Master's thesis

2020

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Maturity of TVD Implementation in Norwegian Public Building Projects

June 2020

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OPAK

Master's Thesis

Maturity of TVD Implementation in Norwegian Public Building Projects

Project Management, Master's Thesis [TBA4910]

Gard Y. Smoge

In cooperation with OPAK AS

Civil Engineering
Due date: June 11, 2020
Supervisor: Agnar Johansen, NTNU/OPAK AS
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Summary

The theme of the thesis relates to design based on Target Cost (TC) and Target Value Design (TVD). These guides the design process and are distinguished by an iterative design process focusing on optimization of value within cost limitations. There is an emerging interest in creating more value for the project's client and the user(s).

The Norwegian construction industry experiences drop off in productivity. This study aims towards investigating the correlation between this and (the lack) of implementation of the previously mentioned design guidelines. International and national research have shown considerable potential in the projects' early phases and that an increased focus reduces the risk of cost overruns. Research shows that the client's Target Value (TV) is positively affected by implementing TVD. Studies reveal that TVD projects are more likely to be completed below anticipated Market Cost (MC), experience an increased accuracy for conceptual estimates, have a lower contingency reserve, in addition, prevent 'overdesign'. Nevertheless, only a few Norwegian projects have fully implemented TVD. Identifying the level of TVD implementation will contribute towards increasing the awareness of current TVD maturity. Consequently, providing potential short- and long-term practical initiatives of how to benefit from its identified results.

The purpose of the research is twofold by both discover and increase the awareness of the maturity of TVD implementation during the pre-project phase in Norwegian public building projects. The following Research Questions (RQs) will be investigated:

1. How is the TVD maturity in the Norwegian construction industry?
2. How can TVD be applied in the pre-project phase of Norwegian public building projects?

Research findings illustrate the current level of maturity among the investigated cases. Five cases (named 'Case 1', 'Case 2' , etc.) have been investigated to answer the RQs. The scores are provided based on a developed scorecard which ranges from zero (meaning not implemented) to three (meaning fully implemented). Scores are differentiated and visualized across the four categories: contracting, organizing, defining (business case and validation study), and steering. The current TVD implementation is on average 'sufficiently implemented' (an Average Score (AS) of two) but the variations are significant. In total, eight possible solutions have been identified to achieve a full TVD implementation. These solutions are divided into short- and long-term initiatives.

The following identified short-term initiatives are: 1) Relational contract, which helps to create a shared understanding of the project, 2) Variations of a 'change' and an 'optimization' must be defined and valued from the start, 3) A preliminary TC creates discipline, and 4) Using Set-Based Design (SBD) during procurement of technical systems enhances value creation.

The long-term initiatives are related to more fundamental changes: 1) Usage of a fixed maximum Allowable Cost (AC) is lacking, 2) The client's business case must comprehend what is

wanted and the client's ability to pay, 3) Comparing MC (a result of a sufficient benchmarking process) to the AC should be conducted before project approval to execute 'the most valuable project' and 4) Transparency within a specified TC is crucial to detect project-specific means, ends, and constraints. TV must be measured and prioritized for optimizing cost reduction activities.

Sammendrag

Tema for studien er prosjektering basert på målsum (Target Cost) og verdistyrt prosjektering (Target Value Design eller 'TVD'). Dette er 'retningslinjer' for prosjekteringsprosesser og kjennetegnes ved en iterativ prosess som fokuserer på optimalisering av verdi innenfor en gitt kostnadsramme. Interessen for dette er økende, blant annet fordi det er ment å skape økt verdi både for byggherren og brukerne av det ferdigstilte prosjektet.

Den norske bygg- og anleggsnæringen opplever produktivitetsfall. Denne studien tar sikte på å undersøke sammenhengen mellom dette og manglende implementering av de overnevnte retningslinjer for prosjektering. Nasjonal og internasjonal forskning viser nemlig at det ligger mye potensiale i prosjektenes tidlige faser, og at økt fokus her reduserer risikoen for kostnadsoverskridelser. Også byggherrens ønskede målverdi (Target Value) påvirkes i følge forskningen positivt ved implementering av verdistyrt prosjektering. Det vises for eksempel at TVD-prosjekter ofte gjennomføres under antatt markedspris, at de tidlige kostnadsestimatene er mer pålitelige, har en lavere usikkerhetsavsetning samtidig som 'overdesign' unngås. Til tross for dette, har kun et fåtall norske byggeprosjekter implementert TVD fullt ut. Å identifisere nivået på implementeringen av TVD vil bidra til økt bevissthet om den nåværende modenheten. Samtidig bidrar dette med potensielle kort- og langsiktige praktiske initiativ som utnytter de identifiserte fordelene.

Formålet med studien er todelt. Den skal både identifisere og øke bevisstheten om modenheten av TVD i forprosjektfasen i norske, offentlige byggeprosjekter. Følgende forskningsspørsmål vil bli utforsket:

1. Hvordan er modenheten for TVD i norsk bygg- og anleggsnæring?
2. Hvordan kan TVD benyttes i forprosjektfasen i norske, offentlige byggeprosjekter?

Funnene i studien viser det nåværende modenhetsnivået blant de utvalgte casene. For å besvare disse forskningsspørsmålene undersøkes 5 utvalgte caser (her kalt 'Case 1', 'Case 2' etc.). Det vil bli gitt poeng basert på en utviklet poengskala som går fra null (i betydning ikke implementert) til tre (i betydning fullstendig implementert). Poengene er differensiert og visualisert innenfor fire kategorier: kontrahering, organisering, definering (prosjektbegrunnelse og bekreftelsestudie) og styring. Den nåværende TVD-implementeringen er i gjennomsnitt 'tilstrekkelig implementert' (tilsvarer en poengsum på to), men variasjonene er store. Tilsammen er det identifisert åtte mulige løsninger for å oppnå en fullstendig TVD-implementering. Disse deles inn i kort- og langsiktige initiativer.

De kortsiktige initiativer er som følger: 1) Samspillskontrakter, som hjelper med å skape gjensidig forståelse for prosjektet, 2) Variasjonene mellom en 'endring' og en 'optimalisering' må defineres og verdisettes, 3) En midlertidig målsum (TC) medfører disiplin, og 4) Økt verdiskaping ved bruk av *Set-Based Design* i innkjøp av tekniske systemer.

De langsiktige initiativ relaterer seg til mer fundamentale endringer: 1) Manglende bruk av en absolutt kostnadsramme (AC), 2) Byggherrens prosjektbegrunnelse bør omhandle egne ønsker og egen betalingsevne, 3) Markedspris (et resultat av en fullstendig benchmarking-prosess) burde vurderes mot kostnadsrammen før igangsettelse for å kunne iverksette 'det mest verdifulle prosjektet' og 4) Åpenhet om en forhåndsdefinert målsum er kritisk for å kunne oppdage prosjekt-spesifikke virkemidler, metoder og begrensninger. Ved å måle og prioritere målverdi kan kostnadsreduserende aktiviteter optimaliseres.

Preface

This master's thesis is the finishing activity of the five-year master's degree program at the Department of Civil and Environmental Engineering at Norwegian University of Science and Technology (NTNU). In total, the workload of this thesis equals to 30 units and has been conducted during the spring semester of 2020. A specialization project (TBA4531 Project management, specialization project) lays the foundation for the knowledge gap investigated (Smoge 2019).

The master's thesis consists of three parts. Part 1 is the master's thesis itself while part 2 consists of a scientific paper delivered to the 28th Annual Conference of the Interantional Group for Lean Construction (IGLC). The conference is due to the Covid-19 situation a virtual conference. Part 3 involves appendix.

I would like to express my deepest appreciation to my supervisor from NTNU and OPAK AS, Agnar Johansen. His guidance, knowledge, and patience have been crucial in achieving the desired level of quality in my work. I also wish to thank Glenn Bjørsrud and OPAK AS for letting me benefit from their knowledge and work. Many thanks to all of the interviewees, without whose cooperation I would not have been able to conduct this thesis. Special thanks to Olav Torp at NTNU for his contribution to the published scientific paper. I gratefully acknowledge the constructive advice and the eyes for details my brother, Kristian, put into the thesis.

And finally, family, friends, and girlfriend, each of whom have provided patient advice and guidance throughout the research process.

Trondheim, June 2020

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Gard Ytterdal Smoge

Table of Contents

List of Tables

List of Figures

Abbreviations

AC Allowable Cost.

AEC Architecture, Engineering and Construction.

AS Average Score.

BIM Building Information Modeling.

BREEAM Building Research Establishment Environment Assessment Method.

CII Construction Industry Institute.

DMP Decision-Making Process.

EC Expected Cost.

EE Energy Efficiency.

GFA Gross Floor Area.

HSE Health, Safety and Environment.

ICE Integrated Concurrent Engineering.

IGLC Interantional Group for Lean Construction.

IPD Integrated Project Delivery.

KVU Concept Evaluation.

LCC Life Cycle Cost.

MC Market Cost.

NPRA Norwegian Public Roads Administration.

NTNU Norwegian University of Science and Technology.

PM Project Manager.

PMs Project Managers.

QA Quality Assurance.

ROI Return of Investment.

RQs Research Questions.

SBD Set-Based Design.

TC Target Cost.

TONE Credibility, Objectivity, Precision and Suitability.

TV Target Value.

TVD Target Value Design.

WBS Work Breakdown Structure.

ZEB Zero Emission Building.

PART 1: MASTER'S THESIS

Chapter 1

Research Introduction and Background

Chapter one introduces the reasoning of why this research is needed and which knowledge gap that has been identified. This research needs to be put in a context and the background, therefore, focuses on underlying issues. Research questions were established to address some of these issues in addition to narrow the identified knowledge gap.

1.1 Introduction

'Target Costing' is defined as a management practice that has been prominent in new product development and manufacturing industries to ensure predictable profit planning by meeting market-determined prices (Cooper & Slagmulder 1997). TVD is an adapted version of 'Target Costing' and is a managerial tool which focuses on achieving a wanted target value during design (Macomber et al. 2007, Ballard & Morris 2010, Lee et al. 2012, Zimina et al. 2012, Namadi et al. 2017). Macomber et al. (2007) developed nine conditions for achieving the target value during the design process. Based on these findings, Namadi et al. (2017) defined the following five independent TVD characteristics: target costing setting, collaboration, co-location, SBD, and work structuring. Ballard & Morris (2010) characterized TVD as the relationship between Expected Cost (EC) and AC with key a feature to "design to target". Doing so increases the predictability of the project by establishing a business case stating what the client is willing and able to pay to accomplish a facility with defined performance. The primary driver for design is the client's value (Zimina et al. 2012) and this "conceptualization of design processes" provides the arguments that TVD is a lean design management method (Lee et al. 2012). The following characteristics distinguish TVD from other traditional methods: An iterative process of evaluating benefits and purpose in design within constraints predefined in the business case. Furthermore, the reasoning for adopting this new process is to create more value (in the sense of increased benefit based on time, cost, and quality). An iterative design process focuses on achieving and maximizing the value for the owner and the user(s).

'Value' in construction projects is a complex term to describe (Bertelsen & Emmitt 2005, Drevland 2019, Khalife & Hamzeh 2019). Bertelsen & Emmitt (2005) underlined that 'value' within construction is defined as the process of understanding and achieving the client's needs. In an attempt, Drevland (2019) distinguish between product and process factors. These factors are dynamic by depending on the given stakeholders' perspectives (Khalife & Hamzeh 2019). Moreover, the weighting of these factors will vary and even be mismatching based on the cir-

cumstances. In other words, instead of constructing the most cost-efficient facility by primarily focusing on time, cost, and quality (the iron triangle), this management practice the target to achieve 'the most valuable project'.

Maximizing project value has gained interest among researchers in recent years. This is for the most part linked to the project evaluation of costs (even cost overruns) against stakeholder benefits. Emmitt et al. (2004) looked at how to take a more integral and holistic approach to design and construction. The cost can easily be quantified and compared up against other 'similar' projects (benchmarking). Benefit, on the other hand, is more challenging to measure. Early decisions and analysis from the initial idea and up until the decision to implement, have the biggest potential for value creation and improved project benefit (Klakegg et al. 2018).

1.2 Background

The Norwegian construction industry has seen a decrease in productivity of 10% since the year 2000, while productivity in other private land-based industries has had an increase of 30% (Todsen 2018). Even so, the number of mega projects within the Norwegian Architecture, Engineering and Construction (AEC) industry is increasing, and mega projects are often associated with performance problems (Samset & Volden 2013, Welde et al. 2014, Welde 2016, Jordal 2019). These studies are related to the Concept program which investigates and evaluates Norwegian mega public projects which have been implemented in the Norwegian governance scheme. At this date, the lower cost limit is 300 MNOK for digital transformation projects and 1000 MNOK for other projects (Longva & Gamstøbakk 2019). This investment regime has been implemented and modified by the Oslo and other large and equipped municipalities. Briefly, this governance scheme provides requirements of both cost and benefit in two stage gates. Quality Assurance (QA)1 is mainly focusing on the choice of concept. QA2 looks into the validation study of the project by investigating the management base and the cost estimate.

Samset & Volden (2013) looked into 40 out of the 50 construction and transportation projects which had been through the Norwegian QA scheme. Among other findings, the writers identified that 80% of the projects were within the AC. However, among the 20% that experienced cost increase, the smaller projects had the highest increase. 12 projects with exceptionally large cost increase were investigated by Welde et al. (2014). The study revealed a significant cost increase during the early phases of the projects while the construction phase was quite stable or even decreasing. Investigating 78 different public projects stated that the cost performance in large Norwegian public investment projects is on average 7% below the formal budget (Welde 2016). On the other hand, Jordal (2019) studied the cost development between the choice of concept (QA1) and the start of the pre-project (QA2). On average, the cost estimates increased by 43% between these to decision gates. Figure 1.1 provides a generic illustration of the tendency in mega projects with a significant cost increase during the early phases:

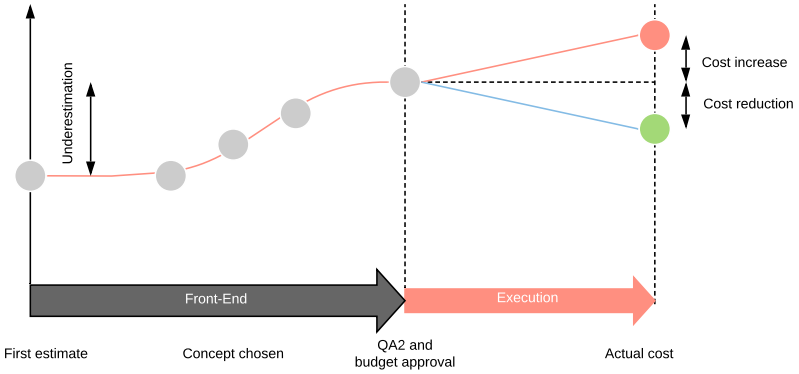

Figure 1.1: The development of cost estimate verification by Welde et al. (2014) and Welde (2016).

Corresponding tendencies of cost increase can be seen in smaller international and national construction projects during planning and construction (Flyvbjerg et al. 2003, Cantarelli et al. 2012, Ulstein et al. 2015, Torp et al. 2016, Onshus et al. 2016, Bakke et al. 2019). Flyvbjerg et al. (2003) pointed at cost escalation across international transport and infrastructure projects by testing the length of the implementation phase, the size of the project, and the type of ownership. Cantarelli et al. (2012) on the other hand uncovered that the length from the decision to build and until the start of construction (in the study defined as 'pre-construction') is a determinant of cost overruns. Each additional year of the pre-construction phase adds five percentage points to the cost overrun. Three independent variables (project type, size, and length of the construction phase) are examined in relation to differentiate cost overrun in Dutch infrastructure projects with international findings. Ulstein et al. (2015) discovered a 55% cost increase between the choice of concept and the execution phase in four Norwegian construction projects due to direct, underlying, and systematic/organizational causes. Based on these causes, which can be further explored in the investigation, the authors recommend implementing EC at an earlier stage in the project development. Additionally, implementing processes for change control and standardized cost estimating and reporting methods. Onshus et al. (2016) investigated the following challenges in the early phases of large public construction and transportation projects: how to develop and confine a beneficial project scope based on the given assumptions, technical requirements, and external factors. Findings in the report point to two main causes for a discrepancy in the range of cost estimates:

- Weakness in the cost estimation process.
- Weakness in project governance.

Torp et al. (2016) revealed a 50% cost increase during the planning phase for 11 large and 34 medium-sized Norwegian construction projects. Furthermore, 19 Norwegian governmental construction projects experienced a cost increase of 30% from the pre-design to completion phases (Bakke et al. 2019). Most of this cost increase occurred prior to construction.

A successful outcome requires that the value to the business is maximized through the delivery of a facility that gives them the benefits they need at a price they can afford at the time when they need it and to a quality that fulfills their expectations. (Dallas 2006)

This statement implies that 'value' depends on achieving the benefits within the constraints of cost, time, and quality which fulfills the client's expectations. TVD has received an emerging interest among researchers and practitioners towards avoiding project cost overruns and adding value. Previous research has shown that TVD projects are completed 15-20% below MC while maintaining quality and time (Ballard & Rybkowski 2009, Zimina et al. 2012). Furthermore, the method increases the accuracy of conceptual estimates (Ballard & Pennanen 2013) and lowers the contingency needed for each project (Zimina et al. 2012, Chen et al. 2014). The methods also manage complexity and prevent 'overdesign' (Lee et al. 2012) by focusing on common goals and objectives (Namadi et al. 2017).

This study will elaborate on the current state of TVD implementation in the Norwegian construction industry. The purpose of the research is to discover and increase the awareness of the maturity of TVD implementation during the pre-project phase in Norwegian public building projects. The following RQs are in the center of attention in this master's thesis:

1. How is the TVD maturity in the Norwegian construction industry?
2. How can TVD be applied in the pre-project phase of Norwegian public building projects?

However, this study is based on a limited number of cases and interviews and therefore does not reflect the 'full maturity' status of the Norwegian construction industry. Consequently, the findings provide a modest basis for the creation of generalized trends and conclusions.

1.3 Scope

The purpose of this study is to analyze and increase the awareness of the maturity of TVD implementation during the pre-project phase in Norwegian public building projects. In other words, the findings are limited to Norwegian public projects and more specifically during the pre-project phase. Each of the five investigated cases was hand-picked based on their uniqueness. A limited number of case studies (within a restricted geographical area) and interviews (mostly Project Managers (PMs) from the client) were investigated. Since statistical validity requires a significant number of cases, a limited number of cases with sufficient uniqueness have been preferred.

'Maximizing project value' is a complex proposition. Firstly, the term 'value' is crucial. Setting project targets based on achieving stakeholders' values implies that 1) these values are identified among all stakeholders, and 2) these values are fixed during the project execution. The first proposition demands comprehensive knowledge of the circumstances affecting the stakeholders' perception of value. Research exploring the second proposition has concluded that the perceived project value changes (matures) during the lifetime of the project (Khalife & Hamzeh 2019). That being the case, controlling and managing project value requires considerable effort. Additionally, some ongoing research projects such as the Oscar project in Norway (Multiconsult n.d.) and the Ph.D. from Drevland (2019), are investigating the topic, which could result in substantial changes to the industry's perception.

Secondly, to have value as the foundation for decision-making, the contracts between actors must be developed and adapted for this exact purpose. Zimina et al. (2012) demonstrated that

relational contracts are better suited to implement the TVD methodology. Investigation of contractual arrangements that seek to maximize project value will only be limited to the case findings and therefore briefly discussed.

To summarize, the following topics are explored in this thesis:

- **General design principles and methods**
- **TVD**
- **Business case and validation study**
- **Determination of TVD maturity**
- **Practical implementation of TVD characteristics**

1.4 Structure of the Master's Thesis

The master's thesis is structured according to Figure 1.2:

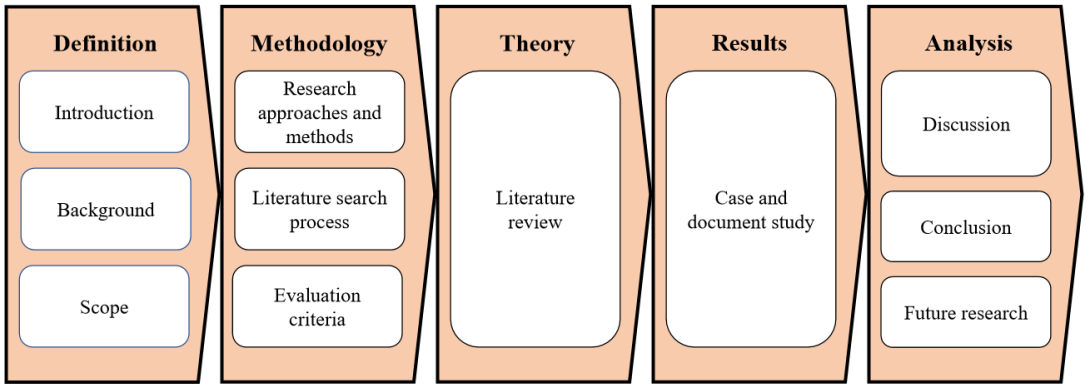

Figure 1.2: Overview of the structure of the master's thesis.

At first, the scope and the limitation of this master's thesis are defined. Creating a context and background comprehends the understanding of why a specific methodology has been used. The chapter describing research methodologies involves both qualitative and quantitative research methods and approaches. Weaknesses and strengths are illustrated before critically discussing the chosen research design. A literature review has created the basis of the theory illustrated in chapter 3. An introduction to the topic and its origin must be understood to comprehend the reasoning behind the characteristics described in the case findings. Triangulation of combining interviews and document studies with the literature review provides a sufficient basis for discussing the level of TVD maturity among the investigated cases. To summarize the analysis, a conclusion and future research recommendations are established. The conclusion also involves short- and long-term improvements that could be beneficial to increase the TVD maturity among Norwegian public building projects.

Chapter 2

Research Method

Chapter two introduces the research methods and elaborate on their weaknesses and strengths. Besides, this chapter will clarify how the literature search has been conducted and the keywords used in the process. Research approaches and methods have been briefly studied and presented creating the basis for the chosen research design. Further, the reasoning behind the case study evaluation process and the interview structure is presented. A scorecard has been developed and the TVD maturity for each project has been identified, ranked, and evaluated against the literature.

2.1 Research Approaches and Methods

Williams (2007) defines research as: "(...) the process of collecting, analyzing, and interpreting data to understand a phenomenon." The overall intention is to answer the research questions stated in this study. Further, this process is divided into two overall methods: qualitative and quantitative. A combination of those two does also occur. The methods presented will be differentiated by data required to answer the research questions.

Qualitative Research Approach

Williams (2007) described qualitative research as: "(...) purposeful use for describing, explaining, and interpreting collected data," which is designed according to a structured framework specific for the area explored. Creswell & Poth (2018) defined qualitative research as the study of a phenomenon in their natural setting in an attempt to interpret or understand the meaning people bring to them. Data is collected and analyzed through both deductive and inductive reasoning to establish patterns (Creswell & Poth 2018). Five qualitative research approaches have been defined based on frequently used approaches in behavioral, social, and health science literature (Creswell 2003, Creswell & Poth 2018, Yin 2018):

- **Narrative research**: A collaborative narrative chronology of the researcher's and one or two studied individuals' views on life.
- **Phenomenology**: To study a limited number of individuals over time to develop patterns and relationships of meaning.
- **Ethnography**: "(...) studies an intact cultural group in a natural setting over a prolonged period of time by collecting, primarily, observational data."

- **Grounded theory**: Using participants' views to: "(...) derive a general, abstract theory of a process, action, or interaction (...)". Two main design characteristics are the comparison of data against categories and the groups' similarities and differences.
- **Case study**: In-depth research of a process, an activity, an event, a program or one or more individuals. The case(s) are limited in time and activity, and the information is collected over a certain period.

Quantitative Research Approach

Creswell (2003) stated that quantitative research comprises: "(...) elaborate structural equation models that incorporated causal path and the identification of the collective strength of multiple variables." The data is often numerical and aligned with statistical data collection methodology. This research approach is divided into three main classifications:

- **Descriptive**: Examines the situation in its natural setting by identifying variables of one or several phenomena.
- **Experimental**: Examines the treatment of an intervention into the study group and then measures the outcome of the treatment.
- **Casual comparative**: Compares and adjusts the dependent variables with the independent ones to examine the causality between them.

Williams (2007) described several approaches that are not further elaborated. However, two main strategies are of equal importance (Creswell 2003, Muijs 2004):

- **Experiments**: "(...) a test under controlled conditions that is made to demonstrate a known truth or examine the validity of a hypothesis."
- **Surveys**: Exploiting a standard questionnaire through various mediums (e-mail, face-to-face etc.). Often used in social sciences due to the need for exploring the variables in their "natural setting".

Mixed Research Approach

Creswell (2003) described the three main strategies: sequential, concurrent, and transformative research procedures. Mixed research is based on the concept of triangulation (Creswell 2003) by combining both quantitative and qualitative methods with equal or unequal focus (Muijs 2004). Combining the two may result in a multiplication of the potential to discover unanticipated outcomes (Bryman 2006). Triangulation is defined by Yin (2018) as: "(...) the convergence of the data collected from different sources of evidence, (...)." The study further expands on the characteristics of case studies and their relevance when investigating 'how' or 'why' questions.

Different research reasoning is related to qualitative and quantitative research. These reasoning strategies must be thought of as tendencies rather than involving separated distinctions (Bryman 2006). Inductive reasoning is often associated with qualitative research by developing a generalized theory based on research observations and findings. Comparatively, deductive reasoning is linked to quantitative by using the theory to create hypotheses and tested them against observations and findings. An abductive strategy explores observations and findings of a phenomenon in the context of their worldview to create a theoretical understanding.

Summary of the Different Research Methods

Table 2.1 provides a summary of the different attributes described by Creswell (2003). Collis & Hussey (2003) stipulate the following issues needed to be explored to fully describe the overall research perspectives and approaches:

- The reasoning behind collecting this data.
- Description of the collected data.
- Where the data was collected.
- How the data was collected.
- How the data was analyzed.

Table 2.1: Summary of the main characteristics and differences of the three research methods described in the previous section based on Creswell (2003).

Research Methods	Description
Quantitative	Predetermined methods Instrument-based questions Performance, attitude, observational and census data Statistical analysis
Qualitative	Emerging methods Open-ended questions Interview, observation, document and audiovisual data Text and image analysis
Mixed	Predetermined and emerging methods Open- and closed-ended questions Multiple forms of data Statistical and text analysis

Research design has been developed based on the described methods and approaches and their characteristics (strengths and weaknesses). The following section further explores this design.

2.2 The Thesis' Research Design

Figure 2.1 describes the chosen research design. This master's thesis is an extension of the theory and knowledge gaps provided by the specialization project. The master's thesis consists of a more comprehensive data collection procedure by involving case studies and semi-structured interviews with key positions in a building project in the Oslo region. A precise definition of the terms 'reliability' and 'validity' is needed to expand on the already written material. 'Reliability' is characterized as the consistency of results over time by being able to create the same

results by using the same methodology (Golafshani 2003). 'Validity' is characterized as the 'precision' of the research method with regards to providing the results one is looking for.

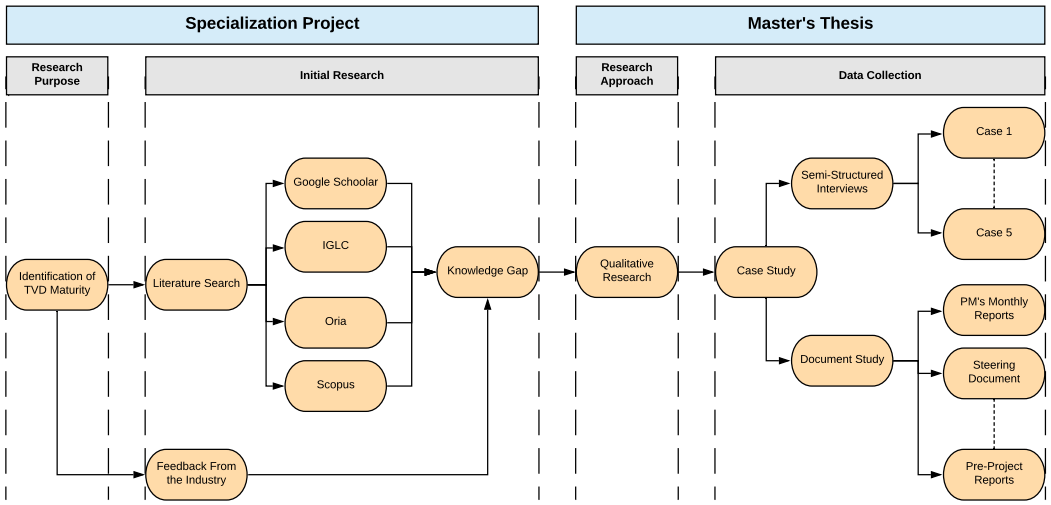

Figure 2.1: Overview of the chosen method for both the specialization project and master's thesis.

An initial literature review is beneficial for identifying and justifying the established research questions (McGhee et al. 2007, vom Brocke et al. 2009, Grant & Booth 2009). Doing so enables the reader to understand the perspective of the research (McGhee et al. 2007). The review process involves identifying quality papers and performing evaluations of their necessity for the topic (vom Brocke et al. 2009). Using previous work as part of identifying information gaps strengthen the formal search process (Grant & Booth 2009).

The challenge of the qualitative approach is the authenticity of the collected data by demanding transparency. Clarifying the search history and the keywords enables the readers to reconstruct the literature search (Fossey et al. 2002). These keywords are located in Appendix 6.3. Qualitative sampling must consider both the appropriateness and the adequacy of the data (McGhee et al. 2007). Alongside the transparency perspective, the authenticity of the data itself is of equal importance (Morse 2008, Kvale & Brinkmann 2009, Mason 2010). The project is interpretative and therefore depends on the theoretical insight of the researcher to create linkages, to synthesize and to identify characteristics (Morse 2008). Support and verification of the participants themselves affect the quality (hence, the authenticity) of the qualitative inquiry. Kvale & Brinkmann (2009) underlined that the number of participants also depends on the study's purpose. Adding more studies and interviews must, therefore, be in harmony with the time and resources needed and the amount of new knowledge gained (Mason 2010).

Case studies involving semi-structured interviews and document studies will strengthen the authenticity of the collected data (Creswell 2003, Dicicco-Bloom & Crabtree 2006, Williams 2007) but as stated by Bowen (2009), a document study has the following limitations:

- **Insufficient detail** due to not be created for research.
- **Low retrievability** due to limited access.
- **Biased selection** due to alignment with corporate procedures and policies.

To understand and to counteract these limitations, one must first define for a document study. A document study systematically reviews or evaluates documents (printed and digital) to examine, interpret, and develop empirical data. Bowen (2009) investigated the use of documents in qualitative research. The study does not explicitly state how many or which documents to include. However, the writer underlined the quality and the contained evidence as the most vital aspects. A few documents can be sufficient if used as to verification or support. Document analysis is often combined with other methods to establish triangulation.

Triangulation, with theory connected to findings in case studies and patterns, revealed by the interviewees are perceived as beneficial (Creswell 2003, Williams 2007, Diefenbach 2008). In-depth, semi-structured interviews are distinguished from unstructured interviews by making use of predetermined, open-ended questions with other questions arising from the dialogue between the interviewer and the interviewee (Dicicco-Bloom & Crabtree 2006). Diefenbach (2008) looked into the methodological issues of semi-structured interviews in qualitative research. These issues point at the need for more methodological awareness with regards to subjectivity (hence validity) of the data description and generalizations. Since TVD recently has gained growing interest, qualitative research is useful to identify important variables (Creswell 2003). Williams (2007) concluded that qualitative research is better for understanding the complexity of a phenomenon and Diefenbach (2008) pointed at the need for additional information and validation when using semi-structured interviews.

Inductive theory building from cases involves multiple challenges (Eisenhardt & Graebner 2007, Yin 2018). Firstly, knowledge gaps must be grounded in theory and the proposed research questions need to address this gap. Moreover, the selection of cases is based on their uniqueness and their contribution to theory development. While single-case studies provide the exploration of a distinct phenomenon (Yin 2018), multiple case-studies create a stronger foundation of empirical evidence (Eisenhardt & Graebner 2007, Yin 2018). Conclusions are therefore related to the uniqueness of the cases and their surrounding environment.

Literature Search Process

Recent and current literature on related topics at various levels of comprehensiveness and completeness have been reviewed. This is illustrated in Figure 2.2.

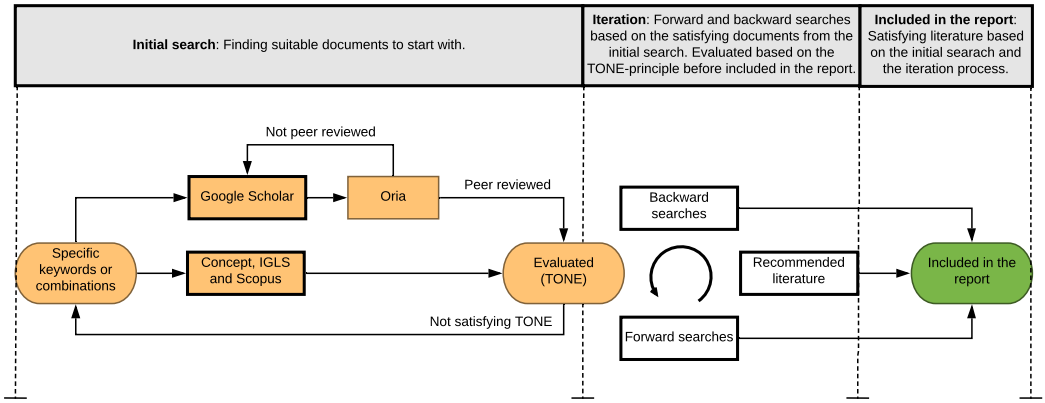

Figure 2.2: The literature search process for this research.

Identification and evaluation of both the search process and the keywords are based on the following characteristics (vom Brocke et al. 2009):

- **Reliability**: The replicability of the search process documenting how the search process has been conducted.
- **Validity**: The precision of the literature search to obtain the right sources.

In addition to the use of keywords and phrases related to the topic, more literature has been provided by forward or backward searches based on relevant findings. As stated by vom Brocke et al. (2009): "Whereas backward search means reviewing the references of the articles yielded from the keyword search, forward search, in turn, refers to reviewing additional sources that have cited the article." Based on the Credibility, Objectivity, Precision and Suitability (TONE)-principle the literature was evaluated and differentiated. Databases and search engines used in the literature search are described and summarized in Table 2.2:

Table 2.2: Description of databases and search engines used in the study.

Database/Search Engine	**Description**
Oria	Several Norwegian libraries' resources for higher education.
Google Scholar	Web search engine with access to large amounts of metadata and journals. The most coverage of engineering literature.
IGLC	An international network of researchers in the AEC industry that aim to develop methods and principles to improve the industry's processes and products.
Scopus	A subscription-based academic database containing summaries and referrals to articles in scientific journals.

Case Studies

The selection of cases is of importance. Each case is selected based on its uniqueness and its surrounding environment and Table 2.3 briefly describes the motives for each of them. An important element in this regard is that all of the cases have exceeded or started the pre-project phase. Consequently, this study conducts an ex-post (backward-looking) evaluation of the cases.

- Every case is located in Oslo and an area close by to create a more consistent project selection by generating better possibilities for detecting patterns or differences related to project execution and governance.
- *OPAK* occupies the position as the Project Manager (PM) for the client. Establish the same starting point concerning internal routines, reporting, and governance.
- Each case is part of a large public development plan focusing on future challenges.

- Contractual arrangements as partnering, design-build, or the combination of them both are used in the cases. Focus on collaboration and the development of new project execution models and methods influence each case. The cases' purpose and stated targets with regards to environmental aspects, collaboration, and the use of TC make them interesting.
- Case 5 is comparable to Case 1 and 2 but evolved completely differently. The case is an example of possible consequences (not satisfying the users' needs) by providing the user with a too dominant position (purpose to achieve the user's stated functions).

Table 2.3: The case study: Brief project description

	Description
Case 1	Part of a larger public development plan to encounter growth within the municipality. Demolition and construction of a new high school (550 pupils), and a swimming pool. Partnering contract.
Case 2	Part of the same larger development plan as Case 1. Constructing a new elementary school (700 pupils), a sports center with a tribune (300 people) and two swimming pools. Involves the same contractor as Case 1. Partnering contract.
Case 3	Part of a master plan to upgrade 2,500 of the municipality's nursing home spots. Constructing 144 nursing home spots, a senior and daycare center. First BREEAM Excellent certified nursing home in the country. Design-build contract.
Case 4	Part of the same master plan as Case 3. Demolition and construction of a new six-stories BREEAM Excellent and ZEB building with 144 new nursing home spots, resulting in the most environmental-friendly nursing home in the country. Partnering and design-build contract.
Case 5	Part of the same development plan as Case 1 and 2. Constructing a sports center but the design competition was canceled. The contract changed from partnering and design-build to a full design-build.

Document Study

Internal case documents are of importance to both identify and later on, verify, the incorporated project management methods and tools. These documents are well known and distributed among all of the involved actors in the partnering-arrangement. The study either supplements or contradicts findings from the interviews creating a context and basis of which TVD characteristics can be identified and ranked. The cases selected for this research are part of development among project clients. Changes in the documents from one case to another can, therefore, be of interest. Table 2.4 which is located on the next page, provides a review of the investigated documents and their main focus. These definitions are based on definitions and contents from Longva & Gamstøbakk (2019), Rolstadås (2018), and OPAK. An important and deliberate aspect of the selection of documents is that only official and distributed documents are investigated. Consequently, internal notes and incomplete documents are left untouched.

Table 2.4: Overview of the documents involved in the document study.

Documents	Description
Steering document	Provides an overview of central project constraints and assumptions. The structure is normative and clarifying for internal actors, the client. and relevant external stakeholders. The main areas of attention are project constraints and conditions (concept, project goals, and interfaces), strategy (execution, organization, and contract) and the governance basis.
Tender document	An introduction of the project (background, duration, procurement propositions, and contact information), deadlines, and preliminary progress schedule.
Pre-project report	A finalized document which is delivered to for political, administrative, and/or external evaluation for approval. Includes technical and economical possibilities, alternative solutions, and the consequences of choices taken.
Evaluation report	Evaluation of the delivered tenders and propositions for project solutions. Conducted by a committee consisting of the client, user(s), and the PM.
PMs monthly report	Monthly reports to the client. Include updates with regards to achieved milestones and future incidents and activities, progress development, and financial (budgeted, accumulated, and prognostic cost), governance and HSE aspects.

Semi-Structured Interviews

In total, six in-depth, semi-structured interviews have been conducted with the PMs from each case. Case 2 involves both the client's and contractor's perspective. The interviews lasted 90-120 minutes and were conducted either face-to-face or by use of digital media. Each of the interviewees signed a consent approving the data collection. The consent is an insurance for the data being handled under policies from the Norwegian Center for Research Data. Every interview was recorded, transcribed, and categorized in accordance with Figure 2.3:

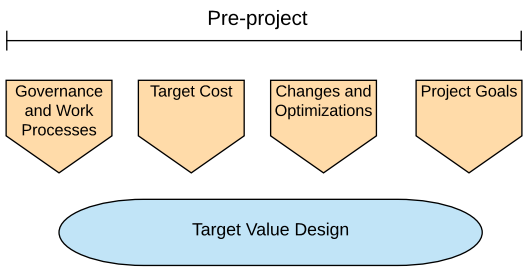

Figure 2.3: These five main subjects and corresponding questions were exploited in the interviews.

Table 2.5 described the number of interviewees of each case and their previous experience. This aspect somewhat establishes a context that might shed light upon the reasoning of the interviewee's perspectives and statements. A scorecard has been established for this research to 'translate' these statements into TVD characteristics.

Table 2.5: Position and previously experience among the interviewees (shortened to 'Int.').

	Int.	Position and Experience (last ten years)
Case 1	2	**PM**: Started first in this case as the assistant PM. Previously worked as the PM and assistant PM in both large and small projects. The first partnering (mainly worked with design-build contracts). **The contractor's PM**: Started first as the design manager. Previously worked as project director and design and project manager. Has participated in design-build and partnering contracts.
Case 2	1	**PM**: Previously worked as a design and project manager for both client and contractor organizations. Worked with design-build contracts, partnering, and a combination of the two.
Case 3	1	**PM**: Previously worked as a PM in design-build contracts. Mainly been working for the public with buildings with the intended use.
Case 4	1	Same person as Case 3.
Case 5	1	**PM**: Previously worked as a PM or in a combined position as a project and construction manager. Mostly involved in design-build contracts.

Scorecard

A developed scorecard has been based on the identified TVD characteristics from the literature and the corresponding in-depth, semi-structured interviews. An analytical framework was necessary to comprehend the investigation of multiple cases. To be precise, a TVD 'characteristic' is an element or activity which has been identified in the literature to be a part of the TVD process. Several of the repeated characteristics were consolidated within the four categories: contracting, organizing, defining (distinguished between the business case and validation study), and steering. The contracting element was added based on statements from the interviewees while the remainder TVD categories arose based on the results in Denerolle (2013). A natural development of the pre-project phase aligns the four categories chronologically, meaning that the characteristics within the 'Organizing' category are reliant on the fulfillment of the previous one to be fully implemented.

Rating scales with varying numbers of possible response points are widely used in a different type of research (Borgers et al. 2004, Dawes 2008, Leung 2011, Holmes & Mergen 2013). An even point scale provides no possibility for a midpoint which has been proven to be a preferred

alternative in the sense of uncertainty (Borgers et al. 2004). A higher point format is preferred due to scale sensitivity, normality, and easiness (Leung 2011). Even so, significant differences cannot be detected when comparing the four-point scale to the 11-point scale.

2.3 Critical Review of the Research Design

To summarize, the discussion on the previous pages points to elements of the research design that must be handled. An initial literature review has been conducted. Due to little or no previous experience regarding the topic, the arguments of not being open-minded and becoming constrained are neglected. Furthermore, the use of the TONE-framework creates a basis to evaluate the literature which emphasizes more transparency in the process. The results of this critical evaluation is displayed by how and why the literature incorporated in this study has been brought into play. Quantitative research is seen as unfavorable due to the nature of exploring 'how' and 'why' questions. Cases are therefore hand-picked based on their uniqueness and the possibility to conduct an extensive document study by access to internal systems. However, one must have in mind that this case-study only consisted of five different cases. Consequently, the study provides a modest basis for the creation of generalized trends and conclusions.

In total, six semi-structured interviews and corresponding document study of the cases have been implemented to create triangulation. In this study specifically, the purpose is to explore the TVD maturity and application among Norwegian public building projects. Constraints such as time and available resources have limited the number of interviews. This limitation must be reflected in the conclusion of this study. Another perceived weakness is that mainly the PMs representing the client have been interviewed. The basis of discussion is therefore mainly associated with the client's perspective. Furthermore, the purpose of this study is to identify and somehow measure the TVD maturity. Jointly, all the cases investigated reflect the TVD characteristics collected from the literature. One cannot argue that saturation has been achieved, but a sufficient number of characteristics have been investigated, analyzed, and ranked.

The comparison of empirical evidence should (hence, not necessarily) convey, and addressing this challenge is of greater concern when multiple cases are involved. Creating a well-structured and visually attractive framework for summarizing the case evidence is needed. Each case was evaluated separately based on internal documents and findings during the interview(s). A subjective ranking of the TVD characteristics was conducted based on a four-scale format ranging from zero (meaning not implemented) to three (meaning fully implemented). This format is judged to be sufficient for this individual and subjective ranking even though the levels do not detect significant project variation. Separately, the characteristics and categories were ranked. The results were an AS for the TVD maturity. Alongside the document and the literature study, the interview is a key element to verify the score of each case. However, the results provided by the triangulation of the three (document and literature study and interview) are dependent on the research design. A critical evaluation must shed light upon its weaknesses to determine its limitations. Accordingly, for this evaluation to obtain sufficient objectiveness, several authors (or evaluators for that matter) have to conduct the same subjective evaluation of all the cases. An AS or the result of a discussion among all the authors would have strengthened the results. Further research is recommended to do so. The nature of the thesis as an individual task limits the possibility to implement this process.

Chapter 3

Theory and Literature Review

Chapter three explores the topics and the following findings of relevant literature needed to answer the research questions. The literature review is based on both recommended literature as well as literature obtained by forward and backward searches.

3.1 Frameworks and Requirements

A project model consists of phases and decision gates. A simple project model goes through the four phases: planning, design, construction, and use. Figure 3.1 illustrates the Oslo municipality's project model, where the planning phase is divided into 'Initiation', 'Choice of Concept Evaluation', 'Choice of Concept', and 'Pre-project', followed by the political decision to start design and construction. The main focus of this research is the pre-project which results in the development of the steering document. An overview of central project constraints and assumptions are provided and structured to be normalizing and clarifying for internal actors, client, and relevant external stakeholders. In terms of cost limits, there is no defined ceiling that dictates a certain project should undertake a QA, but a basis is that projects with an EC of 19.4 MUSD should do so (Welde et al. 2015). Despite this, the City Department has the right to demand a QA for any size if the project inherently contains significant risk.

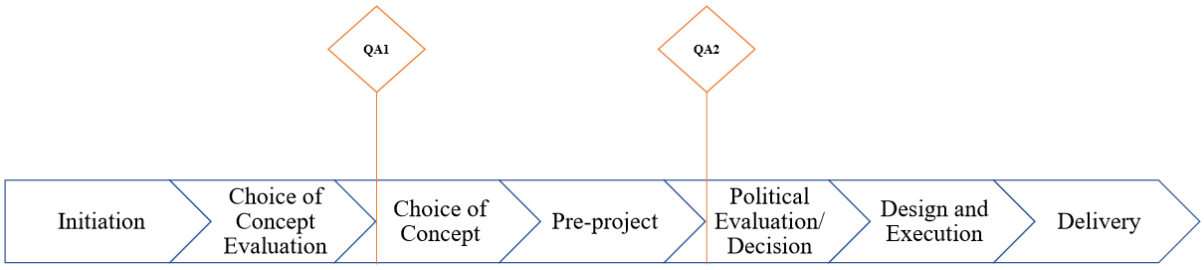

Figure 3.1: The Oslo municipality's project model (City Department of Finance 2011)

City Department of Finance (2011) describes the phases with the following distinctions:

- **Initiation**: The purpose of this phase is to prioritize and determine which needs and measures that must be investigated in the next phase. Evaluation of reported wishes and needs results in structured plans such as a needs and action plan. Based on these plans a

concise assignment describes the needs that must be achieved and political instructions, conditions, deadlines, and more comprehensive reporting requirements.

- **Choice of Concept Evaluation**: Defining definite needs, objectives, and overall demands which will create the basis of alternative concepts.
- **Choice of Concept**: Results in a recommended project concept. QA1 might be conducted by external consultants. Rules a great deal of uncertainty related to the project and the corresponding cost estimate.
- **Pre-project**: The project development results in a steering document. An external QA2 validates the quality of the work and provides a recommended EC and AC.
- **Political evaluation/decision**: The responsible political city department must approve the project and suggest a grant.
- **Design and Execution**: Includes everything that happens after project approval. Involves detailed planning and design as well as execution up until delivery.
- **Delivery**: The project has been delivered to the client. Includes the trial operation and the following tests to secure the operation of the designed systems as specified in the contractual arrangements.

Various design principles and methods are used during the development and execution of construction projects. Since this study emphasizes the implementation of TVD during the pre-project phase, the design principles and methods presented must be by this limitation.

3.2 General Design Principles and Methods

Different design principles and methods are incorporated in the TVD process. Exploring these topics is therefore a necessity to fully understand the characteristics. AC is the amount the customer is willing and able to pay for a facility with a defined performance. EC, on the other hand, corresponds to the amount for a facility with a determined performance provided at current best practice (Ballard 2006). Based on the available funds and the determined cost, TC is set below EC to drive innovation (Ballard 2008). TVD originated from 'Target Costing'.

Target Costing

'Target Costing' is a management practice that has been prominent in new product development and manufacturing industries to ensure predictable profit planning by meeting market-determined prices (Cooper & Slagmulder 1997). Zimina et al. (2012) underlined that target costing is cost rationalization and not minimization. Lee et al. (2012) described three approaches to achieve a predictable profit margin:

- **Market-driven**: Subtract the target profit margin from the target selling price to determine the product's AC.
- **Product-level**: Setting product-level TC below EC to drive design innovation beyond current best practice.
- **Component-level**: Setting component-level TC based on the desired price for components provided by suppliers.

Design-to-Cost and -Value

'Design-to-Cost' is defined by Michaels & Wood (1989) as a: "(...) tool used to enhance the affordability of products, systems, or services over their useful lifetime or, in short, their life cycle." The essence of designing to cost targets is to let the design converge to cost rather than the other way around (Pennanen et al. 2010). SBD is described as a collaborative design process. All disciplines define, prioritize, and choose design alternatives in the 'last responsible moment'. This enables the project to achieve cost targets (Ballard & Rybkowski 2009, Lee et al. 2012) by involving the design team in the process(Lilleland-Olsen et al. 2019). Choosing one of the alternatives is based on multiple factors and criteria and allows the project team to steer EC below AC (Namadi et al. 2017).

To enhance maximum value for the customer during the design phase is the purpose of the 'Design-to-Value'-process (Miron et al. 2015, Khalife & Hamzeh 2019). Miron et al. (2015) highlighted several essential value-generating elements such as the context of each project; identification of client/customer and their involvement; information management and evaluation cycles to mention a few. An important element in this regard is the extensiveness of the 'value' term. Khalife & Hamzeh (2019) discussed different definitions from the perspective of design and construction. One of the definitions focused on the: "(...) understanding and the achievement of the client's needs or the client's objectives." This focus stretches beyond the concept of mainly targeting cost by incorporating 'value' as the main goal. One is therefore in need to align this process with the stated project purpose. 'Benefits Management' is a concept that exploits this 'value creation process'.

Benefits Management

Researchers have in recent years shifted their focus towards benefit-oriented project management (Zwikael & Smyrk 2012, Chih & Zwikael 2014, Serra & Kunc 2015, Zwikael & Smyrk 2015). Zwikael & Smyrk (2012) defined 'benefit' as the "flow of value" which is based on the realization of the target outcome. 'Target outcome' is further defined as: "(...) desired, measurable end-effects that arise when the outputs from a project are utilized by certain stakeholders." Additionally, Serra & Kunc (2015) describe benefit as: "(...) increments in the business value from not only a shareholders' perspective but also customers', suppliers', or even societal perspectives." In line with the definition of 'benefits', Zwikael & Smyrk (2015) defines 'benefits management' as the: "(...) continuous alignment between project outputs, outcomes, benefits, and organizational strategy."

Chih & Zwikael (2014) demonstrated based on findings in the literature, that projects are becoming value creation processes and project success is not only based on output-measures such as time, cost, and quality. Table 3.1 presents the writers' overview of output-focused vs. benefit-oriented project management:

Table 3.1: The distinct difference between output-focused and benefit-oriented project management (Chih & Zwikael 2014).

Focus areas	Output-focused	Benefit-oriented
Managerial focuses	Managing inputs and outputs.	Managing inputs and outputs while focusing on the realization of project benefits.
Project objectives	Achieve agreed efficiency targets measured by the iron triangle (time, quality/scope, cost/budget).	Achieve stakeholder needs, improve organizational capacity, and implement strategic plans.
Performance evaluation	Iron triangle (time, quality/scope, cost/budget).	Differentiate between project success (benefits realization) and project management success (iron triangle).
Project leadership focus	The PM leading the output delivery process.	Project owner leading the benefit realization process while the PM leading the output delivery process.

TVD will be more comprehensively defined and described in the TVD section. Originally, TVD sprung of the target costing-practice in the manufacturing industry. The literature has defined TVD as 'Target-Value-Delivery' due to the emphasis of the construction process as an entirety from project development and up until delivery. Wherefore, 'Target-Value-Design' is mainly focusing on the design process itself. TVD embraces the goal of achieving the target value and therefore goes beyond the design-to-cost principle which correlates with the output-focuses project management. Having this in mind, TVD involves the design-to-value methodology by being benefit-oriented and targeting both cost and value drivers.

Cost and Value Drivers

'Cost drivers' are defined by Klakegg et al. (2018) as premises and/or decisions that affect the investment and operation cost. Additionally, 'value drivers' are a functional attribution necessary for delivering expected project benefits. Knowing both of them provides the possibility to use and control the decision-making towards creating more value within project constraints. Ballard & Morris (2010) determined six cost drivers when analyzing and targeting cost reduction measures during the design phase such as proactive value engineering; scope control; grounding scope in business purpose; aligned with constraints; steering design to targets and scope refinement. Nowadays, drivers focus more on the attributes of the result (quantitative parameters) rather than the process perspective (qualitative attributes). A value profile can be created based on the drivers (Zimina et al. 2012, Klakegg et al. 2018). This profile relates the priority of functions towards maximizing the project value.

TVD is a lean construction method that has gained increased popularity over the years. To the author's knowledge, the first successful TVD application was implemented in a Design-build

project in the USA (Ballard & Reiser 2004), but the method often correlates with Integrated Project Delivery (IPD) projects (Tillmann et al. 2017). "Once we got everyone on board, we then went through each of those systems and developed sub-targets. We then identified cost drivers within each sub-target." This statement originated during interviews with project clients with regards to their experience with the transition to IPD contracts (Fischer et al. 2017). The context of this conversation was the application of TVD and the aspect of treating cost as a design constraint. Members of the team for each project challenged each other to reduce their costs, hence their budgets, with ten percent. To accomplish this exercise, the team members had to get an understanding of how costs and impacts from one system affect the others. Understanding these consequences can create better decisions and more realistic cost estimates.

3.3 The Creation of a Realistic Cost Target

Within the basis of project governance, the project-specific Work Breakdown Structure (WBS) creates the basis for cost estimation (The Ministry of Finance 2008). The structure needs to have a sufficient level of detail. An optimal WBS exploits the advantages such as logically sequenced work, beneficial structured budgets, and management of scope creep (Burek 2013). This project-specific structure needs to consider the complexity and variability of the given project (Siami-Irdemoosa et al. 2015). How a beneficial WBS is constructed will not be described in detail here. Moreover, as stated by Fischer et al. (2017), an appropriate WBS can be used as a basis for project governance by identification of 'controllable factors'.

Cost Estimation Process

The main features of project models are cost estimation and uncertainty analyses (Project Management Institute 2013, Welde et al. 2015). The Project Management Institute (2013) defines a cost estimate as: "(...) the identification and consideration of costing alternatives to initiate and complete the project." Through a consensus-based process, the institution has further defined this process as a: "(...) quantitative assessment of the likely costs for resources required to complete the activity." Welde et al. (2015) divided the cost estimation process into two approaches:

- **Deterministic**: Work packages and components have been estimated based on the quantity and unit price. Often named 'bottom-up estimation'.
- **Stochastic**: Estimation of fewer but larger components and the corresponding uncertainty of each of them. Components with the largest uncertainty, are further designed (higher level of detail) to an acceptable level. Often named 'top-down estimation'.

An overview of the level of uncertainty related to the cost estimation reveals threats and opportunities that might occur during execution (Drevland 2013). Onshus et al. (2016) further described the cost estimation as an iterative process, and the quality of the estimates is based on how well the estimates correspond to the actual cost across different projects:

- **The validity over some time**: How the early estimates correspond to the actual cost. This evaluation is relative to the range of uncertainty and the EC.
- **The number of projects finishing outside the range of the uncertainty**: An actual cost above P85 should not exceed 15%. If so, the analysis is too limited.

- **Systematically deviations in EC**: Considerable deviation between actual cost and EC across the project portfolio reveals a systematic under- or overestimation.

One activity contributing to making projects more predictable is an uncertainty analysis. 'Uncertainty' can be divided into three categories: operational, strategic, and contextual (Rolstadås & Johansen 2008). Operational threats and opportunities are related to the internal circumstances and controlled by the project management team. Strategic relates to impact on the benefits while contextual is connected to circumstances outside of the project. An 'uncertainty analysis' is defined as a structured approach to identify, describe, and quantify all relevant uncertainties related to the project or other forms of actions (Onshus et al. 2016). The evaluations, inputs, the model, and the results should be prepared as an individual document and structured in such manner that they are replicable. Expected value, the distribution of cost, and the sources of uncertainty are the most important results from the analysis. Additionally, the analysis will provide the PM with an overview of the most uncertain project elements.

Creating good estimates is a challenge in the early stages of the design process. Underestimation occurs by approving sub-optimal projects caused by overrating benefits, insufficient estimation methods, and underestimation of risks just to mention a few (Andersen et al. 2016). Norwegian Public Roads Administration (NPRA) verified that the accuracy of the cost estimates is unrealistically low (Onshus et al. 2016). Consequently, a valid early cost estimate is needed in order to set target, make decisions based on these targets as well as administer cost and design management to enhance project cost performance (Dang & Le-Hoai 2018). Johansen et al. (In press) concluded that setting cost targets should consider both the AC and the TC. AC should be determined by the client prior the design and the TC in dialogue with the design and contractor team during or after the procurement process. In this regard, a benchmarking process can help the client to determine AC based on the perceived returns of the facility.

Benchmarking

Among others, Emhjellen (1997) developed a new generic benchmarking process involving 12 different steps which are fully adapted to the project environment. This process is developed based on five out of fifteen studied benchmarking processes whereas the model from Andersen (1995) was the starting point. This study resulted in a new generic processes involving 12 steps. The Ministry of Finance (2008) on the other hand, has established a structured framework for cost estimation for major public projects. This framework compared unit cost with the capacity or the scope of similar projects. Hence, the Ministry points to the necessity to include how the cost estimates have developed throughout the early phases of the project. Onshus et al. (2016) defined 'benchmarking' as the process of comparing the actual costs of completed projects with your own. Furthermore, the report stated that benchmarking is needed to get a sense of whether or not a cost estimate is reasonable.

These changes are hard to expose during the cost estimation or in an uncertainty analysis since these analyses do not look into the reasoning behind the chosen alternative, solution, or system. A benchmarking process can be summarized to the following steps: Firstly, determine a variety of baseline buildings of different variations. Secondly, based on the baseline buildings, identify target building systems. Altogether, this determines the EC which further creates an indication of whether or not the total stochastic cost estimate is reasonable (Onshus et al. 2016).

Uncertainties give rise to both threats and opportunities exceeding the target financial performance described by Lee et al. (2012) about project cost, operational practice and system performance (Davies et al. 2014, Johansen et al. 2014, Rolstadås et al. 2019). Davies et al. (2014) investigated the need for megaprojects to exploit opportunities by using innovation. Nowadays, innovation is associated with a high risk that often results in cost increase. Furthermore, the writers underlined that threats and opportunities related to uncertainty need to be managed simultaneously. Several challenges are influencing the uncertainty analysis (Johansen et al. 2014). Identifying the correct expected value in the early stages is deemed challenging alongside the increasing detailing and a number of objects. Establishing a realistic standard deviation in all phases is hard and the influence from process participants must be comprehended. Lastly, one must exploit the opportunities given. The latter one has been further explored by Rolstadås et al. (2019). Normally, projects fail to chase opportunities Johansen (2015). However, by implementing a structured framework with eight different opportunity classification, the projects managed to identify almost equal numbers of opportunities and risks. Another finding from the Norwegian National Museum was that opportunities regarding short-term cost and time were dominant. Mainly by saving cost/time or avoiding/reducing cost or time overrun. Moreover, there was less focus on opportunities that are beneficial in the long run.

Ballard (2008) presented a Figure 3.2 in the Lean Construction Journal from Evans et al. (1998) that demonstrates the magnitude by which 'organizational operating costs' exceeds the design and construction cost for a healthcare building in the United Kingdom. The operation, maintenance, and business costs are summed over 15 years. Disagreements among researches regarding the size of the ratios developed prior the publication in 1998 (Ive 2006).

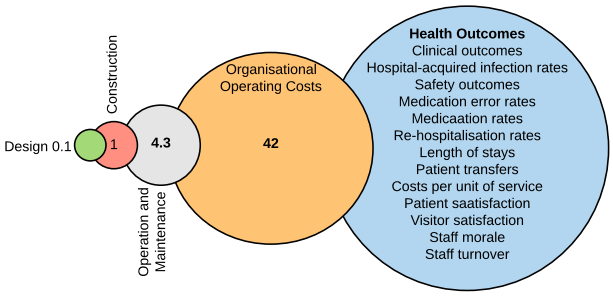

Figure 3.2: Capital vs. operational costs in a health care building in the UK (Evans et al. 1998).

An element incorporating both the capital and operational costs is a Life Cycle Cost (LCC). Objectives of LCC are described by Woodward (1997) as:

- Effectively evaluate investment options.
- See beyond the initial capital cost by evaluating the cost impacts.
- Effective building and project management.
- Enable the comparison and the choice between competing alternatives.

An analysis of the overall costs is important to involve in a decision-making basis (Al-Jibouri & Ognik 2009, Russell-Smith, Lepech, Fruchter & Littmann 2015). Al-Jibouri & Ognik (2009)

points to the need for a balance between the required system performance and its costs. LCC will strengthen the maintainability, reliability, and safety but also increase the activities needed to achieve them. Combining LCC and TVD enables the comparison of LCC impacts of design alternatives (Russell-Smith, Lepech, R.F. & Meyer 2015). Traditionally, tenders for construction projects have been compared and ranked based on capital costs. Using a TC has therefore been widely used. Furthermore, 'cost-cutting' activities result in the lowering of specifications, reduction of quality, and trimming profit. TVD exceeds this narrow focus of achieving TC.

Target Cost

Equation (3.1) links the cost estimation and the uncertainty analyses to the TVD process:

$$AC \geq EC \geq TC \tag{3.1}$$

Tillmann et al. (2017) summarized that factors influencing the project delivery to TVD are: 1) how to set cost targets and to estimate MC, 2) transparency of how shared profit is agreed upon and 3) steering of production costs towards the TC and how this is tracked to identify and mitigate risks. Torp (2019) concluded that stochastic cost estimates can be applied to set AC and MC by either provide the probability distribution of the cost prior to the design or the use of a probability distribution of project value. Based on the results, where the achievement of arriving within AC should be close to a 100% (Torp 2019), TC could be set at P45 to exceed current best practice (Ballard 2008). The following definition of AC, EC, and contingency is illustrated in Figure 3.3 which is visually representing (3.1). 'Contingency' is: "(...) the amount of funds, budget, or time needed above the estimate to reduce the risk of overruns of project objectives to a level acceptable for the organization" (Project Management Institute 2013).

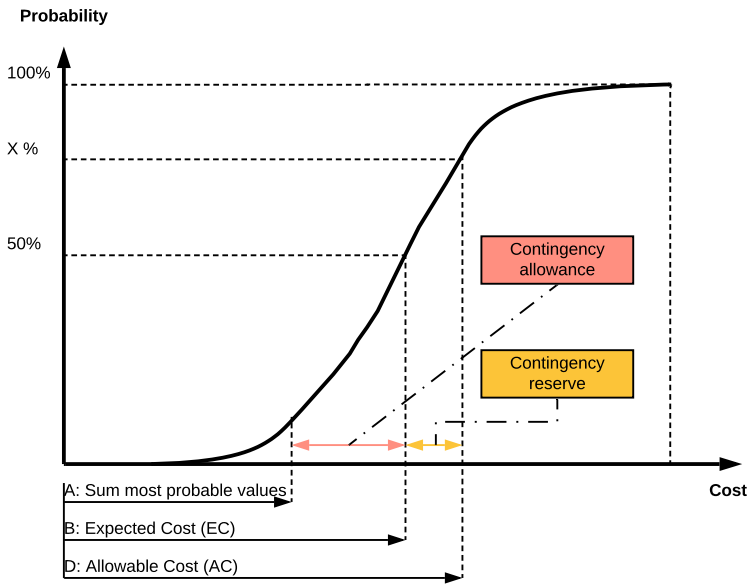

Figure 3.3: The probability distribution illustrating the cost estimate for a project (Torp 2019).

3.4 Target Value Design

TVD is a management method targeting to maximize the value for the client and user within project constraints (Ballard 2008). Ballard & Morris (2010) characterized TVD as the relationship between EC and AC with key features such as "design to targets" to increase predictability. Focus on the shared understanding and collaboration about the project basis has proven to be beneficial (Lee et al. 2012). Moreover, the study further explored the "conceptualization of design processes" which provides the arguments of TVD as a lean design management method. Namadi et al. (2017) described, based on the identified findings in Macomber et al. (2007), five TVD characteristics:

Table 3.2: Five characteristics for TVD from Namadi et al. (2017).

Characteristics	Description
Target costing setting	Focus on detailed estimates rather than estimating based on the detailed design.
Collaboration	Emphasize collaborative work to define the issues, produce decisions, and design to those decisions.
Co-location	Enhance working together in pairs, large groups, or face-to-face rather than in silos and separate rooms.
SBD	Allow several alternative solutions to proceed into the design process rather than narrowing choices to proceed with the design.
Work structuring	Design what is constructible rather than evaluating the constructability of design.

Previous research has shown that TVD projects in the US are completed below market price while maintaining quality and time (Ballard & Rybkowski 2009, Zimina et al. 2012, Chen et al. 2014). A target costing process was utilized in the construction of approximately 79,000 m^2 medical center in the US (Ballard & Rybkowski 2009). During a business planning phase, the TC was established, and the results revealed that the project achieves a TC which was 14% below MC. 12 TVD projects were investigated in Zimina et al. (2012), and the cost projections and performance were on average 15% lower than MC. Chen et al. (2014) investigated and compared the cost overrun and contingency percentage of 47 TVD projects up against non-TVD projects provided by the Construction Industry Institute (CII). Two primary statistical findings from the study: 1) TVD reduces the likelihood of cost overrun as well as 2) reduces the contingency percentage in the project budget. At the same time, the study found no statistical evidence related to project size. Figure 3.4 shows several driving forces that will either increase or reduce the total project cost. Characteristics of TVD are more likely to counteract the forces creating a cost increase. As specified in the study, the magnitude of these forces relies on the capabilities and experience of the team.

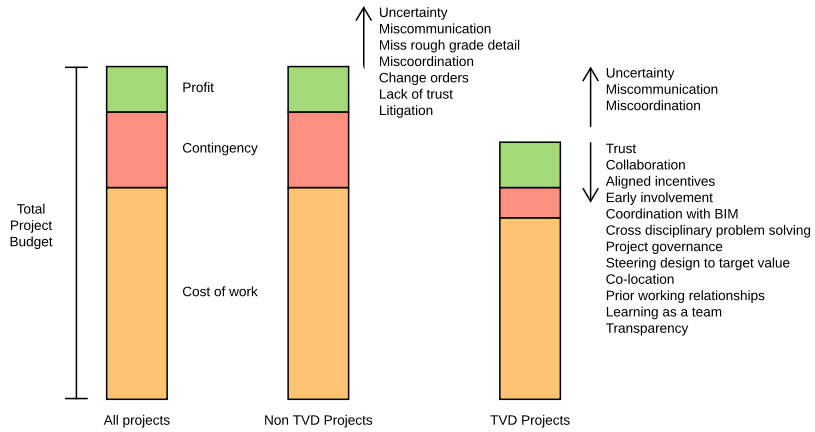

Figure 3.4: Cost control mechanisms in non-TVD and TVD projects (Chen et al. 2014).

Ballard & Morris (2010) presented the results from an international collaborative study between clients, cost estimators, and academic researchers involving the comparison of traditional design methodology and the use of TVD. The study makes clear that the project business case must be undertaken by the client himself. Subsequently, members of the project delivery team are engaged to improve and validate the plan if judged feasible.

Business Case and Validation

The business case includes the strategic project perspective, financial constraints, and profitability which AC is based on. Ballard (2008) described this planning process with the following steps provided in Figure 3.3:

Table 3.3: The business case planning process created by Ballard (2008).

Business case planning
1. Assess the business case (demand, revenues), taking into account the cost to own and use the facility (business operations, facility operations, facility maintenance, adaptability, durability) as well as the cost to acquire it.
2. Determine minimum acceptable ROI or maximum available funds — set the allowable cost for the facility: what the client is able and willing to pay for what they think they want.
3. Answer the question: If we had a facility with which we could achieve our specific purposes, and if we could have that facility within our constraints of cost, location and time, would we do it?
4. If the answer is positive, and if project delivery is not considered risky, fund the project. If the answer is positive and project delivery is considered risky, fund a business plan validation study to answer the question: Can we have the facility we have in mind, will it enable us to achieve our purposes, and can we acquire it within our constraints?

Conceptual cost estimates prior to the design are based on programmatic data (Pennanen & Ballard 2008). 'Programmatic data' involves what is wanted, the location of the asset, and the schedule. 'Wanted' is related to capacities, functionalities, and features. Understanding the client's needs through the delivery of end-customer and the organization's value is a fundamental basis. Expected values within project constraints can be determined by benchmarking of baseline buildings or target building systems (Lee et al. 2012).

Another paper uses the literature and empirical observation of current project management and cost practices to look into TVD and its differences from current practices. Zimina et al. (2012) highlighted the necessity to distinguish between different types of clients with regards to cost planning:

1. **Developers**: The cost target is derived from the business case which is clearly profit-oriented and seen from the client's perspective.
2. **Public clients and clients doing self-construction**: AC is set by developing the business case based on financial constraints, end-customer value, and the organization's value.

Improvements to the business case must deal with cost drivers in order to reduce concealed contingency and to improve constructability. A validation study of the business case will determine EC. Ballard (2008) described with the following steps illustrated in Figure 3.5, how the business case validation process should be conducted:

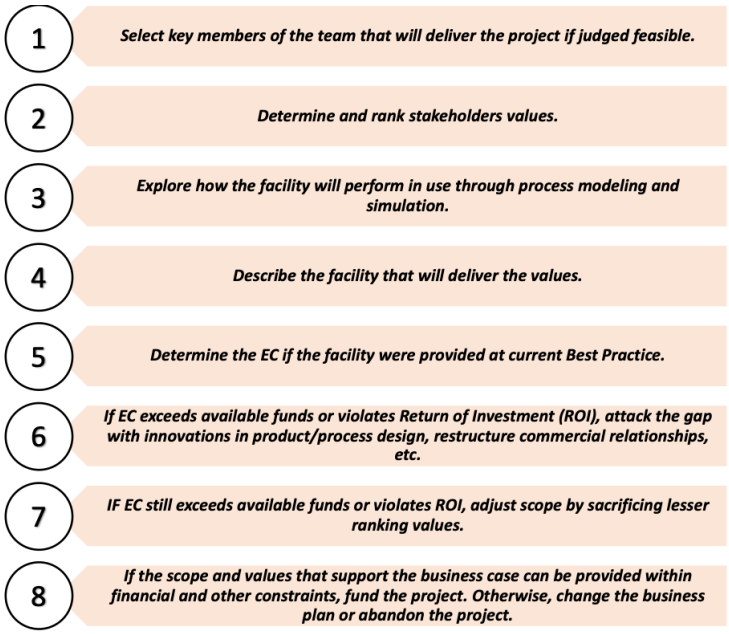

Figure 3.5: The business case validation process defined by Ballard (2008).

The validation process creates a shared understanding of the project (Lee et al. 2012):

- **Basis of design**: Criteria and guidelines related to building components.
- **Basis of budget**: Detailed budget items for the project team to develop designs.
- **Basis of operation**: Description of facility operation.

Ballard (2008) focused on the shifts in strategies, market conditions, technologies, or regulations which create the need for re-validation. An up-to-date plan is needed to determine whether or not changes in the business plan result in changes for EC and project benefits. Value can be maximized by improving the feasibility of the project through the validation process which aligns means, ends, and constraints (Lee et al. 2012):

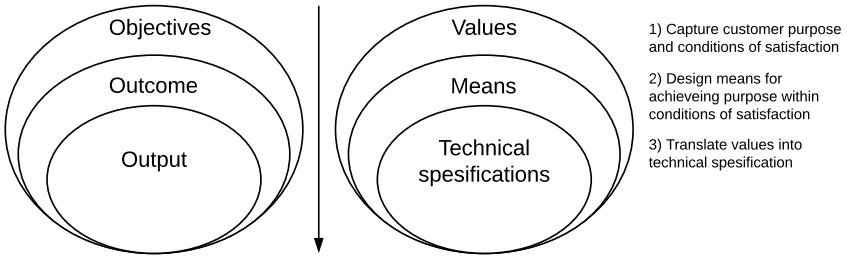

Figure 3.6: Three steps for project definition in TVD in order to align with means, ends and constraints.

Table 3.4 explores the "conceptualization of design processes". More attention towards the 'flow and value view' is in line with the lean design management method (Lee et al. 2012):

Table 3.4: Conceptualization of design processes provided by Lee et al. (2012).

Points of view	**Activities**
"A transformation of inputs into outputs."	Finish individual tasks (neglect the value generation and flow).
"A flow of information through time and space."	Short lead times. Elimination of waste (reduction of rework). Team-based approach (avoid prolonged iterations). Continuous feedback by releasing information in small batches. The use for design structure matrix.
"The generation of value for customers."	Analysis of constraints and requirements. 'Workshop model' to increases the likelihood of delivering value in the design phase.

The above-mentioned key areas must be further explored and elaborated to create a standardized and transparent design process. A weighted decision matrix whose purpose is to help to achieve predefined values and targets from the business case is the 'engine' of this process. Ballard (2008) described two different options for determining project targets:

1. Target lower than budget based on current best practices.
2. Target scope greater than budget based on current best practices.

Setting targets is of crucial importance in decision-making. Emmitt et al. (2004) described a value hierarchy with six key areas: beauty, functionality, durability, suitability, sustainability, and constructability. A weighted decision matrix is mutually agreed upon among the actors, and solutions can, therefore, more easily be distinguished during the workshops described in Table 3.5. Such an integral and holistic approach is beneficial for the design and execution process. Conversely, the study does not comprehend activities taking place between the workshops:

Table 3.5: Necessary activities in a design process by the use of workshops (Emmitt et al. 2004).

Workshop focus	**Description**
Workshop 0: Partnering	Establish communication structures, system architecture, and architectural dialogue. Signing partnering agreement.
Workshop 1: Vision	Establish basis product values and parameters. Based on knowledge and experience from previous projects. Incorporate values from the authorities, investors, client, and users. Selection of appropriate designers. Establish decision-making prior production start to reduce downstream uncertainty. Establish prioritized values (pragmatic document).
Workshop 2: Realism phase	How the project values may be achieved (restraints, funding, etc.). Several alternatives are investigated and ranked according to value. Choosing the 'best suited' proposal.
Workshop 3: Criticism	Critical review and discussion of the chosen solution towards improving the value parameters. Uncertainty and urgency are handled prior the production phase. Project approval and contractual delivery specifications are fixed.
Workshop 4: Design planning	Values related to delivery. Improvement of constructability alongside the reduction of waste in the design and execution phase.
Workshop 5: Execution planning	Establish a process plan linking and identifying missing information related to production activities between the different contractors.

Welde et al. (2015) emphasized the need for a predictable decision-making process to have thorough evaluation regarding needs, demands, and objectives:

- When a decision is made.
- The decision basis.
- What the consequences are.

Lee et al. (2012) developed Figure 3.7 with regards to combining Energy Efficiency (EE) investments with TVD:

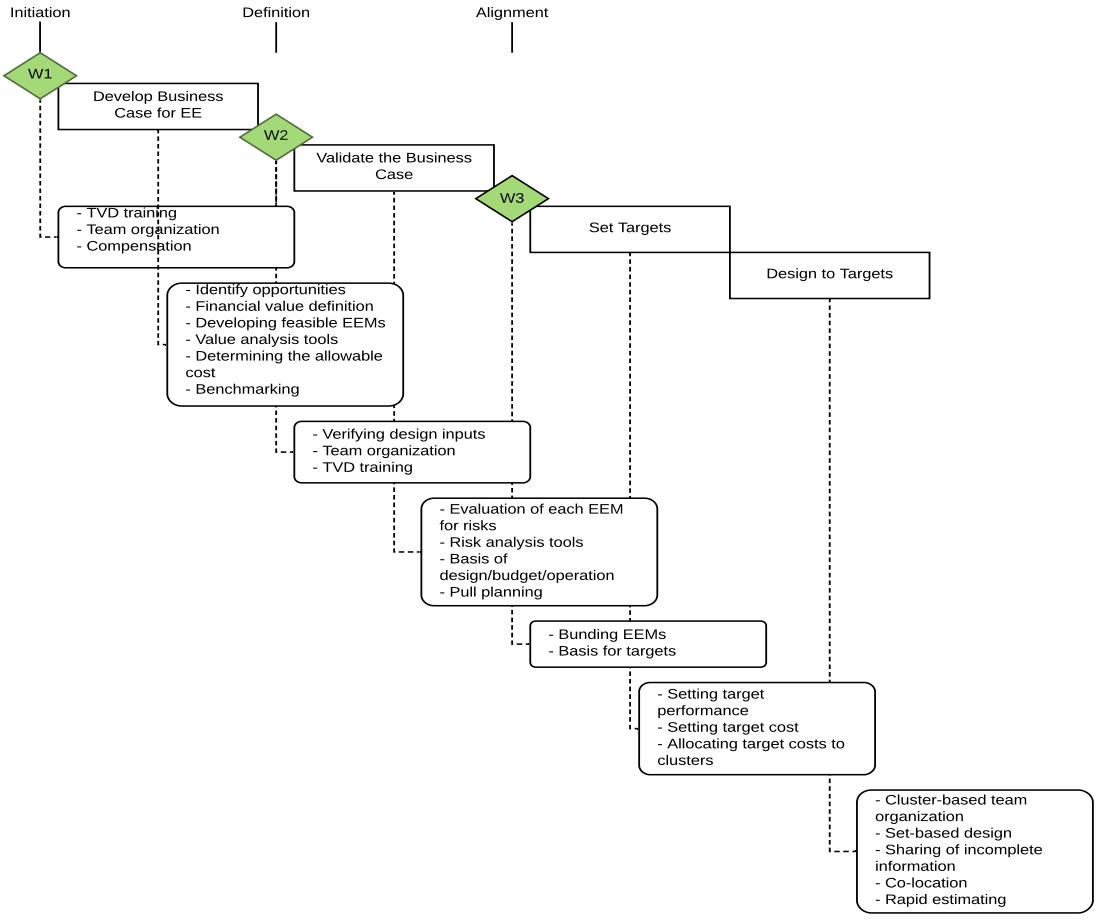

Figure 3.7: An overall TVD-Decision-Making Process (DMP) which resulted in managing complexity, preventing overdesign, maximizing the customers' value and reducing risk (Lee et al. 2012).

3.5 Determination of TVD Maturity

To determine the TVD maturity and to answer the RQs, a scorecard has been developed based on identified TVD characteristics in well-known articles investigating TVD (Ballard 2008, Pennanen & Ballard 2008, Ballard & Morris 2010, Lee et al. 2012, Zimina et al. 2012, Denerolle 2013, Namadi et al. 2017). These findings reflect the theoretical literature which has either explored or identified these characteristics along with their corresponding features and practices in ongoing or past construction projects.

A TVD 'characteristic' is an element or an activity that has been identified in the literature to be part of the TVD process. Repeated characteristics were adapted and merged within the four categories: contracting, organizing, defining (differ between the business case and validation), and steering. These four TVD categories arose based on Denerolle (2013), while the contracting element was added based on the interviews. Naturally, the pre-project develops chronologically

within the four categories. Meaning, that the characteristics within the 'Organizing' category are reliant on the fulfillment of the previous one to be fully implemented.

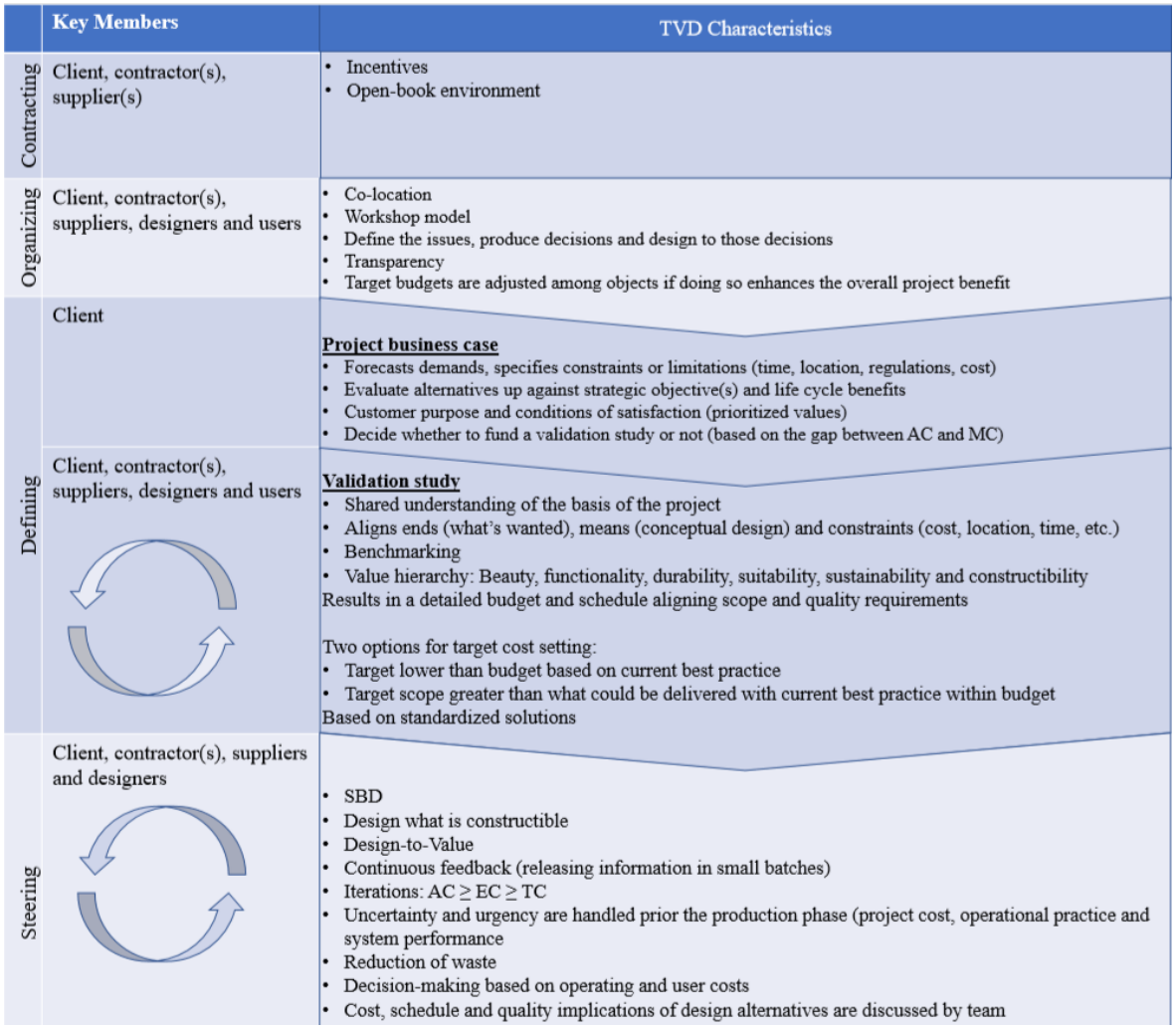

Figure 3.8: Summary of TVD characteristics based on findings in the literature.

Ranking of the Implementation of TVD Characteristics

The level of implementation of TVD characteristics is ranked based on the following scorecard as illustrated in Table 3.6. Score levels reflect the possibility to connect findings in the documents (what the project was meant to do) and the interview (what the project did).

Table 3.6: Scorecard used in the evaluation of TVD characteristics in the case studies.

Grading	Description
0: Not implemented	Not mentioned in internal documents and by the interviewee.
1: Barely implemented	Mentioned in internal documents but not by the interviewee.
2: Sufficiently implemented	Mentioned in internal documents and by the interviewee.
3: Fully implemented	Well documented in internal documents and by the interviewee.

Chapter 4

Case Study Investigation and Analysis

Chapter 4 focuses on the five investigated case studies in order to identify and compare distinctions related to project execution and management with TVD characteristics identified in Figure 3.8. Case study distinctions give rise to a conclusion which either verifies and/or identify the potential for TVD implementation and maturity.

4.1 Case Studies

In total five cases are being investigated in this master's thesis. Figure 4.1 compares the project phases duration in months based on the Oslo municipality's project model. These numbers represent the actual time taken or the planned duration for those projects that are still running. 100% completion is the total of the three phases combined. An overview creates the possibility to compare the duration between cases and link case distinctions with the duration.

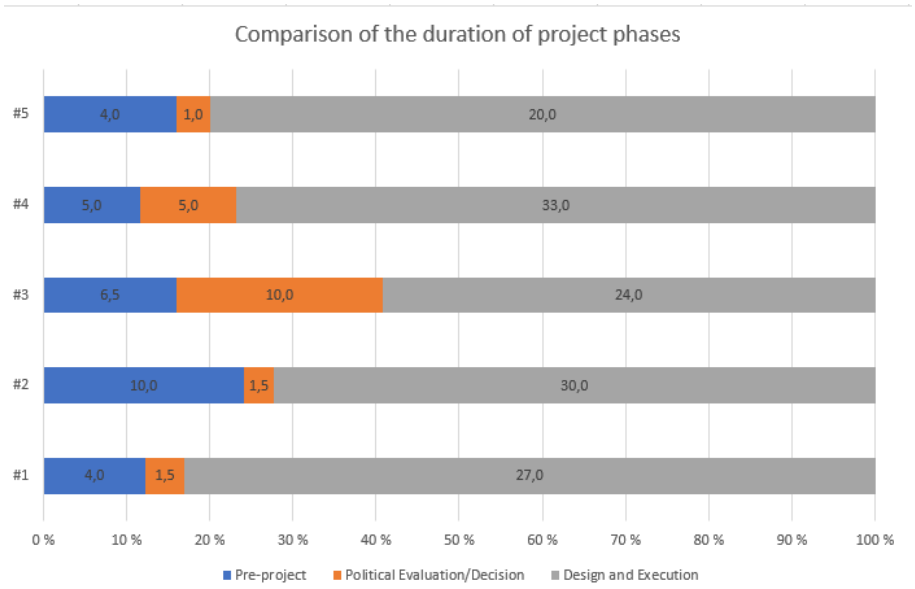

Figure 4.1: Comparison of the differences in duration (in months) of the project phases.

Contractual arrangements are not part of this thesis. Even so, both the interviews and the doc-

ument study revealed a significant connection to the TVD term. Table 4.1 provides a brief description that is necessary in order to establish the project development climate. Award criteria can either be a qualitative (quality) or a quantitative (economy) of which the evaluation of tenders are based on. Project-specific contractual elements are described for each case when seen necessary and beneficial for the discussion in chapter five.

Table 4.1: The case studies: Brief description. *The procurement strategy changed from partnering to design-build. Case 1, 2, and 5 are within the same municipality. The same is valid for Case 3 and 4.

	Contract	**Project / Size (GFA)**	**Type of building**	**Date of completion / AC**
Case 1	Partnering	New Building 7,913 m^2	High School	Autumn 2020 36.0 MUSD
Case 2	Partnering	New Building 13,750 m^2	Primary School, Sports Center and Swimming Pool	Winter 2021 70.8 MUSD
Case 3	Design-Build	New Building 16,238 m^2	Health Center	Autumn 2017 73.2 MUSD
Case 4	Partnering and design-build	New Building 9,120 m^2	Nursing Home	Summer 2020 77.0 MUSD
Case 5	Design Build*	New Building 3,394 m^2	Sport Center	Winter 2021/2022 20.3 MUSD

The reported EC development is based on the delivered monthly reports from the PM to the client. Only a limited number of project phases are included. Figure 4.2 is a graphical representation of the current status due to the differences in progress. Each phase is therefore simplified and the representation of the EC provides a rough overview of the development due to variations in project size. Changes are therefore hard to assimilate. On a general basis, the EC development varies during the three phases. Each of the cases involves a number of events that are partly part of the cost increase. These events will be described later on.

Information from the document study and the interview will be presented and discussed in the next sections for each case chronological. Firstly, basic information regarding the project and project objectives, outcomes, and outputs will be presented. Simplified, 'objectives' is what the project is aiming to achieve. 'Outcomes' reflects what the business gains from the outputs. While 'outputs' reflects the iron triangle with time, cost, and quality which is what the project actually delivers. This knowledge is necessary to establish the TVD environment. Secondly, TVD characteristics are identified based on the overview presented in Figure 3.8. These described features and practices are ranked according to the developed scorecard and the TVD maturity is visually represented in a radar plot.

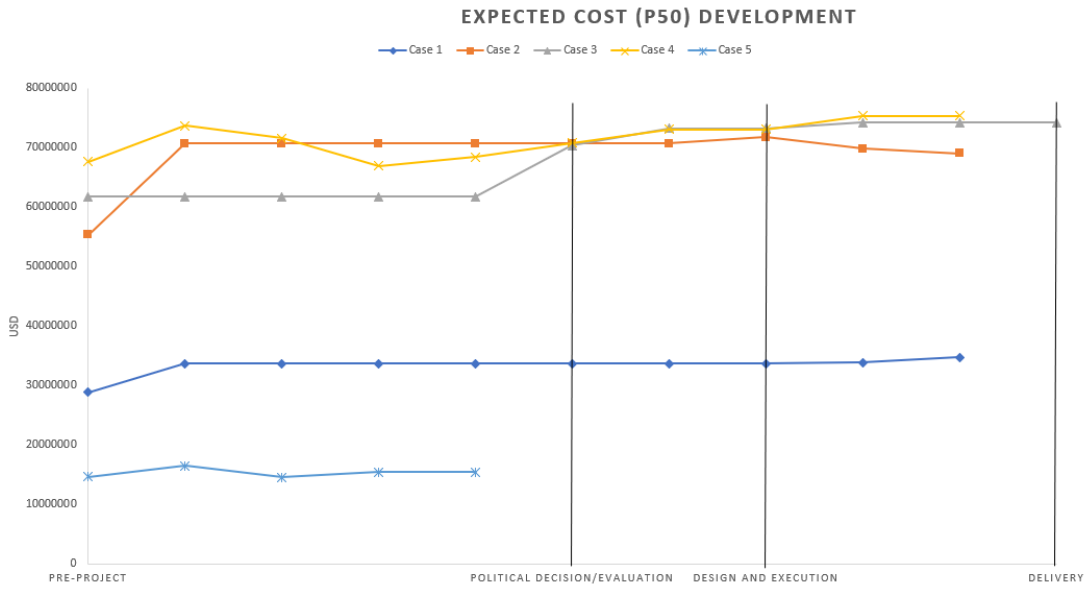

Figure 4.2: Expected Cost development for the involved cases in this thesis based on the reported figures in the PM's monthly reports. Notice that Case 3 is the only case that is completed.

Financial figures reported in the PM's monthly report are reflected for each case. Therefore, fragmented graphs are a result of inconsistency in the reporting or variations between different municipalities with regard to reporting routines. An important feature with regards to cost estimation is that AC, EC, and TC are estimated up until approval. After that, these figures are prognostics about the future cost. Final cost is there only reflected for Case 3 which is completed.

4.2 Case 1

Case 1 is part of the municipality's development plan with regards to encountering the growth within the area (Eklund 2017*a*). One action in this regard is the school needs plan for 2015-2027. The municipality as the client owns approximately 110,000 m^2 of constructed facilities. The new plan aims towards constructing environmental-friendly and forward-looking buildings, and this school with a capacity of 550 pupils and a swimming pool shall be one of them. Figure 4.3 is based on goals stated in Eklund (2017*c*):

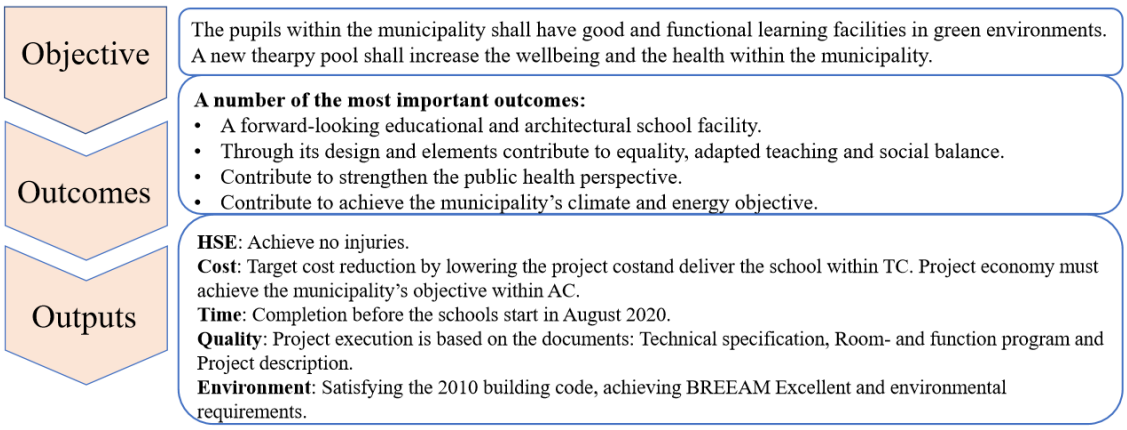

Figure 4.3: Objectives, outcomes and outputs for Case 1.

In total, Case 1 will have a duration of 32.5 months from the start of the pre-project and until the end of the design and execution phase. Figure 4.4 shows the duration of the project phases.

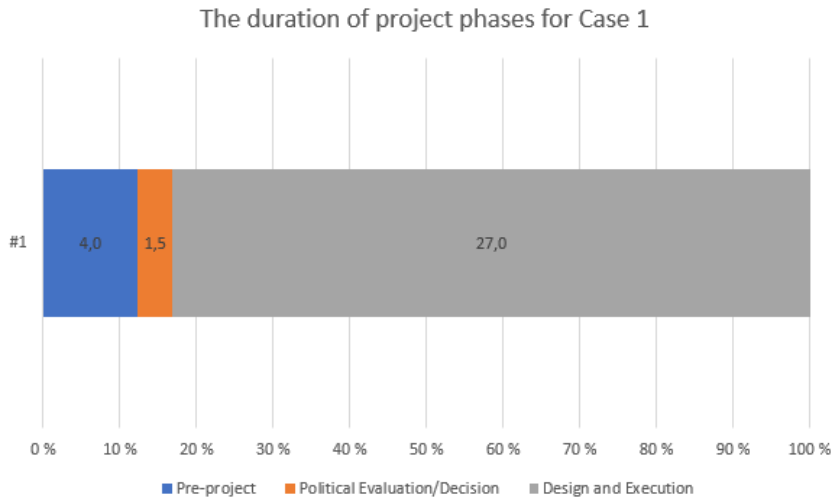

Figure 4.4: The duration of each project phase in months for Case 1.

Figure 4.4 illustrates that the pre-project phase lasted for four months, and the design and execution phase lasted for 27 months, which results in a ratio of approximately 3:20. Using a partnering contract is part of an ongoing transformation from design-build contracts and towards more collaboration across the project organization. Internal documents have divided the project into three phases (Eklund 2017*a*):

Table 4.2: Stated project phases for Case 1 (Eklund 2017*a*).

Phase 1	Partnering contract where the contractor and the involved consultants are remunerated on the basis of actual time taken. An open book environment is established, and the contract involve a clause stating that the client can cancel the project e.g. due to insufficient project development or increased risk.
Phase 2	Maintaining the partnering contract during the design and execution phase. Project incentives involves a determined TC with shared savings and losses of 50% between the client and the contractor due to changes and optimizations.
Phase 3	A claim phase.

Project-specific award criteria are described and summarized below (Eklund 2017*a*):

- **20-30%**: Price based on the client's project-specific pricing form.
- **40-60%**: Related to architectural entirety and concept, the fulfillment of the room function program, and technical description.
- **20-30%**: Proposed competence and project understanding.

Figure 4.5 provides the basis of the project cost development in Case 1. Briefly, due to issues that will be discussed later, one notices that TC increased significantly from the start of the pre-project and throughout the pre-project and design and execution phase. One interesting element is the cost increase from the start of the design and execution phase which occurred due to an unforeseen event. These PM's monthly reports have included AC, EC, and TC.

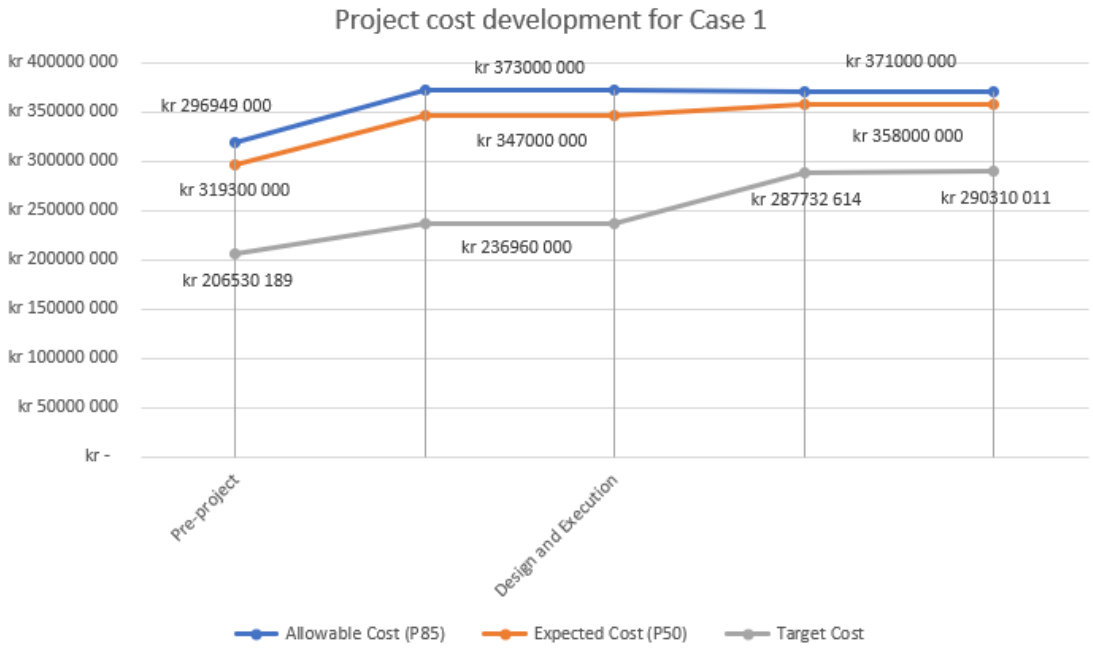

Figure 4.5: Project cost development for Case 1.

4.2.1 TVD Characteristics

Organization

Case 1 is a partnering contract. This establishment provides the foundation of which the structure of the project organization is based on. Reflected on the award criteria for the project, the competence of the organization is of equal importance as the price itself.

Eklund (2017*c*) provides the project description which states that the pre-project is a collaboration between the client and the contractor. This collaboration environment aims towards achieving design solutions to a maturity level which is relevant and detailed enough to describe the main system solutions and principles. In other words, the wanted result of each meeting was to establish a preferred solution. In order to do so, the project organization has been using Integrated Concurrent Engineering (ICE) meetings as a basis of design. These interdisciplinary meetings were conducted as a half-day meeting every other Wednesday. On the Mondays before these meetings, every discipline needed to deliver their updated Building Information Modeling (BIM) models in order to ensure sufficient and up-to-date design information. Each meeting had its own theme and issues, and the participated disciplines were required in order to solve these issues. As stated by the PM, who expected every discipline to be represented at every meeting: "This was not a full implementation of ICE." On the other hand, the contractor described these meetings as a mixture of traditional design meetings and ICE meetings. The contractor and the architect were involved alongside the required disciplines. However, as underlined by the contractor, every discipline was available during these meetings. If needed, the contractor and the needed discipline(s) could have separated meetings in between the ICE meetings.

Alongside the ICE meetings and the sub meetings, the project organization had partnering meetings, steering committee meetings, traditional client and user meetings. Disciplines and actors involved in these meetings changed from the pre-project phase to the design and execution phase. As underlined by the contractor, this development was natural since phase 2 focuses on design and execution based on decisions taken during the pre-project. Due to the lack of decision-making authority, the PM was dependent to report and receive rapid feedback from the client. Structuring the project organizations like this is normal within the given municipality. As stated by the PM, the project organization could have achieved faster decisions. Despite this, the client has maintained an availability which has not significantly limited the execution.

Project Business Case

During the development of tender documents, which is prior to the pre-project phase, the PM involved the users represented by the principal and the client. The three-year old school needs plan for 2015-2027 created the conditions for the project development. A new budget was set by external consultants based on the updated tender documents.

Validation Process

Figure 4.4 illustrates that the pre-project lasted for four months. Due to the partnering contract, all relevant disciplines were involved from the start. As stated by the contractor this phase started with a 'clean slate'. On the account of a more time-consuming tendering process, the pre-project was one month delayed. The time constraint of being finished until the school start

resulted in the delay being absorbed in this phase. Despite this, the contractor underlined that the result of the groundwork issues might not have been any different with an extra month.

During this validation process, the project organization developed a new BREEAM strategy, conducted two cost estimation processes (one at the start and one at the end before setting TC). In addition, the user involvements were comprehensive and a mentioned change in the project scope was conducted during the process (implementing a swimming pool). As a result of a hectic pre-project, the contractor had to continue the project development while the second and final cost estimation process was undertaken. Six weeks of cost estimation was therefore conducted while the system solutions and project assumptions were changing. This was not something the contractor desired but there was no way around since the project organization needed to create a constructible project with a certain control of the risk elements.

A preliminary TC was set based on historical price data from similar projects. Little or no design existed at this stage, and therefore the project-specific constraints are hard to determine. One element in this regard was the unknown BREEAM strategy. The combination of historical price data, user involvement and feedback from the client made the basis of the preliminary TC. Hence, this target was not used absolute limit but more an indication of cost. Cost differences therefore revealed the need of a bigger budget. This was not an option, and the project therefore targeted cost-efficient solutions. The focus shifted towards the level of quality and cost-cutting activities. Cost and target management was therefore needed early on in the pre-project.

Cost and Target Management

Case 1 experienced two incidents that affected their focus towards reducing project costs: 1) adding the swimming pool in the project scope and 2) an unexpected cost overrun regarding groundwork. The latter one has been verified by the two interviewees to have the most effect. TC was higher at the end of the pre-project than at the start. One tool for cost management has been monthly reports. Due to the cost increase, the project conducted an uncertainty analysis and both the AC and EC was presented for political decision. The contractor underlined that an another method for cost management is through regular procurement follow-up since approximately 70% of the their tasks are linked to this element.

An on-going evaluation of maintaining the wanted function (minimum criteria from the client) was set in motion in order to construct the swimming pool at a cost-efficient manner. These evaluations were not considered based on a priority list of some sort, which can be verified by the contractor who described this process as a trail-and-error process on the basis of cost drivers. Another important aspect was to identify which elements that did not affect the desired project and could either be used in a lesser extent or be removed. One example is the cost reduction of outdoor qualities. This cost-reduction focus from the contractor was specifically aimed towards the architect and the landscaper. A list was conducted based on assumptions, expectations and knowledge of elements that could be cost drivers. Based on this list, the contractor stated that both the architect and the landscaper should design their desired project solutions and an (minimal) alternative solution which was sufficient from their professional point of view. A constant focus towards ‘good enough’ is something that both the PM and the contractor aimed for.

One definition which often differs between project organizations, is the difference of a ‘change’

and an 'optimization'. Generally, a 'change' with regards to the project assumption results in an increase of TC and is something that the client must pay for. An 'optimization' on the other hand, is divided in a 50/50-split between the contractor and the client. The PM finds it hard to differentiate between an optimization and a change in the quality delivered. On the other side of the table, the contractor acknowledge that an optimization could result, however rarely, in achieving better quality at the same cost. Moreover, the contractor finds it hard to talk about an optimization of receiving more for less, and therefore aims his focus towards targeting cheaper solutions that fulfill the targeted or described function(s). Another aspect that the contractor underlined was that improvements of a function initiated by the client merely based on reduction of LCC should not be defined as an optimization but rather a change. The reasoning behind this is that the optimization is not within the lifetime of the project that the contractor is a part of. Based on the different expectations between the contractor and the PM, both of the interviewees recognize the need for clarification at the start of the pre-project.

"Nice to have vs. need to have," is an expression that was repeated during the interviews with the PM and the contractor. In this project, more specifically after identifying the consequences of the more comprehensive groundwork, every "nice to have" were rejected and only "needs to have" were implemented if there could not be any proof of significant reduction of operational costs. The same principle ruled regarding user changes. Generally, savings has mainly been achieved by reducing elements related to the swimming pool and the landscaping. Some optimizations have been conducted in the project based on simplifications regarding BREEAM requirements, operations and heating. These have mostly been based on reduction of LCC which has been an important element in the optimization basis (Eklund 2017*c*). Decisions and evaluation have been conducted in consultation with the operation unit. A limited budget has resulted in the project organization rejecting optimizations which could have been beneficial.

4.2.2 TVD Maturity

Figure 4.6 reflects the AS of the TVD maturity for Case 1. Straightaway, one get the feeling of a project which has incorporated a certain amount of the stated TVD characteristics. 'Organizing' is the only category which is not sufficiently implemented.

Table 4.3: Scorecard used in the evaluation of TVD characteristics in the case studies.

TVD char.	Description	AS
Contracting	Partnering, 50/50-split.	3
Organizing	Limited collaboration and co-location, no target budgets among project objects.	1.5
Defining (business case)	Validation not based on AC, no priority of outputs, specifying demands, constraints and limitations.	2
Defining (validation)	Shared understanding, align ends, means and constraints, target scope greater than best practice.	2
Steering	"Nice to have vs. need to have", targeting cost drivers, rejected optimizations due to cost.	2.5

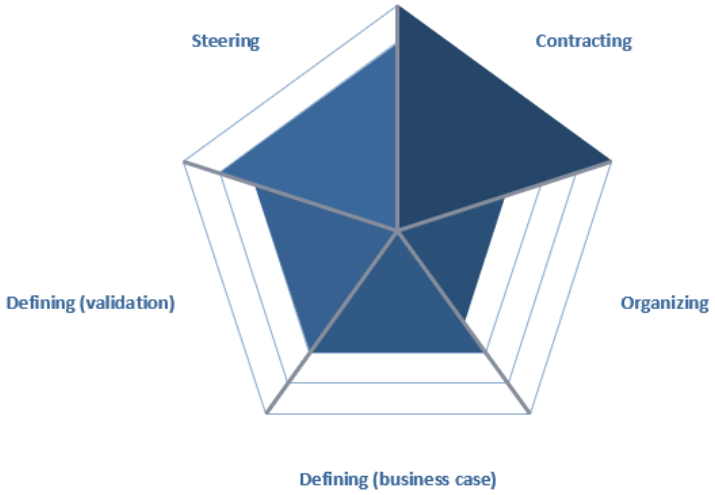

Figure 4.6: TVD maturity for Case 1.

4.3 Case 2

The following paragraph is based on the written material from Eklund (2017*d*). Case 2 is part of the same development plan as Case 1. Project scope includes an elementary school with a capacity of 700 pupils, a sports center (tribune capacity of 300 people) and swimming pools. Originally, this project incorporated an upgrade of the highway running alongside the plot. Only a few adaptations differentiate the contractual arrangements from the ones in Case 1 (Eklund 2017*d*). In addition, the award criteria and the stated outcomes and outputs are equivalent (Eklund 2017*b*). In total, Case 2 will have a duration of 41.5 months from the start of the pre-project and until the end of the design and execution phase as illustrated in Figure 4.7:

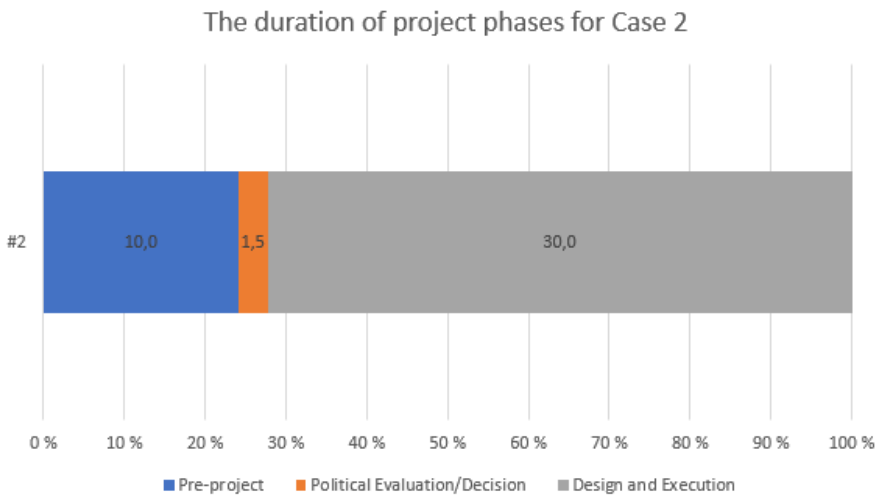

Figure 4.7: The duration of each project phase in months for Case 2.

Figure 4.8 shows a significant cost increase which corresponds to Figure 1.1. Even though the graph generally illustrates a cost increase, the EC decreases during the design and execution phase. The next section will display activities and features that might provide some clarification.

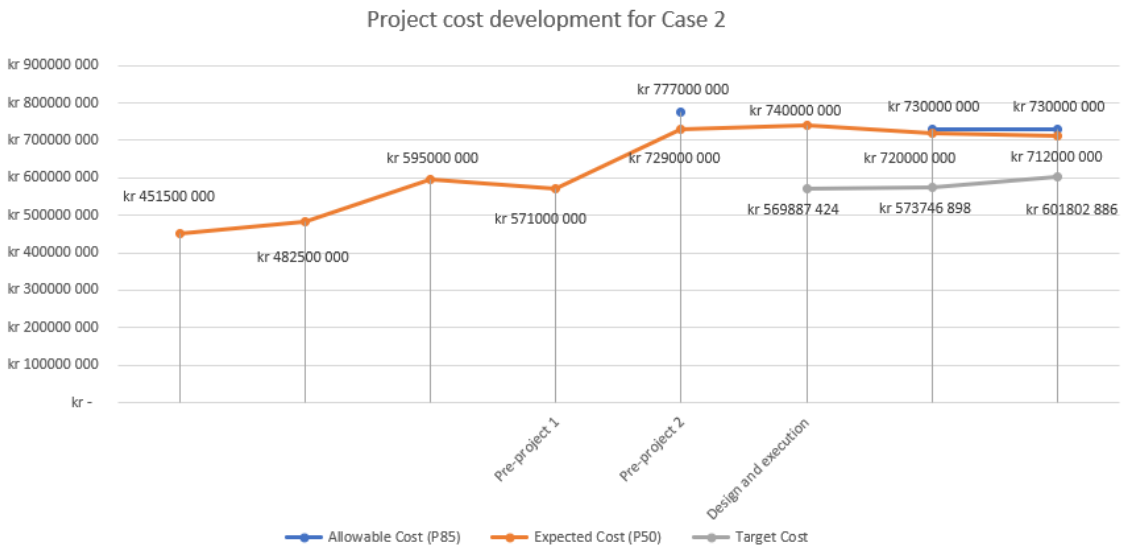

Figure 4.8: Project cost development for Case 2.

As mentioned earlier, the project cost development is based on the reported figures in the PM's monthly reports. Variations in the financial information reported is the reasoning for why AC is fragmented. TC is naturally included once the target is set among the actors and therefore occurs in the design and execution phase. Furthermore, TC is set 40% lower than AC which illustrates a considerable contingency allowance and reserve (illustrated in Figure 3.3).

4.3.1 TVD Characteristics

Organization

Since this is a partnering contract the contractor's tender included a design team of several disciplines. At the beginning the architect and the landscaper started designing the project in collaboration with the users (the principal, the day care representative, operation personnel and representative from the local sports club). A limited duration of the first phase created an insufficient user involvement which resulted in changes occurring later in the design process. The PM specifically pointed at changes implemented due to operations. Further, the PM stated that the project organization need to guide the users and the client towards the important elements. Too often decision are being made without knowing the consequences of them. This realism is necessary before project approval as well as with regards to changes and adjustments of scope and assumptions. Otherwise, the project may 'run wild'. An open-book environment has contributed to transparency regarding costs, and the PM illustrated that this environment has resulted in more opened feedback loops of cheaper alternative solutions than originally designed.

ICE meetings have been an important part of the early phases. In addition, the project organization has conducted design seminars where disciplines worked together in smaller groups. As stated by the PM, more of these meetings could have created a more rapid TC setting. After the first pre-project, a cost estimation revealed a significant cost increase. Instead of proceeding with a political decision to adjust the financial conditions, the project organization started with a new one that purely focused on cost reduction. A significant cost reduction had to be conducted and fundamental changes of the design were implemented. "Everyone knew that this had to be done in order to start the project," stated the PM. During this period the client, the PM, the contractor and the involved disciplines met once a week for 'idea meetings' and brainstorming. In between these meetings the work continued individually. In parallel, the PM and the client had user meetings in order to secure commitment to the suggested changes.

Equivalent to Case 1, the PM possess no decision-making authority, and is therefore in need of the client's approval with regards to changes. The project organization has had a specific focus towards rapid decision-making. Creating relations and understanding for how each discipline works and reacts are important for the PM since this creates a 'give and take'-mentality. For instance, the architect has from the beginning understood the purpose of a public building and the necessity to accomplishing low LCC through designing low-cost, durable and plain solutions.

Project Business Case

An obvious observation from the PM is that the project has had a cost increase of several hundred million NOK springs from the choice of plot. In addition to be located close to a river, the local water and wastewater infrastructure runs straight through the building site. In addition, the exit from the highway leads directly into the school and therefore has been proven to be

more complex than anyone had ever planned and anticipated. The PM stated that the project goal is to achieve a good school for the local community and to establish a swimming pool which will work as a reassembling area for this part of the municipality. These goals have been debated among politicians due to the location within the less populated part of the municipality. Therefore securing stakeholder commitment has been tough.

Validation Process

TC is based on tenders for sub-contractors. The first TC was way higher than expected and therefore created the basis of which the second TC was based on. At the start of the second pre-project the project organization started the cost reduction by identifying cost drivers. These meetings between the PM and the different disciplines used the established design material in an iterative process which critically investigated the designed concepts and systems. The contractor was not part of this process due to the first TC being based on tenders from sub-contractors. Following cost reductions was established during the second process:

- Fulfilling the BREEAM Excellent-requirements but dropping the certification process.
- Reduction in teaching areas.
- Changes to the structure of the swimming pool by elevating the pool to avoid piling and concrete work. Reduce the width of the competitive pool which results in a training pool.
- The structure is changed from a timber structure to steel and hollow core slabs.
- Reductions in landscaping.

Cost and Target Management

Clearly this project was on the edge of refusal if not a considerable cost reduction was executed. As stated by the PM: “At some stage I did not think this project would be built. But we managed to pull this off.” The PM joined the project right before initiating the second pre-project. His experience with the project is therefore mostly linked from that time and onward.

In the course of the cost reduction process both changes and optimizations were necessary. And again, the focus towards the definition of a ‘change’ and a ‘optimization’ is brought to the interviewers attention. The interviewee defines a ‘change’ to diverge from the required specifications and providing another product quality than the one described in the tender. An ‘optimization’ on the other hand, is defined as a solution with the same quality but which is either cheaper or better or both. In order to achieve mechanisms or incentives for the contractor to suggest changes or optimizations, the project must provide the contractor with a profit. The client can not assume to achieve this environment by taking the whole profit themselves. The PM also elaborates that an optimization might result in a more expensive project and that one must understand that this might be tough for the contractor to embrace. For this reason consistency among the project organization and especially among the decision-makers is beneficial.

For both Case 1 and 2 a document involving the client, the PM and the contractors from both cases was made to specify which considerations are valid for a change and for an optimization and how these shall be valued or effect TC (Rastad 2019). One complicating element is that the tender from the contractor is based on tenders and even contracts from sub-contractors and

-suppliers. Changes to established contracts reduce the procurement benefits for the contractor.

Cost and time consequences have had the most impact in the decision-making basis for optimization. The use of prefabricated facade elements is grounded in both reduction of time and cost. Structuring the pool by using steel rather than concrete was grounded based on LCC. Avoiding the use of a timber structure reduced the project cost. Even though BREEAM certification process was dropped, environmental aspects have been prioritized.

4.3.2 TVD Maturity

Based on the briefly discussed AS provided in the Table 4.4, a summary of the TVD maturity is illustrated with the radar plot in Figure 4.9.

Table 4.4: Scorecard used in the evaluation of TVD characteristics in the case studies.

TVD char.	Description	AS
Contracting	Partnering, 50/50-split.	3
Organizing	Limited collaboration and co-location, no target budgets among project objects.	1.5
Defining (business case)	Validation not based on AC, no priority of outputs, debated project location.	1.5
Defining (validation)	Shared understanding, align ends, means and constraints, no benchmarking, target budget lower than best practice.	2
Steering	Limited SBD, focus towards cost reduction.	2

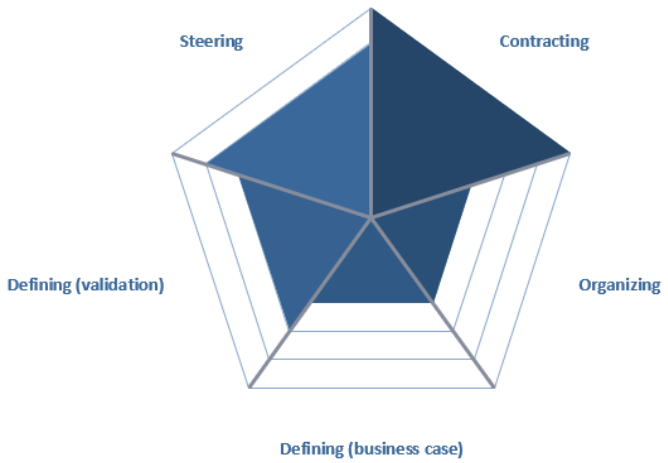

Figure 4.9: TVD maturity for Case 2.

4.4 Case 3

Brodersen & Michelsen (2015) establishes the basis for the following paragraphs. Case 3 is part of a master plan for upgrading the municipality's nursing home capacity. In total, 2,500 nursing home spots need to be modernized within 2020 due to poor building conditions and a change of needs. Existing buildings are still under full operation. Therefore, new nursing homes must be constructed before transferring users from an old home to a new one. Project scope includes planning, designing and constructing 144 spots (14,700 m^2), a senior and a day care center (1,500 m^2) and infrastructure. A public stated project target wass to become the country's most environmental-friendly and energy-efficient nursing home (Brodersen & Michelsen 2015).

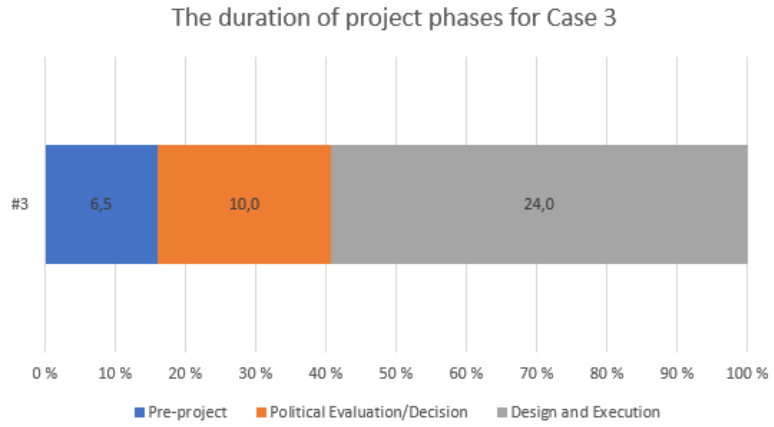

Figure 4.10: The duration of each project phase in months for Case 3.

Figure 4.10 illustrated that the duration of the pre-project up until design and execution, lasted for 40.5 months (a ratio of 4:10). Internal documents divided the project into three phases:

Table 4.5: Stated project phases for Case 3 (Omsorgsbygg 2012*b*).

Phase A	Design and pre-project establishment. An adjusted contractual price must be agreed upon but the client obtain the possibility to cancel the project if not. One contractual paragraph explicitly stated that the contractor could not request any changes that the contractor should or could have recognized.
Phase B	Detailed design and execution based on approval in QA2.
Phase C	Delivery and test of operations for 12 months.

Omsorgsbygg (2012*b*) states the project-specific award criteria:

- **60-70%**: The tender bid, hourly rate for cost-reimbursable work, profit margin for materials, machinery and sub-contractors as well as unit prices.
- **30-40%**: An evaluation of the contractor's concept based with regards to architectural and functional solutions, materials, organization, environmental aspects and energy use.

The tender documents established in Omsorgsbygg (2012*b*) point at an architectural competition. Layout with corresponding descriptions of functional and system solutions, materials and landscaping were the most important elements. Compared to Figure 4.11, one notice the corresponding focus within the stated goals. Be aware, only a number of the written outcomes are presented. Alongside the architectural perspective, the stated goals stresses the project to become a role model within work methods, results and collaboration.

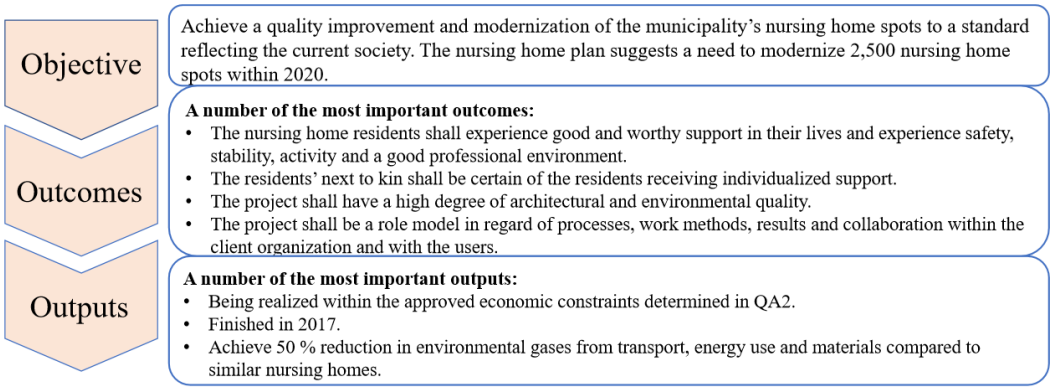

Figure 4.11: Objectives, outcomes and outputs for Case 3.

Noteworthy, the cost increase was significant during the pre-project and at the start of the ten months long political process. External consultants concluded that the project's EC and AC were too low. This action which resulted in a 15% increase (from 600 to 694 MNOK), was baffling for the PM since the original budget was already generous. Furthermore, the cost increase during the design and execution was due to added improvements for the nearby infrastructure. Consequently, the increase was therefore not related to the original scope. However, further examination of the graph reveals an unexploited reserve of 20 MNOK. An interesting question is whether or not the TV could have been increased within this 'leftovers'?

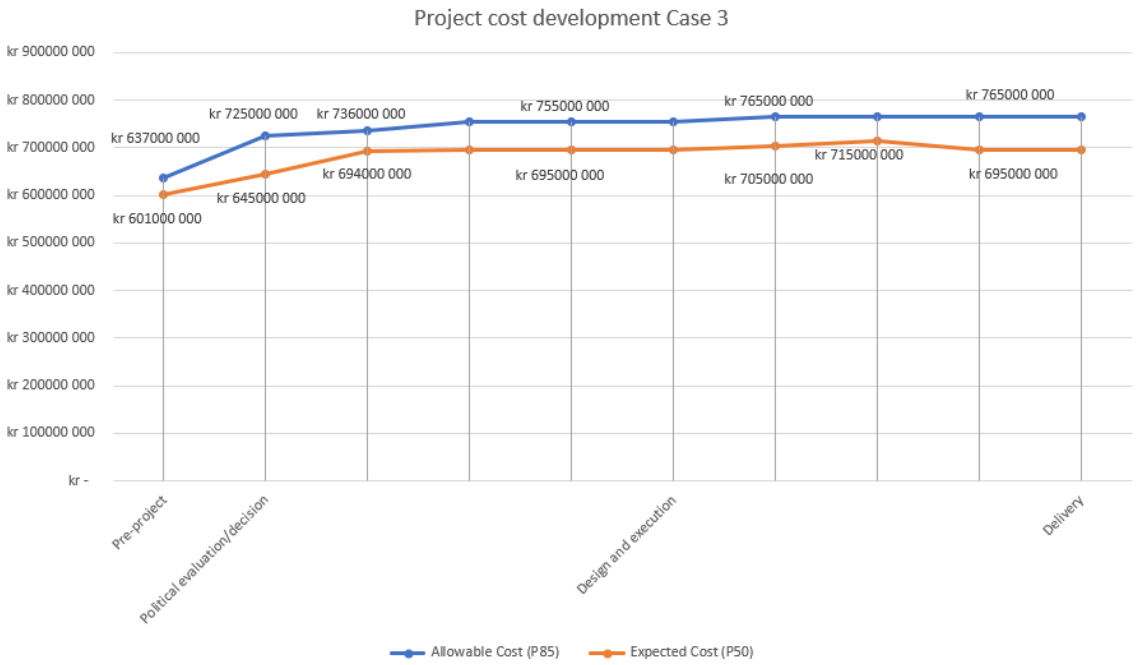

Figure 4.12: Project cost development for Case 3 based on the PM's monthly reports.

4.4.1 TVD Characteristics

Organization

Internal documents provided a comprehensive description of the project organization (Brodersen & Michelsen 2015, Omsorgsbygg 2012*a*). Within the municipality, construction projects are structured specifically after purpose. In this case, the municipality has their own organization that owns and maintains health buildings. Further, the specific users rent the building from this company resulting in the need of a comprehensive client and user involvement. At the start of this project, the Oslo municipality's new investment instruction was implemented and gave birth to the project model illustrated in Figure 3.1. As stated in City Department of Finance (2011), this instruction secures sufficient processes and governance basis by implementing an structured methodology and decision-making process. One of the focus-areas in this case is the pre-project. Firstly, the needed activities in this phase and secondly, how this phase is documented. As underlined in internal documents, the pre-project has the majority of the user involvement and therefore is the most critical phase for achieving the stated goals.

An observation that the interviewee has acknowledge throughout his career is that at each project start the involved people disregard their own experience. At the start the main focus is towards collaboration and helping each other. However, at the end, when the contract and risk is about to set, the focus brutally shifts towards protecting oneself. That happened in this project. An important remark is that the contractor struggled financially, and during the development they were declared bankrupt. These financially 'restrictions' effected the collaboration between the PM and the contractor right from the start. This project, and the PM's authority, stands out from 'traditional' projects by assigning the PM decision-making authority. Having this authority provides the position the ability to make rapid decision alongside the more psychological part of fully legitimize the power and the responsibility needed as a PM.

Project Business Case

Figure 4.11 shows the priority of outputs. This prioritization provides an interesting reflection with regards to the low ranking of the quality. Quality over the lifetime of the project is often an important priority for these facilities. External QA consultants wanted 'cost' to be the number one priority but the PM from a principle point of view demanded 'safety' to be on the top. "The risk of the future is to construct something that is damaging the environment," stated the PM.

Validation Process

The pre-project was developed in collaboration between the PM, the contractor and mainly the architect and the landscaper. As expressed by the interviewee, the different disciplines were not heavily involved. A natural thing in a design-build contracts. During the pre-project a standardized meeting schedule was practiced. Therefore, several other meetings were implemented and some of these meetings were changed to weekly meetings during the next phase.

During the pre-project the contractor used the ICE methodology in parallel with other methods. The PM underlined that implementation occurred side by side with the development of these methodologies. Consequently, these ways of working were new for everyone involved and cannot directly be compared to how the methodologies are conducted nowadays. Even

though specific design decisions did not occur in big room-meetings between the design team and the project organization, some development happened in a collaborative environment. As the representative for the client, the interviewee was not part of every design and project development meeting since the contractor gained complete control of the different disciplines once the pre-project was completed. This control, which the PM underlined the necessity to fully understand the consequences of, makes the pre-project even more important for the client and the users. Once the contract is secured, the contractor starts to sub-optimize through procurement and by transferring risk to sub-contractors or -suppliers. In addition to these somehow collaborative meetings, the PM had meetings with the users since they were not directly involved in these meetings. The purpose of these meetings was to clarify functional solutions regarding layout and architecture, hence, to a lesser extent technical designs and systems. Furthermore, the organization had traditional meetings between the client, the PM and the contractor which addressed financial, contractual and other administrative challenges.

An important element in the evaluation of the two project tenders was the distance between different functions and the residential units. Based on the distances, the PM calculated the consequences into operational costs. One of the layouts needed four workers available on the night shift, while the other only needed three. Calculated into monetary value, the difference over the life time of the project was an increase in operational costs of 60 MNOK. In other words a considerable optimization since the nursing homes within the municipality uses a worker-patient ratio. This ratio determines how many full-time workers that are needed. More specifically, how many part-time workers the is building capable to manage. In addition, the municipality decides yearly a TC for the price of one nursing home spot. The PM believed that this number of 3.5 MNOK which is adjusted for inflation, is based on historical data. Necessarily, the total cost can be calculated by multiplying the number of spots with the TC. However, this cost which the PM underlined, is based on certain assumptions. If these assumptions are not correct for this specific project, the price needs to be adjusted accordingly. Adjusting this TC was hard work since the client could not immediately clarify the following:

- The date of the TC.
- If the TC is based on building on an undeveloped plot.
- If the TC is adjusted for new building laws and requirements that have been approved after the date of when the TC was set.

Compared to similar project, this specific case differed on areas such as renovation of an existing and listed structure, the existing structure has an inadequate layout and environmental requirements of becoming the first BREEAM Excellent certified nursing home in the country.

Cost and Target Management

Internal documents related to the understanding of the project stated several tasks related to cost management. Table 4.6 describes only a number of the them. These tasks were included in the PM's tender to the client (OPAK 2012):

Table 4.6: Project- and PM-specific tasks described in the delivered tender for the PM's position.

Project-specific tasks	**PM-specific tasks**
Comparing project development to current budgets.	Economy in every decision-making processes.
Identify issues and potential changes in order to estimate, analyze and prepare the consequences of them.	Cost-efficient operation solutions based on LCC.
Stay within approved budgets and to create an awareness regarding costs.	Energy-efficiency.
Create economic analyzes as a basis for the decision-making authority.	

The interviewee differs between the actors' perspective with regards to a 'change' and an 'optimization'. More specifically, an 'optimization' is implicate changing something in order to achieve better quality or a better functionality for the users. The contractor on the other hand focuses more towards reducing costs and making the project more constructible. Meaning, improving the efficiency and simplifications of interfaces between different disciplines. A partnering implements 'the best of both worlds'. Hence, the different perspectives are in contrast to each other. Changes arise based on to two factors: 1) client's needs or wishes changes during the project development, and 2) design errors. Number one is a challenge. These changes can be recognized and clarified during the pre-project, but the discussions with both the client and/or the user(s) are too abstract. The project is both too far away in time as well as the users generally do not spend enough time investigating the project. Once the construction has started then the users begin to believe that the project is actually being realized and the motivation shifts completely. One of the tasks for a PM is to help the users to avoid unnecessary (and expensive) changes. Number two: Design errors happen in every project, but the discussions towards who is responsible is not unambiguous. Generally, the contractor in design-build contracts has the overall responsibility, but is not necessarily the one who has to take the cost. The following discussions affect the project collaboration environment.

The client focus more towards function and quality while cost and simplifications is mainly targeted by the contractor. 'Time' has not been an important element in the decision-making processes. On the other hand, the environmental aspect has which is reflected by a BREEAM strategy. Several elements have been implemented in order to achieve these environmental goals such as carbon accounting, reduction of the carbon footprint for the ten most important building components, comprehensive use of pre-fabricated elements to reduce waste. However, the PM cannot say that the environmental aspect had the highest priority. The project had such a generous budget that prioritizing between conflicting outputs rarely occurred.

4.4.2 TVD Maturity

Table 4.7 briefly discuss the reasoning behind the stated AS. These scores are visualized in Figure 4.13 as a radar plot. Generally, the contractual element has had an impact on the project which exceeds the 'Contracting' category. Case 3 has barely implemented characteristics within the 'Organizing' and 'Defining (Validation study)' category.

Table 4.7: Scorecard used in the evaluation of TVD characteristics in Case 3

TVD char.	Description	AS
Contracting	Design-build, possibility to cancel the project.	1
Organizing	Limited collaboration, transparency, workshop model. No target budgets for project objects. .	1
Defining (business case)	Validation not based on AC, part of a master plan, priority of sustainable alternatives.	2.5
Defining (validation)	Limited understanding, target scope greater than best practice, not standardized solutions.	1.5
Steering	Limited SBD, project goals, design to value	2.5

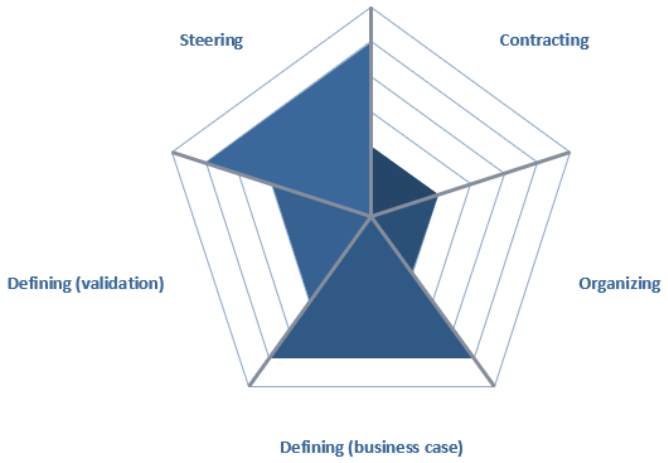

Figure 4.13: TVD maturity for Case 3

4.5 Case 4

The QA2-report written by Steenberg et al. (2017) and the steering document from Omsorgsbygg (2017) creates the basis for this section. Equivalent to Case 3, this project is also part of the same plan for upgrading the municipality's nursing home capacity. Project initiation and planning started already in 2009 and a QA1 was conducted in 2010-2011. In conclusion, the planning proposal in 2013 related to the choice of concept was not approved. A revised initiation was delivered to the client in 2015. An initial pre-project meeting was conducted in May 2016 involving the PM and the client. The project involves demolition and construction of a new six-story BREEAM Excellent and ZEB building. In total, 144 new nursing home spots will be constructed in addition to improve nearby landscaping and infrastructure. Alongside the objective, the following outcomes and outputs are stated in Figure 4.14:

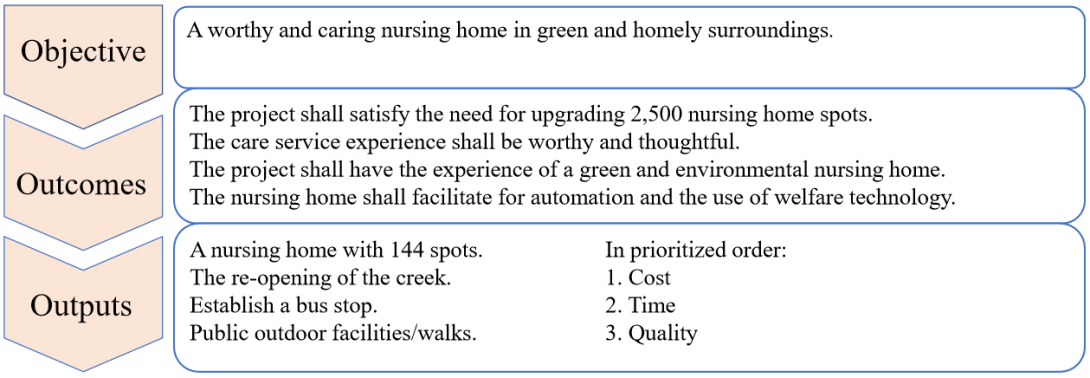

Figure 4.14: Objectives, outcomes and outputs for Case 4.

In total, Case 4 has a planned duration of 43 months from the start of the pre-project and until the facility is delivered. The duration of each phase is illustrated in Figure 4.15

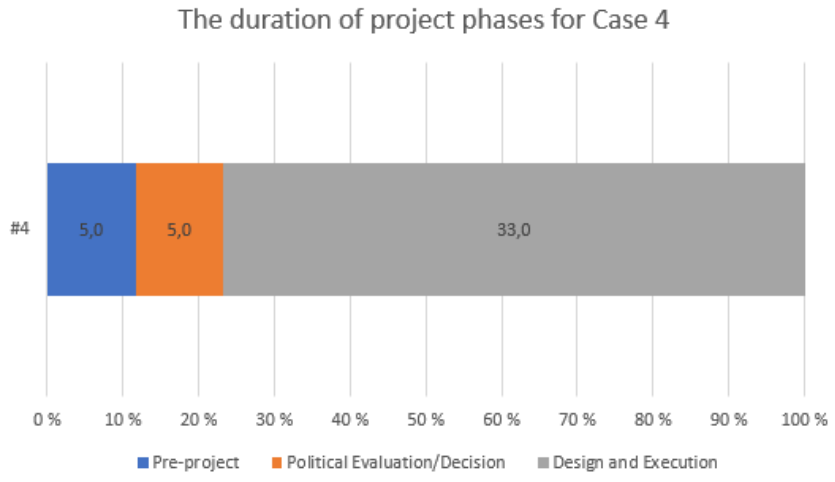

Figure 4.15: The duration of each project phase in months for Case 4.

Figure 4.15 shows that the pre-project phase lasted for five months, and the design and execution phase lasted for 33 months. That is a ratio of approximately 1:6. Using partnering in combination with a design-build contract is part of an ongoing transformation from design-build

contracts and towards more relational ones. Table 4.8 summarizes the three project phases the project organization themselves have defined (Omsorgsbygg 2017):

Table 4.8: Stated project phases for Case 4 (Omsorgsbygg 2017)

Phase 1	Partnering contract which remunerate the contractor and involved disciplines based on the actual time taken. The client is using their framework agreements with an number of disciplines which are transferred to the design-build contractor in the next phase. Similar to Case 3, the contract involves a clause for the client to cancel the project. The contractor is obliged to deliver four contractual estimates whereas the latter one will be the agreed contract sum.
Phase 2	Detailed design and execution. Contractual regulations are based on the standard form of contract alongside project-specific adjustments.
Phase 3	A test operation period of 12 months.

For this specific project, the award criteria are listed below (Omsorgsbygg 2016*a*):

- **40%**: Fixed price for the demolition and the pre-project. Design-build profit margin, hourly prices for changes and profit margins related to changes and machinery.
- **35%**: Competence and experience for key positions such as the contractor's PM and design manager and the main architect.
- **25%**: Project understanding of how the main challenges should be handled, how the collaborative pre-project should be executed, a plan involving the dates and the deliveries of the four milestones and an evaluation of the main uncertainties and suited measures.

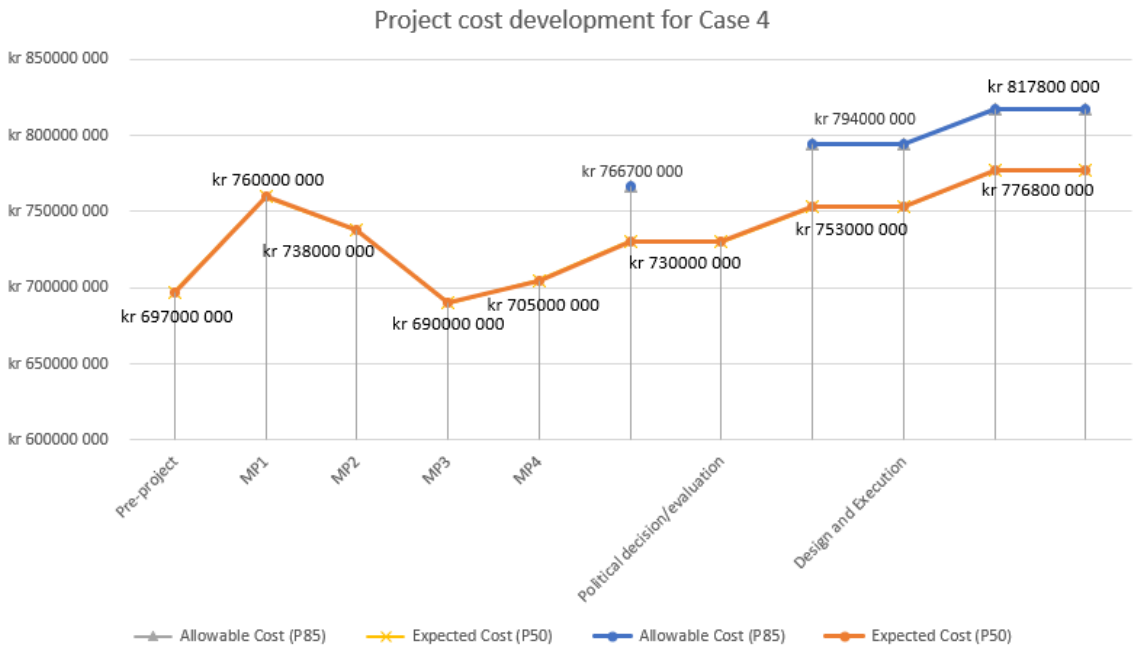

Figure 4.16: Project cost development for Case 4. AC (P85) is based on the results of the QA2.

The obligation to deliver four contractual cost estimates during the pre-project have had an impact on the cost development. During the pre-project the EC altered with a peak at the first delivery. A natural development due to the obligation of achieving the project within the stated cost. Project maturity increases as due to the development progress. MP2 and MP3 reflects this development. So far so good. The EC follows the anticipated goal of reducing uncertainty and increase the maturity as visualized in Figure 4.17. Hence, the development after MP3 due to features soon to be enlightened, was not going as originally planned. The monthly reports did not reflect the AC. Therefore, the AC displayed in the figure is based on the QA2 report from October 2017. Simplified, the author presumes that AC is constant throughout the design and execution phase. It is noteworthy that even after MP4, the EC continued to increase. An uncertainty analysis provided the first increase. The remainder are changes initiated from the client himself.

4.5.1 TVD Characteristics

Organization

The contractual arrangements for this project articulate that the contractor has no obligation to proceed with the same consultants and sub-contractors and -suppliers that were used during the pre-project (Omsorgsbygg 2016*b*). Consequently, a change of personnel happened during the start of design and execution phase. As underlined by the interviewee, this change weakened the relations between the involved actors as well as reducing the knowledge of the project development.

Description of the pre-project from the chosen contractor suggested an extensive use of ICE and other innovative methods. Despite this, as stated by the PM, the description did not reflect the implementation. ICE meetings were conducted every second week in big rooms involving consultants, the contractor, users and the PM. These meetings provided good interdisciplinary discussions supplemented with crash controls and the use of project design maturity. Contractual arrangements contributed to the rise of a more preserved communication during the development due to the knowledge of transitioning to a design-build contract. Alongside the ICE meetings, the project had traditional client and users meetings which involved the user.

A challenge arose during the pre-project in relation to the involvement of the user representative in the ICE meetings. The purpose for these meetings is to make collaborative decisions. But, as stated by the interviewee, the user started making decisions without properly visualizing the consequences. Often these decisions had economically affects and changes could easily occur based on short-term solutions on arising issues. Therefore, the project development proceeded with separated user meetings in order to avoid the temptation.

Project Business Case

Development of the zoning plan and the design of the tender document was conducted in parallel. The project organization was certain of the constraints such as the number of nursing home spots, the location and that renovation was a ‘no go’. Originally, the plan was to let the design-build contractor conduct the development based on the sketches from the zoning plan. A detailed investigation of the sketches revealed that the architect had missed the implementation of technical requirements. For that reason, the pre-project was executed as a partnering.

Validation Process

The contractual arrangements forced contractor deliveries at four specific milestone. First of the four milestones was a cost estimate with high uncertainty. Between each milestone the project development proceeded. But in parallel, the number of specifications from the contractor did the same. This process was conducted inn parallel with the zoning plan which was approved six weeks before the final submission. Each of the cost estimates had to be based on tenders from sub-contractors, detailed estimation etc. On top of that was the stated profit margin. Having the clause in the contract provided the client the possibility to cancel the project before finalizing the pre-project. This clause created some tough negotiations at the final milestone.

The interviewee stated that goals and objectives are mainly used in extraordinary projects. In more 'traditional' projects, the utilization of these are lacking. For the purpose of making the targets more clear and specific, the PM re-defined them between the QA1 and QA2. Consequently, the PM invited the contractor to chase the environmental targets for additional payment.

Operational aspects over the entire lifetime of the building is and has been important for the PM and the client. This is closely related to the understanding of the users and the purpose of the building. Even though the involved disciplines had previous experience with nursing homes, they lacked the understanding of the operation and the situations that arises during operation. Further, the interviewee points out that a nursing home differs from other facilities by involving patient security, infection control etc. Consequently, the local municipality has their own minimum operational requirements. These requirements affects the target cost setting (Oslo kommune 2015). The pre-project execution model illustrated in Figure 4.17 was developed by the PM in order to create more predictability for the client by developing within the stated assumptions for each delivery (Omsorgsbygg 2016*b*). At first sight, this model links the TVD process of targeting project cost through collaborative design to increase the maturity and predictability. Despite this, the model had some unfavorable consequences.

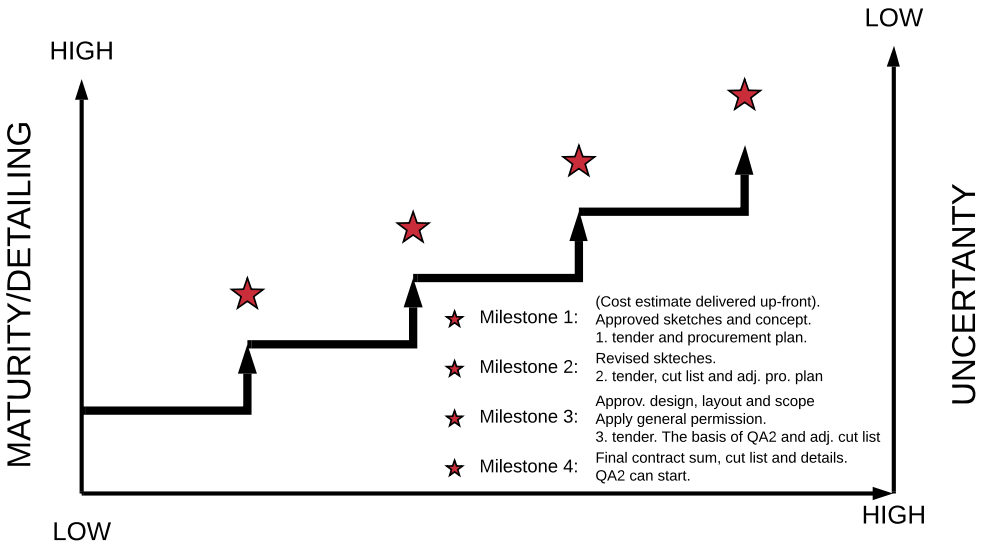

Figure 4.17: Pre-project execution model for Case 4 presented in Omsorgsbygg (2016*b*).

Even though the TC needed to be agreed upon at the last milestone, the project determined that some elements should not be included. The reason why is the increasing technological development and therefore technical elements as solar panels, lighting and appliances were left out. An extensive and vital use of solar panels in order to meet the environmental requirements resulted in a significant cost. Consequently, the solar panels were bought two years after the pre-project was completed. This process as the interviewee underlined, provided the project with the most effective panels in the market. Moreover, these panels have never been used in a project of this size before. Somewhat the same process occurred with the lighting. The criteria from the users with regards to life quality for its residents had to correspond to the most environmental-friendly and cost-efficient alternative. After quite some time the project managed to fulfill all the criteria. Nursing home appliances play a critical role in nursing homes due to its majority of part-time employees. Functionality is therefore critical, and for the same reasons as for the solar panels, the appliances were bought 'just in time'.

Cost and Target Management

A tool called 'SimVision' provided the project organization a possibility to optimize the time spent on 'unmotivated pauses' in the early phases. This tool assisted the PM with an uncertainty analysis of time by identifying the critical path and activities that can be conducted in parallel. One example which the interviewee estimated saved the project of an additional year, was to start the QA2 process while the pre-project was still running. The result: A detailed political progress plan which provided an overview of who needed to be involved at given time periods or in specific activities.

Internal documents revealed a great deal of focus towards LCC calculations and evaluations (Skanska 2017). This process is linked to the four milestones of the pre-project illustrated on the previous page, and therefore has a top-down approach. The purpose of this structured approach as stated in the LCC report written by Skanska (2017), was to create a shared understanding of how to achieve low LCC costs by distinctly defining the evaluation scope and to prioritize the work that can achieve the most. Doing so, resulted in the establishment of two main strategies:

1. Continuous update of the total building's LCC projection by using a budgeting tool.
2. Focus towards evaluation of alternatives.

The contractor provided an evaluation report of the LCC process. Summarized, the following steps as illustrated in Figure 4.18 were the main contributions towards achieving the most environmental-friendly nursing home in the country (Skanska 2017):

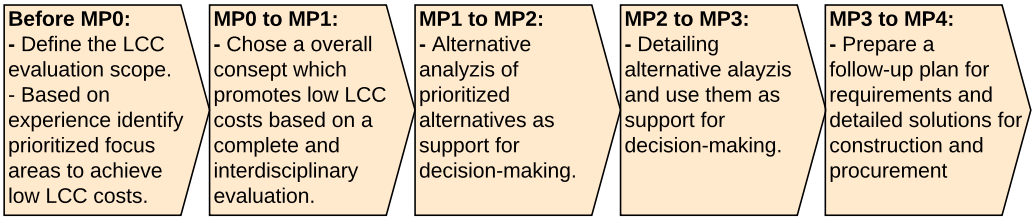

Figure 4.18: The LCC evaluation process provided by the contractor (Skanska 2017).

4.5.2 TVD Maturity

The briefly discussed AS provided in the Table 4.9 shows that Case 4 is the most mature project of the five investigated cases. This is more visually represented in the radar plot in Figure 4.19. On average, the four categories are sufficiently implemented. Chapter five will more extensively explore the reasoning behind the scores and accordingly discuss the potential for the TVD characteristics to be fully implemented.

Table 4.9: Scorecard used in the evaluation of TVD characteristics in Case 4.

TVD char.	Description	AS
Contracting	Partnering pre-project, design-build, possibility to cancel the project.	2
Organizing	Limited co-location, not fully implemented workshop model, four contractual milestones.	2
Defining (business case)	Validation not based on AC, part of a master plan, priority of LCC for alternatives.	2.5
Defining (validation)	Target scope greater than best practice, limited benchmarking and standardized solutions.	2
Steering	Challenging current best design practice, project goals and focus on operation cost.	2.5

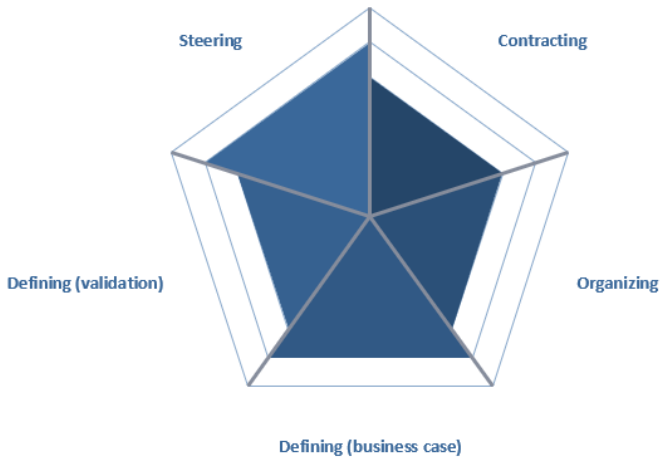

Figure 4.19: TVD maturity for Case 4.

4.6 Case 5

Case 5 is part of the same development plan as Case 1 and 2. As previously described for Case 1 and which is written in the steering document (Municipality 2019), schools and sports areas must experience an increased capacity. Constructing the required design at the right time in the correct location should fulfill the needs within the municipality. Case 5 involves a sports center that is publicly stated to satisfy the functions described by the local sports club. The environmental requirements were targeting BREEAM Excellent, and Municipality (2019) underlined that the facility should achieve the following targets: 1) Low cleaning and energy costs; 2) Centralized operation of power, heating, ventilation and lighting and 3) High quality and maintenance-free materials and solutions. Alongside the environmental aspect of the project, the following outcomes, and outputs are summarized in Figure 4.20:

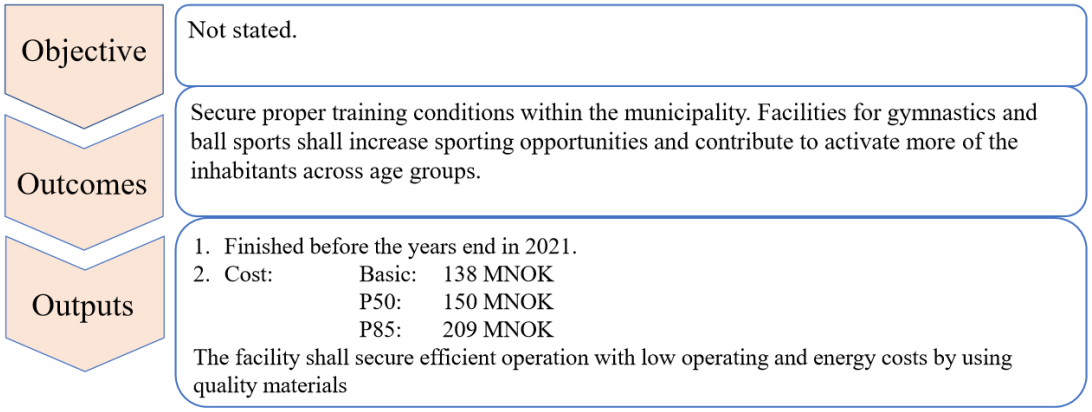

Figure 4.20: Objectives, outcomes and outputs for Case 5.

Furthermore, the project strategy is to focus on the most significant uncertainties, to limit risk, and to exploit opportunities (Municipality 2019). At natural milestones, the project shall undertake uncertainty analysis to uncover uncertainties in the current project proposal and cost estimates. This analysis were planned to be conducted after the project programming, evaluation of tenders (means testing), pre-project, project detailing, and execution.

The design competition was cancel in April 2018 since the delivered project suggestion was not approved by the local sports club. Delivered tenders also revealed that the project cost would exceed the targeted EC. Cost reductions had to be conducted, and an updated version of the steering document reveals the cost-cutting activities and their disadvantages (Municipality 2018*b*). The local sports club prioritized gymnastics, climbing and ball sports, and excluded areas for dancing and martial arts. Originally, the pre-project was meant to be executed as partnering with a following design-build contract. Canceling the first competition resulted in the project being executed as a design-build contract involving the following elements:

- The design team will use the previous user needs and feedback in new project drawings. Award criteria for the design team are competence, previous experience, and price.
- The design and execution phase will be a design-build contract with no user involvement and limited influence with regards to solutions and qualities.

The execution was first planned during the spring of 2018. But due to the cancellation, the project progress is suggested to be postponed and the project will be finished at the years-end of 2021. In total, Case 5 will have a duration of 25 months from the start of the pre-project and up until the design and execution phase is finished as illustrated in Figure 4.21:

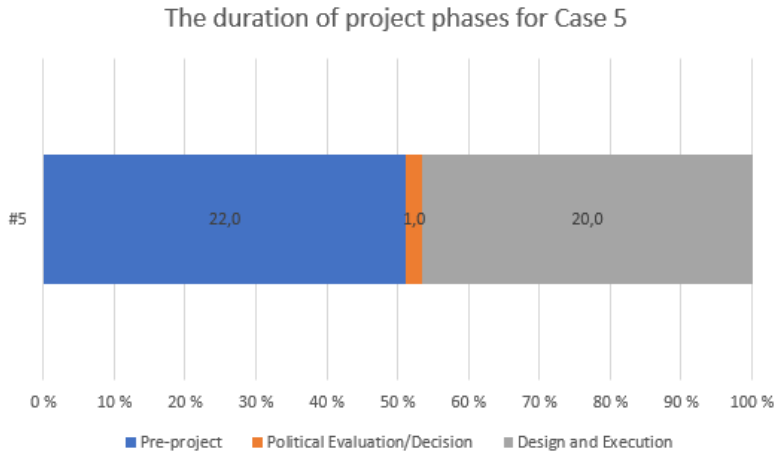

Figure 4.21: The duration of each project phase in months for Case 5 does not reflect the arising delays. This could arguably be included in the pre-project phase.

4.6.1 TVD Characteristics

The political 'battle' and the fulfillment of the user's requirements are not visibly reflected in the time and cost development in the Figure 4.21 and 4.22 respectively. One obvious reason is the change of scope which is not reflected. Arguably, one could investigate if the TV has been realized.

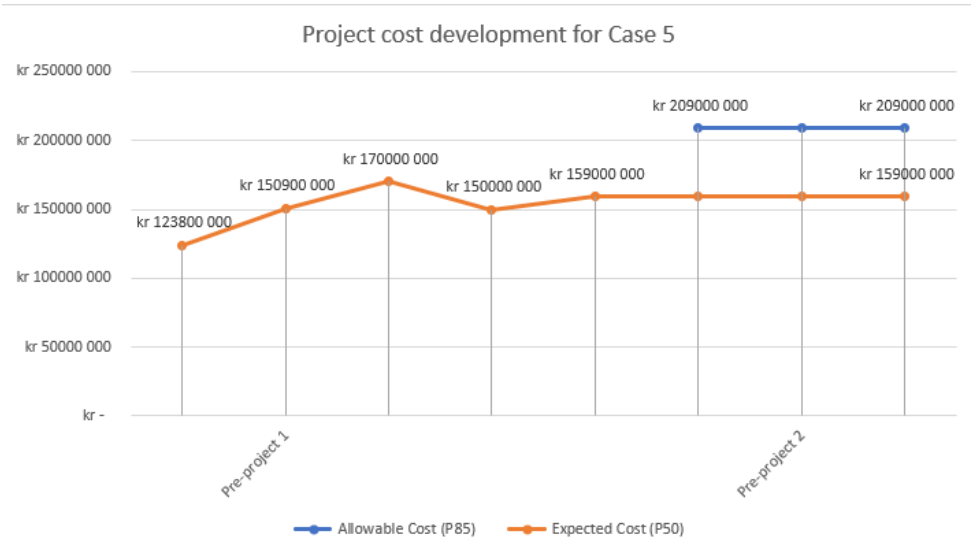

Figure 4.22: Project cost development for Case 5.

Organization

The regularly design meetings were conducted with an architect as the leading member. The design team is following the previous project proposal and scope and therefore the number of meetings was limited. In total, six meetings were conducted with the users. Furthermore, the design team created the cost estimate of the chosen project concept and the PM stated that this provided a favorable continuity. In parallel, steering committee meetings and meetings with the municipality and the operations personnel have been conducted. Operating personnel have not been directly involved, but continuously received updated information on the progress. A strong user which will be more extensively discussed was part of the steering committee meetings.

Project Business Case

Fundamentally, this project is based on the same school needs plan as of Case 1 and 2. Despite this, this project is focusing on the southern part of the municipality. Once the location was set the user meetings started alongside the development of the tender document. A room program was developed together with the two user groups consisting of the school, the local sports club and the operational personnel. One evaluation group and one judgment group was established when the tenders were received from the contractors. The evaluation group had a more structured approach by focusing specifically on price and competence. The latter focused purely on the quality of the solutions. This group consisted of the PM, representatives from the local sports community, the school, the client, and the municipality's sports and nature department.

During the development, the PM made a point of one of the user groups having strong relations within the local politicians and, therefor, had a lot of influence. A project-specific attribute is that the client could not traditionally control the decision-making process which springs from the political decision to build what the local sports club wants (Municipality 2018*a*). This process was characterized by having one strong user and one user with a minimal interest in shaping the project. Having both ends of the scale made the balancing of needs challenging. Meetings with the users and the operating personnel were conducted in parallel.

One of the user representatives could not agree with the following solutions. As a result, a lot of meetings were conducted between the councilman, the client, and the steering committee. Eventually, the committee canceled the process before entering the pre-project based on the argument that one could not proceed without having the project secured among the local sports club. An official political decision to delay was made right after. Consequently, a new procurement strategy was implemented and a design team was hired. Their task was to proceed with a new process of pre-design and -project and the development of tender documents in close collaboration with the two users, the project organization and the client.

In the second process which was led by the architect as head of the design team, meetings with the users were reduced to approximately once a month. During the same period, two or three steering committee meetings were conducted and the representative from the local sports club was also included in these meetings. The interviewee stated that this is unusual.

Validation Process

Originally, the client had set high environmental ambitions by achieving BREEAM Excellent. Due to the cost development, these ambitions had to be dropped, and for that reason, the PM stated that a lot of the project value has been removed. Furthermore, the local sports club possess most of the power and therefore compares every action taken with achieving other sporting-related features. The answer to a question regarding the users understanding of the LCC benefits of a BREEAM certified building, the interviewee stated: "But that cost is located in a different budget." Interestingly, the interviewee further elaborated that users from other sporting center projects have the same unrealistic cost expectations.

Deliveries from the contractors in the first process provided the project an opportunity to get a cost estimate alongside having the solution proposals. All of the tenders were calculated to be above the budget. In retrospect, the interviewee stated that these estimates probably were too optimistic as well, especially based on the extent of the groundwork. Hired external consultants which conducted cost estimates based on the solution proposals, verified this suspicion.

Costs of the first process had an impact on the project. Due to the cost, a new choice of concept evaluation was conducted and every concept was estimated. The chosen concept excluded the climbing hall and the area for martial arts. Having the proposals from the first process created a basis on discussion in the new user meetings. Discussions among the project organization and the users arose based on the user needs and the corresponding economical consequences of implementation. A conclusion and a project proposal was agreed upon and the new design team were to process this proposal and develop the project within the stated constraints in a pre-project. A new uncertainty analysis resulted in an updated cost estimate.

Cost and Target Management

With regards to optimizations and changes the interviewee stated that the current project progress has not yet needed to implement these management and steering methods.

4.6.2 TVD Maturity

Table 4.10 provides a different picture of the TVD maturity compared to Case 4. The TVD maturity is low due to the challenges stated on the previous pages. Characteristics are either not implemented or barely implemented. Figure 4.23 illustrates the AS within the four categories.

Table 4.10: Scorecard used in the evaluation of TVD characteristics in Case 5.

TVD char.	Description	AS
Contracting	Design-build, no incentives.	0
Organizing	Limited co-location, transparency, a single user with influence.	1
Defining (business case)	Validation not base on AC, condition of satisfaction not matching target budget.	1.5
Defining (validation)	Limited understanding, mismatching ends and constraints, no benchmarking. Standardized solutions.	1.5
Steering	No SBD, constructible design, single user's expectations, uncertainty.	1.5

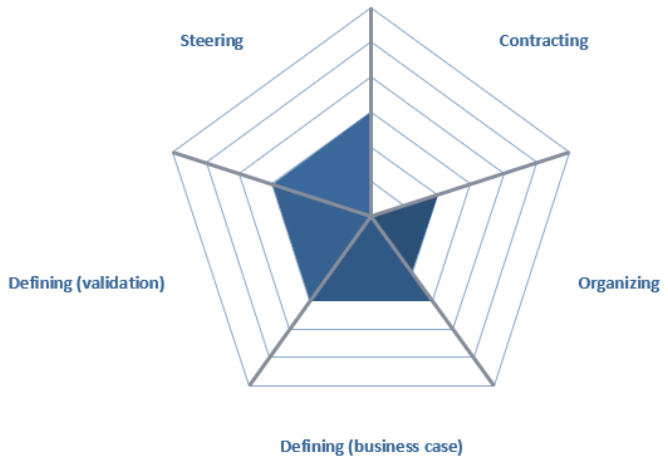

Figure 4.23: TVD maturity for Case 5

Empirical findings from the case study have been chronologically presented for each case. Without comparing these findings to the literature, the research is more or less useless. Verification of the literature or the other way around in the sense of understanding how TVD characteristics can be implemented provides a comprehensive basis for discussion. The following chapter analyzes and discusses the case findings within the context of the literature and industry practice.

Chapter 5

The Implementation of TVD Characteristics

Chapter five discusses and compares the findings from the case studies in chapter four to the theory provided in chapter three. By doing so, the context of the theory and the findings are connected and knowledge gaps are identified. The implementation of TVD characteristics has been identified for each case and significant findings are described. Discussions are centered on the identified characteristics and the corresponding activities and how these can be applied. 'Value' is an important element in the discussion. The definition of value is debatable (Bertelsen & Emmitt 2005, Drevland 2019, Khalife & Hamzeh 2019), but in this thesis 'value' is defined as the achieved benefits based on time, cost and quality. Having this definition in mind during the discussion will hopefully create a more comprehensive understanding of the findings.

5.1 General - Common Basis of Investigation

The analysis is structured by firstly, a precise presentation of the theory with regards to clarifying the perspectives of the literature. Secondly, the case findings are set side by side to shed light upon its resemblances and inequalities. Ultimately, the triangulation of combining a literature review, interviews, and document studies establishes a modest basis with regards to answer the stated RQs. Figure 5.1 illustrates this structure:

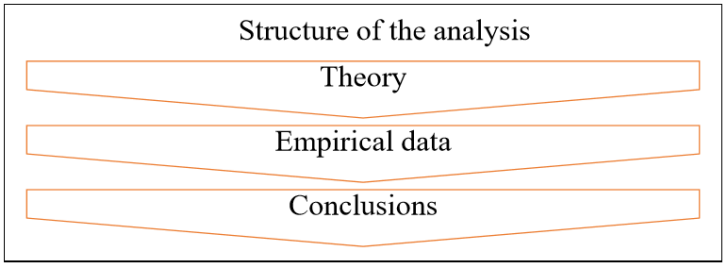

Figure 5.1: The analysis is structured by comparing the presented theory with case findings. Triangulation establishes a modest basis for the creation of generalized trends and conclusions.

The identified TVD characteristics are based on findings in several cited and well-known articles. These findings are combined, evaluated and summarized in the categories provided in Figure 3.8. Doing so enhances a sufficient basis of evaluation, and discussion by incorporating a number of influential articles that contributes to a comprehensive description of the

TVD term. Several characteristics were repeated and are therefore merged in addition to being structured within four categories: contracting, organizing, defining (differentiated between the business case and validation study), and steering. These four categories arose based on findings in Denerolle (2013) along with the contracting elements identified in the interviews and internal documents. Structuring these categories established a chronological way of working as well as identifying the needed key members. One interesting element is that the business case should be conducted by the client. Using the presented cases as a foundation of the following discussion, the business case is conducted in collaboration with a hired PM and the users. Already from the start the cases differs from the theoretical basis of TVD.

Further, both 'Contracting' and 'Organizing' create the foundation of which the 'Defining' characteristics are based on. This is an iterative process conducted by the client. The validation study, on the other hand, is conducted in cooperation with the contractor, suppliers, designers, and users. Having the basis and later on defining the issues that need to be solved, the 'Steering' is meant to keep track of that process, provide adjustments and in a larger extent control the elements of surprise. This establishes a possibility to control uncertainties and therefore chase opportunities that are lacking in Norwegian construction projects (Rolstadås et al. 2019). 'Change' and 'optimization' are keywords in this setting alongside rapid information updates among team members. The main purpose of this 'map' is to motivate and provide the PMs and other representatives from either the contractor or the designers, a framework of identifying and incorporating TVD characteristics.

5.2 Current Industry Practice

Part of this research is to investigate the current level of TVD maturity in the Norwegian construction industry. Based on the author's knowledge of the Norwegian construction industry, only a number of projects have in a full scale implemented these activities. ZEB Laboratory in Trondheim has developed the ZEB design method (Time et al. 2019). Alongside achieving a ZEB-COM ambition, the project is experimenting with the use of partnering and collaborative elements for designing and constructing ZEB buildings. Even though the project has not specifically stated the use of TVD, several TVD characteristics have been implemented and extensively used in the early phase and during design and execution. The pre-project benefited from an integrated team approach which was based on a partnering agreement. A TC was established, and the contractor's early involvement was centered around the idea of developing accurate estimates. The client facilitated the partnering, and weekly ICE meetings were conducted. Moreover, the project implemented ZEB workshops with an extended group exceeding the project team, focusing on ZEB definition (energy and emission) and ZEB technologies.

ZEB Laboratory is a four-stories high office living laboratory of approximately 2000 m^2. In other words, the extent is quite limited compared to the new hospital in Tønsberg. This project which is often referred to as the 'The Tønsberg project', has due to its size and complexity (44,500 m^2 of high-tech solutions) a potential of value creation, increased predictability, and time reduction. Completion is set in March 2021. Another project which to some degree has implemented TVD, is the new National Police Emergency Response Center (35,000 m^2) which will be completed in September 2020. The center is often referred to 'Beredskapssenteret'. Findings in The Tønsberg project and Beredskapssenteret have resulted in a guide related to

TVD (Lilleland-Olsen et al. 2019). This document identifies important elements and tasks which are linked to the project's key positions and provides a structured approach to implement the TVD methods. Furthermore, the document has also incorporated research findings from the Concept program which is in collaboration with NTNU, and the Oscar project. Both the program and the project have been previously mentioned in this research concerning cost estimation and project execution and as an illustration of the complexity of the 'value' term.

Several success factors have been recognized. The client must take responsibility for the largest uncertainties and therefore establish goals and TVs. Decision-making authority lies with the client, and the emphasis needs to be in the selection of the 'right project'. This should be based on a thorough investigation regarding needs, possibilities, and profitability. Coordinated execution models and work methods are crucial to secure predictable steering. Early involvement contributes to the optimization of scope and to reduce costs, in addition, to create a culture for optimizing cost/benefit. Relational contracts, incentives, and co-location create transparency, trust, and more rapid decision-making. However, this guide does not focus on the existing design and practical implementation of TVD characteristics. In addition, the document misses the consequences of the constraints and demands on design and execution. Some of these consequences will be further elaborated during the upcoming analysis of empirical evidence.

Table 5.1: Summary of the most important findings in the current industry practice

Summary of the most important findings
1. The client and not the contractor should facilitate the partnering.
2. Workshops with an extended group specifically focusing on specific values of the project. In this case, current ZEB definitions and technologies.

5.3 Empirical Evidence

Empirical evidence gathered in this study is based on the comparison of the author's framework (Figure 3.8) to the practical implementation of design principles and methods in the investigated cases. Rankings of the activities and features are presented in Table 5.2 and visualized in radar plots in Figure 5.2:

Table 5.2: Summary of the AS for TVD maturity for the investigated cases

TVD characteristics	**Case 1**	**Case 2**	**Case 3**	**Case 4**	**Case 5**	**AS**
Contracting	3	3	1	2	0	**2**
Organizing	1.5	1.5	1	2	1	**1.5**
Defining (business case)	2	1.5	2.5	2.5	1.5	**2**
Defining (validation)	2	2	1.5	2	1.5	**2**
Steering	2.5	2	2.5	2.5	1.5	**2**

Figure 5.2: Average TVD maturity for the cases.

Case 2 should be considered and compared to Case 1 with regards to project execution and management. This provides a possibility to identify and evaluate possible TVD characteristics. Case 5 is part of the same development plan and its original intent was to take part in the transformation towards a more collaborative execution model. Even so, its user challenges changed this plan and comparison cannot automatically be made to the previously mentioned cases. These challenges point to the different approaches and circumstance that can affect a project. More specifically, how the purpose of the project must be carefully defined. Case 3 and 4 are more driven by the project scope by exceeding current best practices through highly sustainable, safe, and technological nursing homes. Both cases are based on the same master plan but are quite different regarding contractual arrangements and project execution. Their complexity and focus towards achieving value are important for understanding the changes in transitioning from traditional 'target cost design' to the more complex 'target value design'.

A summary of the average TVD maturity of the investigated cases does not provide a sufficient picture of the variations of the involved cases. Figure 5.3 compares Case 4 and 5 and illustrates both ends of the scale with regards to the implementation of TVD characteristics in the investigated cases. Case 4 has been identified as the most mature of the cases while Case 5 has the most potential. More comprehensive analysis with regards to the four categories will be presented chronologically for all the cases in the sections below, and activities and features are compared to the literature presented in chapter three. But it is worth mentioning that this study has some limitations. The investigation of current TVD maturity is only based on five public Norwegian building projects within a limited geographical area and therefore provides a modest basis for the creation of generalized trends and conclusions. Nevertheless, these findings provide implication of certain reoccurring features that match or are similar to the identified TVD characteristics. Or the other way around, features, or characteristics that are lacking. The following sections will use the literature to discuss case findings starting with the 'Contracting' category. For each of the sections, the identified TVD characteristics are repeated and each section summarizes the most valuable findings at the end. These findings will be used in chapter six for a conclusion and recommendations for further research based on this thesis.

Figure 5.3: Comparison of the TVD maturity of Case 4 and 5. Case 4 has been identified as the most mature project with regards to implementing the identified TVD characteristics in Figure 3.8. On the other end of the scale is Case 5 which has the most potential.

Contracting - The Need for Incentives

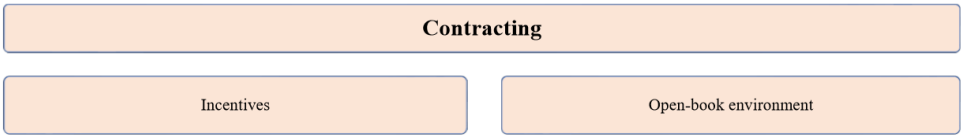

Figure 5.4: TVD characteristics related to 'Contracting' previously stated in Figure 3.8.

Identified contracting elements will not be deemed a major part of this thesis, based on time and resources available. Even so, contracting elements create the foundation of which a fully TVD implementation must be based on. This statement is in accordance with Zimina et al. (2012). To completely utilize the competence among the contractors and designers as well as being able to maximize project value, the contractual arrangements are a necessity. And as stated by the interviewees as well as by Zimina et al. (2012), relational contracts creates the foundation of which 'give and take'-mentality arises. There is a need for incentives to achieve a focus on the project as an entirety. Case 1 and 2 are conducted with a 50/50-split of the savings. In Case 4 the PM challenged the contractor to chase and modify the environmental targets by offering additional payment.

Arguably, the lack of chasing opportunities can and should be related to incentives and Case 4 is an example of how incentives drive innovation beyond current best practice. The use of innovation is one out of several elements that will a positive impact on productivity in the construction industry (Chen et al. 2014, Fischer et al. 2017, Tillmann et al. 2017).

However, as pointed at in Case 3, the human relation differs between project organizations independently of contractual arrangements. In the course of the pre-project, the project organization starts to understand how each discipline works and reacts. This element can be reinforced by

contractual arrangements which oblige the contractor to proceed with the same consultants and sub-contractors and -suppliers. A change of personnel weakens the relations and reduces the knowledge with regards to the project development. This consistency is important for the close collaboration between the project organization and to fully exploit the optimization process. Especially related to key decision-makers. Defining the difference between a 'change' and an 'optimization' seems to be an important element. The different perspectives which both vary between different organizations and even between different personnel within the same organization, have been identified as an essential part to accomplish the full potential of the collaborative environment. A process for identifying, communicating and handling changes are already set in generic contracts. An optimization on the other hand, does not affect the TC, and in the partnering agreement for Case 1 and 2 optimization results in a 50/50-split of the savings or the cost increase. To implement identified optimizations during the design and execution phase, the project organization in Case 1 had to involve the steering committee to grant them an increased EC. This move provided the organization the means to implement optimizations even after the consequences of the groundwork were identified.

Conversely, as illustrated in Figure 5.3, different expectations are related to these two definitions. Case 1 and 2 made an additional note to fully define the variations (Rastad 2019). The establishment of a governing document differentiated between examples of various situations with the corresponding determination of value for these changes or optimizations. As reported in Case 2, this document was implemented during 2019 and therefore not a part of the original tender documents. One interesting finding in the matter of changes and optimizations was that the contractor in Case 1 stated that if the reduction of LCC is the primary cause for the client to change a function then it should be defined as a change. The reasoning why is since the optimization is not within the lifetime of the project that the contractor is a part of. An improvement of the LCC is, therefore, a saving that is beneficial for the client only. The PM from Case 2 stated that one should acknowledge that the contractor needs to achieve a profit, and for that reason have an understanding that 'cost-increasing optimizations' might be tough. Even so, one could argue that the basis of the 50/50-split is to provide a collaborative environment that profits them both. An optimization should therefore not exclusively benefit the contractor. One challenging and complicating element is that the agreed TC might be based on tenders from subcontractors and -suppliers, and optimizations might result in reducing the procurement benefits for the contractor.

The PM in Case 1 underlined the necessity to define these variations early. This is an important matter for two reasons. Firstly, this differentiation determines the incentives for the contractor to identify and provide optimizations due to the 50/50-split. Secondly, a structured differentiation secures the client from suboptimizations which can occur in ordinary design-build contracts. Put in plain words, the difference between the design-build and the partnering contract is the open-book and collaborative environment with a shared interest to achieve optimizations. As a major part of the TVD, process this basis would avoid unnecessary uncertainty. One complicating element generally is that the TC can be based on already established contracts with subcontractors and -suppliers. However, this is often a requirement of the client.

Table 5.3: How to define a project 'change' and an 'optimization'.

	Client	Contractor
Change	Providing another function/quality for the user than described in the tender document.	Change of function/quality.
Optimization	An equal quality which is either cheaper or better or both. Might result in a higher investment cost.	**Unrealistic**: Achieve better quality for the same cost. **Realistic**: A cheaper solution which fulfills the targeted or described function/quality (improved constructability). Within the lifetime of the project that the contractor is a part of.

As stated by the interviewee in Case 3 the combination of the client's and contractor's perspective is the basis of a partnering. However, as underlined by the same interviewee, these perspectives are in contrast to each other.

Table 5.4: Summary of the most important findings in the category 'Contracting'.

Summary of the most important findings
1. Incentives are needed for chasing stated targets and to create a 'give and take'-mentality.
2. Human relations and consistency among key members of the project organization is needed to obtain a collaborative environment.
3. Different perceptions of a change and optimization. Beneficial to define these variances early. A possible solution can be the creation of a governing document differentiating between examples of various situations with the corresponding determination of value.

5.3.1 Organizing - A Collaborative Environment

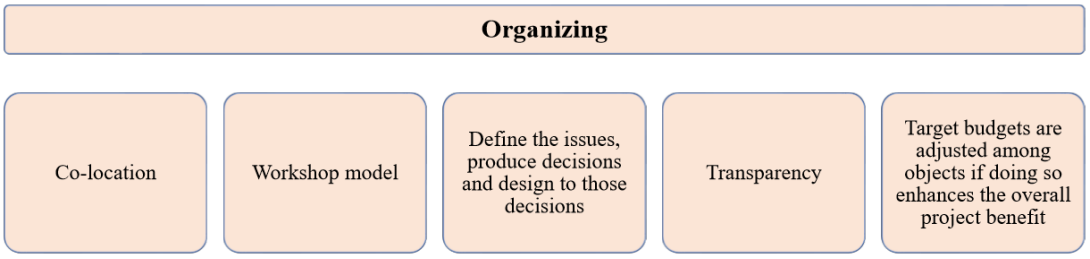

Figure 5.5: TVD characteristics related to 'Organizing' previously stated in Figure 3.8.

Having beneficial contractual arrangements in place establishes the needed protection for the involved actors to fully utilize the potential benefits of a transparent and comprehensive collaboration. Transparency, for example, is deeply related to the choice of contract. Among the identified characteristics in Figure 3.8, one notices that 'co-location' is not an element that is implemented. The contractor is mainly located close to the site but both the client representatives and designers are solely located in their workplaces. Despite this, both the client representatives and designers can work at the site if needed.

A workshop model, on the other hand, has been widely used in most the cases. Besides Case 5, which had a twisted turn during its project development, every case used, or at least stated that they should use collaborative methods. It is worthwhile to mention that this thesis has not conducted any comprehensive analysis of how these meetings have been conducted, and the stated elements are merely based on the interviews and the document study only.

Within Case 1 and 2, the ICE method has been used to achieve design solutions to a maturity level that is relevant and detailed enough for the design and execution phase. This is in accordance with the avoidance of detailed design stated as one out of five TVD characteristics in Namadi et al. (2017). Participation in these sessions varies across the cases. In Case 1 the number of participants varied from having everyone during the BIM meetings to only involve the needed designers to address the week's theme and corresponding issues. The PM insinuated that this was not a full implementation of ICE seen from his perspective. The contractor on the other hand mainly focused on involving only the needed disciplines since the purpose of these meetings was to check project development status and to establish solutions for the interdisciplinary issues. The workshop focus described by Emmitt et al. (2004) involved TVD characteristics that will be further described and identified in the upcoming sections. Workshop 1 and partly 2, include the most important elements for this section. An important element in the workshop model described in Table 3.5, is the focus towards the establishment and incorporation of project value among the involved actors. This focus can be translated into a shared understanding of the project, which is one of the characteristics in the 'Defining (Validation Study)' category. Another element is the close collaboration during the development and the investigation of project solutions up until the selection of the best proposal. SBD is closely related to this element but is located within the 'Steering' category.

The PM in Case 3 and 4 has observed and acknowledged during his professional life that at the beginning of a new project, the involved actors disregard their previous experience and mainly focus on collaboration and helping each other. This 'starting from scratch'-mentality is somehow an important foundation for establishing transparency. However, as stated by the same interviewee, this focus shifts towards protecting oneself at the end as the contract sum and risk is soon about to be fixed. For some reason, this comes as a surprise for the actors. The EC development of Case 4 presented in Figure 4.16 illustrates this need for protection. In this case, the parallel activities of the pre-project development and the delivery of the zoning plan contributed to this 'state-of-mind'. The collaboration stopped and the difference in the involved actors' perception of project risk arose to the surface. Value is in these situations of less importance, and the client, therefore, needs to understand the cost consequences of transferring all of the risks to the contractor. How can transferring the risk be beneficial for collaboration?

One element in the collaborative environment and an element in the 'Organizing' category is

to define issues, produce decisions, and design to those decisions. This collaboration element is verified in Namadi et al. (2017). Meaning, that the project organization is supposed to make interdisciplinary decisions in design that are weighted to be the most beneficial solution to maximize project value (Emmitt et al. 2004). ICE meetings are based upon the perception of conducting interdisciplinary decision-making during these meetings. A prerequisite for this assumption is that necessary decision-makers are involved in the meeting or that project actors have been granted permission to make decisions. Case 3 and 4 stand out from 'ordinary' public building projects by granting the PM more decision-making authority. As stated in the interview, this authority provided the PM the ability to make rapid decisions in addition to legitimize the power and the responsibility needed in that position. Case 1, 2, and 5 are located in a different municipality than Case 3 and 4. The structuring of the projects is the same for Case 1, 2, and 5 by having a PM with little or no decision-making authority but the 'short' distance to the client has made a difference to be able to make rapid decisions. Consequently, this decision-making structure creates a stricter project governance framework but is accordingly dependent on a client that is heavily involved and possesses the capacity to comprehend a rapid feedback environment. Even so, providing the PM with the authority might be beneficial. Often the hired PM is more competent with regards to finding better solutions than the client and the users for natural reasons. The PM is a paid professional in such a manner. Having the possibility to exploit a rapid feedback environment by making decisions without delay during interdisciplinary meetings are beneficial in the TVD methodology.

On the other part of the scale is Case 5. This is an example of the consequences for the client of not having full decision-making authority. Two elements are of special interest:

1. A political decision to build what the local sports club wants.
2. The user representative possesses political influence.

Meaning, that the political influence created a path for the user to sway the municipality as the client. Different expectations should be aligned during the project development and this case is an example of why this is necessary. As a consequence, the cancellation has resulted in delays and a reduction of the project scope. As illustrated by the interviewee, every building element is compared to the achievement of other sporting-related features only. The decision to cancel the first competition was based on the argument of not having the project approved by the local sports club. This will be further discussed under the 'Defining (Validation)' category.

To fully incorporate the project value, the involved actors must understand the needs of the client and the users (Lee et al. 2012). Interviewees in Case 2 and 4 stated that the users do not necessarily need to be involved in the ICE or other design meetings. One of the perceptions of ICE is that decisions are being made interdisciplinary and therefore results in both better and hopefully, more optimized solutions (Emmitt et al. 2004, Lee et al. 2012, Lilleland-Olsen et al. 2019). Further, the interviewee in Case 2 pointed at the need to help the users and the client to focus on the most important elements of the project. This assumption is confirmed by the interviewee in Case 3 which underlined that the discussions during the pre-project are often too abstract for the client and/or the user(s). Generally, the project is too far away and the users do not spend enough time to understand the project. Once the construction has begun the users start believing that the project will be realized which results in a shift of motivation. Helping the user(s) and the client in these early stages of the pre-project will also contribute to less unnecessary and expensive changes. Leaving out the users and the client in the design meetings

contradict the assumptions of deciding during these meetings. Or at least underlines the necessity for the client to transfer some of the decision-making authority to the client representative (which in some of the cases is the PM).

One of the outputs in the validation process described by Lee et al. (2012) is the shared understanding of budget items which creates the basis of design. Target budgets in the context of 'Organizing' focus on the transparency and the 'give and take'-mentality to transfer funds between objects (structured in the WBS) to enhance the overall project value. This benefit-oriented approach and management described by Chih & Zwikael (2014) incorporate the "flow of value"-principle stated by Zwikael & Smyrk (2012) and Serra & Kunc (2015) to align outputs, outcomes, benefits and organizational strategy. Again, the development of the business case is in the center of attention. Also, one assumption with regards to a target budget being distributed among objects. That has not been used among the investigated cases in this study and therefore is a characteristic that lacks. How can this be conducted in real life? A benchmarking process is needed. 'How' will be described in the next section.

Table 5.5: Summary of the most important findings in the category 'Organizing'.

Summary of the most important findings
1. Co-location is not implemented in any of the investigated cases.
2. Transparency is merely based on the contractual and relational arrangements.
3. 'Starting from scratch'-mentality vs. previous experience affects the perception of risk which might result in the lack of focus towards achieving maximum value.
4. Decision-making authority should be located as 'close' to the project organization as possible to fully exploit the collaborative decision-making process.
5. Different expectations should be aligned during the project development in order to make decision which benefits the project as an entirety. User involvement might, therefore, be avoided in design meetings. This element contradicts an identified TVD characteristic.
6. 'Give and take'-mentality is needed to transfer funds among target budgets. This characteristic has not been implemented in any of the cases.

5.3.2 Defining - Developing the Business Case and Execution of the Validation Study

The 'Defining' category is divided into two sections: One elaborating on the business case development and the latter one on the execution of the validation study. Splitting the category is based on two arguments. Firstly, the business case plays a central part in what can be considered to be a fundamental change compared to traditional project execution. Not that developing a business case is new. Developers, as stated by Zimina et al. (2012), have focused on deriving cost targets from the business case. But using the business case to state a maximum cost to achieve the stated purpose or value is somehow new. Secondly, in this context by using the

business case, a validation study is essential to verify and determine project approval and EC. In many ways, this process corresponds with the traditional pre-project phase.

Business Case

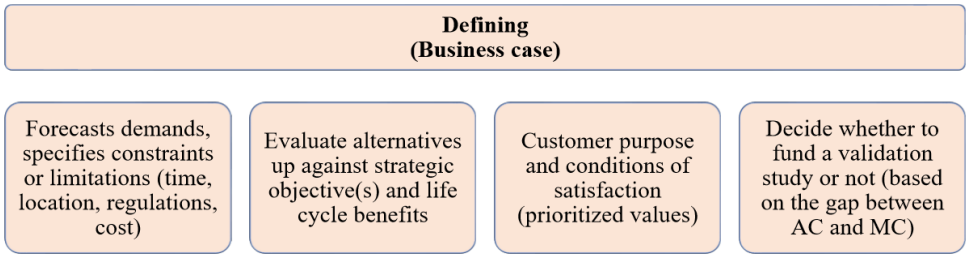

Figure 5.6: TVD characteristics related to 'Defining (Business Case)' previously stated in Figure 3.8.

As stated by Zimina et al. (2012), the target setting in TVD is based on the business case and not cost estimates, which improves the value generation and lowers the project contingency. Johansen et al. (In press) distinguished the target setting between setting the AC before design and TC during or after the procurement process but in cooperation with the contractor and the design team. The business case establishes the strategic perspective, financial constraints, and profitability. The main purpose is to understand the client's needs by delivering user and organizational value. Further, improvements to the business case must emphasize cost drivers. With that in mind, how are these characteristics reflected in the cases?

Characteristics of defining the business case are closely related to the Concept Evaluation (KVU) process in the investment regime of the Oslo municipality (City Department of Finance 2011). The following similarities can be outlined: evaluation of alternatives; prioritized values; requirements and strategy and whether or not to proceed with the project based on full utilization of the opportunity space. Decisions are being made without acknowledging the consequences of them, and the interviewee in Case 2 underlined this visualization issue needs to be addressed earlier. The interviewee indicated that this should be conducted before project approval, meaning in the KVU-process. Compared to the business case planning described by Ballard (2008), one can conceivably state that KVU process exceeds the stated requirements. Also, external consultants control and verify this evaluation within the Oslo investment regime. More comprehensive project development and detailing are conducted during the pre-project which must be compared to the following business case validation process described in Figure 3.5. Meaning, that public construction projects within the Oslo municipality or municipalities with a similar investment regime, have perceivably implemented most of these TVD characteristics.

Despite this, one key difference stands out: AC is not stated as a maximum project cost for which the validation (or the pre-project) is based on. Accordingly, the project should be approved and executed based on the gap between AC and MC. This characteristic is based on the assumption that a benchmarking process has been carried out. How else can one determine the cost to own and use the facility as stated by Ballard (2008)? Even if it is conducted before the end of the pre-project, this process lacks during the business case establishment. Briefly, the benchmarking process includes the comparison of unit costs to the capacity or the scope

of a similar project (The Ministry of Finance 2008). One can either target baseline buildings to identify opportunities for improvement, or one can identify MC through a study of the peer group (Lee et al. 2012). This can be pointed out in the cases. For example, Case 1, 2, and 5 is based on a three-year old school needs plan which has described roughly cost estimates. These estimates are based on the sketches provided in the KVU and therefore define the objects which can be roughly calculated. In other words, the cost estimate (which cannot be compared to AC) is conducted, however in a 'light version' of bottom-up estimation. Within the TVD methodology, this process should be conducted top-down by identifying outcomes and societal objectives. These are further 'translated' by conducting a benchmarking process that defines the cost of similar projects with a certain number of assumptions. Based on the defined WBS which is established during the KVU, target budgets can be set for specific objects. These target budgets are determined based on historical price data for similar objects and feedback from the client and the user(s) to incorporate project-specific values, as stated in Case 1. The benchmarking process integrates the target costing principle of ensuring predictable 'profit' planning. Profit in this context can be the wanted value. Conducting an uncertainty analysis might be beneficial at this phase to create a more realistic assumption of the MC. By doing so, the client receives a cost estimate stating both AC and EC with corresponding uncertainty (threats and opportunities) which is in accordance with the findings in Torp (2019). Comparing these results to other project concepts and therefore more easily create the basis for choosing the 'best project' based on cost. Conversely, this result mainly provides exactly that: A cost estimate and corresponding uncertainty. The analysis does not provide a sufficient foundation for project value which exceeds the traditional target costing perspective. Conducting TVD in practice is a more demanding method to implement due to the complexity of stating 'the most valuable project' rather than the 'the most cost-efficient project'. Figure 3.2 provides a fundamental change by 'neglecting' the investment cost as the main parameter.

One challenge that might arise during the determination of the AC is the creation of too large project budgets which might reduce the likelihood for project execution or funding for ongoing projects. This is in contrast to Case 5. In retrospect, the interviewee saw that the cost estimates conducted based on the solution proposals were too optimistic. This coincides with the systematic under-reporting of actual project uncertainty by Saxebøl (2017) and under-estimation by Andersen et al. (2016). Through the process of determining AC, the need for large enough budgets than estimated might be a consequence. To conduct construction projects within AC can easily be done if the contingency reserve is set high enough. Having a large AC might result in project refusal. Conducting realistic cost estimates is one of the arguments for implementing TVD (Ballard & Rybkowski 2009, Zimina et al. 2012, Chen et al. 2014). However, to drive innovation one must either set TC lower than budget based on current best practice or set target scope greater than what could be delivered with best practice within budget.

Case 1, which is special regarding cost estimation, conducted a preliminary cost estimate based on historical price data and a lot of assumptions. Even though this process was part of the pre-project, the estimation reveals one of the challenges of conducting an early estimate: The dependency of feedback from the client and the user(s). Meaning, that the client and the user(s) must at an even earlier phase know project-specific elements of importance, hence prioritized values. Further, this preliminary TC was not used as a maximum limit but as an indication for the project client that there was a need for a larger budget. Straight away, one get a feeling of this process being of great benefit if conducted before approving the project. Firstly, in order to

create more predictability with regards to funding and secondly, in order to have a realistic basis of comparison when prioritizing and initiating construction projects. Conversely, one could argue that since this process is similar before every project initiation, these projects 'compete' on even terms. Furthermore, in this case, to increase the project budget was not an option. In some way, the same happened in Case 2, where the first pre-project resulted in a need for the further project development due to the project cost being too high. How this cost control was conducted and managed will be further elaborated in the next section. Even so, it is worth mentioning the affect of this 'pressure' had on the project organizations. For both Case 1 and 2, this pressure resulted in a unified process to conduct cost reductions within the stated constraints. Otherwise, the project would not continue. As stated by the interviewee in Case 2: "At some stage I didn't think this project would be built but we managed to pull this through." One must have in mind that the project needed to conduct some fundamental changes with regards to the overall structure, layout, and landscaping, and that these changes might have an impact on the delivered value. As discussed earlier, how to estimate value is a key element, and how to verify and control if the cost reduction correlates to a drop in value is beyond the scope of this thesis.

Defining the project, its constraints and its needs is often a prolonged process in public projects in the wake of securing user commitments as well as achieving a certain level of project maturity. Taking Case 4 as an example, the project development started in 2009 and went through several iterations with regards to the choice of concept and securing project considerations. One of several stage gates in the investment regime to Oslo municipality is the QA1, and one element in this investigation is the stated societal objectives, outcomes and outputs. As can be seen in chapter four all of the cases have stated, however in varying degrees, objectives, outcomes, and outputs. Societal objectives are to a lesser extent described. These targets are of importance in the TVD process since they are the basis of the iterative validation study to compare value and purpose in design to project constraints. To achieve maximum value, the establishment of a priority list can be beneficial if conflicting aspects might occur. Using Case 3 as an example. This project aimed at being the first BREEAM Excellent nursing home in the country, and even so, the cost had to be top of the priority list. Furthermore, as these contrasting elements often occur, the PM stated that future management methods will transition from 'target cost design' and towards 'target environmental design'. This shift, stated the PM, will turn the industry up-side-down with regards to project risk, fixed attitudes, requirements, and functions stated by clients, users, and from building laws and rules. This illustrates that within the industry, conversely have in mind that this is based on the statement from this interviewee specifically, there is a need to extend the horizon of which building projects are based on. The current focus to achieving project cost needs to be evolved to implement other values. Case 3 and 4 are examples of projects where environmental and safety aspects were prioritized before cost. Even so, the stated prioritized outputs in the steering document with regards to the two projects indicate contradictions. One could argue that the outcome to achieve the first BREEAM Excellent nursing home and to build the most environmental-friendly nursing home in the country cannot coincide with the cost being on top. However, as illustrated for Case 3, one cannot state that the environmental aspect had the highest priority when a generous budget rarely created conflicting outputs. In other words, the motivation to prioritize cost and to conduct cost reductions on a generous budget is of less importance.

Table 5.6: Summary of the most important findings in the category 'Defining (Business Case)'.

Summary of the most important findings
1. TVD characteristics for 'Defining (Business Case)' basically corresponds with the KVU process conducted in the Oslo municipality or municipalities with a similar investment regime.
2. Project approval is not based on the gap between AC and MC. A benchmarking process and an uncertainty analysis can be beneficial but cannot verify 'the most valuable project'.
3. Determination of societal objectives, outcomes, and outputs alongside a priority list of values must be conducted and at a minimum, correspond to the stated purpose of the project.
4. Challenges arise if the determination of AC is either over- or underestimated. This element can be a concealed weakness of the TVD approach.

Validation Study

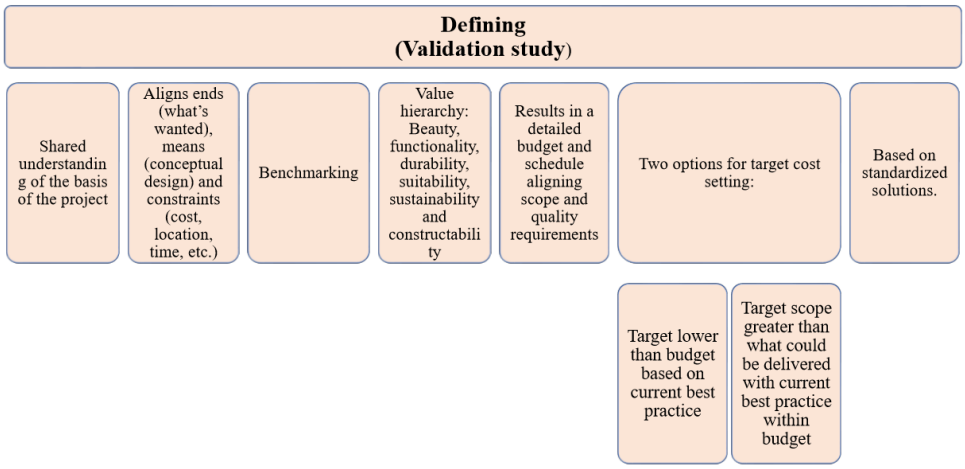

Figure 5.7: TVD characteristics related to 'Defining (Validation Study)' stated in Figure 3.8.

As stated in Eklund (2017*a*), the purpose of the pre-project is to define project goals, the level of quality of materials and solutions and to locate and decide which competence is needed. This definition has similarities to the stated characteristics linked to the business case validation process described by Ballard (2008). The validation process is meant to be determined before project development. In other words an interesting difference to discuss. Because, based on the definition of TVD as a concept of targeting value by using societal objectives and outcomes to define and develop the project, this definition contradicts this aspect by stating that project goals must be defined during the pre-project. Doing so creates the possibility for other actors to define these goals. These goals might be corresponding to the client's wishes, or they may not. Another element in this discussion is whether or not the client and the user(s) have defined what is wanted, and if they are in need of assistance in doing so. In several of the cases involving this aspect is a challenge even during the pre-project. Specific challenges will be discussed soon.

The validation process which often concurs with the purpose of the pre-project is focused on the development and the creation of a common understanding among the involved actors with regards to the basis of design, budget, and operation. (Lee et al. 2012). A validation process must be conducted in close collaboration between the involved actors. As stated earlier in this chapter, ICE meetings have been conducted in four of the five cases. The latter one, Case 5, did not have the chance to implement this methodology due to the cancellation. But in every case, the user(s) and the client have been involved in the development of the tender documents. For example, in Case 5, this was conducted by defining the different functions for each room. Further, the pre-project must result in a certain level of maturity which is relevant and detailed enough to describe the main system solutions and principles. Phase two (the design and execution phase) is more a production phase that relies on the decisions taken during the pre-project.

Aligning means, ends and constraints are of great importance to deliver value. In a TVD context, this break down should be based on the following hierarchy: Values create the means which results in the technical specifications (Figure 3.6). The validation study described by Ballard (2008) focuses on the structured break down of the stated purpose and values in order to adapt them to ends and constraints. This way of comparison is to suppose to deliver EC of the wanted facility which through iterative design workshops are suppose to be provided within AC. Ranking values are therefore a necessity if the cost is one of the most vital constraints. Especially, Case 3 and 4 are examples of projects where cost is not a prioritized value even if the internal documents stated that cost should exceed both environment and quality (Figure 4.11 and 4.14). The cost development for Case 3 is somehow quite stable. A cost increase occurred mainly due to the recommendation by external consultants during the political evaluation/decision phase. As stated by the PM, this increase in contingency provided a budget where conflicting outputs did not occur and the project was even delivered below stated EC. At the other end of the scale, both Case 1 and 2 were significantly impacted by both local and project constraints. The cost was of significant importance, and one could argue that this discipline more rapidly aligned the means with the constraints. Despite this, the interviews and the document study do not reveal a structured approach of using ranking values during the cost reduction. Project values might have been impacted for all we know. Cost drivers were specifically targeted in both cases but does not imply prioritizing any of the value drivers. A value profile could have been beneficial (Zimina et al. 2012, Klakegg et al. 2018). The contractor in Case 1 was determined to use the 'need to have' principle for the landscaper and the architect specifically. Why so will be explained in the 'Steering' category.

Setting targets is necessary to drive innovation (Pennanen & Ballard 2008). Emmitt et al. (2004) called upon a weighted decision matrix which is mutually agreed upon among the involved actors to differentiate based on achieved value. This target setting is related to value but too often decisions are being made purely based on cost. An important and interesting element in the evaluation process for Case 3 of the delivered tenders was the distance between different functions and the residential units within the nursing home. This is of importance due to the worker-patient ratio. These distances were transformed and calculated based on operational costs. The winning tender had the most efficient layout providing the least operational costs. The difference, over the lifetime of the project, was approximately 60 MNOK (approximately 5.82 MUSD). The capital-operational cost ratio displayed in Figure 3.2 verifies these benefits and calls upon a fundamental question of why TC should be of such significant importance? Furthermore, this case had a predetermined TC for each nursing home spot. This provided the

PM the needed information to determine the overall TC. In other words, the characteristic of benchmarking has already been achieved since this TC is based on general historical price data for the Oslo municipality. Every nursing home project should target this cost. However, this TC is based on certain assumptions, and if these assumptions do not correspond to the given project, the TC should be adjusted accordingly. These assumptions could not be identified and clarified for this case which provided the PM unnecessary work to do so. Only so, the benchmarking process should provide transparency in relation to its peer group of corresponding projects. An important project-specific feature was to achieve BREEAM Excellent for the first time for a Norwegian nursing home (and even develop the standard based on this project). An important feature that is beyond a traditional nursing home standard at that time. To have a realistic TC, specific elements have to be compared to their peer groups. Doing so enhances the need for transparency by either targeting a lower cost based on current best practices or delivering target scope greater than current best practice within budget.

The same element can be identified in Case 4. This project aims towards becoming the most environmental-friendly nursing home in the country even though it is not a written target. Doing so means that the project must challenge and overcome current best practices. Another stated outcome is to include automation and the use of welfare technology to increase safety but also to lower the operational costs. The project value is therefore linked to creating an efficient and worthy health care experience for both the residents and its next-of-kin. This can be identified in Table 4.14. With this in mind, the same TC of 3.5 MNOK applies. A big difference from this case and Case 3, which not necessarily should be seen in context to each other, is that the Oslo municipality's investment regime had just been implemented. This created a lot of uncertainty among the client organization with regards to how this should be conducted. Besides, Case 3 was the first big project conducted as a design-build contract for the client. This new execution method and structure resulted in a lot of experience for the client organization which was implemented in Case 4. One of the changes in Case 4 was the partnering-agreement for phase one. Even so, this change cannot be automatically linked to the experience from Case 3 since much of the reasoning behind this was the identification of shortages of technical rooms and flexibility in technical systems in the zoning plan sketches. A need for further development resulted in implementing a partnering during the pre-project.

A second element that differs from Case 3 is the implementation of a gradually TC maturing involving the SBD methodology. Intentionally, by having four stage-gates with a delivery of a contractual TC, the client forced the contractor to further develop the project within the previous delivery. In accordance with Figure 4.17, this should result in a gradual increase of maturity/detailing and a reduction of risk. The first milestone involved a lot of uncertainty, which to a certain degree can be related to the parallel activity of approving the zoning plan. This can be seen in the cost development of Figure 4.16. Each milestone was also based on tenders from the sub-contractors and -suppliers. At the last milestone, the TC increased. The PM explains this development with the contractor's need to limit risk and exposure. Even though the final TC was set at the last milestone, some elements were deliberately left out of the tender due to the faith in further technological development. This move paid off and provided the project better quality for less money as well as being able to satisfy the needs of both the users and the designers. Doing so follows the SBD methodology, which is of importance when trying to optimize project value.

Another interesting example of the target setting was in Case 1, where the contractor conducted a preliminary TC. Doing so provided the PM and other key actors the baseline of the current cost and the possibility to steer towards AC. As elaborated by the contractor this activity is not regularly conducted in construction projects, but is something that more frequently is implemented when pricing is not a major part of the award criteria. In other words, this estimation process follows the evolution of partnering contracts and contracts of similar collaborative features.

A challenge in the pre-project, and therefore in the project validation, is the consequences of having involved actors where the focus is towards achieving its own needs and not the entirety of the project. Having an involved actor with as much influence as the user in Case 5 does not create a collaborative environment where ends, means, and constraints meet. The value hierarchy is in these settings in danger since the influence is unevenly distributed. Likewise, the other user who did barely participate in the project development misses the possibility to affect the value. Having solely one own needs in mind creates a difficulty to achieve sustainability and durability. Even more challenging since the stated environmental requirements in the steering document are BREEAM Excellent and low LCC. Due to the cancellation and the accumulated cost the scope had to be reduced. The definition of TVD as a management method that puts the user's and the client's needs in the center of attention, has an obstructive weakness. If the power is somehow unevenly distributed among the two stakeholders or within one of the two 'groups' than maximizing value is challenging. Such an environment is destructive for the collaborative advantages which TVD is based on. Further, as Emmitt et al. (2004) described with regards to a value hierarchy it will only reflect the stronger part. Achieving a predictable decision-making process will be challenging since the decision basis and the consequences of the decision will be shifted and irrational if not the project as an entirety is in focus. Welde et al. (2015) emphasized a thorough evaluation to steer towards achieving anticipated needs, demands, and objectives. Steering towards targets is crucial once the targets are set.

Table 5.7: Summary of the most important findings in the category 'Defining (Validation Study)'.

Summary of the most important findings
1. Determination of the operating cost through the use of worker-patient (or other factors relevant for the given project) can be beneficial to reduce organizational operating cost which exceeds the capital cost multiple times.
2. Transparency is needed in relation to its peer group of corresponding projects to set a realistic TC in the benchmarking process. Having the contractor providing a preliminary TC at the start of the pre-project might be the first step to do so.
3. Conducting a four stage gate pre-project model with contractual deliveries for each stage-gate created more project uncertainty towards the last delivery.
4. A conceivable weakness of the TVD process lies in unevenly distributed power among the client and/or the user which creates a focus towards achieving its own needs.

5.3.3 Steering - Handling the Elements of Surprise

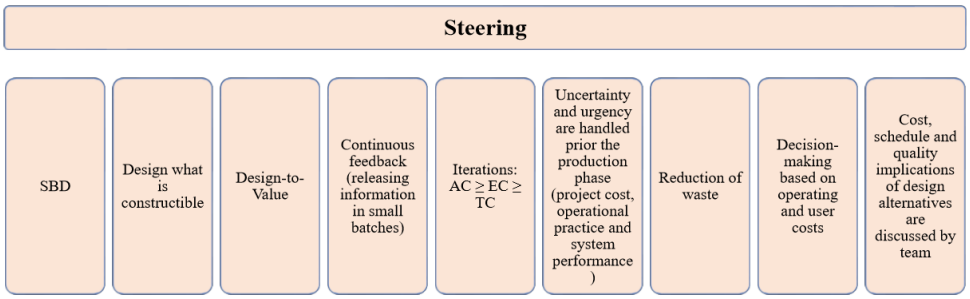

Figure 5.8: TVD characteristics related to 'Steering' previously stated in Figure 3.8.

The business case and the validation study creates the foundation of which the cost control and the project governance is based upon. The steering process is mainly a decision-making process that evaluates and determines solutions based on the stated priorities for the project. A fundamental part of this process is the following (Welde et al. 2015):

- When a decision is made.
- The decision basis.
- What the consequences are.

As one of the main advantages by using TVD is cost reduction and increased predictability (Ballard & Rybkowski 2009, Ballard & Morris 2010, Zimina et al. 2012). To do so, the stated elements must be determined and integrated among the project actors. Other elements that are linked to the TVD methodology is to manage complexity and to prevent 'overdesign' (Lee et al. 2012). This is linked to the reduction of waste, constructible solutions, and systems, rapid feedback, cost iterations as well as visualization and the decision-making basis. This section discusses and compares the literature to Case 1-4. As of Case 5, these TVD characteristics are not relevant due to the current project progress and has, therefore, limited coverage.

SBD tries to incorporate the need to reduce uncertainty as well as increase value by making decision in the 'last responsible moment' (Ballard & Rybkowski 2009, Lee et al. 2012). Doing so enhances the focus towards more detailed schedules and estimates as well as an overview of project activities to determine its consequences. As illustrated in Case 4, rapid technology development increases the need to evaluate the project risk of hasted procurement. Operational opportunities were exploited. The use of SBD paid off by implementing better products that achieved the targets for the client, users, and the contractor. SBD is a characteristic that only Case 4 used in a structured manner while the other cases to a lesser extent exploited its benefits (or at least had a less intentional focus towards the method). One can only wonder if this focus is a result of the target scope being greater than the budget based on current best practices. The reason why the word 'budget' should be left out is that cost in this project was not an issue, and therefore had minor effects on driving innovation beyond current best practice. 'Designing what is constructible' is not as important when aiming to achieve a scope greater than best practice. On the other hand, Case 1 and 2 used this more deliberately. Standardized and constructible solutions were mainly targeted in the cost reduction process. Both LCC and operational cost aspects were implemented. This is also in accordance with one of the main

characteristics for the workshop model described by Emmitt et al. (2004). Using standardized solutions provides an opportunity to apply 'Target Costing' which results in a portfolio of a proven design that reflects reasonable price, cost, and time estimates (Pennanen et al. 2010, Jacomit & Granja 2011). Target costing focuses on cost rationalization and not minimization (Zimina et al. 2012). Accordingly, TVD corresponds to the Lean principle (Namadi et al. 2017).

An appropriate achievement of the 'Design-to-Value' characteristic is hard to determine in any of the cases. 'Value' is a complex term to define as stated in the previous sections. So how do we determine if this characteristic has been implemented? Firstly, by using the case's internal documents as a basis, objectives (to some degree), outcomes and outputs have to be listed. The project purpose must be well-defined. Internal documents from every case reveal that both outcomes and outputs have been created. That is not a surprise since public projects over a certain size often are required to do so before QA1. Ranking of outputs (or values) on the other hand has not been of equal importance. Case 3 and 4 has been clear in this regard, however, the stated rankings in the internal documents have not been conducted in practice. Accordingly, theoretically stated rankings are conflicting with other elements. One of the reasons, which the PM in Case 3 and 4 stated during the interview, is that the purpose of the project is not reflected in the rankings. Achieving the most environmental-friendly nursing home in the country does not comply by having 'cost' as the second-ranked output above both 'environment' and 'quality'. Case 1 and 2 are examples of the opposite: Internal documents describe the outcomes of the project to achieve environmental targets and contribute to the reduction of LCC costs. Once the focus shifted during the pre-project due to the estimation process revealing a cost increase, the environmental targets such as LCC and other designed environmental elements were of less importance. Several aspects of this example should be further discussed. Such as the project business case and its realism and if the implementation of a benchmarking process could have stopped the projects from being approved. Further, how to determine if stated environmental targets were of great impact based on LCC and a healthy environment is demanding. Appropriate use of tools was targeted in Case 4 specifically which can be implemented in other cases. But is all of this administration necessary in a simplified 'cost-benefit' point of view if the size of the project is limited? These questions are unfortunately left unanswered in this thesis. Interestingly, having Figure 3.2 in mind once more reminds the industry that investing in operational aspects are beneficial. The figure is summarized over 15 years only. Of course, these ratios are debated (Ive 2006). Buildings in Norway at least, are constructed to exceed the stated period of multiple times. 'Values' brings a more holistic view of the project over its lifetime. Finding a reasonable TC is needed to create a cost discipline among the team members. But shifting this perspective towards TV is a necessity. TC needs to reflect the TV in monetary value. More specifically, the need to analyze the consequences of one's actions in the early stages of the project is an area in need of further investigation. The combination of having a low TC but generous incentives might be beneficial? Again, the statement is reliant on a TC which is based on project-specific TV. Furthermore, the generous incentives must be elaborate to provide the necessary motivation for everyone involved.

The decision basis in the different cases varies. Case 1 was highly affected by the focus towards cost reduction due to increased project scope and unexpected cost overrun regarding groundwork. As stated by the interviewees, the project had to satisfy a number of minimum criteria or functions as cost-efficient as possible. This minimum criterion provided a baseline. These evaluations were not based on a priority list but from identified or previously experienced cost

drivers. Furthermore, the contractor aimed towards elements that did not affect the desired project. One interesting finding is that this coincided with elements related to the landscaper and the architect. These two actors were motivated to bring forth two solutions, where one was their preferred one and the second one fulfills their minimum requirements. 'Good enough' is a key phrase during this process. Solutions related to cost drivers and the minimum criteria or functions stated in the tender documents were further developed during the pre-project. "Need to have vs. nice to have," is also a statement of great interest. In addition, LCC has been an element in the decision-making basis. Bringing everything together, the main focus for the cost reduction has been identified cost drivers. Value drivers have not been uttered. Even though the outcomes emphasize a forward-looking facility and the achievement of climate and energy objectives, the primary focus lies towards achieving the outputs of cost and time constraints.

Through monthly reporting the PM and the contractor (with his monthly reports) have had an up-to-date indication of accumulated project cost, adjusted TC, and the estimated cost of completion. Some of the cases have added EC and AC in these reports. On top of that, changes that affect TC and therefore automatically EC and AC, are communicated from the contractor, through the PM to the client with a cost estimate and other important consequences (time, quality, etc.). The activity of rapid iterations of comparing AC to the EC and TC are fulfilled in these cases based on the description provided in Lee et al. (2012) with regards to continuous feedback released in small batches. However, in these reports and statements, potential consequences are mostly related to the outputs and more specific towards the cost. Cost is in this regard a clear and comparable measure. Outcomes and societal objectives which are more difficult to quantify are not mentioned. Project goals seem to be of less importance in these cost reduction processes, which are further verified by incidents in Case 1 of denying potential optimizations. Previous discussions of 'value' reveal a challenge with regards to the monthly reporting: How could and should value be incorporated in the monthly reports? Inevitably, how to calculate value.

The number of iterations must be regarded in the sense of handling the elements of surprise. One of the main attributes of TVD is the iterative process. A lot can be said about how this steering process should be executed. More importantly, limited time during especially in the pre-project phase suppresses the number of loops needed to create necessary improvements to designed concepts, solutions, and materials. For each of the investigated cases, the time duration for the three phases (pre-project, political evaluation/decision, and design and execution) has been mapped. The transitioning from one phase to another is not always obvious, but the same criteria (stated in section 3.1) have been used for all the cases. The comparison between the investigated cases is therefore valid. Case 2 conducted two pre-projects (in total 10 months). Despite that the results of this comprehensive evaluation and cost estimation process are not directly reflected in the cost development, one can argue that the project achieved more value. As stated in the interview, the PM was surprised that this project was executed. An extensive pre-project phase contributed to achieving more optimized concepts, solutions and materials compared to its original design. However, Case 5 is once more on the other end of the scale. A considerable reduction in scope is primarily results of the extended pre-project. A shared understanding of the project is one of the elements that might be revealed as a surprise once the project has been approved in the KVU process. Case 3 has a ratio of 4:10 in regard of the pre-project phase compared to the design and execution phase. Accordingly, Case 4 has a ratio of 1:6 and Case 1 a ratio of 3:20. Case 1 revealed an interesting perspective on this matter. The PM stated that although the already short pre-project was reduced with one month, the issues with

the groundwork might not be solved differently. Even detected earlier. Hence, a longer iterative design phase could have revealed the need to conduct further investigation on that specific matter based on the risk contributed with an element of surprise. The project would, therefore, be more prepared in such regard.

Additional elements have been included in the decision-making basis for other cases. Looking at the stated tasks for the PM in Case 3, one gets the impression of the implementation of TVD characteristics. Function and quality are PM's main focus areas while for the contractor the cost and simplifications are the most important ones. By comparison of these elements with the stated prioritized outputs for each case, one gets the feeling of a mismatch. Case 4 is targeting to becoming the country's most environmental-friendly nursing home. The decision-making basis is closely related to two stated strategies: 1) Continuous update of the total LCC projection, and 2) focus on the evaluation of alternatives. Figure 4.18 is the result of creating a united LCC evaluation process that focuses on prioritizing elements that achieve the most.

Table 5.8: Summary of the most important findings in the category 'Steering'.

Summary of the most important findings
1. The use of SBD with regards to technical equipment might be beneficial with regards to achieving better solutions for equal of less cost due to the rapid technological development.
2. The purpose of the project must be aligned with the stated outcomes and outputs to create a clear ranking of values. However, how to achieve the 'Design-to-Value' characteristic is a complex task that cannot be determined based on this study.
3. "Need to have vs. nice to have," is a statement reflecting the focus towards chasing cost drivers. Motivating the actors to produce a project solution which from their perspective satisfy minimum requirements, might be a beneficial approach to control cost drivers.
4. PM's monthly reporting satisfies the TVD characteristic of rapid cost estimation iterations.
5. Gradually maturing the LCC projection and the focus towards an evaluation of alternatives might be one of the elements needed to exceed the 'traditional' focus on cost only.

Chapter 6

Conclusions and Recommendations

Conducting this master's thesis was done in cooperation with *OPAK AS* and *NTNU*. Discovering and elaborating on the current state of TVD implementation in the Norwegian construction industry has been the main intention. More specifically, the purpose of the research is to discover and to increase the awareness of the maturity of TVD implementation during the pre-project phase in Norwegian public building projects. Two RQs have been in the center of attention:

1. How is the TVD maturity in the Norwegian Construction Industry?
2. How can TVD be applied in the pre-project phase of Norwegian public building projects?

'How-questions' are not easily answered. Based on the discussion in chapter five, arguments for the current TVD maturity alongside the validity of the case findings were compared to previous literature. Based on the discussion provided in chapter five, findings of special interest that can contribute towards increasing the awareness of the TVD maturity are presented in 6.3. To do so, the conclusions for the RQs must be presented.

Section 6.1 and 6.2 strive to analyze these RQs up against the literature provided in chapter 3 and the collected empirical data from five cases within Oslo and an adjacent municipality. The empirical data is chronologically presented based on overall themes from the interview guide and further analyzed and arranged in four TVD categories with corresponding identified characteristics from the literature. These characteristics are sorted in the following categories: contracting, organizing, defining (business case and validation study), and steering. In conclusion, section 6.3 recommends further research areas that can contribute to strengthen the TVD application and generally its presence in the Norwegian construction industry. Only a few Norwegian construction projects have implemented this methodology. This study extends on the existing literature by firstly structuring several identified TVD characteristics based on well-cited literature. Further, these characteristics are compared to the current TVD maturity level among ongoing existing Norwegian public building projects. An AS of the maturity and the identified shortcomings are discussed to use the potential of TVD implementation.

Brief Summary of the Study

A handful of cases have been investigated through interviews and internal documents. Table 6.1 provides a summary of the cases which is located in Oslo and an adjacent municipality:

Table 6.1: Summary of the case studies: Brief description. *The procurement strategy changed from partnering to design-build.

	Contract	**Project / Size (GFA)**	**Type of building**	**Completion / AC**
Case 1	Partnering	New Building 7,913 m^2	High School	Autumn 2020 36.0 MUSD
Case 2	Partnering	New Building 13,750 m^2	Primary School, Sports Center and Swimming Pool	Winter 2021 70.8 MUSD
Case 3	Design-Build	New Building 16,238 m^2	Health Center	Autumn 2017 73.2 MUSD
Case 4	Partnering and design-build	New Building 9,120 m^2	Nursing Home	Summer 2020 77.0 MUSD
Case 5	Design Build*	New Building 3,394 m^2	Sport Center	Winter 2021/2022 20.3 MUSD

The reasoning for evaluating these specific projects are based on several elements. Firstly, these projects are part of the *OPAK* portfolio which provides exclusive access to personnel and documents. Having this access promotes a more extensive and in-depth document study where information and data easily can be checked and either verified or disputed. Secondly, these projects are part of an ongoing transformation from traditional design-build contracts and towards more collaborative arrangements. Either as full partnering or in a combination of partnering and design-build. Consequently, the projects can be seen in context to each other (Case 1,2, and 5 and Case 3 and 4). Furthermore, these projects have had proclaimed the project target that exceeds the 'normal' focus towards project cost.

Altogether, these cases have shed light upon different TVD categories and characteristics through their early phase. To determine the TVD maturity and to answer the RQs, a scorecard has been developed. Identified TVD characteristics are based on cited and well-known articles studying TVD Ballard (2008), Pennanen & Ballard (2008), Ballard & Morris (2010), Lee et al. (2012), Zimina et al. (2012), Denerolle (2013), Namadi et al. (2017). Several of the repeated characteristics were adapted and merged within the four categories: contracting, organizing, defining (distinguished between the business case and validation study), and steering. Results from Denerolle (2013) inspired this categorization in addition to the contracting element which was added based on statements from the interviewees. A natural development of the pre-project aligns the four categories chronologically. Based on the designed scorecard, the AS for all of the cases is visualized in Figure 6.1 which will be presented in 6.3. However, this maturity varies between the cases from the most mature one (Case 4) and the one with the most potential (Case 5). Table 6.2 which will be presented in section 6.1, displays the AS for each of the categories.

A simplified statement is that the stated project goals have in varying degrees been achieved. Since most of them are still under construction, one cannot conclude whether a full TVD implementation would have benefited the execution and the benefits management or not. Worth mentioning that Case 3 is the only completed project. Every case has a proclaimed goal to exceed a unidirectional focus towards the cost, and therefore might represent a more advanced project management. Case 3 and 4 had and have a high environmental focus. Case 3 was the first BREEAM Excellent certified nursing home in the country. Case 4 aims towards becoming the most environmental-friendly nursing home in the country. Case 1 and 2 is based on a partnering agreement that shall accomplish a stated TC. Furthermore, the projects shall satisfy the municipalities' environmental and LCC targets. Case 5 is somehow different from the other cases due to the mismatch between purpose and execution. However, this case illustrates an important issue of the client and user(s) involvement in a TVD environment. A conceivable weakness of the TVD process lies in unevenly distributed power among the client and/or the user which creates a focus towards achieving its own needs. If the power is somehow unevenly distributed among the two stakeholders or within one of the two 'groups', then maximizing value is challenging. Achieving a predictable decision-making process will be hard since the decision basis and the consequences of the decision will be shifted and irrational if not the project as an entirety is in focus. Such an environment is destructive for the collaborative advantages which TVD is based on.

Each of the five investigated cases was hand-picked based on their uniqueness. A limited number of case studies (within a restricted geographical area) and interviews (mostly PMs from the client) were deemed necessary, based on time and resources available for this research. Consequently, the conclusion of this study, therefore, provides a modest basis for the creation of generalized trends and conclusions. Furthermore, the developed scorecard is compared to the mentioning of TVD characteristics or similar elements during the interviews and in internal documents. Significant project variations are therefore not detected. A scale ranging from zero (meaning not implemented) to three (meaning fully implemented) is judged to be sufficient for this individual and subjective ranking even though the levels do not detect significant project variation. Accordingly, for this evaluation to obtain sufficient objectiveness, several authors (or evaluators for that matter) have to conduct the same subjective evaluation of all the cases. The nature of the thesis as an individual tasks, limits the possibility to implement this process. To strengthen the results and to create more transparency and reliability, each TVD characteristic is individually evaluated and the AS within each category is presented.

TVD is one of many managerial tools focusing on achieving TV. This iterative process has not yet, to the author's knowledge, been fully implemented in construction projects in Norway. Only a number of Norwegian building projects have started the implementation of the TVD methodology. Findings in this study revealed a number of differences across the investigated cases. Hence, the average level of maturity of TVD implementation can be concluded to be sufficient. The following RQs will describe the reasoning for this conclusion.

6.1 How is the TVD Maturity in the Norwegian Construction Industry?

A TVD 'characteristic' is an element or an activity that has been identified in the literature to be a part of the TVD process. TVD is originally based on 'Target Costing'. 'Target Costing' is a management practice in new product development and manufacturing industries focusing on predictable profit planning by meeting market-determined prices (Cooper & Slagmulder 1997). Ballard & Morris (2010) characterized TVD as the relationship between EC and AC with key features such as 'design to targets' to increase predictability. Focus on the shared understanding and collaboration about the project basis has proven to be beneficial (Lee et al. 2012). Interestingly, the iterative process of evaluating value and purpose in design against constraints predefined in the business case distinguish TVD from other managerial tools (Ballard & Pennanen 2013, Chen et al. 2014, Namadi et al. 2017).

Cost increase through the planning and construction of Norwegian projects is a challenge (Ulstein et al. 2015, Torp et al. 2016, Bakke et al. 2019). Ulstein et al. (2015) discovered a 55% cost increase between the choice of concept and the execution phase in four Norwegian construction projects due to direct, underlying, and systematic/organizational causes. Accordingly, a 50% cost increase during the planning phase in 11 large and 34 medium-sized Norwegian construction projects have been identified by Torp et al. (2016). Moreover, 19 Norwegian governmental construction projects experienced a 30% cost increase from pre-design and to completion Bakke et al. (2019). Research regarding the Norwegian construction industry provides a clear statement that the industry has room for improvement.

TVD has received an emerging interest among researchers and practitioners towards avoiding project cost overruns and adding value (Ballard & Rybkowski 2009, Lee et al. 2012, Zimina et al. 2012, Ballard & Pennanen 2013, Chen et al. 2014, Namadi et al. 2017). Previous research has shown that TVD projects are completed 15-20% below MC while maintaining quality and time (Ballard & Rybkowski 2009, Zimina et al. 2012). Furthermore, using the method increases the accuracy of conceptual estimates (Ballard & Pennanen 2013) and lowers the contingency needed for each project (Zimina et al. 2012, Chen et al. 2014). The method also helps projects to manage complexity and prevent 'overdesign' (Lee et al. 2012) by targeting common goals and objectives (Namadi et al. 2017).

Researchers have in recent years shifted their focus towards benefit-oriented project management. Chih & Zwikael (2014)) demonstrated based on findings in the literature, that projects are becoming value creation processes and that project success is not only based on output-measures like time, cost, and quality (iron triangle). Stated challenges in the Norwegian construction industry corresponds to the 'solution' provided by fully implementing TVD in future projects. But TVD which was defined previously, is more comprehensive and exceeds the 'traditional' focus on the iron triangle. With that in mind, how is the current TVD maturity within the Norwegian construction industry? The following state of maturity is based on the few projects that have in full scale implemented TVD alongside the five investigated cases in this research.

The current industry practice of TVD has similarities to the project execution conducted in the investigated cases (Lilleland-Olsen et al. 2019, Time et al. 2019). Using relational contracts are

identified as crucial for the implementation to create trust and transparency. The 'Contracting' characteristics are therefore achieved. Collaborative methods are also highlighted as a necessity. ICE, workshops involving a group that exceed the project team and early involvement. The Tønsberg project and Beredskapssenteret have stated two interesting elements: The focus of establishing target goals and values and the emphasis towards the selection of 'the right project' grounded in the AC. These elements are currently missing in the cases. Even so, this study has not thoroughly investigated the implementation and therefore relates to the findings in the two papers cited at the start of the paragraph. Another aspect which is not specified in the papers is the use of target budgets which are adjusted among project objects. A realistic benchmarking process is therefore crucial. Rapid estimation is also an element which exceeds the features and activities described in the cases. To summarize, elements from the current (hence, few) Norwegian TVD projects exceeds the implementation in the cases. On a general and simplified the basis these projects have likely fully implemented the TVD process. However, this result is not surprising. These projects are designated pilots in the transformation towards implementing and utilizing TVD in Norwegian building projects.

The average maturity of TVD implementation among the investigated cases and current industry practice shows that the Norwegian construction industry has the potential for fully incorporating the identified characteristics. Even so, the AS displayed in Table 6.2, concludes that TVD characteristics have been sufficiently implemented (AS of two).

Table 6.2: Summary of the AS for TVD maturity for the investigated cases

TVD characteristics	Case 1	Case 2	Case 3	Case 4	Case 5	AS
Contracting	3	3	1	2	0	**2**
Organizing	1.5	1.5	1	2	1	**1.5**
Defining (business case)	2	1.5	2.5	2.5	1.5	**2**
Defining (validation)	2	2	1.5	2	1.5	**2**
Steering	2.5	2	2.5	2.5	1.5	**2**

Figure 6.1: Average TVD maturity compared to Case 4 (most mature) and Case 5 (most potential).

Among the structured categories, 'Contracting' is the one with the largest difference varying from zero (not implemented) to three (fully implemented). This is somehow natural since a

design-build contract which has been preferred contract in the industry for some time, almost automatically becomes one. On the other hand, partnering results in a full implementation. Case 4 differs due to the combination of the two contracts. Consequently, the case has been identified as the most mature of the cases while Case 5 has the most potential. Clearly, one element differs from the two cases and could explain the large variations. The purpose of the two projects is completely different. While Case 4 seeks to design and construct a facility that exceeds current best practice (and has the size, complexity, and funding to do so), Case 5 targets to satisfy its user (the local sports club). The latter one does not reflect the need to exploit each other's competence to maximize project value. The project value is in this case to achieve the goals of one individualized stakeholder. Using TVD in such a context contradicts its attentions of maximizing the value for both the client and the user(s).

6.2 How Can TVD be Applied in the Pre-Project Phase of Norwegian Public Building Projects?

How to utilize TVD will be discussed based on the identified findings. The RQ is structured in accordance with the developed framework in Figure 3.8.

Firstly, the basis for collaboration must be established. Meaning, that relational contracts with partnering being one of them, creates the necessary foundation of an open-book environment and motivation. This results in the needed interdisciplinary environment by providing means for a 'give and take'-mentality (incentives) as well as creating transparency. Obviously, consistency among key members of the project organization seems to be beneficial with regard to the stated mentality. Co-location is one characteristic which might reinforce this mentality as well. Expectations need to be aligned during the project development. One important element in this regard is to evenly distribute power and influence over the project in order to develop a facility that achieves everyone's needs in the best possible manner. Another example is that the definition of a 'change' and an 'optimization' is based on the same 'give and take'-mentality. Both cost increase and reduction are in two of the cases a 50/50-split between the client and the contractor. Different perception needs to be handled early. Creating a document with examples of various situations with the corresponding determination of value might be a reasonable solution.

The current TVD implementation starts in the KVU process which merely corresponds to the 'Defining (Business Case)'. Forecasting demands, specifying constraints or limitations, evaluation of alternatives, and to catch customer purpose and conditions of satisfaction are important characteristics in the TVD process. Even so, this research indicates that a full utilization of the business case is lacking in the current project execution model since AC is not a maximum.

Every case had stated objectives, outcomes, and outputs in the tender documents. A part of the KVU is to evaluate different concepts which do not use the gap between AC and MC to decide whether or not to fund a validation study (or pre-project if you like). Even being conducted before the end of the pre-project, this process lacks during the business case establishment. Within the TVD methodology, this process should be conducted top-down by identifying objectives and outcomes. Based on the defined WBS which is established during the KVU, target budgets can be set for specific objects. The previously stated 'give and take'-mentality is important in this manner. Target budgets are based on historical price data for similar objects and feedback from

the client and the user(s) to incorporate project-specific values.

Conducting an uncertainty analysis might be beneficial at this phase in order to create a more realistic assumption of the MC. As a result, the client receives a cost estimate stating both AC and EC with corresponding uncertainty (threats and opportunities). Comparing these results to other concepts establish more easily a basis for choosing the 'best project' based on cost. Interestingly, this result mainly provides exactly that: A cost estimate and corresponding uncertainty and does not provide a sufficient foundation for the project value. TV exceeds the traditional target costing perspective. Conducting TVD in practice is a more demanding method to implement due to the complexity of stating 'the most valuable project'. Creating a priority list of values which at a minimum corresponds to the purpose of the project, should make this process more transparent and clear. Through the process of determining the AC the need for larger budgets than estimated might be a consequence. To conduct construction projects within AC can easily be done if the contingency reserve is set high enough. However, having a large AC might result in project refusal. Conducting realistic cost estimates is one of the arguments for implementing TVD but is easier said than done. Creating a realistic cost estimate is one of the fundamental elements in the TVD process and over- and under-estimation is therefore hard to avoid. A more transparent and comprehensive benchmarking process should be incorporated to create a realistic overview between cost and the wanted TV. There is a dependency on the TVD process of having a corresponding match between cost and TV.

The establishment of TC has mainly been conducted throughout the pre-project. This is in accordance with the results of Johansen et al. (In press). Furthermore, the study recommends dialogue with the design and contractor team during or after the procurement process. In Case 1 a preliminary TC was established and provided the project organization with important information on the cost. The results initiated a disciplined cost reduction process by seeking cost-efficient project solutions. Traditionally, a comprehensive TC is first established at the end of the pre-project in collaboration between the client, designers, and the contractor. For this reason, the target cost is mainly used during the design and execution phase and not during the pre-project phase. By implementing this preliminary TC at the beginning of the pre-project one can reveal if the current level of cost is above the stated 'AC'. But TC needs to reflect the TV. That is a more complicated element to comprehend. The ratio between capital cost and operational cost illustrated in Figure 3.2 reveals why seeking to enhance TC not necessarily results in the 'most valuable project'. One specific activity that might contribute to increase project value is to a larger extent used SBD related to technical systems.

An iterative, collaborative design process among the client, the contractor, and designers which seeks to maximize project value within constraints, relies on time. Time is needed to create iterative improvements. Mainly, this process seeks to understand a challenge by creating a concept, evaluation of the concept based on stated TVs and finally conduct a cost estimation. Different concepts are ranged according to each. This loop of evaluation and cost estimation during the pre-project is time-consuming. Meaning, that sufficient time increases the number of loops and consequently results in more valuable concepts, solutions or materials.

"Need to have vs. nice to have," focus on chasing cost drivers and revealed to be an efficient means towards achieving cost reduction and to control cost drivers. The need to comprehend value drivers are the next step in this development. TVD is based on an iterative process of

comparing AC with MC. For this reason, a preliminary TC can easily be implemented in ongoing partnering contracts. Case 4 illustrates a TC solutions which both controls and challenges the contractor to maximize project value by developing the project within the previous delivered milestone. 'Time' is a crucial element with regards to enhance value creation. Even so, another setup is needed in order to avoid the rapid cost increase before the final milestone. Another element which targets the value drivers more specifically is to determine the operating cost for project proposals. Rapid cost estimation iterations will more control and manage the consequences of the decisions taken. Visualization has been proven to be difficult, and involving the client and the user in these interdisciplinary meetings requires a strict structure with regards to hasted project decisions. Awareness of the consequences of the decisions made by the client and the user(s) should be pointed out by the project organization.

6.3 Recommended Initiatives and Further Research

Findings from the research point to a number for short- and long-term initiatives that can be implemented in future projects to fully implement the TVD methodology. Short-term initiatives require fewer changes in the current management and execution models. The long-term initiatives, on the other hand, are more demanding and require a significant and committed effort to implement. Table 6.3 illustrates potential initiative which can be beneficial for enhancing the project value for the client, user(s), and the remaining actors.

Table 6.3: Summary of the most important findings from the study.

Short-term initiatives
1. TVD relies on a partnering contract or at least partnering during the pre-project.
2. Create a shared understanding of the project through the creation of a document differentiating between a 'change' and an 'optimization', a 'give and take'-mentality and "need to have vs. nice to have"-environment.
3. Letting the contractor conduct a preliminary TC at the start of the pre-project.
4. To a larger extent use SBD in the procurement of technical systems.
Long-term initiatives
1. Implementation of a sufficient benchmarking process before project approval to identify the gap between AC and MC.
2. To a larger extent create and use a maximum AC based onthe project-specific value to approve and construct 'the most valuable project'.
3. Develop and/or incorporate adapted tools in small and medium-size projects which specifically measure TV.
4. Public building projects need to develop a structured database that creates transparency of the specified TC to comprehend project-specific means, ends, and constraints.

Further research is needed on practical implementation and implications of TVD and benefits management. More focus on the consequences of the stated incentives in contractual arrangements is necessary to fully understand the interdisciplinary and collaborative environment needed in this methodology. Maximizing value by designing after TC is dependent on a comprehensive decision-making basis and strategy towards targeting project-specific cost and value drivers. TC needs to reflect the stated TVs to determine design which provides 'the most valuable project'. The challenges of creating a realistic TC which reflects 'the most valuable project' need to be further investigated to use TVs from the start in the pre-project. One element in this regard is to create a sufficient benchmarking process that more easily displays project-specific elements to increase transparency, traceability, and predictability of future projects. Aligning what the client and the user(s) want starts with the process of setting realistic targets within project constraints. Furthermore, to fully adapt TVD, one must create tools and procedures which more easily measure and compares the correlation of cost reduction and the decrease in project value.

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PART 2: SCIENTIFIC PAPER

Smoge, G. Y., Torp, O. and Johansen, A. 2020. "Maturity of TVD implementation in Norwegian public building projects." *Proc. 28th Annual Conference of the International. Group for Lean Construction (IGLC28),* Tommelein, I.D. Daniel, E. (eds.). Berkeley, CA, USA , pp. xx–xx, DOI: doi.org/10.24928/2020/XXXX. Online at iglc.net.

MATURITY OF TVD IMPLEMENTATION IN NORWEGIAN PUBLIC BUILDING PROJECTS

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ABSTRACT

There is an emerging international interest in the Architecture, Engineering and Construction (AEC) industry towards designing and constructing building projects based on Target Cost (TC) through the development of 'Target Costing' and Target Value Design (TVD)[4]. The aim is to create more value for the client and the users through iterative design processes focusing on optimization of value within cost limitation.

The purpose of this study is to discover and bring awareness of the maturity of TVD implementation during the pre-project phase in Norwegian public building projects. Findings in the research are a result of a literature study and five case studies which included a document study and semi-structured interviews with the involved project managers (PMs) from both the client and the contractor. The case studies provide the current maturity of TVD implementation during the pre-project in a number of Norwegian public building projects and shows that the TVD characteristics are only partially implemented. TVD maturity varies across the categories: contracting, organizing, defining (business case and validation) and steering. Furthermore, enhancing maximum project value is a challenge due to the lack of visualization and the focus towards cost reduction.

KEYWORDS

Target Value Design, Target Value Design Maturity, Target Cost, Collaboration

1. INTRODUCTION

'Target Costing' is a management practice in new product development and manufacturing industries focusing on predictable profit planning by meeting market determined prices (Feil et al. 2004). TVD is a lean construction method that has gained increased popularity over the years, especially in Integrated Project Delivery (IPD) type of projects (Tillmann et al. 2017). The origin of TVD can be tracked back to Target Costing. Though, the iterative process of evaluating value and purpose in design against

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[4] Some scholars use the acronym "TVD" for Target Value Delivery.

constraints predefined in the business case distinguish TVD from other managerial tools (Ballard and Pennanen 2013; Chen et al. 2014; Namadi et al. 2017).

Cost increase through the planning and construction of Norwegian construction projects is a challenge (Ulstein et al. 2015; Torp et al. 2016; Bakke et al. 2019). Ulstein et al. (2015) discovered a 55 % cost increase between the choice of concept and the execution phase in four projects due to direct, underlying and systematic/organizational causes. Torp et al. (2016) revealed a 50 % cost increase during the planning phase in 11 large and 34 medium sized projects. Moreover, 19 governmental projects experienced a 30 % cost increase from pre-design and to completion (Bakke et al. 2019).

TVD has received an emerging interest among researchers and practitioners towards avoiding cost overruns and adding value. Previous research have shown that TVD projects are completed 15-20 % below Market Cost (MC) while maintaining quality and time (Ballard and Rybowski 2009; Zimina et al. 2012). Furthermore, the use of the method increased the accuracy of conceptual estimates (Ballard and Pennanen 2013) and lowered the contingency needed for each project (Zimina et al. 2012; Chen et al. 2014). The method also helped to manage complexity and prevent 'overdesign' (Lee et al. 2012) by focusing on common goals and objectives (Namadi et al. 2017).

This study will elaborate on the current state of TVD implementation in Norwegian public building projects. The purpose of the research is to discover and bring awareness of the maturity of TVD implementation during the pre-project phase. One research question (RQ) is of special interest:

- RQ: How is the TVD maturity in the Norwegian Construction Industry?

2. METHOD AND RESEARCH DESIGN

An initial literature review justifies the research question and brings an understanding of the research perspective. Back- and forward searches were based on the Credibility, Objectivity, Precision and Suitability (TONE)-framework. This ranking provides transparency and an evaluation of 'reliability' and 'validity'.

Qualitative sampling must consider both the appropriateness and the adequacy of the data. Qualitative methods provide value through the concept of triangulation (Creswell 2003), which may result in a multiplication of the potential to discover unanticipated outcomes. Yin (2018) stated that case study is a relevant research approach when investigating 'how' or 'why' RQs. In total, five cases are explored in-depth based on document studies of internal documents (steering document, pre-project report, monthly reports etc.) and semi-structured interviews with the PMs representing both the client and the contractor. In total six 1,5-2 hours interviews have been conducted.

Based on the theory and the literature review a structured scorecard containing the TVD characteristics has been developed. Table 1 provides a brief case description. Each case has based on interviews and the document study been ranked according to their current TVD implementation of these characteristics.

Table 1 The case study: Brief project description.

	CASE DESCRIPTION
CASE 1	Part of a larger public development plan to encounter growth within the municipality. Demolition and construction of a new high school (550 pupils) and a swimming pool. Partnering contract.
CASE 2	Part of the same larger development plan as case 1. Constructing a new elementary school (700 pupils), a sports center with a tribune (300 people) and two swimming pools. Involves the same contractor as case 1. Partnering contract.

CASE 3	Part of a master plan to upgrade 2,500 of the municipality's nursing home spots. Construction of 144 spots, a senior and a day care center. First BREEAM Excellent certified nursing home in the country.
CASE 4	Part of the same master plan as case 3. Demolition and construction of a new 6-storey BREEAM Excellent and Zero Emission Building (ZEB) building with 144 new spots. Resulting in the most environmental-friendly nursing home in the country.
CASE 5	Part of the same development plan as case 1 and 2. Constructing a sports center with the stated purpose to achieve the local sports community's wanted functions. The design competition was cancelled due to not satisfying the users' needs. Further, the contract was changed from combining partnering and design-build to a full design-build contract.

3. THEORETICAL FRAMEWORK

A project model consists of phases and decision gates. A simple project model goes through the phases planning, design, construction and use. Figure 1 illustrates the Oslo municipality's project model, where the planning phase is divided into Initiation; Choice of Concept Evaluation; Choice of Concept; Pre-project, followed by the political decision to start design and construction. The focus of this research is the pre-project.

Figure 1 Public construction projects within the Oslo municipality follows this project model (Samset et al. 2015).

Using standardized solutions provide an opportunity to apply 'Target Costing' which results in a portfolio of proven design that reflect reasonable price, cost and time estimates (Pennanen et al. 2010). Zimina et al. (2012) claimed that the focus of target costing is cost rationalization and not minimization. Allowable cost (AC) is the amount the customer is willing and able to pay for a facility with defined performance. Expected cost (EC) on the other hand corresponds to the cost for a facility with determined performance provided at current best practice. Together they provide the basis of design. The essence of designing to cost targets is to let the design converge to cost rather than the other way around (Pennanen et al. 2010). Set-based design (SBD) prioritize to choose design alternatives in the `last responsible moment' which enables the project to achieve cost targets (Ballard and Rybkowski 2009; Lee et al. 2012) by involving the design team

Zwikael and Smyrk (2012) defined 'benefit' as the "flow of value" which is based on target outcome realization. 'Outcome' is: "(...) a desired, measurable end-effect that arises when the outputs from a project are utilized by certain stakeholders." Serra and Kunc (2015) described benefits as: "(...) increments in the business value from not only a shareholders' perspective but also customers', suppliers', or even societal perspectives."

Researchers have recently shifted their focus towards benefit-oriented project management. Chih and Zwikael (2014) demonstrated that projects are becoming value creation processes and success exceeds output-measures like time, cost and quality.

Tillmann et al. (2017) reported that factors that influence the ability to deliver a project to target costs are 1) how cost targets are set and market price is estimated, 2) how shared profit is agreed upon and made transparent and 3) how production costs are steered towards the target cost and tracked, so risks can be identified and mitigated. In the pre-project phase, how to estimate the cost/set targets and how shared profit is agreed upon is relevant. The following section considers how to estimate cost.

COST ESTIMATION

A cost estimate is: "(...) the identification and consideration of costing alternatives to initiate and complete the project" (PMI 2013). Main features of project models are cost estimation and uncertainty analysis (Welde et al. 2015). Nguyen et al. (2008) discussed different types of cost models such as parametric cost and unit price estimates. Cost estimates are forecasts and therefore always uncertain. 'Cost drivers' are defined by Klakegg et al. (2018) as premises and/or decisions that affects the investment and operation cost. 'Value drivers' are functional attributions necessary for delivering expected project benefit. Ballard and Morris (2010) defined six cost drivers when analyzing and targeting cost reduction measures during the design phase: proactive value engineering; scope control; grounding scope in business purpose, aligned with constraints; steering design to targets; scope refinement. Having knowledge of both cost and value drivers provides the possibility to use and control the decision-making towards maximizing value within project constraints. Addressing and managing the uncertainty is needed to steer towards Target Cost. Zimina et al. (2012) highlighted the need to distinguish between different types of clients in regard of cost planning: 1) Client/Developers: cost target is derived from the business case which is clearly profit oriented, and 2) Public clients and clients doing self-construction: Allowable Cost can be set by developing the business case based on financial constraints, end-customer and organizational value. A validation of the business case will determine the Expected Cost.

Firstly, determine a variety of baseline buildings. Then secondly, based on the baseline buildings, identify target building systems. Altogether this determines the Allowable Cost in the business case. This benchmarking process uses historical information which must specify project-specific elements in order to achieve a realistic maximum project cost. Torp (2019) concluded that stochastic estimates can be applied for setting Allowable Cost (P85) and estimating Expected Cost (P50).

TARGET VALUE DESIGN

TVD is a management method targeting to maximize the value for the client and user within project constraints (Ballard 2008). Ballard and Morris (2010) characterized TVD as the relationship between Expected Cost and Allowable Cost with key features such as "design to targets" to increase predictability. Focus on the shared understanding and collaboration about the project basis has proven to be beneficial (Lee et al. 2012). Moreover, the study further explored the "conceptualization of design processes" which describes TVD as a lean design management method. Namadi et al. (2017) described, based on the identified findings in the literature, five TVD characteristics:

Table 2 Five characteristics for TVD from Namadi et al. (2017).

CHARACTERISTICS	DESCRIPTION
TARGET COSTING SETTING	Instead of estimating based on detailed design, the concept focuses more on detailed estimate.
COLLABORATION	Instead of designing and then converging later for group reviews and decisions, the concept emphasize on working together to define the issues, produce decisions then design to those decisions.
CO-LOCATION	Instead of working in silos and separate rooms, the method advocates working in pairs or large groups and face to face.
SET-BASED DESIGN	Rather than narrow choices to proceed with design, it allows several alternative solutions to proceed far into the design process.
WORK STRUCTURING	Instead of evaluating the constructability of a design one should designing what is constructible.

DETERMINATION OF TVD MATURITY

In order to determine the TVD maturity and to answer the RQ, a scorecard has been developed based on identified TVD characteristics in cited and well-known articles investigating TVD (Ballard 2008; Pennanen and Ballard 2008; Ballard and Morris 2010; Lee et al. 2012; Zimina et al. 2012; Denerolle 2013; Namadi et al. 2017).

A TVD 'characteristic' is an element or an activity which has been identified in the literature to be a part of the TVD process. Several of the repeated characteristics were adapted and merged within the four categories: contracting, organizing, defining (distinguished between the business case and validation) and steering. Three TVD categories arose based on findings in Denerolle (2013), while the contracting element was added based on statements from the interviewees. A natural development of the pre-project aligns the four categories chronologically. Meaning, that the characteristics within the 'Organizing' category are reliant on the fulfilment of the previous one in order to be fully implemented. Table 3 illustrates a structured overview of the TVD characteristics.

Table 3 Summary of TVD characteristics based on findings in the stated literature.

	KEY MEMBERS	TVD CHARACTERISTICS
CONTRACTING	Client, contractors, suppliers, designers and users	Incentives Open-book environment
ORGANIZING	Client, contractors, suppliers, designers and users	Co-location Workshop model Define the issues, produce decisions and design to those decisions Transparency Target budgets are adjusted among objects if doing so enhance the overall project benefit
DEFINING	Client	<u>Business case</u> Forecasts demands, specifies constraints or limitations (time, location, regulations, cost) Evaluate alternatives against strategic objective(s) and life cycle benefits Customer purpose and conditions of satisfaction (prioritized values) Decide whether to fund a validation study or not (based on the gap between AC and MC)
	Client, contractors, suppliers, designers and users	<u>Validation study</u> Shared understanding of the basis of the project Aligns ends (what's wanted), means (conceptual design) and constraints (cost, location, time, etc.) Benchmarking Value hierarchy: Beauty, functionality, durability, suitability, sustainability and constructibility A detailed budget and schedule aligning scope and quality requirements Two options for target cost setting: - Target lower than budget based on current best practice - Target scope greater than what could be delivered with current best practice within budget Based on standardized solutions

STEERING	Client, contractors, suppliers and designers	SBD Design what is constructible Design-to-Value Continuous feedback (releasing information in small batches) Iterations: AC ≥ EC ≥ TC Uncertainty and urgency are handled prior the construction phase (project cost, operational practice and system performance) Reduction of waste Decision-making based on operating and user costs Cost, schedule and quality implications of design alternatives are discussed by team

4. CASE STUDY

Each of the explored cases have their own attributes. A brief summary of the five cases is provided in Table 4. Figure 2 illustrates the Expected Cost development as reported in the monthly reports from the PM to the client. The current project progress is not differentiated based on actual time left before project delivery. Each phase starts at the marked line which is differentiated between the pre-project that starts once the contractor has signed the contract while the design and execution phase begins once the steering document is delivered to political evaluation and verification by external consultants.

Table 4 Summary of the cases used in the study.

Project	*Completion*	*Size [m²]*	*Cost*	*Time [months]*	*Contract*	*Type*
Case 1	Autumn 2020	7 913	36.0 MUSD	Planning: 5.5 Execution: 27	Partnering	New building
Case 2	Winter 2021	13 750	70.8 MUSD	Planning: 11.5 Execution: 30	Partnering	New building
Case 3	Autumn 2017	16 238	73.2 MUSD	Planning: 16,5 Execution: 24	Design-Build	Renovation and new building
Case 4	Summer 2020	9 120	77.0 MUSD	Planning: 10 Execution: 33	Partnering and Design-Build	New building
Case 5	Winter 2021/2022	3 394	20.3 MUSD	Planning: 5 Execution: 20	Design-Build	New building

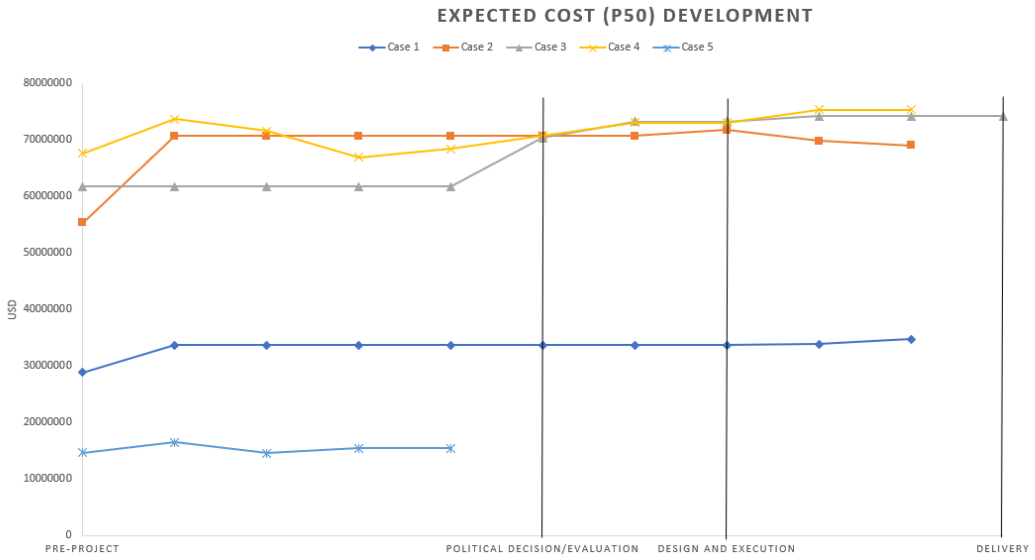

Figure 2 Expected cost (P50) development for the five case. Case 3 is the only one that is finished while case 5 is the project with the least progress.

5. TVD IMPLEMENTATION

Based on the developed scorecard ranging from 0 (not implemented) to 3 (fully implemented) a ranking of the TVD characteristics has been conducted. The results are illustrated in Table 5. Figure 3 displays the average score (AS) for case 4 and 5 and visualize the difference of TVD maturity between the investigated cases.

Table 5 Ranking of TVD implementation for each of the five cases based on the developed scorecard.

PROJECT	TVD CHARACTERISTICS	DESCRIPTION	AS
CASE 1	**Contracting**	Partnering, 50/50 split.	3
	Organizing	Limited collaboration and co-location, no target budgets among project objects.	1.5
	Defining (business case)	Validation not based on AC, no priority of outputs, specifying demands, constraints and limitations.	2
	Defining (validation study)	Shared understanding, align ends, means and constraints, target scope greater than best practice.	2
	Steering	"Nice to have vs. need to have", targeting cost drivers, rejected optimizations due to cost.	2.5
CASE 2	**Contracting**	Partnering, 50/50 split.	3
	Organizing	Limited collaboration and co-location, no target budgets among project objects.	1.5
	Defining (business case)	Validation not based on AC, no priority of outputs, debated project location.	1.5
	Defining (validation study)	Shared understanding, align ends, means and constraints, no benchmarking, target budget lower than best practice.	2
	Steering	Limited SBD, focus towards cost reduction.	2
CASE 3	**Contracting**	Design-build, possibility to cancel the project.	1
	Organizing	Limited collaboration, transparency, workshop model. No target budgets for project objects.	1
	Defining (business case)	Validation not based on AC, part of a master plan, priority of sustainable alternatives.	2.5
	Defining (validation study)	Limited understanding, target scope greater than best practice, not standardized solutions.	1.5
	Steering	Limited SBD, project goals, design-to-value.	2.5
CASE 4	**Contracting**	Partnering during pre-project, design-build, possibility to cancel the project.	2
	Organizing	Limited co-location, not fully implemented workshop model, four contractual milestones.	2
	Defining (business case)	Validation not based on AC, part of a master plan, priority of LCC for alternatives.	2.5
	Defining (validation study)	Target scope greater than best practice, limited benchmarking and standardized solutions.	2
	Steering	Challenging current best practice, project goals and focus on operation cost.	2.5
CASE 5	**Contracting**	Design-build, no incentives.	0
	Organizing	Limited co-location, transparency, single user with influence.	1
	Defining (business case)	Validation not base on AC, condition of satisfaction not matching target budget.	1.5
	Defining (validation study)	Limited understanding, mismatching ends and constraints, no benchmarking. Standardized solutions.	1.5
	Steering	No SBD, constructible design, single user's expectations, uncertainty.	1.5

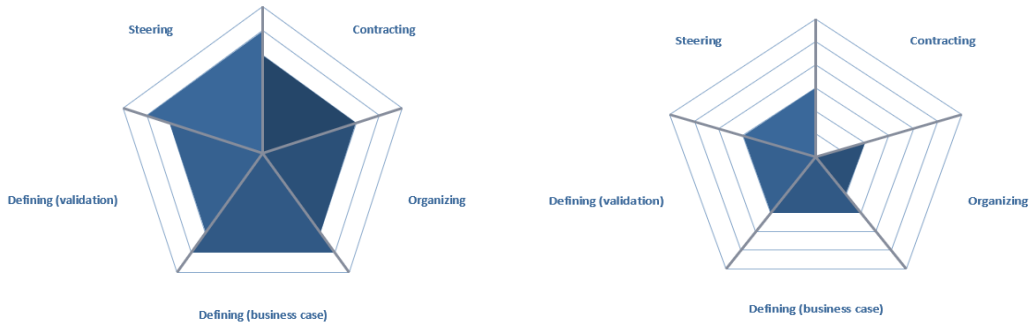

Figure 3 The maturity of TVD implementation for case 4 (to the left) and case 5 (to the right).

DISCUSSION - IMPLEMENTATION OF TVD CHARACTERISTICS

Both the "Contracting" and "Organizing" characteristics create the foundation of which the "Defining" elements are based on. This is an iterative process conducted by the client and during the validation study, conducted alongside the contractor, sub-contractors and -suppliers, designers and user(s). "Steering" is meant to keep track of the iterative process, adjust and control the elements of surprise.

Contracting

Contracting elements create the foundation of which a fully TVD implementation must be based on. In order to completely utilize the competence among the contractors and the designers to maximize project value, the contractual arrangements are a necessity. There is a need for incentives in order to achieve necessary focus towards the project as an entirety. Case 1 and 2 practice a 50/50-split of the optimized savings between the client and the contractor. In case 4 the PM challenged the contractor to chase and modify the environmental targets by offering additional payment. Though, as pointed at in case 3, the human relation differs between project organizations independently of contractual arrangements. A change of personnel weakens the relations and reduces the knowledge obtained during the development. Consistency is important for the close collaboration between the project organization and to fully exploit the optimization process. Especially in regard of key decision-makers. Defining the difference between a 'change' and an 'optimization' in order to avoid uncertainty seems to be significant. TC can be based on established contracts with sub-contractors and -suppliers which complicates the split.

Organizing

Besides from case 5, which had a twisted turn during its project development, every case use, or at least stated that they should use, collaborative methods. One element in the collaborative environment besides having the possibility for co-location, is to define issues, produce decisions and design to those decisions. Meaning, that the project organization is supposed to make weighted interdisciplinary decisions to create the most beneficial solution to maximize project value. A prerequisite for this assumption is that necessary decisions-makers are involved in these meetings. Case 3 and 4 differs from 'ordinary' public construction projects by granting the PM decision-making authority. As stated in the interviews, this authority provided the PM the ability to make rapid decisions alongside legitimizing the power and the responsibility needed for this position. The purpose of having interdisciplinary meetings is to make collaborative decisions. But, as stated by the interviewee, the users started to make decisions without properly visualizing

the consequences of these decisions. Often these decisions had economically effects and changes could easily occur based on short-term solutions on arising project issues. Therefore, the project proceeded with separated user meetings. On the other end of the scale is case 5. Case 5 is an example of the consequences for the client if not obtaining the full decision-making authority. Political influence created a path for the user to sway the municipality as the client. Different expectations have not been aligned which resulted in delays and reduction of project scope.

Defining (Business case)

Characteristics of defining the business case is closely related to the evaluation of choice of concept process within the Oslo municipality investment regime: Involves evaluation of alternatives, prioritizing values, requirements and strategy and whether to proceed with the project based on utilization of the opportunity space just to mention a few. Meaning, that public building projects within the Oslo municipality or municipalities with a similar investment regime, have already implemented most of these TVD characteristics. Though, besides from one characteristic involving the Allowable Cost. AC is not stated as a maximum for which the validation (or the pre-project) is based on.

For example, case 1, 2 and 5 are based on a 3 years old school needs plan which include rough cost estimates. These estimates are based on sketches provided in the basis for concept choice and therefore define the units which can be estimated. In other words, the cost estimates (which cannot be compared to AC) are conducted, though in a "light version" of bottom-up estimation. Within the TVD methodology, this process should be conducted top-down by identifying project targets (Ballard and Morris 2010; Simonsen et al. 2019). Case 1, which stands out in regard of cost estimation, conducted an estimation process based on historical price data and a lot of assumptions at the start of the pre-project. This process revealed one of the challenges of conducting an early estimate: The dependency of feedback from the client and the user(s). Meaning, that the client and the user(s) must even earlier know project-specific elements of importance. Benchmarking is in this regard an important element in the early phase of the cost estimation processes. For both case 1 and 2, this cost pressure resulted in a unified process to conduct cost reductions within the stated project assumptions. Otherwise, the project would not be executed. One must have in mind that the projects needed to conduct some fundamental changes in regard of the overall structure, layout and landscaping, and that these changes might have an impact on the delivered project value. Currently, the focus towards achieving project cost needs to be evolved to implement other values. Case 3 and 4 are examples of projects where environmental and safety aspects were prioritized before cost. Even so, the stated prioritized outputs in the steering document in regard of the two projects indicate inconsistency. One could possibly argue that the outcome to achieve the first BREEAM Excellent nursing home and to build the most environmental-friendly nursing home in the country cannot coincide with cost being the prioritized output.

Defining (validation)

The validation process, which often concurs with the purpose of the pre-project, focus towards developing and creating a common understanding among the involved actors of the: 1) basis of design, 2) basis of budget, and 3) basis of operation (Lee et al. 2012).

Target setting is supposedly related to value, but the interviews uncovered that too often decisions are being made purely based on cost. An important element in the evaluation process for case 3 of the delivered tenders was the distance between different functions and the residential units within the nursing home. Which is of importance due

to the worker-patient ratio. These distances were transformed and calculated based on operational costs. Furthermore, this case had a predetermined Target Cost for each nursing home spot. In other words, the characteristic of benchmarking has already been achieved since this Target Cost is equal within the Oslo municipality. However, this Target Cost is based on certain assumptions, and if these assumptions do not correspond to the given project, the cost should be adjusted accordingly. These assumptions could not be identified and clarified which provided unnecessary work for the project management in order to provide these clarifications. In order to have a realistic Target Cost, project specific elements must be compared to its peer groups and there is a need for transparency for either targeting a lower cost based on current best practice or to deliver a target scope greater than current best practice within the project budget. Another stated outcome for the project is to include automation and the use of welfare technology to increase the safety and to lower the operational costs. Project value is therefore linked to creating an efficient and worthy health care experience for the residents. An element which differs from case 3 is the implementation of a gradually maturing of the TC for case 4. Intentionally, by having four stage-gates with a delivery of a contractual TC the client forced the contractor to further develop the project within the previous delivery. Theoretically, this should result in a gradually increase of maturity/detailing and a reduction of risk. Each milestone was also based on tenders from the sub-contractors and -suppliers. At the last milestone the EC increased which can be seen in Figure 3. This development is explained by the PM to be related to the contractor's need to limit risk and exposure. Even though the final EC was set at the last milestone, some elements were deliberately left out of the tender due to the faith in further technological development. Doing so, follows the SBD methodology for optimizing the project value.

Steering

An important aspect when discussing the time frame of a decision, is the "distance" between the project organization and the decision-making authority. For case 3 and 4 the PM had expanded authority which resulted in more rapid decisions. As of case 1, 2 and 5 the PMs did not have any authority which influenced the decision basis in the different cases varies. Case 1 was highly affected by the focus towards cost reduction due to increased project scope and unexpected cost overrun regarding groundwork. As stated by the interviewees they had to satisfy the minimum criteria or functions in a cost-efficient manner. This provided a baseline. These evaluations were not based on a priority list but from identified or previous experienced cost drivers. "Good enough" was the key phrase in this process. Solutions related to cost drivers and the minimum criteria or functions stated in the tender documents, were further developed during the pre-project. "Need to have vs. nice to have" is also a statement of great interest. A specific focus towards value drivers have not been uttered. Even though the outcomes focus toward a forward-looking facility and the achievement of climate and energy objectives just to mention a few, the focus seem to be at achieving the outputs of cost and time.

Through monthly reporting the PM and the contractor (with his own monthly reports) have had an up-to-date indication of accumulated project cost, adjusted TC (due to changes) and the estimated cost of completion alongside EC and AC. The characteristic of rapid iterations is fulfilled in these cases.

One interesting finding in the manner of changes and optimizations was the contractor in case 1 that stated if the reduction of operating cost is the primary cause for the client to improve a function, then it should be defined as a 'change'. Since the optimization is not within the lifetime of the project which the contractor is a part of.

Furthermore, other elements have been included in the decision-making basis for the other cases. Time and cost consequences were the most important elements in the decision-making basis for case 2. Looking at the stated tasks for the PM in case 3, one gets the impression of the implementation of some of the TVD characteristics. Case 4 aims towards becoming the most environmental-friendly nursing home in the country. Environmental elements are therefore in the decision-making basis.

6. CONCLUSION AND FURTHER RESEARCH

The purpose of this paper was to explore the use of TVD in the early phases of public building projects, and to answer the RQ: *How is the TVD maturity in the Norwegian Construction Industry?*

Based on findings in the literature and case studies, TVD maturity in the Norwegian Construction Industry varies. TVD characteristics within contracting, organizing, defining and steering are only partially implemented. TVD strengthen the focus towards achieving targets within project constraints during the pre-project. Enhancing maximum project value is a challenge in the some of the cases due to the lack of visualization and the focus towards cost reduction. A structured decision-making process which implements 'the best of both worlds' is a possible improvement from current decision-making processes in order to adapt the business case towards project constraints. Decision-making based on identified cost drivers must embrace project value:

- In general, a decision-making process must reflect when a decision is being made, the decision basis and what the consequences are for the client and the contractor.
- TVD methodology can be included in the decision-making basis by stating TC based on project constraints and objectives before the pre-project phase. Both the validation and steering must reflect the 'nice to have' vs. 'need to have'-mentality.

More focus towards the root causes is necessary in order to fully understand the implications of adapting these methods. Difficulties in order to verify and control if the cost reduction correlates to a reduction in project value is an area of improvement.

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PART 3: APPENDIX

Appendix A Literature search

Keywords \ Databases/Search Engines	Filter used	Oria	Google Scholar	MC's own internal system	IGLC	Scopus
Target Value Design	-	1 872 824	5 290 000	1	35	24 170
AND Construction	English language	438 507	4 030 000		35	2 229
AND Target Cost	English language	254 623	3 740 000		-	620
AND Expected Cost	English language	183 583	2 930 000		-	67
AND Allowable Cost	English language	8 947	101 000		-	2
	English language; Journals	4 729	-		-	1
Target Value Delivery	-	771 114	3 560 000		1	4 253
AND Construction	English language	170 424	2 240 000		1	244
AND Target Cost	English language	124 979	1 770 000		-	86
AND Expected Cost	English language	44 212	1 140 000		-	9
AND Allowable Cost	English language	100 288	53 300		-	1
	English language; Journals	1 351	49 900		-	-
Target Costing	-	94 516	310 000		36	886
AND Construction	English language	25 911	232 000		36	145
	English language; Journals	13 577	199 000		-	73
Value Management	-	12 513 365	5 490 000		15	370 112
AND Construction	English language	1 651 412	4 450 000		15	31 497
AND Design	English language	669 133	4 010 000		-	18 643
AND Target Cost	English language	167 822	1 800 000		-	770
	English language; Journals	98 885	1 800 000			489
Expected Cost	-	6 151 132	5 720 000		2	99 876
AND Construction	English language	1 323 160	4 010 000		2	8 649
AND Design	English language	559 686	3 590 000		-	4 714
AND Target Cost	English language	216 728	3 070 000		-	416
AND Allowable Cost	English language	9 730	95 400		-	7
	English language; Journals	5 271	95 400		-	4
Benefit Management	-	399 304	4 350 000		-	291 154
AND Construction	English language	138 782	3 320 000		-	9 288
AND Target Value	English language	21 243	1 660 000		-	82
	English language; Journals	5 796	1 660 000		-	47
Benefit Realization	-	399 304	230 000		1	7 133
AND Construction	English language	138 782	156 000		1	335
AND Target Value	English language	53 824	108 000		-	2
	English language; Journals	22 660	108 000		-	1
Project governance	-	615 829	3 120 000		2	13 365
AND Construction	English language	221 869	2 490 000		2	912
AND Benefit Management	English language	92 264	1 810 000		-	52
AND Target Value	English language	-	533 000		-	1
AND Benefit Realisation	English language	-	50 900		-	-
Nyttestyring		-	15		-	-
AND Prosjekt		-	13		-	-
Kostnadsstyrt prosjektering	-	-	118	1	-	-
AND Byggeprosjekter	-	-	94		-	-
Målverdistyring	-	2	2		-	-

Appendix B Interview Guide

NTNU
Norwegian University of Science and Technology

OPAK

Interview guide

The interview

This interview is a part of the empirical data collection related to a master's thesis. The master's thesis is conducted by a student enrolled at Civil and Environmental Engineering at the Norwegian University of Science and Technology (NTNU) which is part of a specialization within 'Project Management'. The thesis is a cooperation between OPAK and NTNU. Supervisor from NTNU and OPAK AS is Agnar Johansen and Olav Torp (NTNU) and Glenn Bjørsrud (OPAK) are co-supervisors. Parts of this assignment are implemented in a paper published in the 28th Annual Conference of the International Group for Lean Construction.

The purpose of the research is to discover and increase the awareness of the maturity of Target Value Design (TVD) implementation during the pre-project phase in Norwegian public building projects. This interview, alongside document studies and literature review, will provide insights in of how the industry currently use identified TVD characteristics. Your feedback contributes to the practical aspects of how this is being conducted in the cases.

The following research questions are in the center of attention in this research:

1. How is the TVD maturity in the Norwegian construction industry?
2. How can TVD be applied in the pre-project phase of Norwegian public buidling projects?

This interview is being recorded. Your personal data will be stored up until the due date of the thesis (11.06.2020). The data used in the thesis will be anonymous and cannot be traced back to you. Alongside the procedures above, a notification form has been delivered to The Norwegian Centre for Research Data which creates the necessary security for you and your data.

The interviewee

Name:
Position:
Company:
When did you start working on this project:
Previous experience (last 10 years):

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Interview questions

Glossary

- Allowable cost = P85
- Expected cost = P50 / cost estimate
- Project team = steering committee / Decision-making authority within provided mandate. Execute changes regarding project scope, organization and budget in close cooperation with the client.
- Early phase = from the finished pre-liminary project report and up until construction.

The project

- Can you verify that the allowable cost of the project is XX?
- Can you verify that the expected cost of the project is XX?
- Can you verify that the project size is XX?
- Can you explain when the different project phases started and ended/expected to start and finish.
- Can you describe when the different actors were involved in the project / are expected to be involved?

Governance and work processes

1. Which work methods have the project team executed during the project development?
    a. Meetings as a work method in projects are a common thing. Can you explain to me the different meetings that have been conducted in this project?
    b. If you have a fixed meeting schedule, please elaborate regarding the chosen day(s), the purpose, the involved actors and the given time frame for each of the meetings.
2. Did the work methods develop during the project development?
    a. Describe how the work methods developed during the project.

Target Cost

3. Describe the work process of setting target cost in this project.
4. Describe the project work processes utilized in order to follow-up the cost development from the target cost setting.
5. Describe the work methods and tools utilized in this project in order to steer the design to target cost.

Changes and optimizations in the early phase

6. Describe the work process from a change has been identified and up until the approval from the project owner.

7. Describe the elements creating the decision-making basis related to optimizations of project solutions.
8. How has the project team utilized optimization of solutions and concepts in the project development?
    a. Describe how the concequence(s) of the optimization(s) has/have been visualized and communicated in this project.
9. Describe how the project has utilized the relation of cost-benefit related to changes and optimizations.

Project goal

10. Could you describe the project goal(s) (objectives, outcome and output)?
11. Describe how the project has conducted follow-up of goals and project success during project development.
12. During which work sessions and through which methods have the follow-up from the client been conducted during the project development?

Target Value Design

13. What do you relate to the word ‘value’ related to projects and project development?
14. What do you relate to the term ‘Target Value Design’?
15. The literature argues that at a lot of sub-optimizations happens during the execution of projects. From your perspective and based on your experience, which areas have the largest potential of improvement related to sub-optimization?
16. From your perspective, how has the project team’s perception of project value developed during the project development?