also used for this literature study. With these requirements a list of papers was formed. The researcher reviewed every article on the key principles. A more elaborate description can be found in Appendix B1.

Stage 2 – Developing guideline target costing process

The second stage of the project involves empirical testing of the theoretical patterns identified from the literature study, applied to the case of the Oosterweelknoop. This process allows to validate or refine the theoretical framework by examining its practical applicability and relevance.

After this stage, a guideline was developed based on the theory and practice for future applications of the target costing process within the NEC4 contract. This guideline will serve as a valuable resource for future projects, providing a roadmap for the application of the target costing process within the NEC4 contract based on both theoretical and empirical insights.

Case study – Oosterweelknoop

The analysis aims to understand the strengths and weaknesses of the target costing process, scrutinize pitfalls and challenges to find potential solutions, and examine successful processes to identify theoretical patterns. The insights gained from this process will establish an empirical pattern and inform recommendations for optimizing the target costing process. These recommendations will contribute significantly to the broader guideline development effort, ensuring the project's success and efficiency. This involves:

1. **Conducting Semi-Structured Interviews**: Key stakeholders will be engaged in semi-structured interviews. These interviews will be recorded and transcribed to ensure a thorough data analysis (Appendix D1).For these interviews an interview protocol will be developed (Appendix C1).
2. **Data Analysis**: The transcriptions will be analyzed to identify themes and patterns related to the target costing process. This includes understanding the pitfalls, challenges, and areas for improvement.

The Process Analysis Phase of the Oosterweelknoop Project is a critical area of study to understand the real-world implications of project management practices. This project, notable for its use of the NEC4 contract, serves as a unique case study due to its unprecedented scale in the context of NEC contract application. The selection of the Oosterweelknoop Project for this analysis was not only influenced by its innovative contract type but also considered factors such as the contracted amount, the social impact, and the technical difficulty involved. This study aims to provide valuable insights into the effectiveness of project management practices in large-scale construction projects.

Semi-structured interviews will be conducted at the Oosterweelknoop project, where NEC4 is being implemented for the first time. To simplify the analysis of these interviews, the questions were grouped according to their corresponding main principle: “Early Contractor Involvement”, “Risk Management”, and “Price Formation”. The interviews for this study encompasses viewpoints from both the client, Lantis, and the contractor, Rinkoniên, ensuring a comprehensive understanding of the project dynamics. Key stakeholders including the project director, a contract manager, and the technical manager from both Lantis and Rinkoniên will be engaged in the interview process, Table 1. For this master thesis, interview participants had been selected based on their expertise and experience with the NEC4 contract, specifically within the context of the Oosterweelknoop project. The selection criteria prioritize individuals who possess in-depth knowledge and firsthand experience with the implementation of the NEC4 contract framework in the project setting. These participants provided valuable insights into the nuances, challenges, and successes associated with early contractor involvement, risk management, and price formation within the NEC4 contractual framework at the Oosterweelknoop project. By incorporating insights from both parties, a balanced perspective emerged, facilitating the development of a robust guideline. This inclusive approach was particularly crucial given the collaborative ethos inherent in the NEC4 contract framework. Exclusive focus on either the client or contractor viewpoint would risk yielding biased conclusions, underscoring the necessity of considering multiple perspectives for a thorough and equitable analysis.

Table 1 - Interviewees

Client Lantis	**Contractor Rinkoniên**
PROJECT DIRECTOR	PROJECT DIRECTOR
CONTRACT MANAGER	CONTRACT MANAGER
TECHNICAL MANAGER	TECHNICAL MANAGER

The initial focus was on investigating the principles underlying the target costing process from its inception, exploring effective implementation, demonstrated efficacy, and the presence of a clear plan. Inquiry will delve into specific principles' impact on roles and responsibilities, scope alignment, and the influence of open book accounting on collaboration and trust. Questions also addressed the role of cost experts and experienced contractors in client collaboration. Further discussion explored the setup and execution of early contractor involvement, emphasizing its role in fostering collaboration and trust. Following this, the conversation shifted to risk management activities, including early risk identification and allocation processes, to stimulate initiative-taking risk mitigation efforts. Lastly, participants discussed the formation of prices, considering how principles such as transparency and fairness are upheld to ensure a mutually beneficial outcome for both parties involved. Participants were invited to suggest principles for process enhancement and share lessons learned for future projects, emphasizing adjustments and principles for continuity.

An interview protocol was developed for these interviews to elicit the most pertinent responses. The interview protocol and the questions can be referred to in Appendix **Fout! Verwijzingsbron niet gevonden.**. This protocol will outline the structure, sequence, and content of the interviews, ensuring consistency and effectiveness in data collection. By systematically guiding the interview process, the protocol enabled the researcher to gather comprehensive insights from participants while allowing flexibility for exploration and in-depth discussion. The questions included in the protocol were carefully crafted to address key research objectives and facilitate the exploration of relevant themes. Additionally, the protocol incorporated ethical considerations and guidelines for participant interaction to ensure a respectful and productive interview environment.

Guideline development

The guideline for enhancing the target costing process was developed using insights from literature studies and a case study. It included an overview of target costing principles and methodologies, detailed recommendations for effective implementation, and theoretical patterns for fostering stakeholder collaboration. The guideline was structured into sections corresponding to different aspects of the target costing process, each containing theoretical insights, empirical findings, and practical recommendations. An expert review was conducted at the end for validation and verification of the end product.

The development of the guideline will involve the following steps:

1. **Literature Review:** Gather data on target costing principles and methodologies, and their applicability in complex infrastructure projects.
2. **Case Study Analysis**: Conduct a process analysis of the Oosterweelknoop project to understand the practical application of target costing. Establishing an empirical pattern.
3. **Data Synthesis**: Combine the theoretical insights from the literature review with the empirical findings from the case study.
4. **Recommendation Formulation:** Develop detailed recommendations for implementing target costing effectively, accommodating uncertainty factors, and fostering collaborative engagement among stakeholders.
5. **Guideline Structuring**: Organize the guideline into distinct sections corresponding to different aspects of the target costing process. Each section should include a combination of theoretical insights, empirical findings, and practical recommendations.
6. **Document Preparation**: Emphasize readability, conciseness, and relevance throughout the document to ensure that stakeholders can easily navigate and derive value from its contents.
7. **Expert Review:** Conduct an expert review at the end for validation and verification of the end product.

By following these steps, the guideline will serve as a comprehensive resource for stakeholders, providing them with the necessary knowledge and tools to optimize the target costing process.

After the guideline was established, verification and validation became necessary. Consequently, an expert meeting was arranged: This meeting consisted of individual interviews that commenced with an introduction to the research. Subsequently, there was a brief overview of the conceptual guideline and its characteristics. The interviewer then solicited insights from the expert regarding the notable attributes of the conceptual model and queried their views on its applicability and compatibility for future projects under the NEC4 contract with option C. First general comments on the overall guideline will be provided, followed by comments on the noteworthy attributes and additional recommendations to the guideline.

2.6 Structure of the report

Chapter 1 serves as the introduction to the research, laying out the groundwork by introducing collaborative contracting and NEC4. It also sets the stage by describing the scenario at the Oosterweelknoop and its implementation of the target costing process. In Chapter 2, the research design is elaborated upon, detailing the methodology employed. Chapter 3 delves into key principles and theories, synthesizing management principles from existing literature to develop theoretical patterns. The Oosterweelknoop project is scrutinized in Chapter 4 through a case study, wherein the efficacy of the theoretical patterns outlined in Chapter 3 is evaluated. Chapter 5 conducts a comparative analysis of findings from literature and the case study to distill common themes and theoretical patterns. Building upon these findings, Chapter 6 formulates guidelines for the target costing process. Expert evaluation of these guidelines is conducted in Chapter 7. Chapter 8 provides a forum for discussing the research methodology and findings. Following this, Chapter 9 addresses the research questions and draws conclusions. It also offers practical recommendations and suggests avenues for further research. The report concludes with a reference section and appendices.

3. Theoretical framework

In this section, the literature review and its conclusions will be presented, commencing with an overview of collaboration within the construction industry. This initial exploration will then be narrowed down to focus on the utilization of the NEC4 contract, which is renowned for fostering collaborative practices. Within the NEC4 framework, particular emphasis will be placed on Option C (Target Costing) and X22 (Early Contractor Involvement), recognized as pivotal mechanisms for enhancing collaboration and project success. Through an in-depth review of relevant literature, insights will be gleaned regarding the effective implementation of these options within infrastructure projects. Following this comprehensive analysis, the section will culminate in the presentation of results, synthesizing findings to formulate a best practices guideline. This guideline will serve as a roadmap for leveraging Option C and X22 within the NEC4 contract framework to facilitate successful collaboration and project outcomes in the construction industry.

3.1 Collaboration in construction

Delivering infrastructure projects to their pre-defined objectives is a challenge due to complexities and uncertainties that often exist (Ahiaga-Dagbui, Tokede, Morrison, & Chirnside, 2020; Rosander & Kadefors, 2019). To deliver the project required by the client, many organizations work together in the construction industry (Faris, Gaterell, & Hutchinson, 2022). Because of this, collaboration is increasingly recognized as a key driver of success in the construction industry, fostering innovation, efficiency, and improved project outcomes (Hughes, Williams, & Ren, 2012; Grilo, Zutshi, Jardim-Goncalves, & Steiger-Garcao, 2013; Liu, van Nederveen, & Hertogh, 2017; Kożuch, 2009). Collaborative contracting thus is a model based on the recognition that there can be mutual benefit for a project owner and project participants to form a more cooperative working relationship (Sandosham, et al., 2022).

With the implementation of collaborative contracting the desire was to address problems often faced in traditional contracting, misalignment of commercial interest, 'blame game' and minimum compliance (Sandosham, et al., 2022). Different types of contracts are crucial in fostering collaboration among stakeholders involved in construction projects (Willis & Alves, 2019). Collaborative contracts incorporate features designed to overcome the aforementioned problems which are associated with traditional contracting (Sandosham, et al., 2022). For example, traditional fixed-price contracts provide clarity and certainty regarding project costs, which can help foster trust and collaboration among parties (Willis & Alves, 2019). On the other hand, cost-reimbursable contracts offer flexibility and incentivize efficiency by allowing for adjustments to project scope and cost. Collaborative forms of contracts, such as alliance contracting or integrated project delivery, promote a shared risk and reward approach, encouraging open communication, innovation, and problem-solving among project participants (Willis & Alves, 2019). Overall, the selection of the most appropriate contract type depends on project objectives, risk allocation preferences, and the desired level of collaboration among stakeholders.

The advantages of implementing collaborative contracting turn on the model of collaborative contracting employed, and the degree of risk-sharing and collaboration involved (Sandosham, et al., 2022). The practical benefits to be gained from successful collaborative contracting can include the following:

- Encourage innovation;
- Potential cost savings from early risk management;
- Reduce costs associated with disputes;
- Flexibility.

Collaborative contracting, while offering numerous benefits, also carries inherent disadvantages and risks contingent upon the extent of risk-sharing and cooperation involved. These drawbacks encompass several facets (Sandosham, et al., 2022). Firstly, the inclusion of a 'no fault' clause in collaborative contracts can lead to repercussions, as non-performing parties may escape accountability, causing financial losses for others involved. Additionally, traditional insurance policies may prove inadequate for collaborative models, necessitating tailored policies to address associated risks, albeit at potentially higher costs. Moreover, although collaborative contracting theoretically promises cost savings, there's no guarantee of lower project costs compared to traditional methods, especially considering potential defects and the complexities of gain share entitlements (Sandosham, et al., 2022). Nonetheless, successful implementation of collaborative contracting hinges on key requirements such as aligned goals, trust, open communication, effective dispute-resolution mechanisms, a collaborative mindset, and the cultivation of trust among all stakeholders. Inhibitors to the adoption of collaborative contracting include the unfamiliarity of the concept, resistance to mindset shifts, lack of mutual trust, and insufficient incentives for commitment (Sandosham, et al., 2022). Overcoming these challenges demands concerted efforts towards fostering a culture of collaboration, trust, and shared responsibility within the construction industry.

3.1.1 Different types of collaborative contracting

In the realm of infrastructure development, various contract forms serve as instrumental frameworks guiding project execution and stakeholder collaboration. The Design-Build-Finance-Maintain (DBFM) contracts represent integrated contract forms that encourage collaboration by consolidating various project functions and responsibilities within a single contractual arrangement (Koppenjan, et al., 2022). DBFM contracts not only integrate designing, constructing, and maintaining aspects but also include financing components (Bouwunie, 2016). This comprehensive integration aligns the interests of project stakeholders throughout the project lifecycle, promoting a collaborative approach to project delivery (Koppenjan, et al., 2022). Through DBFM, the transfer of risks related to project phases and the management of connections between them is facilitated, enabling the public partner to focus on steering performance while leveraging the expertise of private parties for efficient project decision-making and risk management (Koppenjan, et al., 2022).

The “Bouwteams", or building teams contract form, represent a collaborative approach where different parties, including clients, architects, engineers, contractors, and suppliers, come together early in the project lifecycle to jointly develop and deliver a project (Bouwunie, 2016). This collaborative arrangement promotes open communication, shared decision-making, and collective problem-solving, ultimately leading to optimized project solutions and enhanced stakeholder satisfaction (Boes, 2013). During the preparation and design stages, the contractor acts as an advisor, leveraging their expertise and experience to develop the optimal design in collaboration with the client. There are various motivations for selecting a bouwteam approach, but a key factor is its capacity to foster collaborative design processes that prioritize both quality and feasibility (Uzun, 2022).

The NEC4 contracts, known for their emphasis on collaboration and risk-sharing, provide a structured framework for effective project management and delivery (nec, 2024). Unlike traditional contracts, NEC4 contracts promote transparency, mutual trust, and cooperation among project participants (nec, 2024). They facilitate collaborative working practices and enable better management of project risks and uncertainties through mechanisms such as early warning notices, compensation events, and collaborative risk management processes. Combining the option of target cost with Early Contractor Involvement (ECI) within the NEC4 contract framework results in two distinct phases. One pertains to phase 1, which encompasses the design phase and the establishment of the target cost, while the other phase pertains to the execution of the works. Under this NEC4 contract structure, the contractor assumes the role of an advisor, leveraging their expertise and experience to collaboratively develop the optimal design alongside the client. This arrangement fosters collaborative design processes, ensuring a high level of quality while maintaining feasibility.

These integrated contract forms promote the alignment of project objectives, incentivize collaboration, and streamline communication channels, thereby enhancing project efficiency and reducing adversarial relationships among stakeholders (Ahiaga-Dagbui, Tokede, Morrison, & Chirnside, 2020). By embracing collaborative approaches and selecting appropriate contract forms tailored to project needs, stakeholders can foster a culture of cooperation, maximize value, and achieve sustainable outcomes in infrastructure development (Dewulf & Kadefors, 2012).

Research into collaboration in the construction industry has highlighted its significant benefits and challenges. Studies have shown that collaborative approaches contribute to improved project performance, cost savings, and enhanced stakeholder satisfaction. However, effective collaboration requires overcoming barriers such as lack of trust, resistance to change, and divergent interests among project participants. Therefore, project stakeholders must foster a collaborative culture, select appropriate contract forms, and implement effective collaboration mechanisms to maximize the success of construction projects.

3.2 NEC4 ECC

In the preceding paragraphs, there has been extensive reference to the NEC4 contract. The following section will delve into the various structures and options available within the NEC4 contract. The defining contract that will be referred to in this literature review is Engineering and Construction Contract (ECC). The ECC series covers the contract between the client and the main contractor(s).

First, the structure of the NEC4 is reviewed followed by the target costing option and the aspects of Early Contractor Involvement.

3.2.1 Structure of the NEC4 ECC

The NEC4 ECC contract has a modular structure (Patterson, 2009). NEC contracts are formulated to achieve flexibility, promoting effective project management, and ensuring clarity and simplicity (Eggleston, 2019). Flexibility is attained through the avoidance of industry-specific terminology and the inclusion of Primary and Secondary Option clauses. These clauses enable contracts to be tailored by selecting pricing mechanisms and contractual provisions suitable for each project. Encouraging good project management is emphasized in NEC contracts through their focus on communication, cooperation, scheduling, and risk management (Eggleston, 2019). Clarity and simplicity objectives are pursued by employing a drafting style intentionally distinct from other standard forms. This includes the use of short sentences, avoidance of cross-referencing and technical/legal jargon (Eggleston, 2019).

To setup the NEC contract's conditions for a particular contract the client can:

- Include the nine sections of common Core Clauses;
- Select from the six main options as to which type of pricing mechanism is to apply;
- Specify which options for resolving and avoiding disputes applies;
- Select and include in the contract which, if any, of the twenty-two Secondary option clauses will be applicable;
- Includes in the contract, under Secondary Option Z, any Additional Conditions to the contract.

The NEC contract includes a basic set of nine 'core clauses,' these core clauses are incorporated in any of the ECC contracts (Patterson, 2009). These set of core clauses include (1) the general clause, (2) the contractor's main responsibilities, (3) time, (4) quality management, (5) payments, (6) compensation events, (7) rights to materials, (8) liabilities and insurance, (9) termination. In addition to these nine core clauses, the client can add the following elements to the contract with the core clauses:

- **One main option, relating to payment:**
  - Option A: Priced contract with activity schedule ('lump sum' contract).
  - Option B: Priced contract with bill of quantities.
  - Option C: Target contract with activity schedule.
  - Option D: Target contract with bill of quantities.
  - Option E: Cost reimbursable contract.
  - Option F: Management contract.
- **One dispute resolution option:**
  - These options are numbered W*.
- **Any number of chosen secondary options:**
  - These options are numbered X*.
- **Jurisdiction-specific secondary options:**
  - These options are numbered Y*.
- **Additional conditions to the contract:**
  - These options are numbered Z*.

In the figure below an example build-up of the NEC contract is presented.

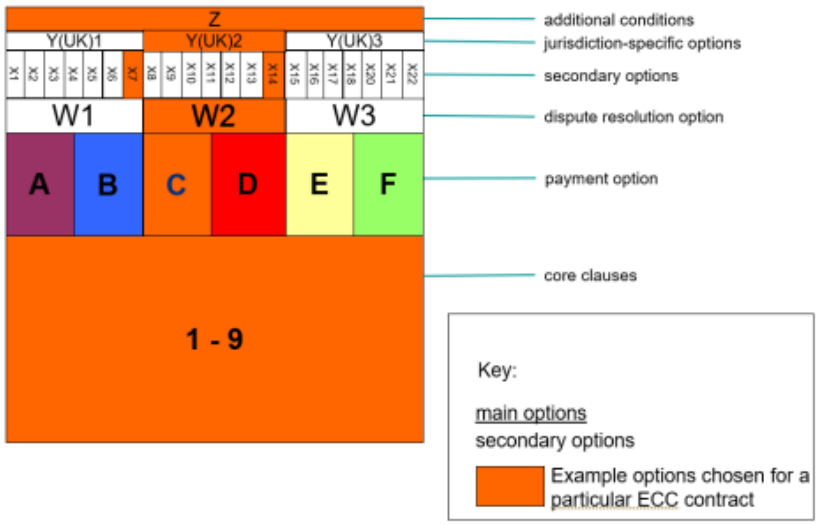

Figure 4 - Setup of NEC contract (Patterson, 2020)

NEC offers a structured approach to adopt various kind of options together with core clauses, which are based on principles of mutual trust and cooperation (Tung, Memon, & Javed, 2020). NEC's characteristics entail the exact allocation of responsibilities within a project setting. It offers structured procedures to manage change, prompting partners to notify each other of any potential issues with positive intentions (Tung, Memon, & Javed, 2020). This foster increased confidence among partners to collaborate effectively. Additionally, NEC provides sanctions for partners to utilize as a last resort in times of necessity. The Engineering and Construction Contract (ECC) delineates the roles and responsibilities within a project framework. Key parties include the Client and Contractor, with administrative functions managed by the Project Manager and Supervisor (nec, 2024). The Contractor bears the primary burden of actions and obligations, with the Project Manager assuming a significant administrative role (nec, 2024). Fundamentally, the Client facilitates and finances the project, the Contractor executes the work, the Project Manager oversees contractual matters on behalf of the Client, and the Supervisor ensures quality control adherence.

Establishing clear roles, functions, and responsibilities within the contract framework is essential for fostering understanding among all participants and facilitating their contribution to the target costing process (van der Pas, 2021). Clarity in roles ensures that each party comprehends their specific duties and obligations, enabling them to effectively collaborate and provide valuable input towards achieving target cost objectives. With a well-defined structure in place, participants can confidently engage in discussions, share insights, and make informed decisions that align with the overarching project goals (van der Pas, 2021). Within the NEC4 contract, the roles of the Client, Project Manager, Supervisor, and Contractor are clearly delineated. This clarity promotes transparency, accountability, and ultimately enhances the efficiency and success of the target costing process.

Theoretical pattern 1: Clear definition of roles and responsibilities promotes transparency, accountability, and ultimately enhances the efficiency and success of the target costing process.

3.2.2 Target costing (Option C)

The target contract with an activity schedule (Option C) is an evolution of cost-reimbursable contracts (Watermeyer, 2017; Wamuziri & Seywright, 2005). In this arrangement, the Contractor submits a target price based on assumed work, or a target is collaboratively established by both parties when the Client recognizes a direct and significant benefit in fostering collaboration through the target mechanism (Watermeyer, 2017). Financial risks are shared between the Client and the Contractor in proportion to their respective share percentages (Wamuziri & Seywright, 2005). The contractor and client are both encouraged to work together to control costs through the sharing of the risk of over / under spend through a pain share / gain share mechanism (nec, 2019). In undertaking this, ensuring alignment of scope between the contractor and client is crucial (van der Pas, 2021). However, under target cost contracts the client is required to carry more risk than in traditional procurement (Wamuziri & Seywright, 2005). In the context of the construction industry, traditional target costing methodologies present several inherent challenges that can impede effective cost management and project success. Firstly, the neglect of information uncertainty in target costing calculations can be particularly problematic given the inherent unpredictability of construction projects, such as fluctuating material prices and unforeseen delays (Clermont, Ahn, & Schwetschke, 2018). This oversight may lead to inaccurate cost estimations and inadequate project planning, potentially resulting in budget overruns and project delays. Additionally, the fixation on fixed target costs throughout the project development process fails to account for the dynamic nature of construction projects, where costs evolve due to changes in scope, design modifications, and unforeseen challenges (Clermont, Ahn, & Schwetschke, 2018). Consequently, this static approach may lead to unrealistic cost expectations and hinder adaptability to project complexities (Clermont, Ahn, & Schwetschke, 2018).

Furthermore, the tendency to overlook indirect costs during target cost definition can result in incomplete cost assessments, neglecting crucial expenses such as overheads and administrative costs, which are significant in the construction industry (Clermont, Ahn, & Schwetschke, 2018). This omission may undermine the accuracy of cost projections and jeopardize the financial viability of construction projects. Overall, these deficiencies in traditional target costing methodologies underscore the need for more adaptable and comprehensive cost management approaches tailored to the unique dynamics of construction projects.

To tackle these deficiencies in the target costing approach, the NEC4 incorporates the following framework for the realization of the target cost. Within the NEC4 ECC option C contract, the Contractor is obligated to submit a target price utilizing an activity schedule (Option C) that they prepare. This activity schedule is a breakdown of the work the contractor has to undertake into a series of tasks which reflect the contractors' methodology for the construction of the works (nec, 2019). The target cost should accurately reflect the expenses the contractor will bear in completing the project, encompassing the base cost, fee, and the risk assumed by the contractor under the contract (Laryea, 2016; Klijn, 2016). The base cost comprises the direct expenses associated with the physical works necessary to fulfil the project requirements as outlined in the contract documentation, priced net of risk. Establishing these agreements early in the target costing phase concerning price composition, fees, and the price determination plan enhances support for the target costing process (van der Pas, 2021). The structure of the total cost is shown below.

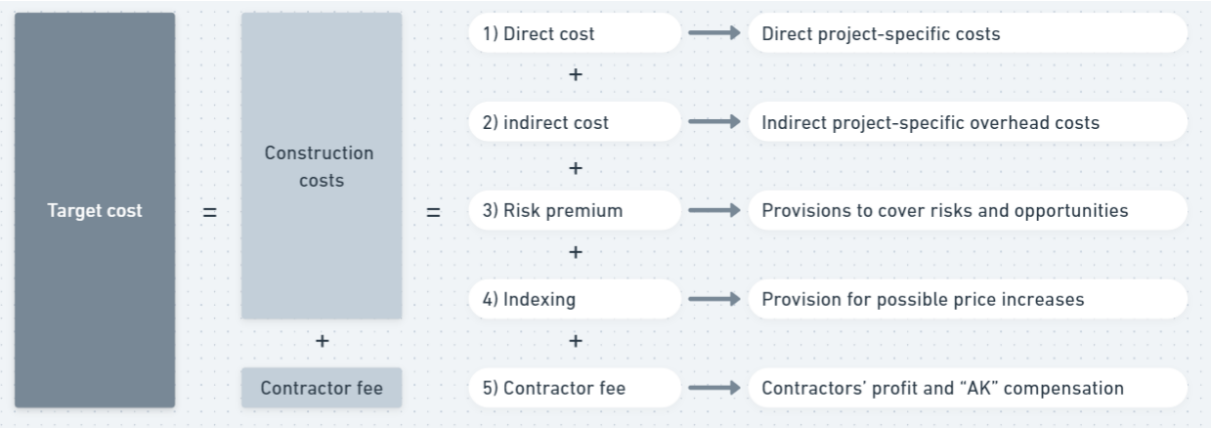

Figure 5 - Structure of Target Cost

1) Direct project-specific costs; This is by far the largest cost item and consists primarily of labour, material, and equipment costs (Klijn, 2016).
2) Indirect project-specific (overhead) costs; These include, for example, general construction site costs, project insurance, and supervision (Klijn, 2016).
3) Risk premium; These are provisions that cover the risks and opportunities, positive as well as negative.
4) Indexing; These are provisions for possible price increases, such as inflation.
5) Contractor fee; These are the contractors' profit and the General Costs (AK) (Klijn, 2016). The General Costs are the sum of costs that cannot be directly attributed to project activities. For example, office costs, administration costs, legal costs and costs for plan development, design, engineering, project management and communication (ProRail, 2023).

The contractor is reimbursed for these costs using an open book accounting approach, in addition to receiving a percentage fee covering profit and overheads (Laryea, 2016; Wamuziri & Seywright, 2005). This open book approach helps to build trust and alignment between client and contractor through the sharing of actual cost information by the contractor giving visibility of the true cost of the project to the client (nec, 2019). This transparency fosters a collaborative atmosphere where both parties work together towards shared objectives, rather than adopting adversarial positions (Nijhof, Graafland, & de Kuijer, 2009). The sharing of information fosters a collective effort aimed at cost mitigation (Lamming, Caldwell, Phillips, & Harrison, 2005). This ensures that the client is fully informed about the actual total cost of the project, facilitating the contractor's ability to achieve the agreed-upon profit margin without encountering any complications or legal disputes.

Under Option C the target cost only changes due to compensation events (nec, 2019). When a contractor puts forward the price of a compensation event (commonly known as variations and/or claims in other forms of contract), the client will already have some knowledge of the actual cost the contractor is paying for the items being claimed (nec, 2019). This process removes any concern that the cost might include unwarranted additional profit. However, any deviations from the agreed target or prices are shared between the contractor and the employer based on pre-determined proportions at the conclusion of the contract. The pain/gain mechanism comes into play, with profits and losses shared between the client and contractor based on whether the project is completed under or over the target cost. In target cost contracts, the contractor has financial incentives to keep project costs down, as depicted in the figure, below and work can start before the design is far advanced (Wamuziri & Seywright, 2005).

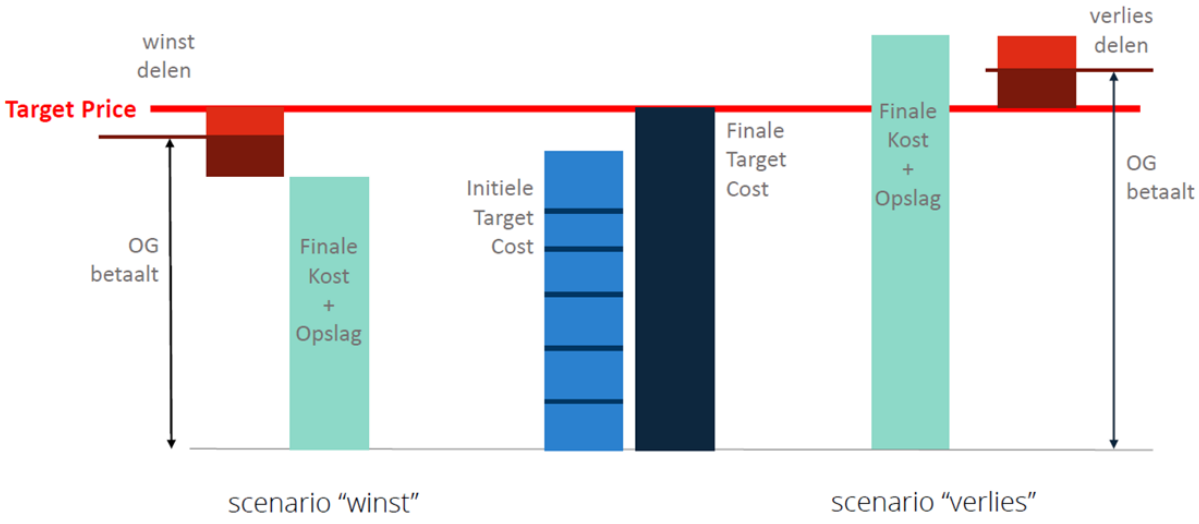

Figure 6 - Target Cost pain/gain mechanism (Rinkoniên, 2024)

So, to successfully run a target cost contract, alignment of scope, clear definitions of costs, fees and equitable methods of target cost adjustment are central (Wamuziri & Seywright, 2005). Overall, it is essential to create alignment in this early phase of the project, which requires transparency by sharing information.

Theoretical pattern 2: Clear scope definition in the design and target costing phase helps the target costing process by fostering alignment between contractor and client, ensuring mutual understanding of project objectives and allow for better identification of cost drivers.

Theoretical pattern 3: Implementation of open-book accounting contributes to the transparency of the target costing process and creates trust between client and contractor.

Theoretical pattern 4: Establishing agreements on the price composition, fees, and price determination plan early in the contracting phase enhances the support for the target costing

3.2.3 Early Contractor Involvement (Option X22)

A tool that promotes collaboration with the payment option C, is option X22, Early Contractor Involvement (ECI). With Early Contractor Involvement, the involved parties establish a single contract to collaboratively define and finalize the project scope and pricing before proceeding to the construction phase (Wamuziri & Seywright, 2005). This procurement strategy reflects the open-book, two-stage approach (Hunter, 2019). Early contractor involvement (ECI) is a concept that strives to involve the contractor collaboratively at an early stage of a project's development to mitigate or otherwise eliminate those risks (Kinlan & Willems, 2023). The addition of option X22 to the NEC contract provides for two stages, the details of which are set out by the client (Lantis) in the scope (Hunter, 2019). Stage one is the pre-construction ECI phase, with development of the scope, detailed design, and agreement on the Target Price. Stage one is paid for on a cost-reimbursable basis (Wamuziri & Seywright, 2005). Stage two is the construction phase, with completion of any remaining detailed design, and is paid for on a target cost basis (Wamuziri & Seywright, 2005).

Upon completion of stage one, the client evaluates whether to advance to stage two, and if affirmative, the project manager informs the contractor accordingly. The decision not to proceed can be due to a range of factors, such as failure to obtain planning approval. Before issuing the notice to proceed to stage two, details such as adjustments to the budget and pricing for the works need to be mutually agreed upon. In the event that the notice to proceed is not granted, the project manager issues an instruction to exclude the stage two works from the project scope. The client reserves the option to engage another contractor for the execution of the construction work (stage two). A typical time for early contractor involvement using option X22 with NEC4 is shown in the figure below.

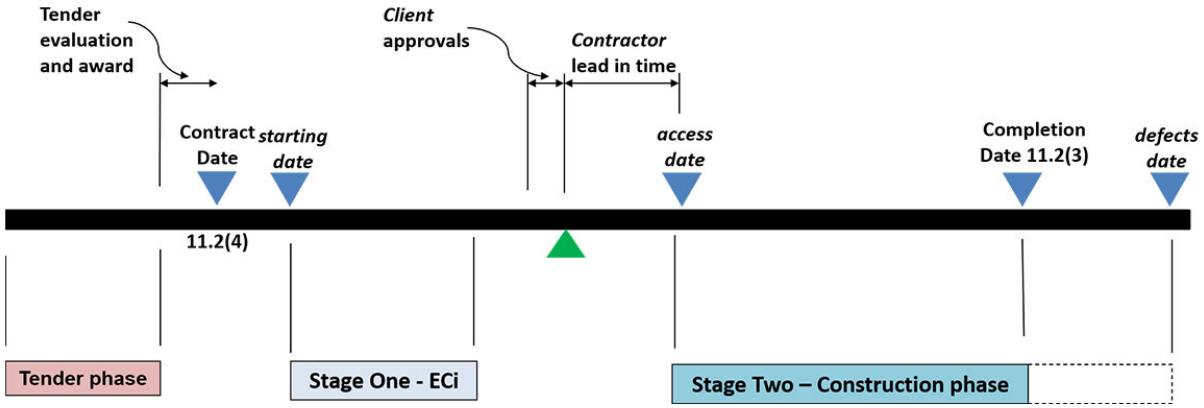

Figure 7 - Time line ECI with X22 (Hunter, 2019)

So it is argued that collaborative engagement reduces the chances of project delay due to its well-planned project schedule, timely decision-making, reliable working programs as well as early contractor's involvement in the design phase which can help to advise constructability and optimize value engineering (Eadie & Graham, 2014; Laryea & Watermeyer, 2016; Yap & Lim, 2023). Sharing knowledge and experience between the contractor and the client fosters transparency, collaboration, and better risk management, ultimately cultivating trust in the project's success (Rahmani, Khalfan, Maqsood, Noor, & Alshanbri, 2013). Failure of design professionals to consider how a contractor will implement the design can result in scheduling problems, delays, and disputes during the construction process, and, hence, harm the overall project performance (Song, Mohamed, & AbouRizk, 2009). Therefore, how to effectively incorporate construction knowledge into the design process is an important subject for performance improvement (Meng, 2019). Contractors not only bring their profound understanding of building methodologies but also house proficient cost experts within their ranks (Rahmani, Khalfan, & Maqsood, 2022). By involving cost experts, justifiable and precise cost estimates can be made. This integration is pivotal in navigating the potential pitfalls of post-design price fluctuations (Nader, 2019). By leveraging the insights of cost experts alongside transparent open-book accounting practices, trust, and collaboration flourish, ultimately diminishing the likelihood of unforeseen expenses for the client.

Early Contractor Involvement also provides better awareness and understanding of the risks of a project between client and contractor (Eadie & Graham, 2014). Collaborative risk sharing lies at the heart of Early Contractor Involvement (ECI), where participants jointly navigate the uncertainties inherent in projects (van der Pas, 2021). The allocation of risks plays a pivotal role in shaping contractors' pricing strategies, necessitating early discussions on risk management. A dynamic approach is advocated, progressively refining risk-adjusted pricing alongside project development, facilitated by transparent accounting practices. Flexibility in risk allocation is key, with parties adapting as project dynamics evolve (Wondimu, et al., 2016). Wondimu, et al. (2016) stress the importance of allocating risks to parties best equipped to manage them, minimizing disputes and additional costs, echoing Wondimu et al.'s (2016) assertion that contractors should shoulder only manageable risks. Early engagement fosters risk reduction, enhancing project appeal to contractors. Mosey (2009) introduces Joint Risk Management (JRM) through two-stage tender procurement, promoting mutual understanding and incentivizing risk mitigation. Effective risk analysis, as emphasized by Mosey (2009), yields benefit only when accompanied by initiative-taking measures. The choice of management strategy, as Mosey (2009) contends, influences risk control and allocation, crucial for averting additional costs in the procurement process. Ultimately, a cost-based approach to risk management, aligned with Swainston's (2006) recommendation for risk-adjusted pricing, ensures a prudent and sustainable project delivery framework.

The NEC4 contract also incorporates the Early Warning process. The early warning process serves as a pivotal mechanism for both parties to proactively identify potential risks to the project's success (Hide, 2024). It operates on a simple yet vital principle, mandating that each party promptly notifies the other upon becoming aware of any matter that could impact time, cost, or quality (Hide, 2024). Once formally communicated, these concerns are subject to joint review to assess their significance and devise strategies for mitigation or resolution, thus enabling collaborative problem-solving and risk management. It is crucial to recognize that the early warning process does not attribute fault for identified issues; rather, its primary focus lies in facilitating timely communication and collective action to minimize or eliminate potential adverse effects. Early warning significantly influences problem solving by aiding in the identification and resolution of issues at various levels, ultimately contributing to the overall success of construction and engineering projects (Meng, 2014).

The NEC4 Early Warning Register serves as a centralized repository for documenting these notifications, encapsulating succinctly the description of the risk and proposed actions to mitigate it (Hide, 2024). As outlined in the contract, the Project Manager bears the responsibility for maintaining and disseminating this register to the relevant parties, underscoring the importance of transparent and effective communication in mitigating project risks. Projects that incorporated early warning were more likely to complete on time or early, on or under budget, and with zero or minor defects (Meng, 2014). In contrast, projects without early warning were more likely to experience delays, go over budget, and have some major defects. Early warning had the greatest effect on quality performance, followed by time performance, and the smallest effect on cost performance (Meng, 2014).

Theoretical pattern 5: The integration of cost experts in target costing, coupled with open-book accounting, fosters trust between client and contractor, making it indispensable for the success of the target costing process.

Theoretical pattern 6: Early contractor involvement fosters collaboration, helps identify risks, and consequently enhances transparency and trust in the target costing process.

Theoretical pattern 7: Being flexible in the risk allocation during the design process supports the target costing process.

Theoretical pattern 8: For the target costing process, risks should be allocated to the party best able to deal with the risk.

Theoretical pattern 9: Early risk identification in combination with the Early Warning register stimulate joint risk management activities in phase 1, which contributes to a successful target costing process.

3.3 The conceptual framework based on the theory

In the previous section, nine theoretical patterns for project management were established within the NEC4 ECC contract's target costing process. These strategies were organized into three fundamental principles.

Following their categorization, practical tools were linked to these theoretical patterns to illustrate their application in real-world scenarios. These tools were derived from an extensive review of relevant literature. The amalgamation of these theoretical patterns constitutes the theoretical framework for the target costing process within the NEC4 ECC contract. This framework incorporates attributes that, as per the literature, significantly enhance the target costing process.

This conceptual framework is shown in the figure below.

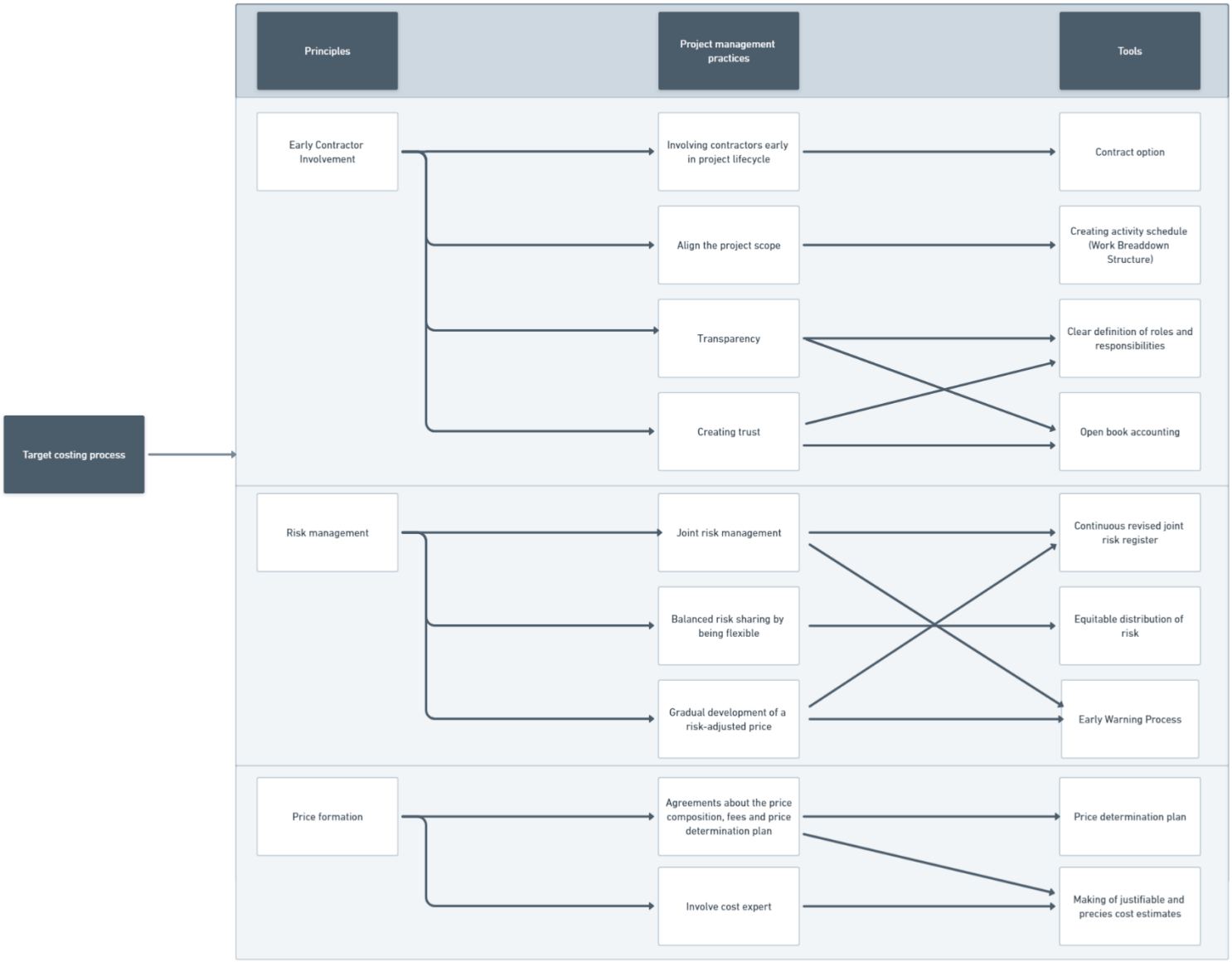

Figure 8 - Theoretical framework

4. Results

This section presents the findings of the case study analysis. To present the findings, this section is divided into the three main principles of the target costing process. Within each section, key themes and insights from the interviews are presented alongside their integration with the literature from Chapter 3. In this section the empirical pattern will be established.

4.1 Early Contractor Involvement

"Clear definition of roles and responsibilities promotes transparency, accountability, and ultimately enhances the efficiency and success of the target costing process."

Defining clear roles and responsibilities within both organizations, RINK and Lantis, is recognized as a critical practice for ensuring the smooth execution of Phase 1 in large infrastructure projects (van der Pas, 2021). Interviewees highlighted that the construction process fundamentally relies on human collaboration, necessitating seamless cooperation within and between organizations.

The technical director of Lantis emphasized the significance of human factors in project success, stating: "So, I say people is an important one, professionalism, proactivity, taking responsibility, but also your organizational chart; how do you set up your organization? Apart from the figures that are in places, but how do you set it up and who do you put where? That is definitely a success factor." This highlights that beyond staffing, the structural organization and role allocation are pivotal to the project's success. At the Oosterweelknoop project both organisations were set up the same, with project management functions being mirrored at both organisations. This was done so that every manager had a counter party to ensure alignment and clear communication on the related topic they were responsible for. However, there have been challenges in this area. At the Oosterweelknoop project, Rinkoniên interviewees noted that the organizational structure within Lantis was sometimes unclear. The NEC4 contract delineates four key roles: Client, Project Manager, Supervisor, and Contractor. In this project, Lantis fulfils the roles of both Client and Project Manager, each with distinct powers and responsibilities. This dual role has led to confusion in meetings, as it is not always clear whether Lantis representatives are acting as the Client or the Project Manager, so who has the right to make certain decisions. The Rinkoniên contract manager expressed inconvenience, saying, "Then you want to make agreements, but then it turns out you are sitting at the table with the wrong person." This sentiment was echoed by the Lantis contract manager, acknowledging the issue within the Lantis organisation. He also mentioned that this structure is now changing so that roles and responsibilities are made clearer to the contractor.

“Clear scope definition in the design and target costing phase helps the target costing process by fostering alignment between contractor and client, ensuring mutual understanding of project objectives and allow for better identification of cost drivers.”

Establishing a clear scope definition during the design and target costing phase is widely regarded as a pivotal practice in determining the eventual target cost of a project (Wamuziri & Seywright, 2005; Nijhof, Graafland, & de Kuijer, 2009; van der Pas, 2021). A clear and definitive scope is ideal for large infrastructure projects because it ensures transparency and accuracy in pricing according to the contract manager of Rinkoniên. At the beginning of a project, the scope is determined by the initial design provided by the client. However, since design and scope are interconnected, the scope will evolve as the project progresses and the design develops further. This is the situation with the Oosterweelknoop project. Additionally, works are being pulled forward via scope instructions during Phase 1 to avoid delays, contributing to the fluidity of the scope. Recognizing the necessity of establishing a price to advance the project, Rinkoniên and Lantis have agreed to implement a design freeze as mentioned by the project director of Lantis. This freeze, along with all agreed documents, will define the scope.

To mitigate risks associated with potential changes, any subsequent alterations to the scope will be treated as compensation events, protecting Rinkoniên from unforeseen liabilities. “We have resolved it this way in order to be able to offer a good price. All matters that have yet to be decided are assumptions. We want to do this with assumptions, where we then agree that when we further develop the design later, that assumption turns out to be incorrect, both plus and minus.” according to the contract manager of Lantis. Moreover, the project director of Rinkoniên highlighted a divergence in interests during the current phase: Rinkoniên aims for a higher price to cover risks, whereas Lantis seeks a lower price to maintain political justification. This tension underscores the complexities in aligning the priorities of both parties within the project's evolving framework. What helps with aligning both organisations to one scope, mentioned by the project director of Lantis, is creating activity schedules or work breakdown structures. These tools provide a detailed plan of the project activities, responsibilities, and timelines, ensuring that both parties have a clear and shared understanding of the project's requirements and progress.

“Implementation of open-book accounting contributes to the transparency of the target costing process and creates trust between client and contractor.”

In the Oosterweelknoop project, open-book accounting is employed, which allows both the client and contractor to have transparency into the project's financial records. The literature suggests that this practice enhances trust and transparency during the target costing process (Wamuziri & Seywright, 2005; Laryea, 2016; nec, 2019). The NEC4 contract mandates open-book accounting, requiring all contractor expenses to be transparently reported and reimbursed by the client. The project director of Rinkoniên views this requirement as having dual benefits: while it is contractually obligatory, adhering to it diligently—without fabricating costs and providing complete transparency—can foster trust in the contractor's work. This perspective is shared by other leaders within Rinkoniên, including another project director and the contract manager. Lantis, the controlling party, also acknowledges the value of open-book accounting in building trust. The contract manager of Lantis remarked, "So yes, open book, which is a basis of trust. So, the more open you are, the more trust and understanding you get from the other side." However, this view is not universally held within Lantis. The technical manager of Lantis expressed scepticism, stating, "Open-book has literally nothing to do with collaboration or trust. I cannot imagine how open-book can help with establishing trust, it is purely a contractual element." His argument was it only functioned as a way of payment for the contractor and therefor has nothing to do with trust or collaboration. This divergence in opinions highlights the differing attitudes towards the role of transparency in fostering collaborative relationships within the project.

“Early contractor involvement foster collaboration, helps identify risks, and consequently enhances transparency and trust in the target costing process.”

Early Contractor Involvement (ECI) was consciously chosen for the Oosterweelknoop project to leverage the distinct strengths of each party involved. As the project director of Rinkoniên explained, "Because people also wanted to recognize the strength of each other. A contractor is good at elaborating and looking for buildability and manufacturability. Clients, in general, are particularly strong in design and stakeholder management, their customers and their local residents and so on." Initially, the ECI phase was structured differently. According to the contract manager of Lantis, in the first phase, Lantis was supposed to complete the definitive design, with Rinkoniên responsible for controlling and monitoring constructability. Rinkoniên's role was primarily engineering focused. However, this structure was altered, and Rinkoniên took on the task of creating the definitive design for Lantis, while Lantis assumed the role of control and monitoring.

This shift significantly impacted the collaboration dynamics between the two parties. Despite Lantis being contractually responsible for the design, they maintained significant involvement in the design process. This led to a situation where Lantis, focusing on ensuring that design requirements were met, was taken aback by the high costs of some designs. The project director of Rinkoniên noted that this could have been prevented by consulting individuals with expertise in construction costs and constructability. He remarked, "So the learning is, I think we have validated the designs with Lantis from: is this what you want, is this what you meant with mainly design-oriented people, from Lantis, without real cost information." This highlights a crucial lesson in the importance of integrating cost and constructability considerations into the design validation process to avoid unexpected expenses and ensure more effective collaboration.

4.2 Risk management

"For the target costing process, risks should be allocated to the party best able to deal with the risk."

In the NEC4 contract, specific risks assigned to the Client and Contractor are clearly delineated, a point emphasized by the contract manager of Lantis: "NEC4 talks very clearly about client and contractor risks." These distinctions are vital for effective risk management. Contractor risks, explicitly defined in Chapter 81 of the NEC4 contract, encompass all liabilities for which the contractor is responsible. When these risks materialize, they incur costs that are not reimbursable, meaning they are entirely borne by the contractor. This clear allocation ensures that the party manages each risk best equipped to manage it, thereby promoting efficiency and accountability in project execution.

"Being flexible in the risk allocation during the design process supports the target costing process."

Flexibility is crucial in the target costing process, particularly when managing distinct client and contractor risks, as well as shared risks. The contract manager of Rinkoniên highlights this aspect: "We have shared risks within this project, the NEC4 does not recognize that, and we do apply that to the Oosterweelknoop. The shared risks are risks that actually fall under Pain/Gain." In this context, shared risks are jointly identified and evaluated by both parties, fostering a collaborative approach. They collectively assess the nature and magnitude of each risk, determining whether it should be categorized as a client or contractor risk. This joint risk management approach not only enhances cooperation but also includes a financial component, as both parties share the potential benefits and losses. This dynamic interaction, often characterized as "give and take," significantly influences the pricing and the establishment of the target cost.

"Early risk identification in combination with the Early Warning register stimulate joint risk management activities in phase 1, which contributes to a successful target costing process."

"The Early Warning system is primarily a contractual measure," remarked the technical manager of Lantis. "Failure to submit one means no compensation event can be triggered." However, as noted by other interviewees, in the context of English projects, submitting an Early Warning serves not only to pre-emptively address risks but also to foster collaboration between the client and contractor. Rather than allowing issues to escalate into disputes or delays, Early Warning prompts joint efforts towards solutions. This collaborative approach is intended to incentivize cooperation, with both parties sharing information about potential issues that could impact costs or schedules. By proactively addressing challenges together, the aim is to optimize efficiency and minimize disruptions. This ethos aligns with the core principles of NEC, where the focus is not solely on meeting targets but on achieving cost-effectiveness and mutual benefit. While Early Warning is a contractual obligation, it also forms an integral part of effective project management, enabling pre-emptive problem-solving and the identification of potential opportunities. It underscores the notion that challenges, whether relating to impact, finances, or time, can also serve as catalysts for positive outcomes when addressed collaboratively, said the project director of Rinkoniên.

4.3 Price formation

"Establishing agreements on the price composition, fees, and price determination plan early in the contracting phase enhances the support for the target costing process."

At the Oosterweelknoop project, a significant portion of phase 2 tasks has been shifted to phase 1. Contracts for these materials and components have already been finalized with negotiated prices, serving as the basis for setting target costs. According to the contract manager of Rinkoniên, establishing agreements on material prices is swiftly achieved, enhancing the efficiency of the target costing process. Alongside these agreements, monthly claims are submitted for incurred expenses, with Lantis conducting occasional audits and random checks to ensure compliance. Additionally, all consortium companies have undergone payroll administration checks, with salaries currently standardized at an average rate, subject to adjustment based on individual earnings annually through external audits. The project director of Rinkoniên highlighted that having predetermined pricing plans for fees bolsters support for the target costing process. The verified prices and agreements for personnel and materials further solidify support for target costing within Lantis, as stated by the project director of Rinkoniên. The concluding remark regarding the current incurred cost, in phase 1, by the project director of Rinkoniên was positive: "Yes, we have actually had relatively little discussion with Lantis so far about their disagreement with the costs."

"The integration of cost experts in target costing, coupled with open-book accounting, fosters trust between client and contractor, making it indispensable for the success of the target costing process."

Cost experts advocate for the preparation of internal estimates, which are then presented to the client. For these internal estimates to be accurate and dependable, it is essential that cost experts collaborate closely with the design, execution, and calculation teams. Calculations for these estimates are derived from detailed scope documents, which play a critical role in determining the overall price. These documents outline the project's parameters and requirements, providing a clear framework for cost estimation. By basing their calculations on these comprehensive scope documents, cost experts can produce precise and justifiable estimates. "People look at the actual calculation, they look at the forecasts, so both parties have access to, or share the same picture. What will the project do in the coming years in terms of cost? That builds trust," said the project director of Rinkoniên. "That is a good thing if you put it on the table together and discuss it," added the contract manager of Rinkoniên.

4.4 Additional findings

In addition to the project management practices highlighted in the literature, this research uncovered several other crucial findings. One significant insight is the importance of the setup and integration of the systems and programs used in the project. For effective collaboration, it is essential that these systems are compatible and facilitate easy sharing and testing of documents and drawings between Lantis and RINK. For example, the use of the Relatics program in combination with Asite, at the Oosterweelknoop project has been instrumental in ensuring seamless information flow. However, it was also noted that RINK's accounting system was not fully operational and remained somewhat primitive during Phase 1, which proved to be a significant drawback mentioned the project director of Rinkoniên and the technical manager of Lantis. This inefficiency hindered the smooth execution of project activities and highlighted the need for robust and well-integrated systems from the outset. To enhance collaboration and efficiency, it is imperative that the systems used for document transfer, design monitoring, and cost control are fully functional and effectively utilized by both parties. These systems should support the project's needs, enabling Lantis and RINK to work together more effectively. When the technological infrastructure is reliable and user-friendly, it fosters a collaborative environment where both parties can trust each other and manage the project more efficiently. This preparedness not only streamlines processes but also contributes to the overall success of the project.

Another significant finding at the Oosterweelknoop project was the absence of a competitive market environment during the target costing process. The big difference to other infrastructure projects is that this phase was not offered under competition, said the contract manager of Lantis. The technical and contract manager of Lantis suggested that to foster a more competitive Phase 1 and stimulate market dynamics, the client could introduce a target cost phase for a specific period—such as 3, 6, or 9 months—for a select group of contractors. During this period, each contractor would submit their target price. The project would then be awarded based on the submitted prices, evaluating criteria such as the economically most advantageous tender and other relevant factors. Implementing this approach would likely enhance competitiveness and drive contractors to propose more efficient and cost-effective solutions, increasing the likelihood of Phase 1 being completed on time. However, it is important to note that this method could undermine the collaborative aspect of the contract during Phase 1. The current contract framework emphasizes early contractor involvement and joint risk management, fostering a collaborative environment. Shifting to a competitive bidding process might reduce the opportunities for such collaboration, potentially impacting the overall synergy between the client and contractors. Thus, while a competitive target cost phase could introduce market efficiencies, it is crucial to balance this with the collaborative goals of the project to ensure both competitiveness and effective partnership.

Another point is that there is not much experience with NEC4, as it is a new contract form in Belgium and the Netherlands. Informing and educating both organizations is enormously important. "You notice that we are getting used to it, that we all have to get used to it, but that is the learning process we are in together. That will probably take a while," said the contract manager and the project director of Lantis.

4.5 Theory vs. practice

In this comparison, theoretical patterns are juxtaposed with the contrasting results derived from interviews. This examination delves into the practical application of theoretical concepts, highlighting discrepancies between idealized principles and real-world outcomes. By analysing both perspectives, gaps can be identified, and actionable recommendations for improvement can be developed. The goal is to bridge the divide between theory and practice, ensuring that projects benefit from both established theoretical patterns and insights gained from practical experiences.

Table 2 - Overview of results.

Theoretical pattern	Empirical pattern	Match	Recommendations for improvement
Theme 1: Early Contractor Involvement			
Clear definition of roles and responsibilities promotes transparency, accountability, and ultimately enhances the efficiency and success of the target costing phase.	❖ Clear definition of roles and responsibilities is wanted but was not always present. ❖ Both organisations had their problems organizing their structure. This led to inefficiencies. ❖ Project management functions were mirrored in order to ensure alignment and clear communication.	–	❖ Implement comprehensive role and responsibility matrices at the project's inception. ❖ Utilize organizational charts and clear documentation to maintain clarity and avoid overlaps.
Clear scope definition in the design and target costing phase helps the target costing phase by fostering alignment between contractor and client, ensuring mutual trust, and understanding of project objectives and allow for better identification of cost drivers.	❖ A cleared scope is the ideal situation, however the scope was dynamic. ❖ When the scope is still dynamic, it is desirable to use a design freeze. ❖ Agree which documents belong to the scope, based on work breakdown structure.	–	❖ Develop a dynamic scope management plan that includes frequent design reviews and checkpoints. ❖ Establish clear criteria for scope changes and ensure all changes are documented and communicated promptly. ❖ Implement a design freeze policy at critical milestones to lock in the scope for target costing purposes.
Implementation of open-book accounting contributes to the transparency of the target costing phase and creates trust between client and contractor	❖ Open-book accounting was beneficial both contractually and relationally. ❖ There is belief that open-book accounting builds trust. ❖ Divergent views on open-book accounting within Lantis.	+/-	❖ Foster a culture of transparency by conducting joint financial audits and reviews. ❖ Regularly update both parties on financial standing to maintain trust and transparency.
Early Contractor Involvement fosters collaboration, helps identify risks, and consequently enhances transparency and trust in the target costing process.	❖ It leverages the strengths from both client and contractor. ❖ By meeting regularly, the likelihood of cooperation and mutual trust increases. ❖ Due to the different approach than initially conceived, the collaborative aspect was not fully utilized.	+/–	❖ Optimize the ECI process by scheduling regular collaborative meetings and joint plannings sessions. ❖ Ensure all parties have a shared understanding of project goals and methodologies. ❖ Utilize integrated project teams to enhance cooperation and communication.
Theme 2: Risk management			
For the target costing process, risks should be allocated to the party best able to deal with the risk.	❖ There is a clear delineation of risks. ❖ These clear distinctions are essential for effective risk management. ❖ The clear allocation of risks promoted efficiency and accountability.	+	❖ Regularly review and update the risk allocation framework to ensure it reflects the current project conditions and capabilities of each party. ❖ Engage both parties in risk assessment workshops to ensure fair and effective risk allocation.
Being flexible in the risk allocation during the design process supports the target costing process.	❖ Both organizations were flexible with allocating risks. ❖ Having a shared risk register promoted collaborative mitigation strategies for the identified risks. ❖ The dynamic interaction of "give and take" influenced creating a target cost.	+	❖ Maintain a flexible approach to risk allocation by regularly revisiting and adjusting the risk register. ❖ Encourage open communication about potential risks and collaborative problem solving.
Early risk identification in combination with the Early Warning register stimulate joint risk management activities in phase 1, which contributes to a successful target costing process.	❖ The mutual believe was: no Early Warning issued, no compensation event. ❖ Early Warnings were considered a preventive and collaborative tool. ❖ Early Warnings enabled pre-emptive problem-solving and the identification of potential opportunities.	+/–	❖ Conduct regular risk identification workshops to proactively identify and address risks. ❖ Promote a proactive approach to risk management by incentivizing early identification and resolution of issues.
Theme 3: Price formation			
Establishing agreements on the price composition, fees, and price determination plan early in the contracting phase enhances the support for the target costing phase.	❖ Efficiency through agreements. ❖ Monthly costs are submitted for incurred expenses by Rinkoniên, with occasional audits and random checks conducted by Lantis to ensure compliance. ❖ Positive feedback on cost discussions.	+/–	❖ Formalize the price determination plan and ensure it is well-documented and agreed upon all parties. ❖ Schedule regular cost review meetings to maintain transparency and address any discrepancies.
The integration of cost experts in target costing, coupled with open-book accounting, foster s trust between client and contractor, making it indispensable for the success of the target costing process.	❖ By basing calculation on scope documents and collaborate with other departments, cost experts produced precise and justifiable estimates. ❖ Sharing actual calculation and forecast fosters trust between parties. ❖ Putting cost estimates on the table and discussing them together is viewed positively by project leaders.	+	❖ Promote open-book accounting practices and regular financial reviews to enhance transparency. ❖ Encourage joint financial planning sessions to foster collaboration and trust.

4.6 Interrelations between three main themes

The three main themes of Early Contractor Involvement (ECI), risk management, and price formation are not only significant individually but also interrelated. The following sections describe how each theme influences the others and highlight the crucial areas of tension that exist between them.

ECI fundamentally changes the project landscape by integrating contractors into the project's early stages. This early integration is crucial for several reasons. Firstly, it allows contractors to identify and mitigate potential risks before they escalate. Contractors bring their practical knowledge and expertise, which is invaluable in pinpointing potential issues related to construction methods, material choices, and scheduling. This proactive risk identification helps in shaping a more realistic and achievable project plan. Conversely, the process of identifying risks can also influence the implementation of ECI. When risks are identified early, it can refine and enhance the ECI process by pinpointing the areas where contractor input is most needed. For example, if a significant risk related to a specific construction technique is identified, the ECI process can be adjusted to include specialized contractors with expertise in that area earlier in the project. This targeted involvement ensures that the most critical risks are addressed by those best equipped to handle them, thereby enhancing the effectiveness of the ECI process. The influence of ECI on price formation is equally significant. Contractors' early input ensures that cost estimates are grounded in practical realities rather than theoretical models. Their insights into market conditions, labour requirements, and material costs lead to more accurate and reliable pricing. Moreover, this early engagement fosters a collaborative environment where transparency in pricing is paramount. Contractors and clients work together to develop a budget that reflects actual project needs and constraints, promoting mutual trust and understanding.

Effective risk management is crucial for any large infrastructure project, and its impact is particularly pronounced when combined with ECI. Early risk identification and mitigation, facilitated by contractors' involvement, allow for more informed decision-making and efficient allocation of resources. The NEC4 framework's clear delineation of roles and responsibilities further enhances this process by ensuring that each party understands their obligations and can manage their assigned risks effectively. The role of risk management in price formation cannot be overstated. By clearly identifying and allocating risks, the project team can incorporate these considerations into the project's budget. This leads to risk-adjusted pricing, where the costs associated with potential risks are factored into the overall price estimate. Such an approach not only ensures financial stability but also allows for better contingency planning. Projects are better equipped to handle unforeseen challenges without significant budget overruns or delays. Transparent price formation practices build trust among stakeholders, as they demonstrate a commitment to fairness and accountability. Identified risks must be accurately priced to ensure that the project budget reflects all potential challenges, involving collaborative discussions between clients and contractors to determine appropriate risk allocations and associated costs.

Price formation, influenced by both ECI and risk management, is the process of establishing a fair and transparent project budget. Early involvement of contractors ensures that price estimates are realistic and based on comprehensive knowledge of project requirements. Transparent price formation practices build trust among stakeholders, as they demonstrate a commitment to fairness and accountability. Risk management plays a vital role in shaping price formation. Identified risks must be accurately priced to ensure that the project budget reflects all potential challenges. This process involves collaborative discussions between clients and contractors to determine appropriate risk allocations and associated costs. The integration of open-book accounting practices further enhances this transparency, allowing both parties to have clear visibility into the project's financial aspects.

Conversely, the principles and practices of price formation can also influence both risk management and ECI. For instance, a well-defined and transparent price formation process can significantly enhance risk management by ensuring that all potential risks are properly accounted for in the budget. When risks are accurately priced and included in the project's financial plan, it ensures that adequate resources are allocated to manage these risks. This comprehensive financial planning reduces the likelihood of budget overruns caused by unforeseen issues, thus providing a more stable and predictable financial framework for the project. Furthermore, the clarity and transparency in price formation can positively impact ECI by fostering a more collaborative and trusting environment. When contractors see that the pricing is fair and that all risks are being transparently managed and accounted for, they are more likely to fully engage and contribute their expertise. This trust and willingness to collaborate can lead to more innovative solutions and more efficient project execution. Additionally, a transparent price formation process can help identify areas where contractor involvement is most needed, allowing for more targeted and effective use of ECI.

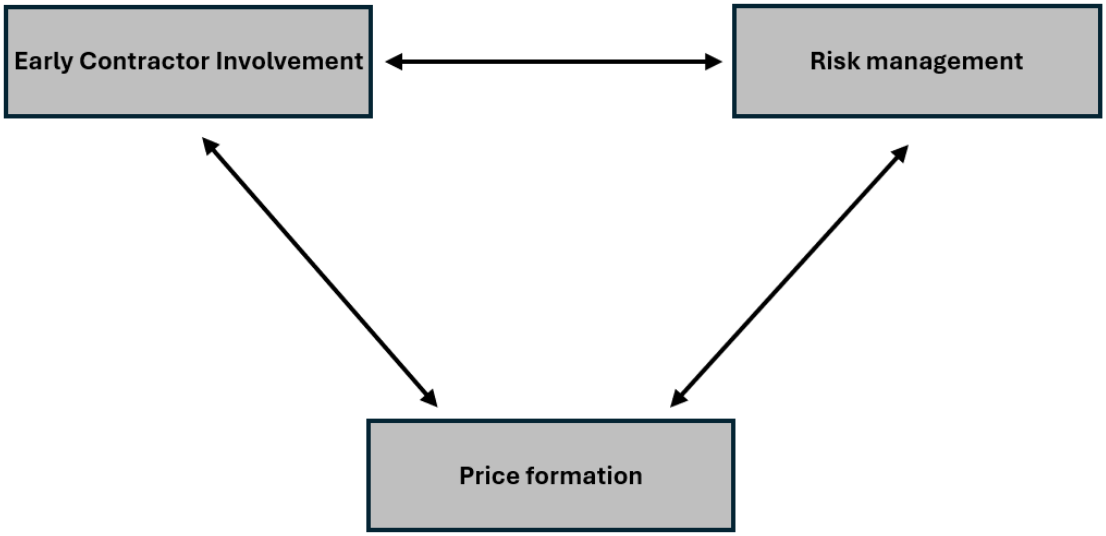

Figure 9 - Relations between Early Contractor Involvement, Risk management and Price formation

4.6.1 Field of Tension

The dynamic interplay between Early Contractor Involvement (ECI), Risk Management, and Price Formation creates a multifaceted field of tension that must be meticulously managed to ensure the success of large infrastructure projects. Each of these elements influences the others in significant ways, and understanding these interactions is crucial for achieving optimal project outcomes.

One of the primary tensions lies in balancing collaboration with control. ECI fosters a collaborative environment by involving contractors early in the project lifecycle. This early involvement allows contractors to offer valuable insights into design and construction methods, potentially leading to innovative solutions that can enhance efficiency, reduce costs, or improve overall project quality. For instance, a contractor might suggest a novel construction technique that could streamline operations and cut down on project duration. However, while such innovations can offer significant benefits, they also introduce complexities in maintaining control over project costs and schedules. The introduction of new techniques or materials, while promising, can bring uncertainties that affect cost estimation and scheduling. For example, a contractor might propose using advanced, yet untested, components that promise increased durability. While these components could indeed improve long-term performance, their cost implications and the time required for testing and integration might not be fully known at the outset. This situation necessitates a careful balancing act: leveraging the benefits of ECI while managing the associated risks through effective risk management strategies. This includes detailed risk assessments to identify potential issues related to new innovations and developing comprehensive contingency plans. Transparent price formation practices are essential in this context, as they help ensure that the cost implications of new solutions are clearly understood and agreed upon by all parties. This approach helps maintain control over the project budget and schedule while allowing for innovative contributions from early contractor involvement.

Another tension arises from the allocation of risks and the need for price certainty. Striking a balance between adequately compensating contractors for identified risks and maintaining a stable and predictable budget is crucial. For instance, overestimating risks might lead to inflated project costs, while underestimating them could result in financial shortfalls if unforeseen challenges arise. Therefore, a nuanced approach to risk allocation and pricing, such as setting aside contingency funds and regularly updating risk assessments, is necessary to navigate this tension effectively.

Transparency versus flexibility is another key tension. While transparent price formation builds trust and ensures accountability, it can also limit the flexibility needed to adapt to changing project conditions. For example, maintaining transparency in cost reporting can restrict the ability to make swift changes to the project scope or materials used, potentially delaying progress. Hence, it is vital to strike a balance where transparency allows for necessary adjustments without compromising trust, ensuring that both accountability and adaptability are maintained.

The interrelation between Early Contractor Involvement, Risk Management, and Price Formation is complex and multifaceted. Each element influences the others in significant ways, and their collective management is crucial for the success of large infrastructure projects. By understanding and addressing the inherent tensions between these elements, project teams can foster a collaborative, transparent, and efficient project environment. This holistic approach ensures that projects are not only completed on time and within budget but also achieve the desired quality and performance outcomes, particularly in the context of infrastructure projects like those in Belgium.

5. Guideline

The NEC4 Option C Target Costing Guideline was developed to provide comprehensive instructions and best practices for implementing target cost contracts within the NEC4 framework. As the research aims to identify theoretical patterns in order so these can be effectively applied and adapted to improve the target costing process amidst concurrent activities, evolving project parameters, and associated risks.

Recognized for its emphasis on collaboration, flexibility, and proactive risk management, the NEC4 contract, particularly Option C, is gaining traction in the Belgian and Dutch construction industries. The guideline aims to streamline project delivery, enhance cost predictability, and promote the efficient use of resources across construction and engineering projects, ultimately leading to more successful and cost-effective project outcomes. The guideline's development stemmed from extensive research conducted as part of a master's thesis focused on the NEC4 contract implementation at the Oosterweelknoop project. This in-depth research involved a rigorous analysis of project documentation, methodologies, and real-world applications of the NEC4 contract. Practical insights from this project highlighted critical areas for improvement and formed the foundation of the guideline. The primary purpose was to address the challenges associated with the implementation and use of NEC4, particularly in the context of target costing.

One of the critical practical insights from the Oosterweelknoop project was the importance of clearly defined roles and responsibilities. While the NEC4 contract specifies roles such as the client, project manager, supervisor, and contractor, these roles were not always clearly understood or implemented at the Oosterweelknoop project. This lack of clarity sometimes made collaboration and decision-making difficult, highlighting the need for even more explicit delineation of responsibilities. The guideline emphasizes the creation of an organizational chart that clearly outlines and aligns project management functions within both the client and contractor organizations. For example, by having mirrored organizational structures, both the client and contractor teams could interact more effectively, understanding each other's hierarchies and decision-making processes. This approach reduces potential friction and misunderstandings, thereby enhancing overall project efficiency. Another essential aspect considered was the potential of open-book accounting to foster trust, openness, and transparency through the transparent sharing of actual cost information between the client and the contractor. However, the consortium at the Oosterweelknoop project was not fully prepared to implement this approach due to a lack of necessary systems. As a result, the guideline emphasizes the need to establish effective digital systems before implementing open-book accounting. This preparation will enable both parties to collaboratively monitor expenses, make informed decisions, and adapt to changes and unforeseen challenges more effectively.

The guideline advocated for creating data exchange protocols and document control protocols that worked for both organizations. The use of digital systems, such as the Asite program and Relatics, streamlined communication and ensured accurate data management. These systems enabled real-time updates and easy access to project documents, which was essential for effective project management. For example, when design changes were made, they should quickly be communicated to all relevant parties, ensuring that everyone was working with the most up-to-date information. This reduced errors and rework, contributing to overall project efficiency. The inclusion of cost experts to create accurate estimations with input from other departments is recommended by the guideline to build trust and transparency. Accurate cost estimates enable the creation of reliable financial forecasts. By establishing agreements on fees, material prices, and a price determination plan, the project can ensure fairness and transparency in financial transactions. Agreeing on material prices with clear indexing for inflation helps maintain cost predictability and stability, minimizing uncertainties related to cost fluctuations, which is essential for maintaining project momentum and preventing financial disputes.

The guideline also places significant emphasis on risk management. By clearly identifying specific client and contractor risks as outlined in chapters 80 and 81 of the NEC4 contract, both parties can manage their respective risks more effectively. This clear demarcation of risks ensures that each party is aware of their responsibilities and can take proactive measures to mitigate potential issues. Additionally, the guideline considers the implementation of a joint risk register, encouraging collaborative efforts to identify the best mitigation strategies for potential risks. An early warning system, as stated in the NEC4 contract, is highlighted for its importance in proactively identifying and addressing issues before they escalate. These measures aim to enhance the overall risk management process, fostering a cooperative environment where both parties work together to achieve project success.

In summary, the guideline for the NEC4 Option C and X22 contracts was derived through a rigorous process that combined theoretical research with practical insights from the Oosterweelknoop project. By emphasizing clear roles and responsibilities, transparent costing mechanisms, effective communication protocols, and robust risk management strategies, the guideline provides a practical framework for enhancing the efficiency and success of large-scale infrastructure projects. The insights and experiences from the Oosterweelknoop project were invaluable in shaping a guideline that is both comprehensive and applicable to real-world scenarios, ensuring that organizations can successfully navigate the complexities of NEC4 and achieve their project objectives.

For a detailed roadmap and further instructions, refer to the full NEC4 Option C Target Costing Guideline provided in the attached document “Guideline NEC4 target costing”.

6. Evaluation of the model by experts

The case study, in combination with the literature study resulted in a conceptual guideline for the target costing process within the NEC4 contract. The conceptual guideline contains management practices and tools for the target costing process. Experts reviewed this conceptual model in an interview. The setup and the results of the expert review are presented in this section.

6.1 Expert evaluation of the conceptual model

The initial version of the NEC4 Option C Target Costing Guideline, Figure 10, provides a foundational framework for implementing target cost contracts. However, there are several areas where the guideline can be enhanced to ensure it evolves into a comprehensive, clear, and practically applicable final document. This final guideline is provided in the document “Guideline NEC4 target costing”. This expert review outlines specific feedback and recommendations to guide these improvements.

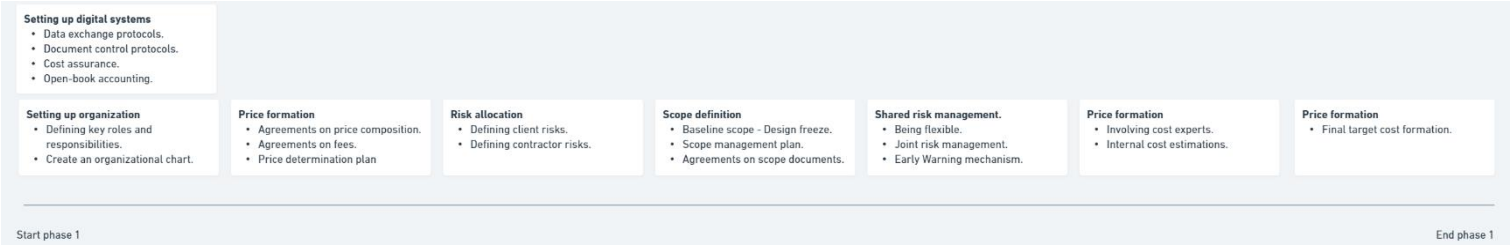

Figure 10 - Initial setup of the guideline.

The structure of the initial guideline was somewhat fragmented, lacking a clear and logical flow. The absence of a detailed table of contents makes navigation challenging. To improve this, it was mentioned that the guideline should introduce a comprehensive table of contents that would facilitate easier navigation and provide a clear overview of the document. Additionally, reorganizing the sections into clearly defined parts such as Introduction, Application, Assumptions, Implementation Steps, Risk Management, and Scope Definition will enhance readability and provide a logical flow of information. A well-structured document is crucial for guiding users through complex processes and ensuring they can easily find the information they need. By implementing these structural changes, the guideline will become more user-friendly and accessible, helping to ensure its successful application in real-world projects.

The content in the initial guideline was basic and lacks detailed explanations and step-by-step guidance for implementing NEC4 Option C Target Costing. To address this, the guideline needed to provide more detailed descriptions of each process and principle. This included elaborating on the specific steps involved in setting up organizations, digital systems, price formation, risk allocation, and scope definition. Furthermore, incorporating practical examples or case studies, such as the Oosterweelknoop project, will illustrate how the guidelines can be applied in real-world scenarios, making the document more practical and relatable. In-depth content was essential for conveying the full scope and intricacies of the NEC4 Option C Target Costing methodology. By expanding the content and providing concrete examples, the guideline will offer more value to its users, enabling them to implement the principles effectively and with greater confidence.

The initial guideline lacked clarity and specificity, particularly regarding key concepts, processes, and terminology. To improve clarity, the document should clearly define all key terms and concepts used, such as "target costing," "NEC4 Option C," and "guiding principles." Additionally, outlining specific, actionable steps for implementing each aspect of NEC4 Option C Target Costing will ensure that each step is clearly explained and easy to follow, making the guideline more user-friendly. Clear and specific guidance is crucial for preventing misunderstandings and ensuring that all users are on the same page regarding the processes and goals of the guideline. By enhancing clarity and specificity, the document will become a more reliable resource for project stakeholders.

The initial guideline did not provide sufficient context about the different elements, the target audience, or the status of the guideline. To enhance its effectiveness, the guideline should offer background information on why each element, such as risk allocation and price formation, is important and how it fits into the overall framework. Clearly identifying the intended audience, such as project managers, contractors, or clients, and tailoring the content to meet their specific needs will make the guideline more relevant and useful. Additionally, indicating whether the guideline is a mandatory standard, a recommended practice, or an evolving document will help users understand its importance and application. Providing context helps users understand not only what they need to do but also why they need to do it. This deeper understanding can lead to better adherence to the guidelines and more successful project outcomes. By clearly defining the target audience and the status of the guideline, the document will be more precise and focused.

The initial guideline provided limited practical guidance for users in the construction sector. To improve its practical applicability, the document should include detailed, practical guidance on how to apply the principles and processes outlined. This guidance should cover common challenges and provide solutions or best practices, ensuring that users can effectively implement the guidelines. Emphasizing the need for an iterative approach to project management, highlighting the importance of continuous updates and revisions to adapt to changing project requirements, will also enhance the guideline's relevance and utility. Practical guidance is essential for helping users navigate the complexities of project management and target costing. By offering actionable advice and best practices, the guideline can become an invaluable tool for achieving successful project outcomes.

The initial guideline did not reflect engagement with industry experts or incorporate practical insights from experienced professionals. To address this, the development of the guideline should involve active collaboration with project managers and experts from both client and contractor sides. Gathering practical insights and feedback from these stakeholders will ensure that the guideline is grounded in real-world experience and industry best practices. Regularly updating the guideline based on feedback from users and experts will ensure it remains relevant and effective. Engaging with industry experts and stakeholders ensures that the guideline is both practical and authoritative. This collaboration can lead to a more robust and widely accepted document that truly meets the needs of its users.

This initial guideline provided a valuable starting point for implementing NEC4 Option C Target Costing. However, to evolve into a comprehensive and practically applicable final document, it requires significant enhancements in structure, content, clarity, context, and engagement. By addressing the feedback and recommendations provided by the expert review, the guideline can be transformed into a robust tool that effectively supports the successful implementation of NEC4 Option C contracts in the construction industry.

7. Discussion

The discussion is divided over three sections. The first section presents the implications and limitations of the research approach for achieving the research goal with respect to validity and relevance. The research objective was to develop a guideline for the target costing process in Phase 1, thus improving project management practices to optimize the target costing process for complex infrastructure projects operating under the NEC4 framework. The second section discusses the difference between the theoretical and empirical findings in this research. The last section discusses additional findings of the research.

7.1 Discussion of the research approach

On the literature study

Due to the scarcity of scientific papers specifically addressing NEC4 with target costing (Option C), the literature often references Bouwteam and Early Contractor Involvement (ECI), which have comparable price determination processes to NEC4 with Option C. These insights are relevant because they provide a framework for understanding NEC4's application in project management. Although NEC4 is an Anglo-Saxon contract form and has seen limited application in Belgium and only once in the Netherlands, this does not preclude its potential efficacy in these countries. The project management principles suggested for two-phase contracts under NEC4 could present valuable opportunities for the Belgian and Dutch construction industries, promoting enhanced collaboration, transparency, and efficiency. However, the distinct contexts and traditional practices within these regions might pose challenges to the adoption and effectiveness of NEC4 and its associated project management principles. The differing regulatory environments, cultural approaches to construction, and existing contractual norms could impact the applicability and success of NEC4 in Belgium and the Netherlands. Therefore, while the potential for NEC4 to improve project outcomes exists, its implementation must be carefully adapted to fit the local context to realize its full benefits.

On the case study

The case study is limited to a single instance, with insights gathered from six interviewees, focusing on the Oostweelknoop project, which is the largest NEC4 project to date. Given the singular nature of the case, the findings may not be broadly generalized to other projects or contexts. The specific characteristics of the Oostweelknoop project and the perspectives of the interviewees heavily influence the validity and applicability of the results.

For this study, comprehensive documentation was available, including the contract and all its options, as well as the contract data. This thorough access to project documents allowed for a detailed analysis of the target costing phase, providing a robust foundation for the research findings. To ensure a balanced and nuanced view of the target costing phase, interviewees were selected from both the contractor and client sides. This approach was intended to minimize bias and prevent the narrative from being skewed towards one party, which is crucial for an objective assessment of the target costing process. The interviewees were highly engaged and often candid in their discussions, freely sharing their experiences and challenges encountered during the target costing phase. Their willingness to participate and speak openly was a significant strength of the study, as it provided rich, qualitative data. However, there were instances where information seemed to be withheld. This reluctance to share certain details likely stemmed from the researcher's employment with the contractor side, raising concerns about potential conflicts of interest and the confidentiality of strategic information. These dynamic underscores the sensitive nature of the target costing phase, despite the collaborative intent of the NEC4 contract.

The NEC4 contract is designed to foster collaboration and transparency between parties, with an emphasis on shared goals and open communication. However, the findings from this case study suggest that, in practice, the target costing phase remains a strategic process where both the client and contractor still harbour competitive interests. This reality highlights the tension between the ideal of complete openness and the practical considerations of safeguarding one's strategic interests.

Conducting individual interviews was a methodological choice aimed at encouraging participants to speak more freely about their experiences and perspectives on the target costing process. This approach likely mitigated some of the hesitations that might arise in a group interview setting, where participants could feel less comfortable sharing openly. However, the potential withholding of information points to the inherent challenges in researching collaborative contracts like NEC4, where the balance between transparency and strategic confidentiality must be carefully managed.

On the expert review

One expert from the NEC organization, who specializes in the NEC contract, has reviewed the conceptual guideline for phase 1 of the target costing process. This expert review adds a layer of validation to the guideline, potentially enhancing its credibility. However, it is important to consider that this review could be biased due to the expert's affiliation with the NEC organization, which authors the NEC4 contract. This potential bias suggests that while the expert's insights are valuable, further reviews from independent experts would be beneficial to ensure a more balanced and impartial evaluation of the guideline's effectiveness and applicability.

7.2 Discussion of the research contribution

The research makes a significant contribution to understanding how the design of a collaborative target cost process within Phase 1 of the NEC4 framework can facilitate optimal project management practices and enhance collaboration between contractors and clients. The literature review covered key concepts and theories relevant to collaborative project management and target costing. While many of these concepts were recognized in the empirical research, their integration within the process appeared more contractual than collaborative, raising questions about their practical implementation.

The empirical findings revealed interrelations between the theories and concepts, such as the impact of early contractor involvement, risk management, and price formation. Unlike the literature, which often focused on individual concepts, the empirical data highlighted how these elements interact in practice. For example, while literature acknowledges that risks influence pricing, in practice, the scope often receives more attention unless the risks significantly impact the price. This indicates that the attention given to risks may vary depending on the project's specific circumstances, with design adaptations often used to manage risks and thereby influence the price determination process.

Another difference between the literature and case study findings was the handling of roles and responsibilities. Both sources identified this as a critical success factor. The NEC4 contract itself implements clear roles and responsibilities, but the practical application of these principles proved challenging, especially in large-scale projects. The availability of sufficient resources and qualified personnel is essential for effectively managing roles and responsibilities, underscoring the complexity of this aspect in large projects. Additionally, the literature suggests appointing a cost expert for target cost reviews, while the case study showed the presence of cost experts on the contractor's side and an independent auditor to verify agreed-upon prices. This reflects a need for non-disclosure agreements (NDAs) to ensure confidentiality, emphasizing the importance of trust and transparency in the process.

The research primarily focused on project management practices, but it also highlighted the significance of soft characteristics such as trust, transparency, openness, and collaboration. These soft characteristics are crucial for the price formation process and overall project success. The case study demonstrated that designing and constructing infrastructure projects involves substantial human interaction, where soft characteristics play a pivotal role. These traits not only support specific project management practices but are also fostered by them, creating a symbiotic relationship that enhances both collaborative efforts and project outcomes. It underscores the importance of integrating both hard project management practices and soft characteristics to achieve optimal project outcomes. This dual focus on structured processes and interpersonal dynamics offers a comprehensive approach to improving collaboration and efficiency in large-scale construction projects.

8. Conclusions & recommendations

This section concludes on the main research objective by first concluding on the sub questions with the gathered findings of the exploratory expert interviews, literature studies (1 & 2), case study and the expert review. Then, this section indicates what the recommendations are for practice and provides recommendations for follow-up research subjects based on the findings of this research.

8.1 Conclusion

This section concludes the main research objective, which is to analyse and refine the target costing process in large-scale infrastructure projects, drawing insights from the Oosterweelknoop project to inform future projects. This research involved identifying theoretical patterns in the target costing process and testing these practices against the dynamic and complex realities of the Oosterweelknoop project. The goal was to identify theoretical patterns in order to effectively apply and adapt these patterns, so the target costing process amidst concurrent activities, evolving project parameters, and associated risks, can be improved.

From the literature, the primary concepts that emerged were Early Contractor Involvement, Risk Management, and Price Formation. These concepts are critical in shaping a successful target cost process. Early Contractor Involvement ensures that contractors are engaged from the outset of the project lifecycle, allowing their practical construction expertise to inform the design and planning stages. This early involvement helps to align the project scope more effectively, ensuring all parties have a clear, shared understanding of project goals and parameters. Trust and transparency are foundational elements, creating an environment where open communication is not just encouraged but essential. Joint risk management, where risks are shared and managed collaboratively, leads to balanced risk distribution and a gradual development of a risk-adjusted price, which considers the evolving nature of project risks. Moreover, having clear agreements on price composition and fees helps in establishing a price determination plan that all stakeholders can trust.

The empirical findings from the case study of the Oosterweelknoop project provided practical insights into these theoretical principles. Unlike the focused approach seen in literature, where each concept is often treated in isolation, the real-world application revealed the interconnectedness of these elements. In practice, the alignment of the project scope and the influence of risks on pricing were more dynamic. For example, while the theoretical frameworks emphasized the importance of risk in price formation, it was observed that the scope often received more immediate attention unless the risks were particularly significant. This suggests that the practical emphasis on scope can vary based on the project's specific context, with risks being managed through design adaptations that directly affect price determination.

The Oosterweelknoop project highlighted several strengths and challenges in the current target costing process. Early contractor involvement was a notable success, with contractors contributing valuable construction insights that enhanced the constructability of the design. However, the project faced challenges with a dynamic and evolving scope, making it difficult to achieve a definitive scope alignment. This issue suggests the need for a robust scope management protocol to stabilize the scope and facilitate more accurate target costing. The practice of open book accounting, mandated by the NEC4 contract, has fostered trust and openness, essential for collaborative working relationships. However, the digital systems required for effective open book accounting had not been implemented effectively yet. Thus, making cost assurance and other digital protocols hard to execute. By setting up the digital systems beforehand or at the start of the project, this process could have taken place more efficiently and effectively. While roles and responsibilities were clearly defined in the contract, the practical implementation of these roles was hindered by an unclear demarcation of actual responsibilities on the client and contractors' side. A clearer organizational structure, with defined key roles and clear demarcated responsibilities, could improve the efficiency of these practices.

Risk management practices were also a strong point with risks allocated to the parties best equipped to handle them, as required and stated in the NEC4 contract data. The NEC contract stated clear client and contractor risk. The shared risk register, which influences the pain/gain mechanism, necessitates flexibility from both client and contractor and enhances mutual trust and openness. This trust and openness occurred by having the shared risk register and having periodical meetings to discuss the risks, allocate them and try to think of mitigation strategies for these risks. By having these periodic meetings together impact and costs of these risks were determined, increasing collaboration and trust in this process. The presence of cost experts and agreements on price composition, fees, and a price determination plan contributed to a more predictable and transparent target cost submission process, fostering a more collaborative and less contentious price formation phase.

A practical guideline was developed based on insights from the literature, case study, and expert interviews, focusing on collaboration, risk management, and cost monitoring. This guideline provides a structured approach to implementing target costing in NEC4 contracts, promoting best practices, and offering actionable steps for construction firms. The expert review provided insights to create a comprehensive and coherent guideline, to ensure its completeness and practical applicability, suggesting it could significantly enhance the target costing process in real-world scenarios. The guideline's focus on collaboration emphasizes the importance of working together towards common goals, which is crucial for the successful implementation of target costing in large-scale projects.

In conclusion, this research has provided a robust framework for improving the target costing process in complex infrastructure projects under the NEC4 framework. The findings underscore the importance of early contractor involvement, clear communication, and proactive risk management in achieving successful project outcomes. The Oosterweelknoop project case study serves as a valuable reference, demonstrating how these theoretical patterns can be effectively applied and adapted to meet the dynamic and evolving challenges of large-scale infrastructure development. By integrating these elements, the target costing process can be significantly improved, leading to better cost control, enhanced collaboration, and ultimately, more successful project outcomes.

8.2 Recommendations for practice / guideline

Early Contractor Involvement

To maximize the benefits of early contractor involvement, it is essential to integrate contractors into the project from the earliest stages of design and planning. This approach leverages their construction expertise, ensuring the project is both feasible and optimized for cost and efficiency. Regular workshops and joint planning sessions should be scheduled to foster collaboration and ensure that the contractor's insights are effectively incorporated into the project development. By doing so, potential issues can be identified and addressed early, reducing the risk of costly changes later in the project.

Risk Management

Joint risk management practices should be prioritized to ensure that risks are identified, assessed, and managed collaboratively. A shared risk register should be maintained, where both the client and contractor contribute to and monitor the list of risks. This register should be reviewed regularly, and risks should be allocated to the party best equipped to manage them. Regular risk workshops can help in updating the risk register and ensuring that all parties remain aware of the current risk landscape. Such collaborative risk management practices not only distribute risk more evenly but also enhance trust and cooperation between parties.

Cost Management

To ensure a calm and transparent price formation process, cost management practices must be well-defined. Appointing cost experts on both the contractor and client sides can help in accurate cost estimation and verification. Regular cost reviews and audits should be conducted to ensure that prices remain fair and aligned with the agreed-upon terms. Clear agreements on price composition, fees, and the price determination plan should be established early in the project. These agreements provide a framework for negotiating and finalizing costs, reducing the likelihood of disputes, and fostering a more collaborative relationship.

Scope Management

Effective scope management is critical in large-scale infrastructure projects, particularly under the NEC4 framework where the scope can evolve. It is recommended to implement a robust scope management protocol that includes regular scope reviews and updates, clear documentation, and a well-defined process for managing scope changes. Establishing a design freeze at specific milestones can help stabilize the scope, providing a reference point for accurate target cost calculations. This practice ensures that all stakeholders have a clear and consistent understanding of the project scope, minimizing misunderstandings and scope creep.

Organizational Structure and Resources

A clear organizational structure with defined roles and responsibilities is crucial for effective project management. It is recommended to develop an organizational chart that outlines key roles and responsibilities, ensuring that all team members understand their duties and reporting lines. Adequate resources must be allocated to each role to avoid bottlenecks and ensure that tasks are completed efficiently. Regular training and development programs should be implemented to ensure that all team members are adequately skilled and informed about the latest project management practices and tools.

Trust and Transparency

Building a culture of trust and transparency is fundamental to the success of collaborative contracts like NEC4. Open book accounting, where financial information is shared openly between the client and contractor, is mandatory. This practice promotes transparency and helps in building mutual trust. Regular communication through meetings, progress reports, and shared digital platforms can further enhance transparency. Additionally, fostering an environment where all parties feel comfortable sharing concerns and suggestions can lead to more effective problem-solving and innovation.

By following these recommendations and guidelines, future projects under the NEC4 framework can achieve enhanced collaboration, improved project management practices, and more successful project outcomes.

8.3 Recommendations for further research

Exploring Other NEC4 Options

While this research focused exclusively on Option C of the NEC4 Engineering and Construction Contract (ECC), further studies should explore other options within the NEC4 suite. Each option has unique mechanisms for cost management and risk allocation, which could offer different insights into optimizing project management practices. For instance, Option D (target contract with bill of quantities) and Option E (cost reimbursable contract) may provide alternative approaches to managing collaboration and cost control that could be beneficial in different project contexts. Comparative studies analysing the effectiveness of these options could provide a broader understanding of how different contractual mechanisms impact project outcomes.

Investigating Other NEC4 Contracts

The NEC4 suite includes several other contracts, such as the Professional Services Contract (PSC), the Term Service Contract (TSC), and the Supply Contract (SC). Future research should examine how the collaborative principles and target cost processes can be adapted and optimized within these other contract forms. Each type of contract addresses distinct aspects of project delivery and service provision, which could offer valuable insights into broader applications of collaborative project management practices beyond construction projects.

Longitudinal Studies on NEC4 Projects

Longitudinal studies following NEC4 projects from inception to completion would provide deeper insights into the long-term effectiveness of collaborative project management practices. Such studies could track the evolution of the project scope, risk management strategies, cost adjustments, and stakeholder relationships over time. This approach would help identify which practices contribute most significantly to project success and how they evolve throughout the project lifecycle.

Cross-Cultural Comparisons

Given that the NEC4 framework is relatively new to regions like Belgium and the Netherlands, comparative studies across different cultural and regulatory contexts would be valuable. Research could explore how the principles and practices of the NEC4 framework are adapted in various countries and how cultural differences impact the implementation and success of collaborative project management practices. This could lead to a better understanding of the flexibility and adaptability of the NEC4 framework in diverse environments.

Impact of Digital Tools on Collaboration

Future research should also investigate the role of digital tools and technologies in enhancing collaboration and efficiency within the NEC4 framework. Studies could examine how tools for document control, design monitoring, cost assurance, and communication influence project outcomes. Understanding the impact of digital integration on transparency, trust, and information flow could provide practical recommendations for improving digital collaboration in NEC4 projects.

Detailed Case Studies on Scope Management

Further research focusing specifically on scope management within NEC4 projects would be beneficial. Detailed case studies examining how scope changes are managed, the effectiveness of design freeze protocols, and the impact of scope alignment on project costs and timelines could provide more granular insights. This research could help develop more refined scope management strategies tailored to the dynamic nature of large-scale infrastructure projects.

Behavioural Aspects of Collaboration

Lastly, investigating the behavioural aspects of collaboration, such as trust, transparency, and stakeholder engagement, in NEC4 projects would add valuable depth to the understanding of collaborative project management. Qualitative studies involving interviews and surveys with project participants could shed light on the human factors that influence the success of collaborative practices. This research could lead to strategies for fostering a more collaborative culture in project teams.

By pursuing these areas of future research, scholars and practitioners can build a more comprehensive and nuanced understanding of how to optimize the NEC4 framework for a wide range of projects and contexts. This will ultimately contribute to the development of more effective, efficient, and collaborative project management practices in the construction industry and beyond.

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Appendix

A1 – Definitions and translations

Table 3 - Definitions and translations

English	Dutch	Description
Activity schedule	Werkpakketten schema	A diagram that helps to break down large projects into smaller and more manageable parts, which contain the project results that need to be achieved.
Bouwteam	Bouwteam	A construction team is a project-related partnership between a client and one expert or several experts who, in a coordinated context, work together on the design, engineering of the design and construction.
Client	Klant/ Opdrachtgever	A client is a person or a company that provides a specific assignment to perform work to another person, the contractor.
Compenstation event	Compenseerbaar voorval	A mechanism for clients to pay contractors extra time and/or money for dealing with unexpected changes. Compensation events are set out in NEC4 ECC clause 60.1 and may also be included in the contract data.
Contractor	Aannemer/ opdrachtnemer	A contractor is a person or company that takes on the responsibility of realizing and coordinating construction activities; the contractor provides, for a price determined in the contract and within an agreed period, the delivery of a fully completed structure.
Cost-reimbursable	Kosten vergoedbaar	Cost-reimbursement contracts are contracts where the contractor is reimbursed for the actual costs incurred in performing the work, plus a fee or profit margin.
Design Build Finance Maintain (DBFM)	Ontwerpen, bouwen, financiën, onderhouden	With a Design, Build, Finance and Maintain (DBFM) contract, the contractor is responsible for the design and construction of the project, as well as for financing and overall maintenance.

Design & Construct (DC)	Ontwerpen & bouwen	a contractual pattern for project delivery where the Contractor supplies both the design and the construction.
Design freeze	Het ontwerp bevriezen	Design Freeze means that no further changes can be made to the design. It is a cut off point for the engineers, because if they continue to change the design past a certain date, the Project will not be on time for the construction phase.
Definitive design	Definitief ontwerp (DO)	The definitive design follows from the preliminary design when that is agreed upon. Here is more indicated how the project is going to be made. It is an iteration and refinement form the preliminary design.
Early warning	Tijdige waarschuwing (TW)	a mechanism for both parties to identify potential problems to the project. The contract emphasises that both Parties are obliged to notify the other as soon as they become aware of a matter that could affect time, cost, or quality.
Engineering and Construct Contract (ECC)	Engineering- en constructiecontract (ECC)	The NEC4 Engineering and Construction Contract (ECC) is the main works contract in the NEC4 suite of collaborative, flexible and clearly written contracts for built environment procurement.
Early Contractor Involvement (ECI)	Vroegtijdig betrekken van de aannemer.	Early contractor involvement (ECI) is an approach to contracting that can complement either a traditional or novated design and build delivery model. ECI can be used to gain early advice and involvement from a contractor into the buildability and optimisation of designs.
Institution of Civil Engineers (ICE)		The Institution of Civil Engineers is an independent professional association for civil engineers and a charity in the United Kingdom.
Implementation design	Uitvoeringsontwerp (UO)	The implementation design follows from the definitive design. This design includes the complete detailing and engineering drawings that makes the project executable.

Lantis	Lantis	The organization that realizes and manages mobility projects of regional importance in the Antwerp region. It is the name under which BAM operates, a public limited company, established by the Flemish government and financed with taxpayers' money and its own income.
New Engineering Contract (NEC)		The New Engineering Contract (NEC) is a series of contracts designed to manage any project from start to finish.
Oosterweelknoop		The future entrance and exit complex in the southern part of the port, the Oosterweelknoop, gives the port and the Eilandje a direct connection to the Antwerp Ring. The complex forms the link between the Schelde tunnel and the kanaal tunnels.
Oosterweelverbinding		The Oosterweelverbinding rounds off the Antwerp ring road and thus ensures better mobility. In this way, Antwerp and its port can remain an engine for the Flemish and European economy. traffic-safe infrastructure is being constructed and at the same time we are working together to create a liveable environment for everyone
Open book accounting	Openboek boekhouding	A business practice which opens up an organisation's accounts to some or all of those with an interest in the organisation, including its employees and its shareholders
Organizational chart	Organogram	An organizational chart is a diagram that visually conveys a company's internal structure by detailing the roles, responsibilities, and relationships between individuals within an entity
Pain/Gain	Verlies / winst	a mechanism that ensures that both the client and the contractor have an incentive to

		manage costs effectively. Where they eventually share loss and profit.
Preliminary design	Voorlopig ontwerp (VO)	The preliminary design includes the first drawings and sketches of the project of what is going to be made.
Price formation	Prijsvorming	Price formation is the economic process that determines the price at which goods and services are traded.
Project manager		The project manager in the NEC4 contract gives instructions as necessary and as required in accordance with the contract to the contractor.
Relatics		Relatics is the leading Model-Based Systems Engineering application to fully support clients and contractors of construction projects.
Rinkoniên		Contractor consortium consisting out of five contractors: Mobilis|TBI, Boskalis, Artes, Stadsbader and CIT Blaton.
Scope	Omvang	Scope are the defined features and functions of a product, or the scope of work required to complete a project.
Supervisor	Opzichter	The Supervisor plays an important, quality control role in the ECC, checking that the works are carried out by the Contractor in accordance with the Works Information.
Target cost	Doelkost	Target cost is a strategic approach used in project management to determine the maximum allowable cost for a product or service, ensuring profitability while meeting customer expectations.

A2 – Oosterweelknoop project

The Oosterweelknoop project, located in Antwerp Belgium, is a transformative infrastructure initiative overseen by client Lantis. Spearheaded by a consortium of esteemed contractors including Mobilis | TBI, Boskalis, Artes Group, Stadsbader, and CIT Blaton, collectively known as Rinkoniên, the project aims to revolutionize the region's transportation network. This significant endeavour involves the development of multiple infrastructure components, notably the construction of the Oosterweelknoop at the northern edge of Antwerp, near the Oosterweel church on the right bank (Lantis, 2024). This interchange, situated below ground level, integrates the Scheldetunnel with the Canal Tunnels, forming a crucial link in completing the Antwerp Ring Road network. With on and off-

ramps connecting to the port and the northern part of the city, the interchange facilitates access to key areas while minimizing its environmental footprint through compact design and a distinctive paperclip shape. Additionally, a covered portion of the interchange will accommodate the Ringpark Noordkasteel.

In Belgium, groundbreaking strides are being made as these projects are executed for the first time under the NEC4 contract. Spearheaded by the governmental body Lantis, these ventures mark a significant shift in project management methodologies. Notably, these projects are integral components of the expansive Oosterweelverbinding, a transformative initiative aimed at addressing vital transportation and infrastructure needs.

Lantis (2024) has opted for NEC4 for several reasons. Firstly, the technical and environmental risks are too substantial to be borne solely by contractors. Additionally, Lantis aims to collaborate with contractors to develop the design into an optimized, integrated, and feasible final design. Lastly, Lantis seeks to transition from a traditional conflict/claim culture to a collaborative culture that assists both the client and the contractor in achieving common project goals throughout the entire delivery process. Lantis specifically chose the NEC4 Engineering and Construction Contract (ECC) option C (Target costing) in combination with option X22 (Early Contractor Involvement) because it incorporates specific tools that promote collaboration between the client and the contractor (Lantis, 2024). As a result of Lantis' selection of Option C: Target Cost and Option X22: Early Contractor Involvement, the contract effectively adopts a two-phase structure. In the initial contract/agreement, the contractor assumes the exclusive opportunity to submit the initial bid for the subsequent contract (van der Pas, 2021). Consequently, project pricing is segmented into distinct phases, each viewed independently (Uzun, 2022).

Within the first contract, all risks are borne by the client, and the contractor's work is compensated on a cost-plus-fee basis. During this phase, the contractor and client collaboratively design, allocate risks and negotiate the pricing for the second contract. A successful negotiation ensures continuity, with the same contractor overseeing both the design and execution phases. Conversely, if an agreement on pricing cannot be reached, alternative contractors may be considered for the execution phase (Uzun, 2022). However, for optimal benefits under the NEC4 contract (with ECI), maintaining continuity with the same contractor is preferred, as they possess intricate knowledge of the design details and specifications (Uzun, 2022). It is important to note that the final price may differ from the target price agreed upon for the execution agreement. This study focuses solely on the formation of the target price itself, thus excluding the costs associated with the execution phase. Also, due to this two-phased structure, this NEC4 contract closely resembles the Dutch Bouwteam contract. Encouraging an exploration of the lessons and research findings on pricing formation from the Bouwteam contract to gain valuable insights for the pricing dynamics of the NEC4 contract.

Use of NEC4

Context

This segment aims to provide insight into how the contractual framework should ideally operate and how it is presently functioning at the Oosterweelknoop project. This was done by conducting early exploratory interviews with key players on the project. These individuals were: the Project Director from client Lantis, Technical Manager of Lantis, Project Director from contractor Rinkoniên, and Technical Manager of Rinkoniên.

Intended use NEC4

As options C and X22 have been selected for this NEC contract, the project has effectively become a two-phase contract. In Phase 1, the target costing process, the client, and contractor collaboratively finalize the Definitive Design, finalize the project scope, and eventually agree on a target cost. This target cost is determined, reflecting the contractor's estimate of project expenses based on the Definitive Design and identified and allocated risks. For infrastructure projects, clients, often government agencies, must initially allocate a budget, ensuring funds are reserved for the project. However, these initial budgets are frequently underestimated. Similarly, an initial budget must be established for the NEC4 contract. The availability of this initial budget can significantly influence the implementation of a collaborative target costing approach. This influence arises because if the target costs exceed the initial budget, clients may lean towards adhering more closely to the initial budget due to political pressures associated with government involvement. In Phase 2, the contractor takes charge of completing the implementation design and realizing the works based on the established design from Phase 1. The client pays the contractor directly for the incurred costs, promoting transparency and trust through the open-book principle (Timming & Brown, 2015). These two phases ensure a comprehensive and cooperative approach to managing financial risks in the execution of complex projects.

In an ideal scenario with a NEC4 Option C X22 contract, the project unfolds seamlessly across its defined two-phase structure, with each phase intricately linked to the other. During Phase 1, characterized by Early Contractor Involvement (ECI), the client and contractor engage in extensive collaboration to finalize the Definitive Design. This involves not only aligning the design with project objectives and specifications but also meticulously discussing and negotiating the allocation of risks inherent in the project. Through open and transparent communication channels, both parties work together to identify potential risks and determine appropriate mitigation strategies, ensuring a shared understanding and acceptance of the risk allocation framework. The NEC4 contract explicitly allocates risks to either the client or the contractor. The execution of conditioning works within the ECI phase introduces an additional layer of complexity. These preliminary works, essential for preparing the site and establishing accessibility for subsequent construction activities, require careful coordination and management. The contractor's involvement in executing conditioning works allows for early identification of site-specific challenges and potential risks, facilitating proactive risk management strategies and informed decision-making.

Moreover, Phase 1 encompasses the most critical process of establishing the project scope and pricing. Here, the client and contractor collaborate closely to define the scope of work, considering a range of factors such as project complexity, site conditions, and regulatory requirements. The pricing process is an iterative exchange between client and contractor, with the contractor providing input based on their expertise and experience. In Phase 1, all these processes collectively constitute the target costing process. Through constructive dialogue and negotiation, a target cost is determined, reflecting the contractor's comprehensive estimate of project expenses. This collaborative approach not only fosters transparency and trust but also enhances accountability, as both parties are actively involved in shaping the project's financial framework. Phase 2, which follows Phase 1, sees the contractor taking charge of executing the implementation design based on the finalized plans and specifications. This phase involves the actual realization of the works. However, through effective collaboration and communication established in Phase 1, potential challenges associated with the execution of conditioning works are proactively addressed, minimizing disruptions and delays.

Throughout both phases, transparent communication, trust, and collaboration remain paramount, facilitating the timely exchange of information, resolution of issues, and alignment of project objectives. The open-book principle, which underpins the client's direct reimbursement of incurred costs to the contractor, further enhances transparency and trust between the parties. By fostering a culture of collaboration and cooperation, the NEC4 Option C X22 contract ensures a comprehensive and cooperative approach to managing financial risks, ultimately contributing to the successful execution and completion of complex infrastructure projects.

Situation NEC4 at Oosterweelknoop project

A distinctive aspect of the OosterweelKnoop project execution is the adoption of a non-traditional contract format, deviating significantly from the established construction contracts like the AUR in Belgium. Specifically, the Engineering and Construction Contract Option C with option X22 from the NEC4 contract series was chosen. The NEC4 Engineering and Construction Contract (ECC) Option C is a target cost main works contract featuring an activity schedule. Suited for larger and more complex projects, it accommodates any design level. This option fosters a fully collaborative approach between the client and contractor, allowing them to share project financial risk (nec, 2024). As the contract originated in England, a translation to Flemish has been undertaken by Lantis to accommodate the NEC4 contract to the Belgian context, aligning it with the requirements of the AUR. Since the AUR is the standard Belgian law for infrastructure works. It is important to note that neither the client, Lantis, nor the contractor has prior experience with the use of the NEC contract forms. In the ongoing construction activities at the Oosterweelknoop project, a notable distinction exists between the preliminary works and the main works. These preliminary works are of utmost importance as they prepare the work area for subsequent phases, ensuring accessibility and readiness for the main works phase. Preliminary works in NEC4 encompass small tasks such as the felling of trees. However, at the Oosterweelknoop, much bigger works are already being executed. The execution of the preliminary works depends on a scope instruction from client Lantis. These works need to be paid for, in a cost-plus-fee model, by Lantis. However, Lantis cannot issue a blank check for the work to be carried out. So, it must first be clear what a job will cost. Therefore, Rinkonien is informally instructed by Lantis to first prepare a cost estimate for the works to be carried out. This procedure is not stated anywhere in the NEC4 contract; this method was implemented by Lantis itself in order to carry out the preliminary works. Money must first be made available before a scope instruction can be made and issued. This is Lantis company policy but driven from a political point of view. This makes collaboration very difficult, which is the intention of the NEC4 contract.

This reactive behavior highlights the dependency on external directives and underscores the need for agile decision-making and efficient communication to minimize delays and ensure project continuity. Clear communication and collaboration are vital aspects of successful project management; however, the OosterweelKnoop project faces challenges in these areas. Despite efforts to stimulate collaboration between Lantis and Rinkoniên, discrepancies in risk allocation perspectives and objectives alignment have led to occasional breakdowns in communication. Additionally, Lantis tends to reactively approach products from Rinkoniên, resulting in delays and difficulties in planning. The NEC4 contract explicitly allocates risks to either the client or the contractor. What sets the Oosterweelknoop project apart is the introduction of a unique concept: shared risk. Unlike the standard allocation of risks between client and contractor as defined in the NEC4 framework, the Oosterweelknoop project involves a collaborative approach where certain risks are mutually shared between both parties.

In addition to carrying out the conditional works for the Main Works, the Definitive design for the Main Works is still underway. This is accompanied by the preparation of execution methods and ongoing negotiations regarding risk allocations. These multifaceted discussions are vital for laying a solid foundation for the project. Meanwhile, the calculation of the target cost for submission is also ongoing. Phase 2 can officially commence upon submission of the target cost; however, the effectiveness of this target costing process depends heavily on the advancement of the design, execution methods, risk allocations, and detailed considerations such as man-hours, materials, planning, and work terrain layouts. Striking the right balance in the target cost is imperative – not too high to risk rejection and not too low to avoid significant losses – making it a pivotal aspect of the project's success.

Therefore, the ongoing situation at the Oosterweelknoop project presents unique challenges within the intended use of the framework. With works already underway and amidst a dynamic environment characterized by evolving assumptions, ongoing negotiations on risk allocation, and changing designs, the project faces complexities in establishing a well-founded target cost. The presence of an additional process, namely the execution of conditioning works outside, further complicates the target costing process. Given this departure from the original organisational structure, a nuanced approach is necessary to align the target costing process with the project's evolving realities.

Due to the concurrent processes occurring during the target costing phase, several consequences arise. The relations between the simultaneous occurrence of the multiple critical processes at the OosterweelKnoop project are projected in Figure 11. The relations between the occurring consequences are exemplified in the paragraph below.

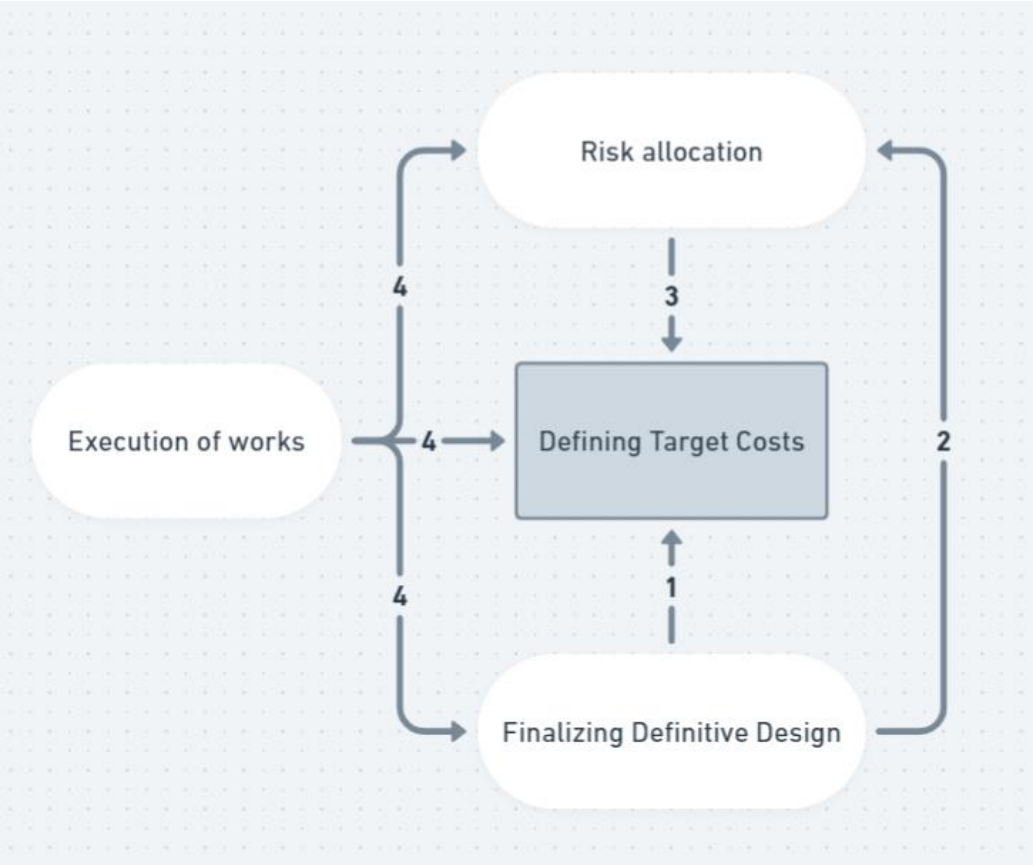

Figure 11 - Relations betwen processes taking place

The simultaneous occurrence of multiple critical processes at the OosterweelKnoop project introduces significant challenges, particularly in the determination of the target cost.

1) The ongoing finalization and potential changes to the design pose a challenge as the project team attempts to establish a target cost based on a design that may still be evolving. This uncertainty in the design phase impacts the accuracy of cost estimations and introduces the risk of unforeseen expenses as design changes unfold.

2) The parallel process of risk allocation negotiations further complicates matters. Risks associated with design changes, execution works, and evolving assumptions for materials need to be comprehensively identified and allocated. However, as these negotiations unfold simultaneously with other processes, ensuring a thorough understanding of potential risks becomes more intricate, potentially leading to oversights or misjudgements in risk assessment.

3) The process of risk allocation holds significant importance in determining the target cost. Thorough identification and negotiation of risks contribute to a more accurate assessment of potential challenges, enabling a realistic estimation of project expenses. Transparent risk allocation promotes collaboration between the client and contractor, establishing a mutual understanding of potential financial implications. Proper allocation of risks to either the client or contractors is crucial. Conversely, incomplete, or inadequate risk allocation can result in inaccuracies in the target cost, posing the risk of underestimating financial impacts. In addition to risk allocation, the OosterweelKnoop project addresses risks borne by both the contractor and client, a practice not present in the NEC4 framework. Moreover, the concept of shared risks adds complexity to the negotiation process regarding risk allocation.

4) The execution of conditioning works outside introduces a layer of unpredictability to the drawing up of the target cost. Unforeseen factors, such as variations in soil quality and/or unforeseen objects in the ground, can significantly impact the target cost estimation. The inherent uncertainties associated with outdoor conditioning works can lead to additional costs that were not initially accounted for in the target cost calculation. Moreover, the influence of these unforeseen factors can reverberate into the definitive design, requiring adjustments based on real-time on-site conditions. This, in turn, triggers the need for comprehensive risk allocation for Phase 2, where uncertainties arising from conditioning works must be identified, negotiated, and allocated collaboratively between the client and contractor. Therefore, the dynamic nature of conditioning works outside not only affects the immediate target costing but also prompts a need for adaptability in the definitive design, and risk allocation, emphasizing the importance of flexibility and contingency planning within the NEC-4 framework.

Moreover, the dynamic nature of these simultaneous processes increases the difficulty in achieving consensus among project stakeholders. Balancing the need for a target cost that is both realistic and acceptable becomes a delicate task, especially when facing uncertainties in design, ongoing works, and risk factors. The challenges arising from these interwoven processes highlight the importance of effective communication, collaboration, and adaptability to navigate the complexities during the target costing process.

A3 – Background target costing

Target costing, originating from the Japanese concept of "Genka Kikaku," differs from traditional costing methods like full costing or activity-based costing (Loosveld, van Acker, Schollier, & Sarens, 2006; Okano, 2002). It involves two primary processes: determining the target cost early in new product development and then achieving it through cost management strategies. Target costing integrates into the product development process, providing cost information to guide decisions and design choices aimed at meeting the target cost (Loosveld, van Acker, Schollier, & Sarens, 2006). It serves as a motivator for cost-reduction efforts across functional teams, encouraging collaboration to find innovative ways to reduce costs while maintaining product quality (Loosveld, van Acker, Schollier, & Sarens, 2006). Target costing is a continuous process, requiring ongoing assessment and adjustment to remain competitive in evolving markets.

B1 – Methodology

The initial step in understanding the dynamics of the Oosterweelknoop project involved conducting early exploratory interviews with key stakeholders. Among those interviewed were pivotal figures such as the Project Director representing the client, Lantis, as well as the Technical Manager from Lantis. Additionally, insights were gathered from the Project Director and Technical Manager of the contracting firm, Rinkoniên. These interviews served as a foundation for comprehensively assessing the project's situation. Subsequently, findings from these interviews informed a thorough literature review, aiding in gaining a deeper understanding of the project's complexities and challenges.

Literature Review:

To establish a comprehensive understanding of target costing processes in construction project management, an extensive literature review was undertaken. Academic databases, industry publications, and relevant books were scoured to gather a diverse array of literature on the topic. The aim was to extract and synthesize key concepts, theories, and identify theoretical patterns related to target costing in complex infrastructure projects, particularly those governed by the NEC-4 framework. This involved critical analysis and evaluation of the literature to identify gaps, contradictions, or areas necessitating further exploration, thus laying the groundwork for the study's conceptual framework. The search was conducted using Google Scholar, Scopus, and Web of Science, employing search terms such as 'Risk allocation,' 'Risk mitigation,' 'Early Contractor Involvement,' 'Collaboration,' 'NEC4,' 'Target cost,' 'Compensation events,' and 'Collab*.' Through this process, a wealth of pertinent documents emerged, shedding light on key insights crucial to understanding NEC contracts. Initially, eight documents were found under the term 'NEC4,' contrasting with seventy-seven documents retrieved under 'NEC.' Recognizing the relevance of NEC3 contracts for comparative analysis, exploration expanded to include projects featuring Option C. Filters targeting 'management' and 'civil engineering' were applied to refine the search and exclude tangential realms like medical research. Similarly, for the term 'target cost,' specific variants such as 'target-cost' and 'target-costing' were utilized to focus the results. This step helped eliminate irrelevant papers, resulting in the exclusion of 2165 documents discussing unrelated topics. Further searches for 'collaborative contracting' and 'collaborative procurement' yielded a total of 252 and 133 relevant results, respectively. Filtering based on the categories of 'management' and 'civil engineering' narrowed down the pool of documents to 133 for both search terms combined. Within this curated collection, emphasis was placed on themes such as 'risk and reward sharing' and 'early contractor involvement,' aligning with the study's objectives. By employing these filters, the literature review was streamlined to ensure that retrieved documents directly addressed construction project management and civil engineering practices, enhancing the relevance and focus of the review.

The practical significance of this study lies in the need for a deeper understanding of the price formation process between contractors and clients, particularly within the NEC4 contract framework. By elucidating processes like target costing, the research aims to provide insights that could mitigate conflicts and enhance project outcomes in terms of time and budget. From a scientific perspective, this research fills a notable gap in existing literature by providing a rigorous examination of target costing within the NEC4 framework. While ample literature on NEC and NEC4 exists, primarily from the Institution of Civil Engineers, there remains a dearth of scientific inquiry into the contracts' intricacies and implications. Thus, this study contributes to scholarly discourse in construction project management and contract administration, enriching the body of knowledge in the field.

Process Analysis at Oosterweelknoop:

In the process analysis phase focusing on the Oosterweelknoop project, qualitative research methods will play a crucial role in understanding the intricacies of the target costing process. The first step involves conducting semi-structured interviews with key stakeholders directly involved in the target costing process, including project managers, contractors, and other relevant personnel. These interviews will be designed to capture insights into how the target costing process is organized, managed, and executed within the project. Participants will be encouraged to provide detailed descriptions of their experiences, challenges faced, and successes achieved during the target costing process. During the interviews, particular attention will be paid to recording the discussions accurately. Audio recordings of the interviews will be made to ensure that all information shared by participants is captured faithfully. These recordings will then be transcribed verbatim, providing a written record of the interviews' contents. Transcribing the interviews allows for a more thorough analysis of the data, enabling to identify nuances, themes, and patterns within the discussions. Once the interviews are transcribed, the data analysis process will begin. Thematic analysis will be employed to systematically identify and interpret patterns within the interview transcripts. This involves categorizing the data responses into themes and sub-themes related to different aspects of the target costing process. Pitfalls, challenges, and areas for improvement will be identified as themes, while processes that are functioning well will also be extracted and categorized separately. Observational methods, such as attending meetings, will complement the interview data by providing direct observations of the target costing process in action, allowing for a deeper understanding of practical challenges and opportunities for improvement. Through this analysis, a comprehensive understanding of the strengths and weaknesses of the target costing process at Oosterweelknoop will be obtained. Pitfalls and challenges will be scrutinized to uncover underlying causes and potential solutions, while successful processes will be examined to identify theoretical patterns and lessons learned. By extracting insights from both the pitfalls and successful processes, targeted recommendations for optimizing the target costing process within the project will be developed and inform the broader guideline development effort.

Guideline Development:

The development of the guideline for enhancing the target costing process is a meticulous process, drawing insights from literature studies and a comprehensive case study. This guideline aims to provide stakeholders with invaluable resources to optimize the target costing process, ensuring efficiency and success in complex infrastructure projects, particularly those operating under the NEC4 framework.

To create this guideline, a systematic approach will be followed, encompassing several key steps. Firstly, a thorough literature review will be conducted to gather data on target costing principles and methodologies, assessing their relevance and applicability in real-world scenarios. Concurrently, a process analysis of the Oosterweelknoop project will be undertaken to understand the practical application of target costing in a specific context. The synthesis of theoretical insights from the literature review with empirical findings from the case study will form the foundation of the guideline. This synthesis will inform the formulation of detailed recommendations for implementing target costing effectively, considering uncertainty factors, and fostering collaborative engagement among stakeholders. The guideline will be meticulously structured into distinct sections, each corresponding to different aspects of the target costing process. These sections will include theoretical insights, empirical findings, and practical recommendations, ensuring a comprehensive coverage of all relevant aspects. Additionally, the guideline will emphasize readability, conciseness, and relevance to ensure accessibility and usability for stakeholders.

Before finalization, an expert review will be conducted to validate and verify the end product, ensuring its accuracy, completeness, and practicality. By following these steps, the guideline will serve as a vital resource for stakeholders, equipping them with the necessary knowledge and tools to navigate and optimize the target costing process effectively.

C1 – Interview protocol

The interview will have the following structure:

1) **Introduction**
   - Introducing myself, my role as a researcher, and the purpose of the interview.
   - Provide an overview of the master thesis topic, emphasizing the focus on the target costing process.
2) **Participant information**
   - Collecting information such as the participant's name, job title, company, and relevant experience with the topic.
   - Write this information down
3) **Informed consent**
   - Getting consent to record.
   - Assure confidentiality and anonymity
4) **Warm-up questions**
   - Starting with general questions and ease the participant into the interview process.
5) **Core questions**

Theme 1 Early Contractor Involvement:

Questions:

- What are important aspects in the use of early contractor involvement, when the design and objectives are still dynamic and not (completely) fixed, for realizing a representative target cost.
- Within NEC4 and the target costing process there are different roles and responsibilities, what does that mean for collaboration, trust, and transparency?
- In the current phase the scope of the target cost is very dynamic, what are important aspects to consider when this is happening?
- What are important aspects with the implementation of open-book accounting during the target costing phase and what is the influence on transparency and trust between the organization and the client?

Theme 2 risk management:

Questions:

- What are important aspects, in the Early contractor involvement phase, with risk identification and the still changing design?
- What are important aspects in risk allocation during the design process for supporting the target costing process?
- What are optimal approaches for managing the evolving design and its associated risks when maintaining a joint risk register?
- What are important practices with early risk identification, combined with the Early Warning register, during the target costing phase?

Theme 3 price formation:

Questions:

- What are important practices establishing agreements on price composition, fees, and price determination early in the contracting phase for supporting the target costing process?
- How do you integrate cost experts into the target costing process, and how does this foster trust and collaboration between your organization and the client?

Additional questions for improvement of the target costing process:

- Which additional principles could be integrated to enhance the efficiency and effectiveness of the target costing process?
- What lessons have been learned from the target costing process, and how would they inform future projects with similar contract types?
- What adjustments in principles or ways of working would be made for future projects with similar contract type?
-

6) Conclusion

- Thank the participant for their time and valuable insights.
- Offer the opportunity for any final comments or reflections.
- Reiterate the confidentiality of the information shared and provide contact details for further questions or follow-up.

D1 – Interview analysis

The found data in the semi-structured interviews is used to analyse the findings for the target costing process. The analysis includes qualitative research approaches. The following steps will be followed:

1) **Organise and prepare the data for analysis for verbatim transcripts.**
   - Transcribing the interviews with removing of names and dates for the anonymity of the interviewees. The interviewees received the transcripts with additional questions if needed to be able to make comments on the interview data, which supports validity of the interview data.
2) **Intensive reading of the interview transcripts.**
3) **Coding the data.**
   - The transcripts are coded thematic driven with the three main themes within the target costing process: Early contractor Involvement (Blue), Risk management (Red) and Price formation (Yellow).
   - Possible additional findings will be marked green.
4) **Representing the themes.**
   - Here the themes and their relations are mapped in a conceptual model.
5) **Describing the themes.**
   - In this last step, the storyline of the conceptual model is written down in the section of the analysis of the theoretical framework compared to the case study of the Oosterweelknoop. Here it is summarised what the literature mentioned about the theme, the ideas of the different interviewees about the theme and quotes that clarify the theme.

Upon analysis of the interviews, a guideline will be formulated. The development of guiding principles for the target costing process entails extracting prevalent themes and optimal strategies gleaned from literature reviews and case studies. These principles condense into core concepts that offer guidance and organization for the guideline or model. Serving as the bedrock, these guiding principles furnish a unified and logical framework for target costing in construction project management.

NEC4 Option C Target Cost Guideline

NEC4 OPTION C TARGET COSTING

Guideline

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Summary

In recent years, optimizing target costing processes in complex infrastructure projects under the NEC4 framework has gained significant attention. After a research that addressed the challenges inherent in these processes and improve efficiency and collaboration this guideline was developed.

The NEC4 framework is favoured for its emphasis on fostering collaboration and effective risk management. Early contractor involvement in the design process under NEC4 ensures that substantial effort is invested when the design is still developing and risks are at their highest. This approach offers numerous advantages, including enhanced risk and cost management, opportunities for innovation, and reduced fragmentation of expertise. However, the intricacies of the target costing process within NEC4 necessitate a cooperative approach to price development between clients and contractors. The objective of the conducted research was to analyse and refine the target costing process in large-scale infrastructure projects, emphasizing insights drawn from the Oosterweelknoop project to inform future projects. This involved identifying theoretical patterns in the target costing process and testing these patterns against the dynamic and complex realities of the OosterweelKnoop project. The conducted research aimed to identify best practices, gain insights from practical situations, and compare them to explore how a guideline for the collaborative target costing process in phase 1 of the NEC4 framework can be conceptualized to enhance project management practices and foster collaboration between contractors and clients. Eventually, how this can be effectively applied and adapted to improve the target costing process amidst concurrent activities, evolving project parameters, and associated risks.

To address this question, the research adopted a mixed-methods approach. Initially, a comprehensive literature review was conducted, examining existing knowledge on target costing, the NEC4 framework, and collaborative practices in construction. Recognizing gaps in the literature, the study then proceeded with an in-depth case study of the Oosterweelknoop project. This case study involved semi-structured interviews with key stakeholders and thematic analysis of the data collected. Key findings from the research highlight several important aspects. Early contractor involvement (ECI) significantly enhances the target costing process by improving communication, reducing risks, and fostering a collaborative environment. However, to fully leverage the benefits of ECI, clear guidelines and effective stakeholder management are essential. Effective risk management practices also emerged as crucial. Proactive identification and mitigation of risks early in the project lifecycle are necessary to prevent cost overruns and delays. Additionally, aligning prices during the project's early phases through transparent negotiations and continuous monitoring is vital to ensure that the target costing process remains effective and realistic.

The outcome of this research was a practical guideline for the target costing phase, provided in this document. This guideline integrated theoretical patterns from both literature and empirical findings, focusing on three main aspects: collaboration and communication, risk management, and cost monitoring. Establishing clear channels and protocols for stakeholder interaction enhances cooperation and understanding, while proactive risk identification and mitigation strategies address potential issues early in the project lifecycle. Utilizing tools and techniques for continuous cost assessment and adjustment ensures financial control throughout the project. Document analysis and interviews with representatives from both client and contractor sides who participated in the target costing process provided empirical support. Validation of the guideline was achieved through expert evaluation. Validation involved feedback from industry experts, assessing the completeness and applicability of the guideline in real-world scenarios.

Guideline NEC4 Target costing

NEC4 Option C target costing Guideline

The NEC4 Option C contract is designed to promote collaboration and cost management in construction projects. By setting a target cost, it aligns the interests of the client and the contractor towards achieving cost efficiency and project success.

Setting up organisation

Setting up the organization is important because it establishes clear roles and responsibilities, which promotes transparency and accountability, ultimately enhancing the efficiency and success of the project .

- **Clear roles and responsibilities.**
  There are four defined roles within NEC4:
  1. Client
  2. Project manager
  3. Supervisor
  4. Contractor

  Client and Project manager can be of the same organisation, however clear demarcation between roles and responsibilities has to be clearly communicated between all involved parties.
- **Create an organizational chart.**
  - Mirror project management functions within both organisations to ensure alignment and facilitate transparent communication.
  - Fill in the key roles on the organisational chart and then build the project teams around this structure based on the pre-defined activity schedule (Work Breakdown Structure).

Setting up digital systems

Setting up digital systems is important because they facilitate efficient communication, streamline project management processes, and ensure accurate data management, which are crucial for the successful execution of complex projects .

- **Create data exchange protocols that work for both organisations.**
  - For example Asite program.
  - For example Relatics program.
- **Create document control protocols together with both organisations.**
  - Set up document controle teams within both organisations.
  - Control protocols within data exhange programs such as Relatics.
- **Establish agreements on maximum response and control time**
- **Create a cost assurance system in order to facilitate the open-book accounting.**
  - insight in the contractors finances helps with transparency and creates trust between client and contractor.

Price formation agreements

- **Create agreements on fees, checked by independent auditors.**
  - Establishing agreements on fees verified by independent auditors ensures fairness and accuracy in financial transactions, enhancing transparency and trust between parties while mitigating the risk of disputes over billing.
- **Agreements on material prices for frequently used materials, including clear indexing for potential inflation.**
  - Agreeing on material prices with clear indexing for inflation provides predictability and stability in project costs, fostering trust and collaboration by minimizing uncertainties related to cost fluctuations.
- **Create a price determination plan outlining how elements will be prices, how prices will adjust over time, factors triggering adjustments, and calculation methods.**
  - Developing a price determination plan clarifies how pricing decisions are made, promotes transparency by outlining factors influencing cost adjustments, and encourages collaboration through shared understanding and agreement on cost management strategies.

Risk allocation

- **NEC4 clearly identifies specific client and contractors risks in chapter 80 and 81.**
  - These risks should be known by each party and each party is liable for their allocated risk.

Scope definition

With a clear scope:

- **Create a scope document database.**
  - Establish a scope document database containing all documents to be included in the scope for both organizations, aligned with the activity schedule (Work Breakdown Structure).
    - Design documents.
    - Desing notes.
    - Planning and phasing.
- **Creating a price based on this scope.**

With a dynamic scope:

- **Set up a scope management plan.**
  - The scope management plan defines protocols for identifying, evaluating, and documenting scope changes during the target costing process, ensuring transparency and facilitating informed decision-making.
- **Make use of a design-freeze.**
  - This design-freeze will be used as a milestone and pricing will be based on this scope. Possible scope changes after agreeing upon a target cost will be formulated as a compensation event.
- **Create a scope document database.**
  - Establish a scope document database containing all documents to be included in the scope for both organizations, aligned with the activity schedule (Work Breakdown Structure).
    - Design documents.
    - Desing notes.
    - Planning and phasing.
- **Creating a price based on this scope.**

Shared risk management

- **Together, identify potential risks.**
  - By identifying risks together, collaboration to promote mitigating strategies is encouraged, fostering trust by demonstrating that both parties have the project's best interests at heart.
- **Create a joint risk register.**
  - After identifying risks, consolidating them in a joint risk register and assigning their impacts and costs fosters transparency by ensuring all parties have a clear understanding of potential threats. This transparency builds trust as it demonstrates a commitment to open communication and shared responsibility in managing project challenges effectively.
- **Implement Early Warning mechanism.**
  - Implement an Early Warning mechanism to promptly alert parties about potential risks related to time, cost, or construction issues, thereby fostering trust, collaboration, and transparency through shared documentation in the risk register.

Price formation

- **Involve cost experts**
  - Engage cost expert from both sides to thoroughly assess and establisha pragmatic target price, promoting transparency and trust through collaborative decision-making.
- **Utilize internal cost estimations**
  - Use internal cost estimations to create forecasts and ensure ongoing mutual updates with the client, fostering transparency and collaboration in project cost management.

Final target cost agreement

2. Introduction

The NEC4 Option C Target Costing Guideline is an essential document designed to provide comprehensive instructions and best practices for implementing target cost contracts within the NEC4 framework. NEC4, the latest edition of the New Engineering Contract, is gaining traction in the Belgian and Dutch construction industries as a modern and effective contracting method. However, many organizations in these regions are grappling with the challenges associated with the implementation and use of NEC4, particularly in the context of target costing.

NEC4 is renowned for its emphasis on collaboration, flexibility, and proactive risk management. Option C within this framework specifically addresses target costing, a method aimed at controlling project expenses while fostering a collaborative environment among all project stakeholders. By setting a target cost for the project, NEC4 Option C encourages all parties to work together efficiently to achieve the desired outcomes within the agreed budget.

This guideline aims to streamline project delivery, enhance cost predictability, and promote the efficient use of resources across construction and engineering projects. It provides a detailed roadmap for organizations seeking to adopt NEC4 Option C, outlining strategies for successful implementation and management of target cost contracts. By following this guideline, stakeholders can better navigate the complexities of NEC4, ultimately leading to more successful and cost-effective project outcomes.

3. Application

3.1.Status guideline

The guideline includes guiding principles for the target costing process under NEC4. These guiding principles differ from standards and work agreements in the following ways:

- A standard typically has a formal status and is mandatory, or it can be used to demonstrate quality, which also entails obligations.
- Work agreements are sector-wide agreements without mandatory enforcement.
- Guiding principles are directives that provide direction but allow each organization to implement them in their own way. Organizations are free to use only a few principles if they choose.

This guideline opts for guiding principles because decisions regarding the target costing process are made within organizations. This guideline encourages organizations to adopt and consistently apply these guiding principles to achieve better alignment and outcomes of project using the NEC4 contract in combination with a target cost.

3.2.Widely applicable

This guideline is widely applicable across the entire construction sector for those considering using or working with the NEC4 contract in combination with a target cost, including both clients and contractors. It is particularly beneficial for project managers, as they are responsible for overseeing project delivery, ensuring cost control, and fostering collaboration among stakeholders. By adhering to these guiding principles, project managers can enhance cost predictability, streamline project execution, and promote the efficient use of resources.

4. Assumptions

4.1.Implementation

The successful implementation of this guideline for NEC4 Option C target costing rests on several key assumptions. First, it assumes that all stakeholders, including clients, contractors, and project managers, are committed to the principles of collaboration and transparency that underpin NEC4. This commitment is essential for fostering the cooperative environment necessary for target costing to be effective.

Second, it assumes that organizations have or will invest in adequate training and resources to familiarize their teams with the NEC4 framework and its digital systems. Proper education and training are crucial for ensuring that personnel can effectively utilize the digital tools and processes outlined in the guideline. Additionally, it assumes that there is a willingness to engage in iterative processes, particularly in areas like risk management, scope definition and organizational setup, to adapt to the evolving nature of construction projects.

The implementation of this guideline involves a structured approach that begins with establishing the foundational elements, such as setting up organizational structures and digital systems. These initial steps are followed by the creation of the price formation agreement, risk allocation, and scope definition. Throughout the project lifecycle, shared risk management is continuously revisited to address changes in scope and associated risks. This iterative process ensures that the project remains aligned with its objectives and can adapt to any emerging challenges. By adhering to these assumptions and following the structured implementation approach, organizations can enhance cost predictability, streamline project delivery, and promote efficient resource use, leading to successful and cost-effective outcomes in construction and engineering projects.

4.2.Timeline

The guideline is structured in a particular sequence, beginning with fundamental elements and then progressing to more specific aspects. This ordered approach ensures a solid foundation before addressing the complexities of the target costing process. While some elements can be initiated simultaneously, the guideline intentionally prescribes a step-by-step sequence. This approach promotes a systematic and cohesive strategy when starting the target costing process, ensuring that each component builds on the previous one for greater stability and coherence.

Starting with foundational elements such as setting up organizational structures and digital systems provides the necessary groundwork. These initial steps are critical for establishing the framework within which all subsequent activities will operate. Once these are in place, the focus shifts to creating the price formation agreement, risk allocation, and scope definition. This logical progression ensures that all parties have a clear understanding of their roles, responsibilities, and the project's financial framework before moving into more dynamic and iterative processes like shared risk management.

By following this structured approach, organizations can avoid common pitfalls associated with disjointed project initiation. It facilitates a smoother transition between phases, reduces the risk of oversight, and promotes a comprehensive understanding among stakeholders. This methodology ensures that every aspect of the target costing process is thoroughly addressed in a logical and interconnected manner, ultimately leading to a more efficient and effective implementation of NEC4 Option C contracts.

4.2.1. Setting Up Organizations

Establishing an effective organizational structure is crucial for the successful implementation of NEC4 Option C target costing. The NEC4 contract identifies four key roles: Client, Project manager, Supervisor and Contractor. These roles must be clearly defined and assigned with their respective responsibilities. Construction projects are typically large-scale endeavours that span multiple years, involving various stakeholders from different disciplines. As such, there is a natural turnover of personnel—team members leave, and new individuals join the organization. This turnover necessitates a repeated process of setting up and reconfiguring organizational structures to ensure continuity and alignment with the project's goals and methodologies. Regular updates to the organizational setup help maintain operational efficiency, facilitate knowledge transfer, and ensure seamless collaboration among all stakeholders. Moreover, this iterative process allows the organization to adapt to changes in project requirements, ensuring that the right expertise is always available to meet project demands.

4.2.2. Setting Up Digital Systems

Setting up digital systems is a one-time process that lays the foundation for managing NEC4 Option C target costing efficiently. These systems are essential for handling project data, facilitating communication, and managing workflows. Specifically, these digital systems should offer comprehensive data management with secure, centralized storage for all project-related documents, drawings, and records, ensuring easy access and retrieval. Additionally, effective workflow management features are necessary to track project progress, assign tasks, and monitor deadlines. An effective cost management system is crucial, enabling detailed tracking of expenses, budget monitoring, and cost forecasting to ensure that the project remains within its financial targets. Once these systems are established and functioning correctly, they provide a robust framework for project management. However, the success of these digital systems relies heavily on the users' ability to operate them effectively. Therefore, it is crucial to implement comprehensive training programs to educate all personnel on the proper use of these systems. Continuous education and refresher courses should be part of the organization's strategy to ensure that everyone remains proficient in using the digital tools, thereby maximizing the benefits of digitalization and enhancing overall project efficiency.

4.2.3. Price Formation Agreement

The price formation agreement is a cornerstone of the NEC4 Option C framework, establishing the financial foundation for the project. This phase involves determining the base prices for staff and materials under Phase 1, with agreements on these prices being made and checked by independent auditors. In addition to setting these base prices, a comprehensive price determination plan for arriving at the target cost will be developed. A crucial component of this plan is the determination and agreement of the fee and indirect costs, which are often the most challenging to negotiate. These elements require careful consideration and validation to ensure they accurately reflect the overheads and other non-direct costs associated with the project. By defining the target cost from the outset, including these difficult-to-determine components, the agreement promotes transparency and aligns the financial interests of the client and contractors. This alignment fosters a collaborative environment where all parties work toward achieving the project's financial objectives, thereby minimizing disputes and promoting financial stability throughout the project lifecycle.

This first price formation process is primarily a one-time activity at the beginning of the project to establish the initial financial groundwork. However, the agreements and prices set during this phase should be periodically reviewed and adjusted as necessary to reflect any changes in project scope, market conditions, or other relevant factors. This iterative review ensures that the financial aspects of the project remain accurate and aligned with the project's evolving needs.

4.2.4. Risk Allocation

Effective risk allocation is critical in the NEC4 Option C target costing process. This phase involves clearly defining and assigning potential risks between the client and contractors as specified in the NEC4 contract. Proper risk allocation ensures that each party understands its responsibilities and liabilities, facilitating proactive risk mitigation. By explicitly designating who is responsible for each risk, the process promotes fairness and encourages all stakeholders to collaborate in managing and minimizing these risks. During this phase, risks identified in the NEC4 contract will be allocated to the designated parties. It is essential that all parties are aware of these risks and work together to mitigate them collaboratively. Additionally, flexibility is crucial; if one party is better suited to handle a particular risk than initially stated in the contract, adjustments should be made to reallocate that risk accordingly. This proactive and adaptable approach to risk management helps prevent unforeseen issues from derailing the project and ensures that all parties are prepared to handle potential challenges effectively.

4.2.5. Scope Definition

Defining the project scope is a fundamental step in the NEC4 Option C framework. The scope outlines the project's objectives, deliverables, and boundaries, providing a clear direction for all stakeholders. A well-defined scope helps prevent scope creep, which can lead to project delays and cost overruns. It serves as the foundation for effective project planning, execution, and control, ensuring that all stakeholders are aligned with the project's goals and understand their roles and responsibilities. Clear scope definition is essential for maintaining project focus and achieving the desired outcomes within the agreed timeframe and budget.

Early contractor involvement is critical in this process, as it allows contractors to contribute their expertise during the initial planning and design stages. This collaborative approach ensures that the scope is realistic, achievable, and in cohesion with the design process. By involving contractors early, potential issues can be identified and addressed before they impact the project's progress, leading to a more robust and comprehensive project scope.

When the scope is not clearly defined or is dynamic, a robust scope management plan should be put in place. This includes the use of a design freeze and maintaining a scope document database. In cases where the scope is well-defined, this is a one-time process. However, for dynamic scopes, it is crucial to establish clear agreements and regularly revise and update important milestones, making it an iterative process. This ensures that all stakeholders remain informed and aligned with any changes, maintaining project focus and control throughout its lifecycle. Establishing a clear baseline is vital, as it provides a reference point against which all scope changes can be measured, ensuring that any deviations are managed effectively and transparently.

4.2.6. Shared Risk Management

Shared risk management is an ongoing process that is essential for handling the dynamic nature of construction projects. This process involves the continuous assessment and management of risks in relation to the defined project scope. Since both the scope and associated risks can evolve over time, it is crucial to update and manage them in tandem. By integrating risk management with scope management, the project team can ensure that any changes in the scope are accompanied by corresponding risk adjustments. A particularly challenging aspect is managing shared risks, not initially incorporated in the NEC4 contract. These risks should be addressed through a collaborative approach, involving all stakeholders in identifying, assessing, and developing strategies to mitigate them. This often requires joint risk workshops and regular communication to ensure that all parties are aligned. The influence of these shared and new risks on price formation is significant, as they necessitate the inclusion of contingencies and potential adjustments to the target cost to cover unforeseen issues. This proactive management of shared risks promotes a culture of transparency and cooperation, fostering stronger collaboration among all parties and enhancing the overall stability and predictability of the project. By ensuring that risk management evolves with the project scope, the project team can effectively respond to emerging risks and changes, maintaining alignment with project goals and financial objectives.

In this guideline, both elements—scope management and risk management—are viewed and addressed separately to highlight their individual importance and to ensure that neither is overlooked. However, they are inherently interconnected; when the scope changes, new risks may arise, necessitating a revision of the risk register. An early warning system is a key principle within this framework, enabling the project team to identify and address potential risks as soon as they emerge. When dealing with a dynamic scope, scope changes often introduce new risks. Implementing an early warning system is vital for identifying and addressing these risks promptly. A collaborative approach is necessary to mitigate risks effectively, utilizing a shared risk register to assign each risk to the party best able to handle it. When a dynamic scope is solidified through a design freeze, the associated risks should also be frozen to create a cohesive whole. This approach simplifies the final price formation. However, both the scope and risks should be regularly revised and updated when changes occur. Clear agreements and the continuous use of early warnings are essential for maintaining alignment and preparedness throughout the project lifecycle.

5. Development of the guideline

The development of this guideline stemmed from research conducted for a master's thesis focused on the NEC4 contract implementation at the Oosterweelknoop project. This in-depth research began in February 2024 and was instrumental in gathering detailed insights and practical knowledge about the NEC4 framework, particularly its application in target costing. The comprehensive study involved rigorous analysis and evaluation of project documentation, methodologies, and real-world applications of the NEC4 contract.

5.1. Origin of the Guideline

The origin of this guideline is rooted in the findings and outcomes of the master's thesis research. The results provided a robust foundation for creating a structured and practical guideline tailored to the needs of the Belgian and Dutch construction industry. This guideline aims to address the challenges and intricacies of implementing the NEC4 Option C framework with target costing, as identified during the research at Oosterweelknoop.

5.2. Accompaniment and Expertise

The development of this guideline was further enriched by the accompaniment and expertise of project managers from both the client and contractor sides, who possess extensive knowledge of NEC4 and its specific application in target costing. Their practical insights and experiences were invaluable in ensuring that the guideline is both comprehensive and applicable to real-world scenarios. Their involvement ensured that the guideline reflects best practices and addresses common challenges encountered in construction projects using the NEC4 Option C framework.

These project managers provided critical feedback and validation at various stages of the guideline's development, ensuring that it is grounded in practical experience and aligned with industry standards. This collaborative approach has resulted in a well-rounded and effective guideline designed to facilitate the successful implementation of NEC4 Option C contracts in the construction industry.