A Theoretical Framework for Implementing Convertible Contracts in Oil and Gas Projects

Moazzami Goudarzi, Mohammad

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A Theoretical Framework for Implementing Convertible Contracts in Oil and Gas Projects

by

Mohammad Moazzami Goudarzi

A THESIS
SUBMITTED TO THE FACULTY OF GRADUATE STUDIES
IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE
DEGREE OF DOCTOR OF PHILOSOPHY

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Abstract

Conventional forms of contract cannot address the dynamic and unpredictable environment of fast-track projects in the oil and gas industry. Using a single contract type such as cost reimbursable or lump sum for the whole project life cycle shifts the project risks to the owner or the contractor inequitably. Convertible contracts have been used in some oil and gas projects as an alternate contracting strategy to optimize risk taking/rewarding between contracting parties. Through this study, it was discovered that there is a significant gap in academic studies addressing the most challenging issues in managing convertible contracts. This identified gap led the researcher to design the research questions regarding the conversion time, estimation strategy, potential risks, and contractual relationships in convertible contracts. Accordingly, by addressing the research questions, this research aimed to develop a theoretical framework for implementing convertible contracts in oil and gas projects. Since the research questions were quite interpretive and investigative and the main objective of this study was to develop a theoretical framework, a grounded theory study was chosen as the main qualitative research design. Interview was the major instrument to collect the required data and information, and an in-depth review of documents was conducted. The collected data were analyzed through open coding, axial coding, selective coding, and theoretical integration to develop the main deliverable of the study, a theoretical framework, which consists of four main modules: conversion process, estimating strategy, potential risks, and collaborative strategy. To optimize the conversion process in convertible contracts, Module One provides important factors that influence deciding the conversion points, practical recommendations to enhance the conversion process, and possible conversion strategies in application of convertible contracts. Module Two presents an effective way to estimate a more accurate and reliable lump sum price at the time of
conversion. The third module presents the potential risks in applying convertible contracts in oil and gas projects and appropriate strategies to mitigate the impact of cost risks in estimating the lump sum price. The fourth module proposes organizing a project collaboration centre with focus on critical activities/decisions before and after conversion.
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Last but not least, I would like to offer my deep thanks, appreciations and gratitude to my family who are always supportive, understanding, patient and encouraging. My beloved wife and my best friend, there has not been a single moment that I have not felt your love, kindness, patience, and support. You have always been a source of energy and motivation for me in every step of this journey. Thank you.
Dedication

To my parents whose prayers have always been with me

To my wife for her love, encouragement, patience, and constant support

To my daughters, Parinaz and Behnaz, God’s most beautiful gifts to me

And

To God for giving me the strength to continue this journey during tough times
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<td>AACE</td>
<td>Association for Advancement of Cost Engineering</td>
</tr>
<tr>
<td>AC</td>
<td>actual cost</td>
</tr>
<tr>
<td>ACE</td>
<td>aligned construction enterprise</td>
</tr>
<tr>
<td>ACWP</td>
<td>Actual Cost of Work Performed</td>
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<tr>
<td>AFE</td>
<td>approval for expenditure</td>
</tr>
<tr>
<td>AGC</td>
<td>Associated General Contractors of America</td>
</tr>
<tr>
<td>AIA</td>
<td>American Institute of Architects</td>
</tr>
<tr>
<td>ANN</td>
<td>artificial neural network</td>
</tr>
<tr>
<td>BCWP</td>
<td>Budgeted Cost of Work Performed</td>
</tr>
<tr>
<td>BCWS</td>
<td>Budgeted Cost of Work Scheduled</td>
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<tr>
<td>BOOT</td>
<td>build–own–operate–transfer</td>
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<tr>
<td>BOT</td>
<td>build–operate–transfer</td>
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<tr>
<td>C</td>
<td>Construction</td>
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<tr>
<td>CBS</td>
<td>cost breakdown structure</td>
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<td>CCDC</td>
<td>Canadian Construction Documents Committee</td>
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<td>CII</td>
<td>Construction Industry Institute</td>
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<tr>
<td>CM</td>
<td>construction manager</td>
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<tr>
<td>CV</td>
<td>cost variance</td>
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<tr>
<td>CWP</td>
<td>construction work package</td>
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<tr>
<td>DBM</td>
<td>design basis memorandum</td>
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<tr>
<td>DG</td>
<td>decision gate</td>
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<td>E&amp;P</td>
<td>engineering and procurement</td>
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<td>EDS</td>
<td>engineering design specifications</td>
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<td>EPC</td>
<td>engineering, procurement, and construction</td>
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<tr>
<td>EPCM</td>
<td>engineering, procurement, and construction management</td>
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<tr>
<td>ETC</td>
<td>estimate to complete</td>
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<tr>
<td>EV</td>
<td>earned value</td>
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<td>EVA</td>
<td>earned value analysis</td>
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<tr>
<td>EWP</td>
<td>engineering work package</td>
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<td>FEED</td>
<td>Front End Engineering Design</td>
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<td>FEL</td>
<td>Front End Loading</td>
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<td>FID</td>
<td>final investment decision</td>
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<tr>
<td>FIFIC</td>
<td>International Federation of Consulting Engineers</td>
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<tr>
<td>FIWP</td>
<td>field installation work package</td>
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<tr>
<td>GMP</td>
<td>guaranteed maximum price</td>
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<td>HAZOP</td>
<td>hazard and operability</td>
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<tr>
<td>HSE</td>
<td>health, safety, and environment</td>
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<tr>
<td>IFC</td>
<td>issue for construction</td>
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<td>IFD</td>
<td>issue for design</td>
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<tr>
<td>IFH</td>
<td>issue for HAZOP</td>
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<tr>
<td>IPD</td>
<td>integrated project delivery</td>
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<tr>
<td>ISO</td>
<td>Isometric</td>
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<tr>
<td>JCT</td>
<td>Joint Contract Tribunal</td>
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<td>JOA</td>
<td>Joint Operating Agreement</td>
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LLI  long lead item
MR   model review
MTO  material take-off
OBE  Open Book Estimate
P&ID: piping and instrumentation diagram
PCC  project collaboration centre
PCSA pre-construction service agreement
PDRI Project Definition Rating Index
PFD  process flow diagram
PMO  project management office
PO   purchase order
PSM  process safety management
PV   planned value
SPI  schedule performance index
SV   schedule variance
TDA  technical design allowance
UG   Underground
WBS  work breakdown structure
CHAPTER 1. INTRODUCTION

The unpredictable and fast-track environment of oil and gas projects increases the level of risk and uncertainties during the project life cycle. Contract is the mechanism to manage the risk allocating/rewarding process between contracting parties. In a tight economic atmosphere with a high level of risks and unpredictability, project stakeholders fight harder for more benefits, which results in tough contract language and conditions (Grynbaum, 2004).

Cost reimbursable and lump sum are used as two common contract price arrangements in the oil and gas industry. The cost reimbursable contract has been frequently used in the Canadian oil and gas industry to address the needs for fast-tracking (O’Toole & Jergeas, 2010). Although this contract price arrangement is more flexible to changes and unpredictable situations, it has higher probability of cost overruns on material and labour, which is the larger portion of the project cost (Van der Werf, 2003). In cost reimbursable, the owner does not have a clear vision of its financial commitment and the contractor is not incentivized to minimize the project costs (Nkuah, 2006). As a result, owners prefer to perform the projects on a lump sum basis, which mostly transfers the risks of cost overruns and project performance to the contractor.

The conventional approach of using a single contract type cannot address the unpredictable environment of mega projects in the oil and gas industry and the project risks are shifted to the owner or contractor inequitably. A dynamic contractual arrangement should be structured for the major projects to optimize risk taking/rewarding philosophy between contracting parties.

Convertible contracts, as a hybrid contracting strategy, have been used recently in some oil and gas projects to optimize the risk balance between project owners and contractors (Brkic & Romani, 2009). In this contractual model, different contract price arrangements such as cost
reimbursable, unit rate, and lump sum are used at different levels of project definition and through the project life cycle to allocate cost and performance risks between contracting parties appropriately (Moazzami et al., 2015). Since convertible contracts are new in the oil and gas industry, important aspects of this contracting strategy have not yet been addressed in academic publications, and few industrial articles present convertible contracts in general.

1.1 Problem Statement and Significance

Oil and gas projects have an essential role in the Western Canadian Economy. According to a report by the Alberta Ministry of Economic Development and Trade (2015), Alberta produced about 78% of Canada’s crude oil and 67% of its natural gas in 2014. As shown in Figure 1.1, the gross revenues from all hydrocarbons in 2014 for this province were $111.7 billion.

![Figure 1.1. Alberta’s energy revenues 2014, total: $111.7 billion](image)

Also, energy resource exports totaled $90.8 billion in 2014, about 75% of Alberta’s total commodity exports that year (Figure 1.2).
Figure 1.2. Alberta’s energy exports 2014, total: $90.8 billion

Thousands of workers, engineers, contractors, and suppliers are working in Alberta oil sands projects with a range of between $8 and $10 billion in each project (Jergeas & Ruwanpura, 2010). Because of this large amount of investment, oil and gas projects require an effective contracting strategy to properly allocate project risks and liabilities between contracting parties in a trustworthy environment. “Contracting strategies set the DNA of a project, as they influence power positions, payments, and responsibilities” (Hartman, 2003, p. 37). According to Elliot (2005), ineffective contracting strategy has been among the most important reasons for major schedule and cost overruns in Canadian oil sands projects.

Engineering and construction phases are often overlapped in EPC projects to reduce the project duration. Starting construction activities without complete design information typically results in more subsequent claims and disputes over design changes and construction rework. According to the U.S. Federal Facilities Council (2007), 33% of fast-track projects have claims as compared with 7% of conservatively scheduled projects. This large amount of claims and disputes signify the necessity of an adapted contracting strategy to optimize the risk balance between project stakeholders and accommodate the needs for fast-tracking.
Commonly used conventional forms of contracts in EPC projects such as cost reimbursable and fixed price (lump sum) usually shift the project risks to the owner or the contractor inequitably. Inappropriate risk assignments in contractual relationships result in more risk premiums and contingencies, which will end with greater overall project cost (Moazzami et al., 2011a). In conventional contracting strategies, owners typically try to assign project risks to the contractors through exculpatory clauses (Zach, 1996). Exculpatory clauses are contractual clauses that transfer potential risks from one party to another (Haddad, 2007). As a contingency plan, contractors add a risk premium in their bid price to balance accepting exculpatory clauses, which will end up with more claims, disputes, and a higher overall project cost (Zaghloul & Hartman, 2003). Figure 1.3 illustrates the usual consequences of using ineffective contracting strategies.
Figure 1.3. The usual consequences of ineffective contracting strategies

In fact, using a single contract type for the whole project life cycle cannot address the dynamic environment of fast-track oil and gas projects. Major oil and gas projects with high level of complexity and unpredictability need a dynamic contractual framework to optimize the concept of risk taking/rewarding between contracting parties (Moazzami et al., 2013b).

Convertible contracts combine the initial flexibility of the cost reimbursable with subsequent discipline and cost certainty of the lump sum contracts (Brkic and Romani, 2009).
However, important aspects of this contracting strategy have not yet been addressed in academic publications, and few industrial articles present convertible contracts in general. In fact, very few studies have addressed the characteristics of convertible contracts, and there is a lack of an academic framework to address the main challenges of applying this contracting strategy in oil and gas projects. As shown in Figure 1.4, this problem has been broken down to the following research questions:

**Lack of an effective framework for applying convertible contracts in oil and gas projects**

- **How to determine the conversion points and timeline?**
- **What is the most effective estimating strategy for convertible contracts?**
- **What are the potential risks of applying convertible contracts in Canadian oil and gas projects?**
- **What is the most effective relational strategy for convertible contracts?**

*Figure 1.4. Research problem and research questions*
1.2 Research Objectives

By addressing the research questions, the main objective of this research is to develop a theoretical framework for implementing convertible contracts in oil and gas projects. The sub-objectives are as follows:

- To develop conversion strategies to determine the conversion points and timing
- To present an effective estimating strategy fit for convertible contracts
- To identify potential risks of implementing convertible contracts in Canada
- To propose a collaborative strategy to enhance the relationships in convertible contracts

1.3 Literature Review

An extensive literature review conducted in this research confirms that various project delivery methods and contracting strategies have been studied from different perspectives by other researchers. Previous researchers have studied different aspects of common forms of contract, especially fixed price and cost reimbursable. Also, the risk distribution style between contracting parties in various contract types has been extensively discussed in several papers. In some research, the relationship between the contract type and project execution strategy such as fast-tracking and the related effects on project outcomes have been studied.

However, the following gaps were identified in the existing knowledge on the subject of contractual framework of the oil and gas projects:

- The focus of previous studies has been more on project delivery methods and contracting strategies in the building construction industry, and few studies have addressed the contractual pitfalls of oil and gas projects.
- No contractual framework is systematically adapted for oil and gas projects to address the needs for fast-tracking as well as optimizing the risk allocation between
contracting parties. Therefore, applying traditional forms of contract such as cost reimbursable and lump sum, may not allocate project risks equitably to contracting parties. A contractual framework tailored for fast-tracking is required to consider the complex characteristics of this strategy and equitably allocate its extra risks and liabilities between contracting parties.

- By considering the importance of applying effective contracting strategy in oil and gas projects, the researcher recognized convertible contracts as combined contractual arrangements to accommodate the needs for fast-tracking and to optimize the risk allocation between contracting parties. *However, except for a few industrial presentations, no academic work was found on characteristics and detailed implementation of convertible contracts in the literature survey.*

- Although convertible contracts have been used recently in a few oil and gas projects, there is no agreement among industry experts on the main challenges of this contracting strategy. In particular, conversion timeline, effective estimating approach to convert the contract to a realistic lump sum price, potential risks in applying convertible contracts in oil and gas market, and effective relational strategy for convertible contracts are challenging issues in managing convertible contracts. Currently, project participants do not have an established structure to apply convertible contracts and just rely on their experience, which often results in different decisions for different experts.

Identified gaps have been addressed in this research by delivering a theoretical framework that addresses the main challenges of convertible contracts.
1.4 Scope of Research

The scope of this research will be limited to the large oil and gas projects with more focus on the Canadian oil and gas industry. Also, the owner company and the EPC contractor have been considered as the main contracting parties in the scope of this research. The contract scope covers engineering, procurement, and construction (EPC) phases and can be extended to front end engineering design (FEED) phase before starting the EPC. Small projects are out of the scope of this research.

1.5 Research Method

Since the research questions were quite interpretive and investigative and the main objective of this study was developing a theoretical framework, a grounded theory study was chosen as the main qualitative research design to develop the anticipated framework. Figure 1.5 illustrates this research approach, design, and main activities to achieve the research objective.

As a frequently used method of data collection in grounded theory study, interview was the major instrument to collect the required data and information. Interview is one of the most frequently used methods of data collection in grounded theory study (Thomson, 2011). Interviewees were selected among those who represent the typical perceptions and perspectives of the research scope. In compliance with an acceptable sample size for grounded theory methodology, 27 interviews were conducted to achieve the theoretical saturation. Besides, an in-depth review of project documents was conducted. Companies’ procedures, contract, lessons learned, risk registers, and other related documents of oil and gas projects were scrutinized.
The collected data were analyzed through: Open Coding, Axial Coding, Selective Coding, and Theoretical Integration to develop a theoretical framework for convertible contracts.

The validity of the findings of the study was examined through the suggested validation methods for qualitative research including: Respondent validation, Feedback from others, and Triangulation technique by using other source of data from real projects with convertible contracts.
1.6 The Main Research Deliverable

The main deliverable of the study is a theoretical framework for implementing convertible contracts in oil and gas projects. This theoretical framework consists of four main modules as follows:

- Module One, Conversion Process: The first module is focused on the conversion process.
- Module Two, Estimating Strategy: The second module illustrates a dynamic and flexible estimation approach to address the complexity of the conversion process in a convertible contract.
- Module Three, Potential Risks: The third module presents the potential risks of using convertible contracts in Canada.
- Module Four, Collaborative Strategy: The fourth module focuses on a collaborative strategy to enhance the relationships in convertible contracts.

1.7 Research Contributions

The research is certainly a unique and new subject in academia and delivers a methodological framework for implementing convertible contracts in oil and gas projects. Through a comprehensive literature review, this study provides a broad knowledge of contractual aspects of oil and gas projects. Also, this research has a significant contribution to the research method by applying a systematic grounded theory research design in the area of contract management.

The results of the study provide a clear vision of execution strategy, conversion process, estimating strategy, potential risks, and relational strategies in managing convertible contracts. The proposed framework can help to minimize the contractual problems of oil and gas projects.
regarding unbalanced risk allocation, fast-tracking, incomplete scope definition, and unrealistic cost estimation. The research outcomes will have an effective role in developing contractual relationships in oil and gas projects.

1.8 Thesis Structure

This thesis is structured as below:

- **Chapter 1. Introduction**: This chapter provides an overview about the main focus of this research, problem statement, and research objectives. In addition, research design, method, and major deliverables are explained in this chapter.

- **Chapter 2. Literature Review**: This chapter covers previous studies on design development and execution phases of oil and gas projects, project risks allocation, project delivery methods, different contract price arrangements, contract provisions, and convertible contracts.

- **Chapter 3. Research Method**: In this chapter, the research approach, design, and the main research activities to accomplish the research objective are described.

- **Chapter 4. Classifying and Analyzing Collected Data**: This chapter illustrates the whole process of analyzing collected data and information.

- **Chapter 5. The Theoretical Framework for Implementing Convertible Contracts in Oil and Gas Projects**: This chapter presents the proposed theoretical framework as the main deliverable of the study and its modules.

- **Chapter 6. Validating the Proposed Theoretical Framework**: This chapter introduces the validation criteria and the conducted methods to defend the validity of the proposed framework and the findings of the study.

- **Chapter 7. Conclusion**: This chapter summarizes the main results of the study.
• **References**: Provides a list of references.

• **Appendices**: Provides the attached appendices as follows:
  
  o Appendix: Consent form of participation

  o Appendix B: Interview transcripts

  o Appendix C: Respondent validation/feedback from others
CHAPTER 2. LITERATURE REVIEW

A preliminary literature survey was conducted through previous relevant studies, journal papers, conference proceedings, and industrial publications. Previous researchers have studied different aspects of common forms of contract, especially fixed price and cost reimbursable. Also, the risk distribution style between contracting parties in various contract types has been extensively discussed in several papers. In some research, the relationship between the contract type and project execution strategy such as fast-tracking and the related effects on project outcomes have been studied.

As a result of this preliminary literature review, it was discovered that very few industrial papers have discussed just general characteristics of the convertible contracts. Since convertible contracts are new in the oil and gas industry, important aspects of this contracting strategy have not yet been addressed in academic publications; a few industrial articles by Brkic and Romani (2009), Lawrence (2009), and Davis and Dornan (2008) present convertible contracts in general. Significant challenges in managing convertible contracts do exist, including:

- Systematic approach in deciding the timing of the conversion
- Bidding/award approaches to properly involve the contractor
- Collaborative strategy to establish the required relationships between contracting parties in a convertible contract
- Effective estimating strategy fit for convertible contracts

In fact, lack of scientific research on convertible contracts was identified in a preliminary phase of the literature review. As shown in Figure 2.1, Chapter 2 provides relevant concepts and the results of the previous studies required to have a strong background on the research area.
Figure 2.1. The main concepts of literature review

Understanding design development and execution phases of oil and gas projects is essential for discussing the concept of phased contract price arrangement and conversion process through the project life cycle. Also, fast-tracking as a common execution strategy in oil and gas projects should be discussed and considered in constructing the theoretical framework for conversion process. By overlapping project phases and activities, fast-tracking reduces the project duration. However, starting project phases or activities without complete information and scope definition will result in high levels of risk and uncertainties. The level of scope definition is an essential parameter in the conversion process. Understanding the process of defining the project scope and measuring the level of scope definition are necessary to determine the conversion points. Therefore, the concept of scope definition and a reliable tool to measure the
level of scope definition have been explained in this section. Correspondingly, scope changes and their impacts on convertible contracts have been discussed in detail.

The high level of technical complexity in mega projects as well as unstable market condition in the oil and gas industry result in different levels of risk and uncertainty throughout various phases of the project. A realistic approach to evaluate project risks and an accurate method to estimate contingencies are essential requirements for a successful conversion process. Cost, schedule, and performance risks are inevitable characteristics of oil and gas mega projects. Developing a useful theoretical framework for proper management of convertible contracts requires a strong background and knowledge of project uncertainties, risk, and management of contingencies. Contract is an instrument to allocate project risks between contracting parties. The unpredictable, frequently fast-track nature of oil and gas projects requires a flexible contractual framework to balance the high level of risk and uncertainties shared between contracting parties and to minimize potential claims, disputes, and litigation costs during the execution of the project (Moazzami et al., 2015). Project risks are allocated to contracting parties through:

- Project delivery methods
- Contract price arrangements
- Contract provisions

These three main pillars of contractual risk allocation have been discussed in detail in this chapter.

Lastly, the main characteristics of convertible contracts have been described in this chapter based on the few available references in the literature.
2.1 Design Development and Execution of Oil and Gas Projects

A clear vision of the phases of defining and executing oil and gas projects provides a better understanding of varying contract price arrangements at different stages of the project. Figure 2.2 illustrates the typical phases and decision gates in design development and execution of oil and gas projects.

The first three phases before the project execution, also called Front End Loading (FEL) phases, are feasibility study, conceptual design, and basic design or Front End Engineering Design (FEED). The feasibility phase validates technical and economic viability of the identified options to execute the project. Once the feasibility study is completed, conceptual design and expected values of preferred alternatives are developed to select the best option. Engineering
activities during this phase are mainly process and systems engineering, with a few non-engineering activities. The main deliverable of this phase is the design basis memorandum (DBM) package including design basis, cost estimate, execution plan, project organization plan, and contracting strategy of the selected project (Ruwanpura et al., 2006).

The last phase before starting the execution of the project is the basic design or FEED phase. The intent of the FEED is to develop the definition of project scope and to provide all detailed plans required for the execution of the project. Engineering Design Specifications (EDS) and project cost estimate are major deliverables of this phase. EDS defines all elements of the project scope and is the control document for commencement of detailed engineering and procurement activities. Based on the cost estimate classification system developed by Association for Advancement of Cost Engineering (AACE) International, the low and high ranges of estimate accuracy at the end of the FEED are \( L: -10\% \) to \( -20\% \) and \( H: +10\% \) to \( +30\% \).

A decision gate (DG) exists after each pre-execution phase of the project. There are two main purposes for each decision gate: to check if the previous phase is significantly completed and to decide if the project owner still wants to continue with the project. Therefore, decision gate 3 (DG 3) at the end of the FEED is the basis for approval for expenditure (AFE) or final investment decision (FID), meaning official budgeting approval for the execution of the project.

The execution phases, including detailed engineering, procurement, and construction (EPC) activities, are usually performed by an EPC contractor. The FEED or basic design package is the basis of bidding for EPC contracts in oil and gas projects. The EPC contractor may be directly responsible for performing all the required work or may subcontract parts. In either case, the EPC contractor is in charge of the project performance and obliged to deliver the
entire facility to the owner. The last phase of the project is handing over the commissioned plant to the operator and starting the operation of the facility.

**Fast-Tracking:** In response to the vast fluctuations in the oil and gas market and with respect to the importance of the early return of investment, most oil and gas projects in Canada are performed in a fast-track mode to accelerate the project schedule and start early operation. Fast-tracking is generally defined as the compression of the design and/or construction schedule through overlapping of activities or reduction in activity durations (Cho, Hyun, Koo, & Hong, 2010). By overlapping project phases and activities, fast-tracking reduces the project duration (Dehghan et al. 2015). However, as stated by Dehghan and Ruwanpura (2014), starting project phases or activities without complete information and scope definition will result in high levels of risk and uncertainties.

As shown in Figure 2.3, in a normal execution strategy, engineering, procurement, and construction phases of the project are almost performed sequentially. However, most of EPC oil and gas projects are performed in fast-track mode by overlapping engineering, procurement, and construction phases.

a) Normal Execution:

```plaintext
Engineering  Procurement  Construction
```

b) Fast-tracking:

```plaintext
Engineering
Procurement
Construction
```

**Figure 2.3. Normal execution vs. fast-tracking**
While more overlapping affords more reduction in project duration, fast-tracking decreases the accuracy of the project estimation and increases the risk of more changes, reworks, and cost overruns. Engineering and construction risks are inevitable elements in the execution of oil and gas projects, and significant risks in fast-tracking result mostly from an incomplete scope of work and design package in the bidding stage.

Cost overruns, design errors and omissions, change orders, construction rework, and overlooked work are most common risks in fast-track projects (Moazzami et al., 2011b). Although these problems are not specific to fast-tracking, their frequency is relatively higher in this approach. Regardless of the high level of risks and uncertainties in fast-tracking, the overall project profitability could be achieved if the project team is flexible and prompt in response to complications stemming from overlapping of design and construction (Fazio et al., 1988). Williams (1995) noted that fast-track projects require large amounts of hard work, planning, communication, trust, empowerment, commitment, experience, and talent.

2.2 Project Scope Definition and Changes

The chance of success in the execution phase of the project is highly related to the level of scope definition during the design development phases. Through a 3-year investigation of the front-end stages of three Alberta mega projects by Jergeas (2008), incomplete scope definition or inadequate front-end loading and poorly completed front-end deliverables were identified among the main reasons for cost and schedule overruns.

According to Cho and Gibson (2001), one of the major sub-processes of the pre-project planning process is the development of the project scope definition package. Project scope definition is the process by which projects are defined and prepared for execution. Pre-project planning should be implemented after the project initiation and at the early stage of the project
development. The process of defining project scope identifies the owner’s requirements for the project outcome and brings the contractor’s expectations and understanding into alignment with those of the owner (Kraus & Cressman, 1992).

Jergeas (2008) believes that the incomplete scope definition and inadequate front-end loading are mainly due to the fast-tracking nature of mega projects. He states that the current project delivery timeline is approximately one year shorter than the traditional execution timelines a few decades ago. In convertible contracts, the level of scope definition at the time of conversion to the lump sum is a highly important factor. Avoiding a large number of premiums and contingencies, project scope should be defined enough to convert the contract to a lump sum scheme. The practice of owners and contractors of pushing work to the field early puts construction under an unrealistic compressed schedule with increased overtime requirements and often with little or no consideration for the field cost (Jergeas, 2008). Kraus and Cressman (1992) supported this argument by stating that “if the scope of a project is inadequately or inaccurately defined, not properly documented or communicated, or misunderstood, then the outcome of the project is in jeopardy”.

The Project Definition Rating Index (PDRI), developed by the Construction Industry Institute (CII), is a reliable tool to measure the project definition level. The PDRI was developed specifically for industrial projects such as refineries, chemical plants, power plants, and heavy manufacturing and provides project team members with a structured approach for developing a good scope definition package (Cho & Gibson, 2001). As shown in Tables 2.1, 2.2, and 2.3, this effective tool consists of three main sections, 15 categories, and 70 elements in a weighted checklist format (Dumont et al., 1997). These three main sections are “basis of project decision”, “front end definition”, and “execution approach”. The PDRI score ranges from 0 to 1000. A
lower score means higher level of project definition. Cho and Gibson (2001) conducted a study on 40 projects by using industrial PDRI. The results of the study showed that those projects scoring below 200 versus those scoring above 200 had:

- Average cost savings of 19% versus that estimated for design and construction
- Schedule reduction by 13% versus that estimated for design and construction
- Fewer project changes
- Increased predictability of operational performance

Table 2.1. Basis of project decision elements

<table>
<thead>
<tr>
<th>Basis of Project Decision</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Manufacturing objectives</strong></td>
<td><strong>C. Basic data research and development</strong></td>
</tr>
<tr>
<td>A 1. Reliability philosophy</td>
<td>C1. Technology</td>
</tr>
<tr>
<td>A3. Operating philosophy</td>
<td><strong>D. Project scope</strong></td>
</tr>
<tr>
<td><strong>B. Business objectives</strong></td>
<td><strong>D1. Project objectives statement</strong></td>
</tr>
<tr>
<td>B1. Products</td>
<td>D2. Project design criteria</td>
</tr>
<tr>
<td>B3. Project strategy</td>
<td>D5. Lead/discipline scope of work</td>
</tr>
<tr>
<td>B4. Affordability/Feasibility</td>
<td>D6. Project schedule</td>
</tr>
<tr>
<td>B5. Capacities</td>
<td><strong>E. Value engineering</strong></td>
</tr>
<tr>
<td>B6. Future expansion considerations</td>
<td>E1. Process simplification</td>
</tr>
<tr>
<td>B7. Expected project life cycle</td>
<td>E2. Design and material alternatives considered and rejected</td>
</tr>
<tr>
<td>B8. Social issues</td>
<td>E3. Design for constructability analysis</td>
</tr>
</tbody>
</table>
### Table 2.2. Front end definition elements

<table>
<thead>
<tr>
<th>Front End Definition</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>F. Site information</strong></td>
<td><strong>H. Equipment scope</strong></td>
</tr>
<tr>
<td>F1. Site location</td>
<td>H1. Equipment status</td>
</tr>
<tr>
<td>F2. Surveys and soil tests</td>
<td>H2. Equipment location drawings</td>
</tr>
<tr>
<td>F3. Environmental assessment</td>
<td>H3. Equipment utility requirements</td>
</tr>
<tr>
<td>F4. Permit requirements</td>
<td>I. Civil, structural, and architectural</td>
</tr>
<tr>
<td>F5. Utility sources with supply conditions</td>
<td>I1. Civil/Structural requirements</td>
</tr>
<tr>
<td>F6. Fire protection and safety considerations</td>
<td>I2. Architectural requirements</td>
</tr>
<tr>
<td><strong>G. Process/Mechanical</strong></td>
<td><strong>J. Infrastructure</strong></td>
</tr>
<tr>
<td>G1. Process flow sheets</td>
<td>J1. Water treatment requirements</td>
</tr>
<tr>
<td>G2. Heat and material balances</td>
<td>J2. Loading/Unloading/Storage facilities requirements</td>
</tr>
<tr>
<td>G3. Piping and instrumentation diagrams (P&amp;IDs)</td>
<td>J3. Transportation requirements</td>
</tr>
<tr>
<td>G4. Process Safety Management (PSM)</td>
<td><strong>K. Instrument and electrical</strong></td>
</tr>
<tr>
<td>G5. Utility flow diagrams</td>
<td>K1. Control philosophy</td>
</tr>
<tr>
<td>G6. Specifications</td>
<td>K2. Logic diagrams</td>
</tr>
<tr>
<td>G7. Piping system requirements</td>
<td>K3. Electrical area classifications</td>
</tr>
<tr>
<td>G8. Plot plan</td>
<td>K4. Substation requirements/power sources identified</td>
</tr>
<tr>
<td>G9. Mechanical equipment list</td>
<td>K5. Electrical single line diagrams</td>
</tr>
<tr>
<td>G11. Tie-in list</td>
<td></td>
</tr>
<tr>
<td>G12. Piping specialty items list</td>
<td></td>
</tr>
<tr>
<td>G13. Instrument index</td>
<td></td>
</tr>
</tbody>
</table>
Table 2.3. Execution approach elements

<table>
<thead>
<tr>
<th>Execution Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>L. Procurement strategy</strong></td>
</tr>
<tr>
<td>L1. Identify long lead /critical equipment and materials</td>
</tr>
<tr>
<td>L2. Procurement procedures and plans</td>
</tr>
<tr>
<td>L3. Procurement responsibility matrix</td>
</tr>
<tr>
<td><strong>M. Deliverables</strong></td>
</tr>
<tr>
<td>M1. CADD/ model requirements</td>
</tr>
<tr>
<td>M2. Deliverables defined</td>
</tr>
<tr>
<td>M3. Distribution matrix</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
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<tr>
<td></td>
</tr>
</tbody>
</table>

Once scope is defined, it should be closely monitored for identifying scope changes. Unlike in a cost reimbursable contract, scope changes during the lump sum stage would result in several claims, disputes, and an adversarial environment in the project. To allow scope to be controlled, Kraus and Cressman (1992) suggested the following steps to identify and analyze the potential scope changes:

1. Identify potential scope changes. Some potential changes are obvious a request for a change proposal from the customer, an unavoidable delay in delivery of critical equipment, or the like. Others are insidious, such as the cumulative effect on the
schedule of a number of customer-requested changes in scope. The cost engineer must evaluate the progress of the project on a regular basis and identify actual or suspected changes in scope.

2. Compare all scope changes to the current, documented, approved scope.
   a) Is a modification to the project work breakdown structure involved?
   b) Are elements previously specifically included or excluded in the scope involved?
   c) Is there an increase or decrease in quantities?
   d) Is a change to the statement of work required?
   e) Is a change in pricing involved?
   f) Is a change in schedule involved in completion, milestones, sequencing, overtime, or shift work?
   g) Is a change in performance characteristics involved?

If the above analysis results in the conclusion that a change in scope is involved, then the following steps apply:

3. Identify the impact(s) of the scope change. Is a change in contract price or performance period justified? Do terms and conditions of contracts need to be revised? Are coordination requirements changed? Are “work-arounds” necessary?

4. Gain approval/acceptance of the scope change.

5. Update scope documents to reflect change.

2.3 Project Risks

Project risk is an uncertain event or condition that, if it occurs, has a positive or negative effect on one or more project objectives (Project Management Institute, 2013). According to PMBOK, the origin of the project risk is in the uncertainty present in all projects. Projects are
subject to different uncertainties and measuring variations in cost and time without consideration of the integration of these uncertainties does not produce a true reflection of reality (Moussa et al., 2009). Changes and risks, accepted as an inevitable part of any project, are a major cause of disruption, delay, and disputes, and they can generate significant cost and schedule impacts (Chen & Hartman, 2000).

The high level of risk and uncertainty in capital projects must be managed properly during project development and execution. As explained before, the main intent of front-end loading (FEL) and various phase-gate processes is fully defining the project scope to reduce the risk of cost and schedule overruns in execution.

As a result of a 3-year investigation of the front-end stages of three Alberta mega projects, Jergeas (2008) presented the main causes for cost and schedule overruns as follows:

- Unrealistic or overly optimistic original cost estimate (AFE) and schedules
- Incomplete scope definition or inadequate front-end loading and poorly completed front-end deliverables, including milestone schedule slippage in the front end
- Inappropriate project strategies
- Mismanagement of the construction phase

Yeo (1990) also listed the most frequent sources of risk and reasons for cost overruns in various types of projects as follows:

- Scope and quantity increases
- Engineering and design changes, faulty design, and late design
- Underestimation
- Misestimating
- Unforeseen inflation
- Project size and complexity
- Advanced technology and innovation
- Unforeseen technical difficulties
- Schedule changes
- Tight schedules and excessive concurrency of project phases
- Poor project definition
- Poor contract administration and policies
- Labour problems and poor industrial relations
- Government legislation of increased safety and environmental requirements

According to Dysert (2006), risk analysis is a process that provides a realistic view of completing a project for the specified estimate value by taking a scientific approach to understanding the uncertainties and probabilities associated with an estimate and to aid in determining the amount of contingency funding to be added to an estimate. It provides a way in which to associate a level of risk with a selected project funding value.

However, through the concepts of “Tunneling Vision” and “Black Swans”, Rolstadas, Hetland, Jergeas, and Westney (2011) and Taleb (2007) illustrate why financial disasters often occur in mega projects due to risks that seem eminently predictable. Rolstadas et al. (2011) explain tunneling as the neglect of sources of uncertainty outside the plan itself (see Figure 2.4).
Figure 2.4. Tunneling vision concept

Usually, the first formal assessment of risk and uncertainty occurs at the end of the feasibility phase. As the work progresses, uncertainty and risk are assumed to decrease, resulting in tunnel vision.

Through the concept of Black Swans, Taleb (2007) presents the neglected risks as the main reasons for major overruns in capital projects. Strategic and contextual risks are external to the project organization and usually beyond the control of project management. Figure 2.5 illustrates the Black Swan concept.

Figure 2.5. Black swans and tunnel vision
To have a better understanding of different types of project risks, especially “strategic” and “contextual risks”, Table 2.4 presents different types, levels, and definition of project risks as defined by Rolstadas et al. (2011).

**Table 2.4. Major types of project risks**

<table>
<thead>
<tr>
<th>Type</th>
<th>Level</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operational risks</td>
<td>Project</td>
<td>Operational risks are threats with a potential impact on project objectives resulting from actions that are controlled by the project manager. Operational risks originate from uncertainties in estimates of time, resources, and costs.</td>
</tr>
<tr>
<td>Strategic risks</td>
<td>Corporate</td>
<td>Strategic risks are threats with a potential impact on project business objectives resulting from decisions made by corporate management such as the project lifecycle, maturity at project sanction, the project execution strategy, changes to project objectives, and acceptance of project business risk exposure.</td>
</tr>
<tr>
<td>Contextual risks</td>
<td>Market</td>
<td>Contextual risks are threats with a potential impact on business and project objectives imposed by circumstances outside the project and beyond the control of project and corporate management. Such threats often originate from project location, business practices, factor market conditions, culture, and geopolitics.</td>
</tr>
</tbody>
</table>

Project risks can be “known” or “unknown” risks. Known risks are those that can be identified, analyzed, and responded to by a mitigation plan. According to the Project Management Institute (2013), a “contingency reserve” should be assigned to the known risks that
cannot be managed proactively and unknown risks should be addressed by a “management reserve”.

2.4 Accuracy of Cost Estimate

As identified by Jergeas (2008) and Yeo (1990), unrealistic or overly optimistic original cost estimate (AFE), underestimation, and misestimating are among the main causes of costs risks and cost overruns in capital projects. Therefore, effective cost estimation is an important element in management of oil and gas projects. The concept of project cost estimate and its important aspects have been illustrated in this section.

In its recommended practice, Cost Engineering Terminology (AACE International, 2014), defines a cost estimate as “an evaluation of the elements of a project or effort as defined by an agreed-upon scope”. However, Dysert (2006) argues that the AACE International definition fails to fully portray the uncertainty involved with estimates. He defines estimate as a prediction of the expected final cost of a proposed project that by its nature involves assumptions and uncertainties and is therefore associated with some level of error.

Dysert (2006) correlates this level of error and uncertainty to probabilities of over-running or under-running the predicted cost. Based on its probabilistic nature, an estimate should not be viewed as a single point cost value. In fact, an estimate reflects a range of potential cost outcomes, with each value within this range associated with a probability of occurrence (Dysert, 2006).

Bent (2001) introduced six major factors affecting the accuracy of a cost estimate, as shown in Table 2.5.
Table 2.5. Factors that impact on the quality of an estimate (adapted from Bent (2001))

<table>
<thead>
<tr>
<th>Factor</th>
<th>Weight (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic process design</td>
<td>30</td>
</tr>
<tr>
<td>Estimator’s experience and cost data base</td>
<td>16</td>
</tr>
<tr>
<td>Time allowed to develop the estimate</td>
<td>15</td>
</tr>
<tr>
<td>Project and site conditions</td>
<td>15</td>
</tr>
<tr>
<td>Current business and labour conditions</td>
<td>13</td>
</tr>
<tr>
<td>Team experience and the quality of input</td>
<td>11</td>
</tr>
</tbody>
</table>

According to Trost and Oberlender (2003), the accuracy of an estimate is measured by how well the estimated cost compares to the actual total installed cost and depends on four factors:

- who was involved in preparing the estimate
- how the estimate was prepared
- what was known about the project
- other factors considered while preparing the estimate

Dysert (2006) put emphasis on the idea that estimate accuracy should be considered as a probabilistic assessment of how far a project’s final actual cost may vary from the single point value that is selected to represent the original estimate. The accuracy of estimate is usually denoted as a +/- percentage range around the original estimate, with a stated confidence level that the actual cost outcome will fall within this range. Range estimates provide the estimator with a tool to express and quantify his/her personal assessment of risk involved in certain estimating parameters instead of relying on a single-point best estimate (Yeo, 1990).
Among different probabilistic methods, Monte Carlo Simulation has been frequently used to contemplate cost risks, generate the range of estimate, and estimate the required contingency to address cost risks. Monte Carlo Simulation generates a set of artificial cost values for each cost item within its cost range, together with an assumed probability density function (Moselhi, 1997). Moselhi explains that Monte Carlo Simulation generates cost sets that are used to calculate the mean or target project cost and its associated variance. Then, it calculates the probability of the project cost exceeding the calculated target by a specified amount.

The central limit theorem, as a fundamental theorem of probability, states that the distribution of the sum (or average) of a large number of independent, identically distributed variables will be approximately normal. In the case of project cost estimation, the number of cost items is large. Therefore, the distribution of the sum of project cost items will be approximately normal. A theoretical normal distribution has been shown in Figure 2.6. The normal distribution is symmetric about its mean (\( \mu \)). About 68\% of values drawn from a normal distribution are within one standard deviation (\( \sigma \)) from the mean, about 95\% of the values lie within two standard deviations, and about 99.7\% are within three standard deviations.

![Figure 2.6. Theoretical normal distribution](image)

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In real projects, however, cost variables in an estimate do not present a theoretical normal distribution and most exhibit a skewed distribution. Through a cost estimate example, Figure 2.7 illustrates this concept.

![Diagram showing frequency of occurrence and original estimate with accuracy range at 70% confidence level.](image)

**Figure 2.7. Probabilistic method to estimate accuracy range**

In this example, the original estimate has a value of $100 million. As shown in Figure 2.7, the original estimate has a greater than 50% probability of being exceeded by the final cost of the project. In other words, the probability of cost overrun is more than 50%. In this example, with a 70% confidence, the cost of the project is limited between $90 million on the low side and $130 million on the high side. It means, at 70% level of confidence, the accuracy range would be –10% to +30%.
Logically, the accuracy of estimate improves by developing the level of project definition during the project life cycle. AACE International (2005) has developed a cost estimate classification system as a recommended practice that maps the phases and stages of project cost estimating. In this system, only the level of project definition determines the estimate class, and other characteristics are generally correlated with the level of project definition. The cost estimates covered by this system are for engineering, procurement, and construction (EPC) work in the process industries. Table 2.6 presents the AACE International cost estimate classification system for process Industries.

Table 2.6. AACE International cost estimate classification for process industries

<table>
<thead>
<tr>
<th>Estimate Class</th>
<th>Level of Project Definition (%)</th>
<th>Expected Accuracy Range of Estimates</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>0% to 2%</td>
<td>L: -20% to -50%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>H: +30% to +100%</td>
</tr>
<tr>
<td>4</td>
<td>1% to 15%</td>
<td>L: -15% to -30%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>H: +20% to +50%</td>
</tr>
<tr>
<td>3</td>
<td>10% to 40%</td>
<td>L: -10% to -20%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>H: +10% to +30%</td>
</tr>
<tr>
<td>2</td>
<td>30% to 70%</td>
<td>L: -5% to -15%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>H: +5% to +20%</td>
</tr>
<tr>
<td>1</td>
<td>50% to 100%</td>
<td>L: -3% to -10%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>H: +3% to +15%</td>
</tr>
</tbody>
</table>

The main estimate characteristics of this cost estimate classification system are defined as follows:
• **Level of Required Project Definition:** expressed as a percent of full definition. For the process industries, this correlates with the percent of engineering and design complete.

• **End Usage:** a short discussion of the possible end usage of this class of estimate.

• **Estimating Methods Used:** a listing of the possible estimating methods that may be employed to develop an estimate of this class.

• **Expected Accuracy Range:** typical variation in low and high ranges after the application of contingency (determined at a 50% level of confidence). Typically, this results in a 90% confidence that the actual cost will fall within the bounds of the low and high ranges.

Based on its classifications of estimates, AACE International exhibits the association of cost estimate classes to the expected range of accuracy as shown in Figure 2.8.

![Figure 2.8. Association between estimate accuracy and class of cost estimate](image-url)
As explained in section 2.2., the level of project definition can be measured by the Project Definition Rating Index (PDRI) tool, which effectively measures the project definition level and covers other important factors such as technical complexity, market conditions, and execution strategies. The PDRI score ranges from 0 to 1000. A lower score means a higher level of project definition.

2.5 Allocation of Contingencies

The management of cost risks begins with a systematic risk evaluation and appropriate allocation of contingency (Yeo, 1990). Traditionally, a percentage of the project cost that is usually included in the project budget as a contingency is to address the risks that cannot be managed proactively. According to Yeo, the objective of the contingency allocation is to ensure that the budget and schedule set aside for the project are both realistic and sufficient to contain the risk of unforeseen cost increases.

“Classes of estimate” method is frequently used to allocate contingency to the cost estimate. Major companies in different industries have their own cost estimate classification systems. In practice, it is common for the upper-bound value of the accuracy range to be used for contingency allocation (Yeo, 1990). Chen and Hartman (2000) stated that the conventional method of contingency allocation is largely based on judgment and is arbitrarily allocated, often as a multiple of 5%. They believed that the phenomenon of a multiple of 5% is probably an indicator of the application of arbitrary contingency allowances.

However, the conventional method of assigning an overall contingency to the overall bottom-line estimate, based on the project manager’s experience, is in danger of being overly simplistic and is probably unrealistic (Chen & Hartman, 2000; Yeo, 1990).
Instead of the “class of estimate” conventional method, a structured risk evaluation through a statistical approach can be used to estimate the contingency by the application of probability concepts for risk quantification. In this approach, contingency is a portion of cost estimate to cover a statistical probability of the occurrence of unpredictable cost elements within the project scope (Cost Engineers’ Notebook, 1995). In other words, a contingency amount will be added to an estimate to equalize the probability of underrun or overrun of the expected final cost. Equal probability of cost underrun or overrun means 50% level of confidence.

Through an example, Figure 2.9 illustrates this approach to estimate the contingency amount in a cost estimation process.
If the same estimate probability distribution as in Figure 2.7 is considered, if the value of cost estimate at 50% is $110M, a contingency amount equal to $10M should be added to the original point of estimate ($100M) to equalize the probability of underrun or overrun. The amount of contingency may be higher if a higher level of confidence is desired by project owners. Although the accuracy range is still bounded between $90M and $130M at 70% confidence level, the accuracy range around the new point of estimate including the contingency amount ($110M) is now –20% to +20%.

Although methods based on assumed statistical distributions have been suggested to estimate the contingency amount, Chen and Hartman (2000) argue that the problem with these methods lies in the fact that the assumed statistical distribution may not truly represent the underlying cost and time variations. Accordingly, they have suggested an artificial neural network (ANN) based technique for predicting project performance and allocating contingency at the front-end stage of project development. Chen and Hartman (2000) introduce ANN as an information processing technology that simulates the human brain and nervous system.

In the context of project management, according to Al-Tabtabai and Alex, (1997), the ANN technique is capable of predicting and monitoring project performance (e.g., cost variance and schedule variance) in the area of construction. In this framework, the project control system has five neural network modules that allow a project manager to automatically generate revised project plans at regular intervals during the progress of the project.

2.6 Contractual Risk Allocation

Contract is an instrument to allocate project risks between contracting parties. According to Ward, Chapman, and Curtis (1991), contractual allocation of project risks is essentially in the hands of the client and if the client is unwilling to bear a particular source of risk, he/she can pass
this on to one or more of the other parties involved in the project. Also, the main result of the study performed by Lam, Wang, Lee, and Tsang (2007) was that the allocation of risks is more essentially based on accepted criteria by contracting parties rather than using standard clauses from typical conditions of contracts without understanding the rationale behind.

The unpredictable, frequently fast-track nature of oil and gas projects requires a flexible contractual framework to balance the high level of risk and uncertainties shared between contracting parties and to minimize potential claims, disputes, and litigation costs during the execution of the project.

According to Jergeas (2001), resistance to improving the allocation of risk may arise from the following:

- A failure to recognize shortcomings in existing methods
- A traditional social conditioning toward winning versus losing
- Unfamiliarity with the concept of risk sharing
- Hesitation to extend trust in a contractual relationship

Jergeas (2001) suggested the following considerations within contract documents:

- Fairness is required in the allocation of risk.
- Parties must be able to manage the risk they bear.

Project risks can be allocated to contracting parties through the project delivery methods, selecting contract price arrangements, and drafting contract provisions. These three main pillars of contractual risk allocation have been explained in the following sections.
2.6.1 *Project delivery methods*

Project delivery method designates the contract scope, roles, and responsibility of contracting parties. The most common project delivery methods in execution of projects are as follows:

**Design–Bid–Build**

According to Hale et al. (2009), in the design–bid–build project delivery method the owner enters into a contract with an engineering firm that provides design services based on the requirements provided by the owner. The engineering firm provides engineering documents including equipment specifications and drawings required for building the project. These engineering deliverables will be used by the owner as the basis to make a separate contract with a construction contractor, which is usually called a general or prime contractor. In design–bid–build, engineering and construction activities are performed by two different entities through two separate contracts.

Figure 2.10 presents the contractual relationships in design–bid–build. There is no direct contractual relationship between engineering and construction contractors. If any problem arises during the construction phase due to design errors, the contractor proceeds with change orders, and the lack of communication between the engineering firm and the construction contractor may result in negative impact on project performance (Shrestha & Mani, 2014). The owner does not have direct contracts with subcontractors or suppliers, and the prime contractor will manage purchasing materials and equipment as well as construction activities through several contracts with vendors and subcontractors.
This approach provides the opportunity to start construction activities with a complete engineering package, which results in less rework in the construction phase. However, an additional bidding process to select a different organization for performing construction activities is a time-consuming approach that delays project completion. Moreover, using different organizations to perform engineering and construction activities increases the risk of more claims and disputes in the project environment.

**Design–Build or EPC**

In a design–build strategy, one single organization executes engineering, procurement, and construction phases of the project. In the oil and gas industry, an EPC contract is an alternate term for the design–build delivery method. If the scope of the EPC contract covers commissioning and start-up in addition to the engineering, procurement, and construction activities of the project, the contract is usually called EPC Turnkey. Figure 2.11 shows the simple contractual structure when the EPC contractor has a single contract with the owner and several contracts with various subcontractors and suppliers in a non-financed project.
environment. There is one single contract between the owner and design–build or EPC contractor in the design–build project delivery method.

Figure 2.11. A non-financed EPC project delivery method

However, in many cases EPC contractors are involved in large oil and gas projects developed by using external financing from sponsors and lenders. In these situations, the EPC Contractor’s performance is an important issue as the financial institutes decide to whether or not to participate in the project. In this contractual structure, the owner signs a Joint Operating Agreement (JOA) with a project company. The agreement might be in forms of build–operate–transfer (BOT), build–own–operate–transfer (BOOT), or other forms of concession agreements. The EPC contractor will be hired by the project company to perform the job. Figure 2.12 illustrates the contractual structure of a financed oil and gas project involving the EPC contractor.
Using the same organization to perform engineering and construction activities decreases potential claims and disputes in the project life cycle. However, the design–build delivery method gives more power to the contractor and lessens the owner control in project management and supervision. The EPC or design–build approach provides the opportunity for fast-tracking to reduce the overall project duration.

Through a study conducted by Stutz in 2000, the advantages of design–build delivery methods were compared with design–bid–build in main areas of benefits and considerations. He listed several advantages for the design–build delivery method, including single point of responsibility, more accurate project costs identification, faster delivery of facility, improved risk management, and better scope change management. The important findings of this study have been summarized in Table 2.7.
Table 2.7. Comparison between design–bid–build and design–build

<table>
<thead>
<tr>
<th>Important Areas</th>
<th>Design–Bid–Build</th>
<th>Design–Build (EPC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point of responsibility</td>
<td>• Project owner must manage two contractors</td>
<td>• one contractor, with one source of responsibility</td>
</tr>
<tr>
<td></td>
<td>• managing interface with designer and contractor</td>
<td>• eliminates adversarial relationships between the designer and contractors</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• saving cost due to eliminating one contract</td>
</tr>
<tr>
<td>Risk distribution</td>
<td>• project owner retains the risk for project completion</td>
<td>• the EPC contractor assumes increased risk of design errors/omissions</td>
</tr>
<tr>
<td>Accurate cost identification</td>
<td>• greater cost is uncertain since engineering and construction firms are not working directly</td>
<td>• a better understanding of the project costs with a single entity to perform both design and construction</td>
</tr>
<tr>
<td></td>
<td>• Uncertainties due to design errors/omissions</td>
<td></td>
</tr>
<tr>
<td>Delivery of facility</td>
<td>• fast delivery is difficult to achieve because of the need for two bidding/award processes (design and construction)</td>
<td>• faster delivery by omitting one bidding/award process</td>
</tr>
<tr>
<td>Control of scope changes</td>
<td>• accurate estimate of the impacts of scope changes on project need design and construction contractors working together</td>
<td>• impacts of scope changes on project costs and schedules can be evaluated more accurately and quickly with a single contractor</td>
</tr>
</tbody>
</table>
Construction Management

Construction Management is another form of project delivery in which the contractor performs management activities on behalf of the project owner. The construction manager can act as general contractor or as a liaison between the owner and the general contractor (Tenah, 2001). These two common forms of construction management have been explained as follows:

*Construction manager (CM) as agent* is a contractual approach in which the construction manager acts as an agent of, and advisor to, the owner. There is a direct contract between the owner and the construction manager. There are no direct contracts between the CM and engineering or general contractors; however, the CM acts on the owner’s behalf in managing and coordinating the engineering and general contractors. Figure 2.13 shows the contractual relationships in CM as Agent project delivery method.

![Figure 2.13. CM as agent project delivery method](image)

In this approach, the owner takes all of the risks inherent in contracts with engineering and general contractors. This form of construction management is sometimes also referred to as the “CM as Advisor”.
**Construction manager (CM) as constructor** is a form of construction management under which the construction manager enters into multiple trade contracts with the subcontractors and suppliers. The construction manager assumes responsibility for the performance of the subcontractors and suppliers much as a general contractor would under the traditional method. Contractual relationships in CM as Constructor are shown in Figure 2.14.

![Diagram of CM as Constructor project delivery method](image)

**Figure 2.14. CM as constructor project delivery method**

The CM is usually paid for the subcontract works on a cost reimbursement basis, but it may enter into a lump sum contract, when the design is sufficiently complete. In this case, construction management is sometimes also referred to as “CM at Risk”. The main difference between CM as constructor and design–bid–build approaches is that the CM works with the designer from the beginning of the design phase through completion and manages and oversees the entire project, either with or without being at risk (Tenah, 2001).

**Relational Contracting Strategies**

A relational contract is dominated by an often extensive interaction between buyer and seller from contract award to completion (Rolstadas et al., 2011). As explained by Kumaraswamy, Rahman, Ling, and Phng (2005), relational contracting defines relationships
among the parties who do not always follow the legal mechanism offered by formal contracts and appreciate the mutual benefits and “win–win” scenarios through a more collaborative attitude. As flexible strategies, relational contracts provide more collaborative atmosphere for the contracting parties during the project life cycle. When the concept of relational contracting is extended to cover a time period, rather than a single project, it is often referred to as a frame agreement (Rolstadas et al., 2011).

Unlike adversarial project delivery methods, the collaborative project delivery model aims at aligning interests, fairly apportioning risks, and creating an environment where trust prevents disputes and facilitates the successful completion of projects (Jergeas & Lynch, 2014).

The most common forms of relational contracting are

- partnering
- alliancing
- integrated project delivery (IPD)

**Partnering:** According to the Construction Industry Institute (1991), partnering is a long-term commitment between two or more organizations for the purpose of achieving specific business objectives by maximizing the effectiveness of each participant’s resources. Partnerships are intentional strategic relationships between entities to achieve common goals and benefits by creating a transparent environment based on respected principles such as commitment, trust, information sharing, and joint problem solving approach (Mohr & Spekman, 1994). In traditional strategies, contracts are mainly used to transfer the project risks to other parties inequitably while in partnership the risks are shared among partners based on their ability to manage the risks.

The origin of modern development of partnering is in the relationships forged between manufacturers and suppliers in the Japanese car industry in the 1960s and 1970s, and it was
extended to the construction industry in the USA in the 1980s. The first of these arrangements was the one between Shell Oil and Parsons SIP in 1984 (Loraine, 1994).

By partnering, and avoiding adversarial and blaming environment in traditional contracting strategies, the project performance can also be improved. The results of a study conducted by Cho et al., (2010) show that the performance of fast-track projects is relatively higher in a partnering contract.

**Alliancing:** Through a collaborative process, an alliance contract is highly based on a pain share – gain share concept to align commercial interests of contracting parties with project objectives. Open and honest communication, equitable sharing of risks and rewards, and a no blame culture are the core principles of an alliance contract (Ross, 2003). While exculpatory clauses are used in traditional contracts to transfer project risks to one party inequitably, alliancing is focused on sharing risks/rewards between contracting parties appropriately. In Australia, alliancing has experienced tremendous success, consistently bringing in hundreds of large-scale projects on time and on budget (Morwood et al., 2008).

**Aligned Construction Enterprise (ACE):** Jergeas and Lynch (2014) evolved the existing collaborative model to create a hybrid and high performance system called ACE. This system is specifically designed to address the unique difficulties found in industrial mega projects, which are typically plagued by cost and time over-runs mainly due to misalignment and fragmentation. As they explained, the ACE adds a new dimension to alliance model by the creation of a system integrator function embedded in the middle of the value network to unify project delivery. The project systems integrator will act as a facilitator, alliance manager, and integrator, cooperating and assisting the stakeholders and the owner/investor’s organization(s) to provide critical support...
to the project delivery teams, especially in areas that are not traditionally embraced in the core competence of any of the delivery members.

As depicted in Figure 2.15, these operational functions enable maximum performance and are centrally coordinated through the “Management Centre”.

![Figure 2.15. Aligned construction enterprise management centre](image)

The ACE Management Centre systems integration functions are to

- Define and forge alignment on common goals and objectives between the alliance partners, developing plans for their achievement, and establishing working relationships endorsed by senior leadership, and supported by the project owner
• Create an environment where open and honest communication, trust, and teamwork foster a cooperative bond, promote innovation, and prevent breakdowns at interfaces

• Plug the gaps in missing competencies and capabilities to create a whole system

• Establish cross-functional leadership teams for managing ever-changing alignments

• Discuss and resolve any conflicts or adversarial relationships that may emerge

• Provide facilitation, team training, and conduct regular organizational “health checks”

Suggested by Jergeas and Lynch (2014), the ACE Management Centre could be an independent project management firm or project management office established, jointly owned, and controlled by the stakeholders (owners, contractors, EPCs, employees, suppliers, labour unions, and the public) who put up the money for its staffing in proportion to the amount of reward they share in the venture.

**Integrated Project Delivery (IPD):** According to the American Institute of Architects (AIA) guideline published in 2007, IPD is a project delivery approach that integrates people, systems, business structures, and practices into a process that collaboratively harnesses the talents and insights of all participants to optimize project results, increase value to the owner, reduce waste, and maximize efficiency through all phases of design, fabrication, and construction. At the core of an integrated project are collaborative, integrated, and productive teams composed of key project participants.

AIA guideline introduces the main principles of IPD as follows:

• **Mutual Respect and Trust:** In an integrated project, owner, designer, consultants, constructor, subcontractors, and suppliers understand the value of collaboration and are committed to working as a team in the best interests of the project.
- **Mutual Benefit and Reward**: All participants or team members benefit from IPD. Because the integrated process requires early involvement by more parties, IPD compensation structures recognize and reward early involvement. Compensation is based on the value added by an organization and it rewards “what’s best for project” behavior, such as by providing incentives tied to achieving project goals. Integrated projects use innovative business models to support collaboration and efficiency.

- **Collaborative Innovation and Decision**: Innovation is stimulated when ideas are freely exchanged among all participants. In an integrated project, ideas are judged on their merits, not on the author’s role or status. Key decisions are evaluated by the project team and, to the greatest practical extent, made unanimously.

- **Early Involvement of Key Participants**: In an integrated project, the key participants are involved from the earliest practical moment. Decision making is improved by the influx of knowledge and expertise of all key participants. Their combined knowledge and expertise is most powerful during the project’s early stages, when informed decisions have the greatest effect.

- **Early Goal Definition**: Project goals are developed early, agreed upon, and respected by all participants. Insight from each participant is valued in a culture that promotes and drives innovation and outstanding performance, holding project outcomes at the centre within a framework of individual participant objectives and values.

- **Intensified Planning**: The IPD approach recognizes that increased effort in planning results in increased efficiency and savings during execution. Thus the thrust of the integrated approach is not to reduce design effort, but rather to greatly improve the
design results, streamlining and shortening the much more expensive construction effort.

- **Open Communication**: IPDs focus on team performance is based on open, direct, and honest communication among all participants. Responsibilities are clearly defined in a no-blame culture leading to identification and resolution of problems, not determination of liability. Disputes are recognized as they occur and promptly resolved.

- **Appropriate Technology**: Integrated projects often rely on cutting edge technologies. Technologies are specified at project initiation to maximize functionality, generality, and interoperability. Open and interoperable data exchanges based on disciplined and transparent data structures are essential to support IPD. Because open standards best enable communications among all participants, technology that is compliant with open standards is used whenever available.

- **Organization and Leadership**: The project team is an organization in its own right and all team members are committed to the project team’s goals and values. Leadership is taken by the team member most capable with regard to specific work and services. Often, design professionals and contractors lead in areas of their traditional competence with support from the entire team; however, specific roles are necessarily determined on a project-by-project basis. Roles are clearly defined, without creating artificial barriers that chill open communication and risk taking.

2.6.2 *Contract Price Arrangements*

Contracts are mainly distinguished by the contract price arrangement and generally fall into one of the three main categories: “fixed price”, “cost reimbursable”, and “guaranteed
maximum price contracts” (Fisk & Reynolds, 2006). According to Carty (1995), the best way to understand the various types of construction contracts is to view them from the perspective of the risk involved. He states that the range of risk from a contractor point of view runs from a fixed price contract at one end of the spectrum to a non-risk cost reimbursable contract at the other end.

Fixed Price Contracts

Lump sum and unit price as two major variations of fixed price contracts are explained as follows:

- **Lump Sum or Stipulated Price:** Under a lump sum contract, the contractor is obliged to perform the whole project work on a stipulated price basis and assumes most of the project risks and liabilities. The main advantage of this approach is to know the ultimate time and cost required to complete the project. A lump sum contract requires a well-defined scope of work that completely provides project performance requirements. Owing to the complete project definition, the execution phase of the project is usually more efficient and shorter in a lump sum framework.

- **Unit Price:** In the unit price arrangement, the contractor performs each unit of work on a fixed rate. In this contract type, the rate of performing each unit of work is fixed, but the quantities are subject to change. Inaccurate estimation of project quantities would be potential risk for the project owner. The unit may be the volume of excavation or the length of piping in the construction phase of the project.

Cost Reimbursable Contracts

Under a cost reimbursable form of contract, the owner agrees to reimburse the contractor all of its costs plus an agreed upon fee, and often all of the contractor’s main office costs, costs
of financing, etc., are included in the fee (Carty, 1995). Cost reimbursable contracts are more flexible to changes and unpredictable situations.

However, in this contractual framework the owner does not have a clear vision of its financial commitment and the contractor is not motivated to minimize the project costs (Nkuah, 2006). Under this contracting strategy, project risks are mostly transferred to the owner. Selecting contractor in a cost reimbursable contract is usually a subjective, easy, and fast process, while it is formal, difficult, and slow in lump sum contracts. Several variations are commonly used in the cost reimbursable contracts including cost plus percentage of cost, cost plus fixed fee, and cost plus incentive fee.

- **Cost Plus Percentage of Cost or Time and Materials Contract:** This contract type guarantees payment to the contractor of its actual costs plus a specified percentage of costs that covers contractor’s overhead and profit (MacEwing, 2001).

- **Cost Plus Fixed Fee:** In this contract type, the contractor is reimbursed its actual costs plus a pre-agreed fixed fee.

- **Cost Plus Incentive Fee:** In this contract type, time and quality criteria are specified in the contract. If the contractor meets the specified criteria, it is paid its actual costs plus a set fee. If the contractor exceeds those criteria, he is paid an additional fee and if the contractor does not meet the criteria, the fee is less (Fisk & Reynolds, 2006).

**Guaranteed Maximum Price (GMP) Contracts**

Guaranteed maximum price (GMP) is an alternate contractual approach that comprises features of both cost reimbursable and lump sum contracts. In this contract type, the contractor is paid actual costs in addition to an agreed fee while guaranteeing that the total cost to the owner will not exceed a stipulated maximum amount (Boukendour & Bah, 2001). GMP is an incentive-
based procurement strategy, which rewards the contractor for any savings made against the guaranteed maximum price and penalises him when this sum is exceeded as a result of his own mismanagement or negligence according to a pre-agreed share ratio (Masterman, 2002). Carty (1995) defines GMP as follows:

The contractor and owner agree that the contractor will perform an agreed scope of work at a price not to exceed an agreed upon amount, the GMP. If the final actual cost and the agreed upon contractor’s profit are less than the GMP (Case 1), the owner and contractor will share the savings in cost based on an agreed upon formula. If the final actual cost exceeds the GMP without any changes to the defined scope (Case 2), the contractor must solely bear the additional cost but not the owner. This concept has been illustrated in Figure 2.16. In Case 1 the saved $X value as the difference between actual cost and guaranteed maximum price (GMP) will be shared between the owner and contractor. In Case 2, the amount of actual cost that exceeded the GMP ($Y) is contractor’s costs risk.

![Figure 2.16. Guaranteed maximum price (GMP) contracts](image-url)
2.6.3 **Contract provisions**

The general and special conditions of contracts typically consist of written clauses and provisions that specify the interests and obligations of contracting parties and assign the risks of contracting between them. Standard forms of contracts consist of contract clauses to allocate the project risks between the contracting parties. These include the standard forms of contracts published by the American Institute of Architects (AIA) and endorsed by the Associated General Contractors of America (AGC), Canadian Construction Documents Committee (CCDC), International Federation of Consulting Engineers (FIDIC), and Joint Contract Tribunal (JCT).

Using traditional contracts and lack of a fitting contracting strategy for fast-track projects has increased the risk of changes, reworks, claims, disputes, and cost overruns. Although these problems are not specific to fast-tracking, their frequency is relatively higher in this approach. This high level of risks and uncertainties should be managed properly during the project development and execution.

### 2.7 Fast-Tracking and Conventional Contracts

A technical report from the US Federal Facilities Council (2007) shows that 33% of fast-track projects have claims as compared with 7% of conservatively scheduled projects.

Most oil and gas projects are executed in a fast-track manner to reduce the project duration by overlapping project phases and activities. The main contractual problems of using traditional contracts in fast-track projects can be discussed at two levels: contract types and contract provisions. Based on the literature, (1) it is necessary to develop a contract type fit for fast-tracking to optimize the risk allocation between contracting parties and (2) the lack of adapted provisions for fast-track projects results in applying exculpatory clauses in contract
language by contracting parties, which consequently leads to inequitable risk transferring to other parties. Some studies show that the two conventional contractual frameworks, lump sum and cost reimbursable, are not quite fit for fast-tracking. Pedwell, Hartman, and Jergeas (1996) conducted a study on the effects of contracting strategies and contract types on project outcomes in terms of cost and time. Based on the results of the study, they provided a list of recommendations as follows:

1. To minimize total project cost and schedule duration, the owner should strive for a high degree of project definition. In highly defined situations, the owner should allocate, when reasonable and within the capacity of its contractors, a substantial proportion of the project risk.

2. Fast-tracking produces less project definition at the start of construction and reduces total project (schedule) duration, but increases total project costs and risks.

3. The additional cost (premium) for fast-tracking paid by the owner must be carefully weighed against the financial benefits derived from earlier completion of a project.

4. The premium paid and the associated risks (both cost and schedule) for fast-tracking are related to the types of contracts selected by the owner.

5. There is a premium — both in time and cost — associated with contractual complexity. Arrangements that can reduce the contractual complexity will reduce overall project costs and construction duration.

6. In simple contractual arrangements, the lowest expected cost but the highest owner risk are obtained with cost-plus contracts. The lowest risk is obtained with unit-price contracts.
7. In complex contractual arrangements, the lowest expected costs and least risk is obtained with unit-price contracts. However, as the level of complexity increases, there is an increasing need for alignment of interests and risk-sharing to minimize total project costs and risks.

According to Jergeas (2001), changes and associated claims are common when fixed price contracts are applied to fast-track projects. Inappropriate contract selection significantly increases the associated risks and cost of fast-track projects.

In an additional research project, Pedwell, Hartman, and Jergeas (1998) discovered the effects of fast-tracking on total project cost for various contract types and contractual arrangement. Their research was conducted in the oil and gas industry, and if more than 20 trades and/or 15 subcontractors were involved, the project was considered complex. The results of this study are shown in Figures 2.17 and 2.18. These figures show that:

- If the project was simple and schedule reduction was lower than 8%, then the lump sum contract type produced the lowest and the cost-plus contract type produced the greatest overall project cost. If the schedule reduction was greater than 8%, then the cost-plus contract type produced the lowest and the lump sum contract type produced the greatest overall project cost.

- If the project was complex and schedule reduction was lower than 4%, then the lump sum contract type produced the lowest and the cost-plus contract type produced the greatest overall project cost. If the schedule reduction was greater than 4%, then unit-price contract type produced the lowest and the lump sum contract type produced the greatest overall project cost.
Figure 2.17. Cost vs. time saving by fast tracking in non-complex projects

Figure 2.18. Cost vs. time saving by fast tracking in complex projects
However, it seems that the research results are not surely reliable because of doubtful assumptions in the research. For instance, the definition of simple and complex projects in the oil and gas industry is now totally different with when the study was conducted and cost increasing does not have necessarily a linear relationship with time increasing.

In 2001, Jergeas found that changes and associated claims tend to arise when fixed price contracts are applied to fast-track projects. Therefore, previous studies envisage that the cost reimbursable contract is more flexible than fixed price to accommodate fast-tracking.

Brkic and Romani (2009) compared lump sum and cost reimbursable contracts from different points of view. Table 2.8 shows the results of their study.

**Table 2.8. Comparing lump sum and cost reimbursable contracts**

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Lump Sum</th>
<th>Cost Reimbursable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contractor selection</td>
<td>Formal, slow, difficult</td>
<td>Subjective, fast, easy</td>
</tr>
<tr>
<td>Project definition</td>
<td>Extensive</td>
<td>Narrow</td>
</tr>
<tr>
<td>Owner involvement</td>
<td>Little</td>
<td>High</td>
</tr>
<tr>
<td>Guarantee on final cost</td>
<td>High</td>
<td>Little</td>
</tr>
<tr>
<td>Flexibility</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Project risks</td>
<td>Contractor</td>
<td>Owner</td>
</tr>
</tbody>
</table>

Since the fast-track strategy is widely used in the design–build delivery method, it is very important to analyze the risk distribution between contracting parties by using various contract types in the design–build. Oztas (2004) studied the risk distribution between contracting parties in a design–build system considering different contract types. As shown in Table 2.9, the results of his study indicate that cost plus fixed fee and the cost plus percentage of cost are the most
risky contract types for the owner whereas the fixed fee and the guaranteed maximum price (GMP) types allocate more risks to the contractor.

Table 2.9. Risk distribution between main contracting parties in different contract types

<table>
<thead>
<tr>
<th>Contract Price Arrangement</th>
<th>Risk Allocation*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lump sum</td>
<td>Owner’s risks</td>
</tr>
<tr>
<td>Unit price</td>
<td>Contractor’s risks</td>
</tr>
<tr>
<td>Cost + Fixed FEE</td>
<td>Owner’s risks</td>
</tr>
<tr>
<td>Guaranteed maximum price</td>
<td>Contractor’s risks</td>
</tr>
<tr>
<td>Cost + Percentage of cost</td>
<td>Owner’s risks</td>
</tr>
<tr>
<td>Cost + Incentive FEE</td>
<td>Contractor’s risks</td>
</tr>
</tbody>
</table>

*Owner’s risks
Contractor’s risks

Therefore, in cost reimbursable and lump sum contracts, the balance of power is shifting between owners and contractors and applying each of them in fast-track projects with additional risks and uncertainties reduces the success of projects.

In addition, there are some chronological statements in the literature that confirm the lack of adapted provisions in standard contract forms for fast-track projects. In 1983, Bynum stated, “The author is unaware of any AGC or AIA forms specifically tailored for use in fast-track situations”. According to Fisher (1990), no provisions in the AIA forms deal with fast track or are even remotely related to the special problems raised by fast-track.

Most fast-track projects are performed in a design–build delivery system and are governed under its contract documents. However, design–build contract documents do not quite fit for fast-tracking. Saltz (2007) supports the argument, “It is not unusual for design–build contracts to be used in fast-track situation but the forms do not really contemplate fast-track construction and must be modified to accommodate that situation”. Lack of adapted contract
clauses for fast-track projects in standard forms of contracts results in using exculpatory clauses to transfer risks of the project to other party. Exculpatory clauses are contractual clauses that transfer potential risks from one party to another (Haddad, 2007).

In conventional contracting strategies, owners typically try to assign project risks to the contractors through exculpatory clauses (Zach, 1996). Also Jergeas and Hartman (1996) confirmed that owners tend to contractually pass responsibility for many project risks to the contractors via disclaimer clauses. Contractors, in turn, must protect themselves, so they must attach premiums, hidden or explicitly identified, to their bid pricing. The net result is that project costs become inflated. The usual consequence of this inequitable risk assignment is considering more contingencies and premiums by designers and contractors in their bid price, which will end with greater overall project cost (Zaghloul & Hartman, 2003). Zaghloul and Hartman stated that the assessed premium associated with the five most commonly used exculpatory clauses in construction is between 8% and 20%.

Sakal (2005) supports the argument from a different point of view. He believes that owners often use contracts in an attempt to shed unbearable risks to contractors by using harsh exculpatory clauses that subsequently leads to contractors passing the same risks to the subcontractors who are in the weakest position to manage the risks.

Hartman, Snelgrove, and Ashrafi studied the effectiveness of the written contract language to communicate risk assignment between contracting parties in lump sum contracts and published the results in three related papers between 1996 and 1998 (Hartman & Snelgrove, 1996; Hartman, Snelgrove, and Ashrafi, 1997, 1998). Table 2.10 presents their major findings.
As a result of contractual problems discussed in preceding sections, there are common issues in fast-track projects. Through an extensive literature review, Moazzami et al. (2011b) illustrated these issues as follow:

**Liability for inaccurate cost estimating and cost overrun risks**

Incomplete plans and specifications in the design phase of a project result in inaccurate cost estimating and increase the risk of cost overrun. According to Fisher (1990), the principal issue associated with fast-tracking is which party will bear the risk of cost overruns or, perhaps better stated, the risk of not being able to estimate cost accurately because of the absence of sufficiently completed plans and specifications. The incompleteness of the data and information
at the time of project estimating should be considered in the contract and the risk of inaccurate cost estimation must be fairly assigned to the contracting parties.

**Liability for design errors and omissions**

Design deficiencies liability is another legal challenge in fast-tracking. When activities are carried out rapidly and the project team has to focus on bidding and early construction at the same time, it is hard to sustain reliability in design. Regardless of the real complexity and uncertainties inherent in this approach, owners usually expect a perfect design with minimum effects on the project construction phase. “Most design–build/fast-track firms attempt to limit their design liability by excluding the liability for consequential damages. They also try to negotiate a guaranteed maximum price high enough that the cost of redesigning and repairing most design deficiencies is borne by the owner” (Bynum, 1983). However, the contract document should align stakeholders’ expectations with the real complexity and uncertainties inherent in this approach to prevent inequitable risk allocation.

**Delay damages**

Another issue fast-track projects frequently encounter is scheduling problems resulting in claims for delay damages (Fisher, 1990). According to Squires and Murphy (1983), as the plans and specifications for a fast-track project are completed and/or revised, scheduling problems are more probable to happen owing to more changes in activity durations. Therefore, the claims for delay damage are more likely to happen.

Usually the contractor is responsible for completing the project on schedule and is liable for the sequential damages. However, as stated by Bynum (1983), there are ways contractors may avoid liabilities owing to lack of information or facilities that should be provided by the owner to start a particular phase or activity of the project. For instance, when an owner cannot
provide the required site geotechnical data on time or delays the approval process, the contractor will be entitled to reasonable adjustments. An effective delay analysis procedure should be agreed to in the contract to distinguish excusable and non-excusable delays by contracting parties in the project life cycle.

**Numerous change orders**

Design changes are inevitable when project activities are overlapped and as a result, fast-track projects have a higher number of change orders. “The dilemma of many design–build/fast track projects has been that the changes are so numerous in comparison with the original project trade work that the trade contract’s calculation provisions in no way account for the incurred impact and loss-of-efficiency costs” (Tieder & Cox, 1983). Since design and scope changes have been identified as the major sources of claims and disputes, more change orders increase the likelihood of claims and litigation in fast-tracking. More contingency should be considered in the project budget and contract provisions should specify the contingency to compensate for the extra costs of numerous design and construction changes.

**Construction rework and modifications**

Incomplete drawings and specifications in bid packages submitted to subcontractors or trade contractors cause unavoidable rework and modifications in the next phases of projects. Inadequate procedures to deal with extra work are major source of disputes and conflicts in fast track projects. Suitable provisions should be considered in the contract to compensate for the extra work and modifications resulted by overlapping strategy.

**Risk liability of overlooked work (assigned to no party)**

If the plans and specifications for several subcontractors, whose scopes of work interface or overlap at various points, are incomplete, it is likely that the important elements of the project
are delegated to no one (Squires & Murphy, 1983). Confusing risk responsibilities for these neglected tasks is another legal problem between contracting parties in fast-track projects. Appropriate contracting arrangements with open communication and strong coordination will minimize the risk of overlooking work elements.

2.8 Frequent disputes and claims

Inequitable risk allocation through the conventional contracts results in large numbers of claims and disputes in oil and gas projects. According to Jergeas (2001), a project claim may be considered as a request for additional compensation due to damages or expenses incurred during the performance of a construction contract and disputes occur when parties disagree regarding the content or extent of the assertion. Jergeas categorized the causes of claims into two main groups as follows:

1. Misunderstanding of contract intentions: Failure to recognize the following concepts has been identified as common sources of contractual misunderstanding.
   - The contract must be considered as a complete document.
   - Contracts will be construed against the drafter. The individual deriving the document is assumed to best understand its provisions.
   - The written contract supersedes oral discussions.
   - Specific terms are considered to govern general terms.
   - The document must be read within the industry context; industry-specific terms and their accepted definitions are recognized.

2. Owner’s desire to reduce costs: Claims are frequently rooted in the owner’s desire to save money through inefficient means. The owner’s inclination to reduce capital expenditures may result in the following problems:
A poor choice of contract: various forms of contracts are common in the construction industry, including fixed price, maximum guaranteed price, and cost plus. Claims tend to arise when the contract characteristics are mismatched with the state of project design development. For example, changes and associated claims are common when fixed price contracts are applied to fast-tracked projects.

Inadequate or rushed project design: some owners are inclined to reduce capital costs by commencing construction with incomplete design data. Poorly defining the scope often results in numerous changes and revisions to specifications and drawings.

Poor project planning: inadequate planning on the part of either the owner or contractor may result in claims.

3. Other causes of claims and disputes may include some of the following.

- Design changes, errors/omissions, and extras and their impact on time and productivity
- Late owner-supplied equipment
- Lack of co-ordination between the different project participants
- Changed soil/site conditions
- Fixed price contract and fast-tracking
- Insufficient bid preparation time
- Inadequate bid information
- Underestimation by contractors
2.9 Two-Stage Tendering Contracts

Two-stage tendering has been used in construction projects to achieve the early engagement of a contractor under a pre-construction service agreement (PCSA). The intention of the parties is to work together on a cost reimbursable or unit rate basis during the PCSA to develop the design and enter into a lump sum construction contract in the second stage (Davis and Dornan, 2008). The main advantage of a two-stage tendering approach is the participation of potential contractors in the design development phase and project scope definition. Involvement of the contractor in the pre-execution phase provides early communication between the owner and the contractor to develop the design package that reflects the contractor’s views regarding constructability, work sequencing, and selecting subcontractors (Lawrence, 2009).

However, there is no contractual obligation for both parties to proceed to the second stage and enter to the construction contract after the completion of the PCSA. Lawrence (2009) noted that the conversion from a PCSA to a lump sum construction contract will typically occur when the contractor has successfully tendered 70%–80% by value of the subcontract packages for the project.

2.10 Convertible Contracts

Convertible contracts, as a hybrid contracting strategy, have been recently used in some oil and gas projects to optimize the risk taking/rewarding principle between project owners and contractors. In this contractual model, different contract price arrangements such as cost reimbursable, unit rate, and lump sum are used at different stages of the project life cycle to allocate cost and performance risks between contracting parties more appropriately (Moazzami et al., 2015). Convertible contracts start under a cost reimbursable or unit rate scheme when the project scope is not complete enough to bid a lump sum price with an acceptable range of
accuracy. Once the project is sufficiently defined, the contract will be converted to a lump sum price to minimize the risk of cost overrun and increase the contractor’s efficiency.

This contractual framework brings several benefits to the project. Using the cost reimbursable contract at the start of a project with an incomplete scope of work accommodates the needs of fast-tracking without absorbing a high level of risk from inadequate scope definition. In other words, this approach reduces the high costs of risk premiums and contingencies that are commonly included in a lump sum price contract. Further, converting the contract when the contractor has more accurate information to bid a realistic fixed price provides a clear vision of the project’s overall cost. Ultimately, convertible contracts combine the initial flexibility of the cost reimbursable methodology with the cost certainty of lump sum contracts (Brkic & Romani, 2009).

Since this contractual arrangement is new in the oil and gas industry, important aspects of this contracting strategy have not yet been addressed in academic publications and few industrial papers present convertible contracts. Significant challenges in managing convertible contracts do exist, including designing a bidding/award approach to involve the contractor, estimating strategy to reach a fixed price value, and timing of the contract conversion.
CHAPTER 3. RESEARCH METHOD

As shown in Figure 3.1, this section describes the research approach and design as well as the main research activities performed to accomplish the objective of this study.

Figure 3.1. Research design and activities
Based on the results of the literature review, gap identification, and problem statement, the research questions were designed as follows:

- How to determine the conversion points during the conversion process?
- What is the most effective methodology to estimate prices in convertible contracts?
- What are the major risks in application of convertible contracts in Canadian oil and gas projects?
- What is the most effective relational strategy in managing convertible contracts?

Accordingly, the main objective of this study was to develop a theoretical framework to implement convertible contracts in oil and gas projects by addressing the research questions.

3.1 Research Approach and Design

According to Leedy and Ormrod (2013), research is a systematic process of collecting, analyzing, and interpreting information or data in order to increase our understanding of a phenomenon. Research originates with at least one question about one phenomenon of interest (Williams, 2007). The three major research approaches are quantitative, qualitative, or a mix of both.

Quantitative research involves either identifying the characteristics of an observed phenomenon or exploring possible correlations among two or more phenomena (Leedy & Ormrod, 2013). On the other hand, qualitative approach is used to develop theories when partial or inadequate theories exist for certain populations and samples or existing theories do not adequately capture the complexity of the problem we are examining (Creswell, 2007).

Obviously no single answer underlies the research questions regarding the execution strategy and conversion process in convertible contracts. Different experts might have different, and perhaps equally valid, answers relevant to the research problem. Since the research questions
are quite interpretive and investigative, a qualitative study was conducted to accomplish the main objective of this study, developing a theoretical framework for implementing convertible contracts in oil and gas projects.

3.1.1 **Qualitative approach**

Williams (2007) describes qualitative research as a holistic approach that involves discovery. Instead of describing an existing phenomenon, qualitative approach is used more for developing new theories. Also, Creswell (2014) describes qualitative research as an effective model that occurs in a natural setting that enables the researcher to develop a level of detail from being highly involved in the actual experiences.

Qualitative research can be conducted through various methods. As suggested by Leedy and Ormrod (2013), the common qualitative research designs can be classified and explained as follows:

**Case study:** in a case study, a particular individual, program, or event is studied in depth for a defined period of time. In order to have the opportunity to make comparisons, usually two or more different cases are studied by the researchers; however, sometimes researchers focus on a single case because of its unique qualities (Leedy & Ormrod, 2013). The data collection for a case study is extensive and draws from multiple sources such as direct or participant observations, interviews, archival records or documents, physical artifacts, and audiovisual materials (Williams, 2007). The researcher also records details about the context surrounding the case, and by this the researcher helps others to draw conclusions about the extent to which findings might be generalizable to other situations (Leedy & Ormrod, 2013).

Creswell (2007) suggested the following steps to analyze data in a case study:

- Organization of details about the case
- Categorization of data
- Interpretation of single instances
- Identification of patterns
- Synthesis and generalizations

**Ethnography**: Leedy and Ormrod (2013) explain that in an ethnography, the researcher looks at an entire group and, more specifically, a group that shares a common culture in depth. The focus of ethnography is on everyday behaviors to identify norms, beliefs, social structures, and other factors to understand the changes in the group’s culture over time (Williams, 2007). The risk of this qualitative method is that the results of the study cannot be generalized to other theories. Site-based fieldwork is the best engagement strategy in ethnography study. However, participant observation also can be used in some studies (Leedy & Ormrod, 2013). The data analysis process can be conducted through the following steps suggested by Wolcott (1994):

  - **Description**
    - Describing events in chronological order
    - Describing a typical time period in the life of the phenomenon under study
    - Focusing on a critical event
    - Developing a story, complete with plot and characters
  - **Analysis**
  - **Interpretation**

**Phenomenological study**: The intent of this study is understanding people’s perceptions or a particular situation and searching for underlying meaning of the experiences of participants (Leedy & Ormrod, 2013; Croswell, 2007). If one considers the researcher’s experience and knowledge in the research area, unbiased research is a critical requirement for the reliability of
this method. The study collects data that leads to identifying common themes in people’s perceptions of their experiences (Williams, 2007). Long interviews are the main instrument for data collection in this study.

The following steps are suggested by Croswell (2007) to analyze data in a phenomenological study:

- Identify statements that relate to the topic
- Group statements into meaningful units
- Seek divergent perspectives
- Construct a composite

**Content analysis**: According to Leedy and Ormrod (2013), content analysis is a systematic examination of the contents of a particular body of material for the purpose of identifying patterns, themes, or biases. These materials would be the results of any forms of human communications, such as books, movies, and newspapers. As proposed by Leedy and Ormrod (2013), data analysis can be conducted through the following steps for the content analysis:

- A description of the body of material that the researcher studies
- Precise definition of the characteristics that the researcher is looking for
- The coding or rating procedure
- Tabulation for each characteristic
- A description of patterns that the data reflect

**Grounded theory studies**: A grounded theory study uses a prescribed set of procedures for analyzing data and constructing a theoretical model from them (Leedy & Ormrod, 2013).
Grounded theory studies are especially helpful when current theories about a phenomenon are either inadequate or nonexistent (Creswell, 2014).

Interview is the main instrument to collect the data in the grounded theory process. The criticality is to ensure that the collected data reflect the actual perspectives of participants.

The most commonly used approach to analyze data in a grounded theory study is the one suggested by Corbin and Strauss (2015) to conduct following steps:

- open coding
- axial coding
- selective coding
- theoretical integration

As explained by Birks and Mills (2015), grounded theory methods are referred to as inductive in that they are a process of building theory up from the data itself.

Since the main characteristics and challenging aspects of convertible contracts were not addressed in academic studies and also because the main objective of this study is developing a theoretical framework, grounded theory study was chosen as the main qualitative research design to develop the anticipated framework.

According to Birks and Mills (2015), a theory is an explanatory scheme comprising a set of concepts related to each other through logical patterns of connectivity. Identifying, developing, and connecting relevant concepts to produce the grounded theory of this study were conducted through the process of data collection and analysis.

3.2 **Data Collection**

Considering the grounded theory study as the main qualitative research design, interview was chosen as the major instrument to collect the required data and information. Interview is one
of the most frequently used methods of data collection in grounded theory study (Thomson, 2011).

Semi-structured and open-ended interviews were conducted to collect the required data and information concerning the research questions. Central questions and some related follow-up questions were designed to collect projects experts’ opinion concerning the main challenges in managing convertible contracts.

An in-depth review of documents was conducted as well. Companies’ procedures, work instructions, contracts, lessons learned, risk registers, and other related documents of oil and gas projects were scrutinized to obtain required information. Ethical standards and confidential policies were followed during the document review.

3.2.1 Sample size

It will be very difficult to find a unique solution for the research problem in all oil and gas projects. “We cannot be everywhere at once or take in every possible viewpoint at the same time whether observing, interviewing, or practicing some combination of strategies” (Schram, 2003, p. 97). Therefore, data sources should be selected through an organized sampling process to present the research scope as accurately as possible. In a qualitative research, the selection of data sources is more often non-random and purposeful (Leedy & Ormrod, 2013). In fact, particular samples that yield the most information about the research questions should be selected.

The grounded theory study requires enough data to generate concepts, patterns, categories, and dimensions of the subject under the study. Therefore, it is essential to obtain an appropriate sample size that will generate sufficient data (Auerbach & Silverstein, 2003).
Thomson (2011) conducted a study to provide an outline of sample size and the reason for these requirements for grounded theory. To provide some empirical guidance for estimating an appropriate sample size, he reviewed 100 articles that used grounded theory and used interviews as a data collection method. The findings of his study indicate that the point of theoretical saturation can be affected by the scope of the research question, the sensitivity of the phenomena, and the ability of the researcher. However, the average sample size was 25, but it is recommended to plan for 30 interviews to fully develop patterns, concepts, categories, properties, and dimensions of the given phenomena. Also, Creswell (2007) suggested 25 interviews in compliance with an acceptable sample size for grounded theory methodology.

**Theoretical saturation**: Deciding the appropriate sample size of interviews for the grounded theory study depends on the point of theoretical saturation. Theoretical saturation occurs when further data collection fails to add properties or dimensions to an established category (Birks & Mills, 2015). Thomson (2011) and Corbin & Strauss (2015) defined the following criteria for theoretical saturation:

a) no new or relevant data seem to emerge regarding a category

b) the category is well developed in terms of its properties and dimensions, demonstrating variation

c) the relationships among categories are well established and validated

In fact, theoretical saturation means that the collected data become repetitive and continuing interviews will not provide new data. There is no set number for when theoretical saturation occurs in the case of interviews (Glaser & Strauss, 1967; Corbin & Strauss, 2015).

**Theoretical sampling**: In grounded theory, the analysis begins with the collection of the first pieces of data (Corbin & Strauss, 2015). According to Birks and Mills (2015), fundamental
to a grounded theory research design is the concurrent process of data generation or collection and analysis. The gathering of data based on analysis of previous data is termed Theoretical Sampling (Corbin & Strauss, 2015). Iterative analysis of the collected interviews allows the researcher to visualize the emerging patterns, categories, and dimensions by moving back and forth through the data in order to find, compare, and verify the patterns, concepts, categories, properties, and dimensions of the phenomena (Kwortnik, 2003).

Considering the concept of theoretical sampling, a group of 14 project experts was selected to provide the first set of data. Data analysis was practically started when the first pieces of data were collected and continued in parallel with data collection. The second round of interviews were conducted and continued during the analysis until theoretical saturation was reached. With more than 13 interviews and after 27 in total, data collection did not add properties or dimensions to recognized categories.

3.2.2 Selection of participants

As stated by Creswell (2007), the idea behind qualitative research is to purposefully select participants who provide the best help to the researcher to understand the problem and research the question. Therefore, the first round of interviews was conducted by purposeful selection of participants who had been involved in management of convertible contracts or lump sum turnkey projects. Because of the experience of the researcher in oil and gas projects, some of the participants were known to the researcher. Also, some experts were referred by the selected participants.

Interviewees were chosen among those who represent the typical perceptions and perspectives of the research scope. Executive managers, business managers, project managers, engineering managers, and project control managers participated in the study. Participants were
selected from owner companies, EPC contractors, and industry professionals to incorporate different perspectives in constructing the theoretical framework. Figure 3.2 shows the breakdown of participants by the type of organizations.

![Figure 3.2. Breakdown of participants by their organization type](image)

Table 3.1 illustrates the breakdown of the positions of participants in each organization.

<table>
<thead>
<tr>
<th>Organization</th>
<th>Executive Managers</th>
<th>Business Managers</th>
<th>Project Managers</th>
<th>Engineering Managers</th>
<th>Project Control Managers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owner</td>
<td>3</td>
<td>5</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contractor</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>Industry Professionals</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Figure 3.3 provides the participants’ range of experience in the oil and gas industry.

![Pie chart showing participants' range of experience in the oil and gas industry.]

**Figure 3.3. Breakdown of participants by their experience**

3.2.3 *Interview set up and questions*

To set up effective interviews, the researcher followed a structured approach suggested by Leedy and Ormrod (2013) as follows:

- In order to direct and speed up the interviews and avoid unproductive conversions, some specific questions related to the research problem were prepared in advance. Interview questions, although prepared, were not fixed and limited to these questions.
- An abstract of the research were sent to the participants.
- Once accepted, the consent form of participation, including the permission to tape the interview, was sent to the participant.
- A reminder was sent before the interview.

The researcher invited potential participants through phone calls, emails, or meetings in person. The research topic, objectives, and ethical requirements were explained to the
participants through a recruitment email, a prepared abstract, and a consent form of participation as follows:

Recruitment email:

Dear …,

I would like to invite you to participate in an hour interview regarding a research program as part of my PhD studies in the University of Calgary.

The research topic is as below:

“A Theoretical Framework for Implementing Convertible Contracts in Oil and Gas Projects”

Please see attached an abstract of the research which provides more details about research background and objectives. The University of Calgary Conjoint Faculties Research Ethics Board has approved this research study.

In this research, I will look for expert ideas and opinions. The questions are quite general questions to seek different opinions regarding the important factors in deciding the time of conversion in convertible contracts and no personal question will be asked. Also, projects’ confidential data and information such as contract value will not be asked. Interviews may be recorded.

Participants cannot be identified and only the position (e.g., project manager, technical manager) and the type of their organizations (e.g., owner, EPC contractor) will be retained for the analysis of the collected information.

Participation in the requested interview is completely voluntary. Participants are free to discontinue participation at any time during the study. Please see attached a copy of the consent form to participate in the study.
If you have any question, please feel free to contact me.

Best Regards,

Mohammad Moazzami Goudarzi

Abstract:

Conventional approach to use a single contract type such as cost reimbursable or lump sum for the whole project life cycle cannot address the dynamic and unpredictable environment of fast-track projects in the oil and gas industry. Project cost and performance risks should be addressed by appropriate contract price arrangements during the project life cycle. Convertible contracts, as a hybrid contracting strategy has been recently used in some oil and gas projects to optimize the risk taking/rewarding principle between project owners and contractors. In this contractual model, different contract price arrangements such as cost reimbursable, unit rate, and lump sum are used at different levels of project definition and through the project life cycle to allocate cost and performance risks between contracting parties appropriately. However, effective bidding/award approach, deciding the points of conversion, and effective conversion process have been challenging issues in managing convertible contracts. This study provides a theoretical framework for implementing convertible contracts in oil and gas projects.

A copy of the consent form is attached in Appendix A. Before starting interviews, some specific interview questions were prepared to direct and speed up the interviews and avoid unproductive conversations. In particular, the bidding/award approach to involve the contractor, the estimating process to reach the fixed price value, and conversion timing were discussed to
develop the expected theory for conversion process in convertible contracts. Designed interview questions are shown in Table 3.2.

Table 3.2. Central interview questions

<table>
<thead>
<tr>
<th>Interviewee Information</th>
<th>Type of Organization:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Position:</td>
</tr>
<tr>
<td></td>
<td>Years of Experience:</td>
</tr>
<tr>
<td></td>
<td>Central Interview Questions</td>
</tr>
<tr>
<td>1-What are the most important factors in deciding the conversion points in convertible contracts? Why?</td>
<td></td>
</tr>
<tr>
<td>2-Do you think the percentage of engineering completion is a reliable indicator to decide the conversion points? Why?</td>
<td></td>
</tr>
<tr>
<td>3-How is the conversion time linked to the level of project scope definition? How do you measure the level of scope definition? Have you ever used Project Definition Rating Index (PDRI)?</td>
<td></td>
</tr>
<tr>
<td>4-What would be the amount of purchase orders (POs) for major equipment and bulk materials that should be placed before conversion to lump sum? Why?</td>
<td></td>
</tr>
<tr>
<td>5-What would be the amount of construction subcontract packages that can be subcontracted before conversion?</td>
<td></td>
</tr>
<tr>
<td>6-How is the accuracy of cost estimate linked to the conversion time?</td>
<td></td>
</tr>
<tr>
<td>7-Are you familiar with the Open Book Estimate (OBE) process? If so, do you believe that it’s an effective estimation process for convertible contracts?</td>
<td></td>
</tr>
<tr>
<td>8- What is the best bidding/award approach to involve the main contractor in a convertible contract?</td>
<td></td>
</tr>
<tr>
<td>9- What would be the best strategy to establish the required relationships between contracting parties in a convertible contract?</td>
<td></td>
</tr>
<tr>
<td>10-What are the major risks in applying convertible contracts in oil and gas projects? What is the acceptable range of contingencies in convert contracts?</td>
<td></td>
</tr>
</tbody>
</table>
3.2.4 *Involvement of the researcher*

The experience of the researcher in the oil and gas industry helped him to facilitate effective interviews and maximize the quality of collected data. During the study, the researcher was involved in two oil sands projects that were performed by using the convertible contracts in Alberta, Canada. Also, his previous experience in oil and gas projects performed by international contractors in the Middle East helped him to incorporate his practical experience in developing the theoretical framework for convertible contracts.

Besides using prepared interview questions, the researcher led open and professional discussions with participants on the research area. During the interviews, the focus was on the information was gained from the interviewee without revealing the researcher’s perspective. The data gathered from interviews and relevant documents were collected in an organized data base. An example of interview transcripts is shown in Table 3.3. Interview transcripts are attached in Appendix B.
Table 3.3. Sample interview transcripts

<table>
<thead>
<tr>
<th>Interviewee Information</th>
<th>Type of Organization: EPC Contractor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Position: Project Manager</td>
</tr>
<tr>
<td></td>
<td>Years of Experience: 16 years</td>
</tr>
<tr>
<td>Central Interview Questions</td>
<td></td>
</tr>
<tr>
<td>• To me engineering progress is a good indicator. The further engineering definition means more certainty in quantities and less contingency in your price.</td>
<td></td>
</tr>
<tr>
<td>• The 50%–60% engineering concepts is when most of critical decisions are made.</td>
<td></td>
</tr>
<tr>
<td>• It’s much more on scope completion rather than engineering completion. If we are in detailed engineering and scope is still open and client is changing the scope, it’s difficult to convert to the lump sum regardless of the engineering progress.</td>
<td></td>
</tr>
<tr>
<td>• The logical points are 30%, 60%, and 90% model review which are linked to quantiles. Because these activities are collaborative with client. Ideal spot depends on the level of risk and contingency that client wants to take.</td>
<td></td>
</tr>
<tr>
<td>• At 60% model review you could have all vendor data for major equipment and can define module fabrication quite well and 90% pipe rack modules as well. So, you can place an order for around 80% of equipment. Maybe 2 months after 60% model review could be a good point to convert the contract.</td>
<td></td>
</tr>
<tr>
<td>• Placing order for 80% of equipment means most bulk materials are already estimated.</td>
<td></td>
</tr>
<tr>
<td>• In construction, major part of civil work should be done before conversion. I would convert the construction phase at the end of piling.</td>
<td></td>
</tr>
<tr>
<td>• I have not used PDRI before, but the concept seems a very good and reliable metrics.</td>
<td></td>
</tr>
<tr>
<td>• Fast-tracking: It might not affect to the time of conversion directly, but might result in higher conversion factor to cover the risks of rework and possible changes due to start of construction without engineering completion. However, if EPC contractor is forced to start construction earlier, it means that he will get subcontractor’s bids earlier and will have realize actual cost of construction to convert earlier.</td>
<td></td>
</tr>
<tr>
<td>• Logically by early conversion you would have higher conversion factor.</td>
<td></td>
</tr>
<tr>
<td>• Contingency calculated based on risk profile of the project quantitative risk assessment could be another indicator to decide time of conversion. The acceptable range of contingency to convert the contract is totally dependent of the client risk taking attitude.</td>
<td></td>
</tr>
</tbody>
</table>
3.3 Data Analysis

Corbin and Strauss (2015) describe a grounded theory as a pyramid construction with each level of concepts standing on top of the others. The process of constructing a grounded theory has been depicted in Figure 3.4.

![Grounded Theory Pyramid](image)

**Figure 3.4. Constructing a grounded theory (adapted from Corbin and Strauss (2015))**

In this pyramid, basic-level concepts are the conceptual names given by the researcher to raw data that provide the foundation of a theory. Categories are higher-level concepts and more abstract terms that represent the major theme of a group of basic-level concepts. These higher-level concepts provide the structure or framework of the theory. Theorizing process is constructing an explanatory scheme that systematically relates concepts to each other around a core concept (Corbin & Strauss, 2015).
Coding methods are used to conceptualize raw data. In this study, a systematic coding process was conducted from the basic levels of concepts to the highest levels of abstraction. Suggested by Corbin and Strauss (2015) and Birks and Mills (2015), the collected data were analyzed through open coding, axial coding, selective coding, and theoretical integration to develop a theoretical framework for convertible contracts. Analytic memos and diagrams were also used as effective analytic tools in all levels of analysis. Memos and diagrams preserve the dialogues occurred in the researcher’s mind while interacting with data (Corbin & Strauss, 2015).

3.3.1 **Open coding**

Open coding is to identify codes and categorize them to a further level of analysis during the initial coding process. Open coding is a method that enables organizing similarly coded data into categories because they share some characteristic (Saldaña, 2010). The open coding started with the collected data from the first set of interviews.

Codes are the names given to the concepts derived through coding (Corbin & Strauss, 2015). Different coding methods can be used during the initial coding cycle depending on the nature of the qualitative study. Descriptive, process, and in vivo coding methods were used in this study for initial coding of the interview transcripts and relevant documents. As explained by Saldaña (2010), “descriptive coding” summarizes the basic topic of a passage of qualitative data in a word or short phrase and “in vivo” refers to a word or short phrase from the actual language found in the qualitative data. “Process coding” indicates action in the data (Charmaz, 2014).

Examples of coding interview transcripts are shown in Table 3.4.
### Table 3.4. Open coding: Coding raw data

<table>
<thead>
<tr>
<th>Code</th>
<th>Coding Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Lump sum turnkey”</td>
<td>In vivo</td>
</tr>
<tr>
<td>Open Book Estimate (OBE)</td>
<td>Process</td>
</tr>
<tr>
<td>“Around 55%–60% of engineering could be suitable to convert, but generally is about to define the scope of work.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>Front-End Engineering Design (FEED)</td>
<td>Process</td>
</tr>
<tr>
<td>Level of contractor involvement</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Purchase piping and steel structures</td>
<td>Process</td>
</tr>
<tr>
<td>Cost reimbursable contract</td>
<td>Descriptive</td>
</tr>
<tr>
<td>“Canada market is not ready for lump sum contract.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>“It’s always definition of the scope which is the driver, not the maturity of the engineering.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>“Engineering definition is for sure an indication to know if it is the right time to convert the contract.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>Freezing design basis by client</td>
<td>Process</td>
</tr>
<tr>
<td>P&amp;IDs – IFH/IFD/IFC*</td>
<td>Process</td>
</tr>
<tr>
<td>Fast-tracking</td>
<td>Process</td>
</tr>
<tr>
<td>Site preparation and U/G* IFC</td>
<td>Process</td>
</tr>
<tr>
<td>“Concrete and piling due to weather constrains are very uncertain, so the minimum level of definition for these activities is 80%.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>Phased conversion</td>
<td>Process</td>
</tr>
<tr>
<td>“I think PDRI is a very good tool to support conversion decision.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>Purchase of long lead items (LLIs)</td>
<td>Process</td>
</tr>
<tr>
<td>“If starting conversion after FEED you might consider 25–30% contingency.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>Code</td>
<td>Coding Method</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>“Risk is the key factor.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>“After FEED the accuracy of estimate is about 30%.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>Reliability in quantities</td>
<td>Descriptive</td>
</tr>
<tr>
<td>“Conversion period must be between 60% and 90% model review.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>Estimating quantities</td>
<td>Descriptive</td>
</tr>
<tr>
<td>“Conversion after 8–10 months from the start of detailed engineering.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>“In Alberta the main concern is poor productivity and efficiency.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>“At 60% it may be 5%–10% contingency for E&amp;P, but for construction you may have a bigger percentage.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>Partnering/Alliancing relationship between contracting parties</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Harsh weather in Alberta</td>
<td>Descriptive</td>
</tr>
</tbody>
</table>

*IFH, issue for hazop; IFD, issue for design; IFC, issue for construction, U/G, underground

After giving the conceptual names to the raw data, they were categorized to more abstract terms presenting higher levels of concepts by the “constant comparisons” process. Constant comparisons refers to examining one piece of datum against another piece (Glaser & Strauss, 1967) to determine if the two data are conceptually the same or different (Corbin & Strauss, 2015). For instance, specific engineering milestones such as 60% or 90% model review sessions and end of Front-End Engineering Design (FEED), which similarly indicates the degree of engineering definition, have been grouped in the “Engineering Completeness” category. By showing some codes and relevant categories, Figure 3.5 illustrates categorizing approach during the open coding process.
Figure 3.5. Open coding approach

The second round of interviews was conducted and continued during the analysis until achieving the theoretical saturation. Theoretical saturation occurs when further data collection fails to add properties or dimensions to an established category (Birks & Mills, 2015). With more than 13 interviews and after 27 in total, data collection did not add properties or dimensions to recognized categories.
To develop the concepts and illustrate their properties and dimensions (Corbin & Strauss, 2015), memos and diagrams were created for each category of concepts.

3.3.2 Axial coding

To go beyond description and to construct theory, data need to be analyzed for what Corbin and Strauss (2015) call “context”. Context locates and explains action–interaction within a background of conditions and anticipated consequences (Corbin & Strauss, 2015). To develop a theory, context links extracted concepts from raw data. The process of coding for context is called axial coding. Axial coding, as a form of intermediate coding, facilitates exploring the interconnections among categories. Although the data are broken apart in open coding to identify concepts, they are put back together again by relating those concepts in axial coding (Corbin & Strauss, 2015). Figure 3.6 illustrates the axial coding process with possible examples of action–interaction between categories.
Figure 3.6. Axial coding approach

During the axial coding some memos and diagrams were also created to develop the concepts and provide more abstract terms by discovering the interconnections between categories.

3.3.3 Selective coding

Selective coding is an advanced coding process to identify a core or central category which has the greatest explanatory power and the ability to link the other categories to it and to
each other (Corbin & Strauss, 2015). The following list of criteria was developed by them for choosing a core category:

1. It must be sufficiently abstract so that it can be used as the overarching explanatory concept tying all the other categories together.
2. It must appear frequently in the data. This means that within all, or almost all, cases there are indicators that point to that concept.
3. It must be logical and consistent with the data. There should be no forcing.
4. It should be sufficiently abstract so that it can be used to do further research leading to development of general theory.
5. It should grow in depth and explanatory power as each of the other categories is related to it through statements of relationships.

3.3.4 Theoretical integration

Theoretical integration generates the final product of the grounded theory study by integrating the findings around the core category. Birks and Mills (2015) propose three factors necessary for the integration of a grounded theory:

1. An identified core category
2. Theoretical saturation of major categories
3. An accumulated bank of analytical memos

There are several analytical techniques that can be used to facilitate the integration process (Corbin & Strauss, 2015) and serve as a bridge between analysis and theory (Birks & Mills, 2015). Writing descriptive/conceptual summary memos (story line) and integrative diagrams are among these techniques suggested by Corbin and Strauss (2015).
3.4 Theoretical Framework

As a final point, the explanatory components of the theoretical framework were constructed based on the summary memos and integrative diagrams created during the data analysis process. The theoretical framework consists of four main modules as follows:

- Module One: Conversion Process
- Module Two: Estimating Strategy
- Module Three: Potential Risks
- Module Four: Collaborative Strategy

The whole process of data collection, data analysis, and constructing the theoretical framework has been illustrated in Chapter 4.

3.5 Validation of the Research Results

The validity of a research project depends highly on the reliability of the data collection instruments and also the validity of the research method. By focusing on these two aspects, the validity of the research project has been defended in Chapter 6 by examining the validity of the data collection instruments and the research method.

- Validity of data collection instruments

  The validity of a data collection method is the extent to which that method or instrument can measure what it is supposed to measure. As explained in this chapter, interview was chosen as the major instrument to collect the required data and information. Besides, an in-depth review of project documents was conducted to obtain required information.

- Validity of the research method

  The validity of the research method concerns the accuracy, meaningfulness, and credibility of the research project as a whole (Leedy & Ormrod, 2013). The validity of a
qualitative research can be examined by its *credibility (or internal validity), transferability (or external validity), dependability (or reliability), and confirmability (or objectivity).* To satisfy these criteria, the following methods were used in this study:

- **Respondent validation:** One method to validate a qualitative research is to send the research findings back to the participants to determine whether they agree or disagree with the conclusions.

- **Feedback from others:** As another validation method, the results of the study were also shared with some of oil and gas experts who did not participate in the study to examine whether they agree or disagree with the findings of the study.

- **Triangulation:** Triangulation is a commonly used method to validate qualitative research. In this method, multiple sources of data are collected with the hope that they will all converge to support a particular theory (Leedy & Ormrod, 2013).

The above validation methods have been conducted for this study and explained in detail in Chapter 6.
CHAPTER 4. ANALYZING DATA AND CONSTRUCTING THE COMPONENTS OF THE THEORETICAL FRAMEWORK

This section illustrates all the steps of analyzing and classifying data to construct the explanatory components of the final product of the study.

4.1 Data Analysis

As explained in Chapter 3, the collected data were analyzed through open coding, axial coding, selective coding, and theoretical integration to construct a theoretical framework for convertible contracts. Analytic memos and diagrams were also used as effective analytic tools in all levels of analysis.

4.1.1 Open coding

Open coding is to identify codes and categorize them to further level of analysis during the initial coding process. In grounded theory, the analysis begins with the collection of the first pieces of data (Corbin & Strauss, 2015). Therefore, after collecting enough data through the interviews, the process of open coding was conducted through the following steps:

Step 1: Giving the conceptual names to the raw data

Tables 4.1 to 4.27 illustrate the extracted codes from collected data through interviews and their relevant coding methods. The interview transcripts are attached in Appendix B.
Table 4.1. Open coding: coding raw data collected by interview 1.

<table>
<thead>
<tr>
<th>Interview No.: 1</th>
<th>Position: Project Manager</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interviewee Code: MT</td>
<td>Experience: 16 years</td>
</tr>
<tr>
<td>Type of Organization: EPC Contractor</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Coding Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>“To me engineering progress is a good indicator (to determine the conversion points).”</td>
<td>In vivo</td>
</tr>
<tr>
<td>Between 50% and 60% engineering most of critical decisions are made.</td>
<td>Process</td>
</tr>
<tr>
<td>More engineering means less contingency in lump sum price.</td>
<td>Descriptive</td>
</tr>
<tr>
<td>“It (conversion process) is much more on scope completion rather than engineering completion.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>30%, 60%, and 90% model review sessions</td>
<td>Process</td>
</tr>
<tr>
<td>Level of risk and contingency</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Vendor data</td>
<td>Descriptive</td>
</tr>
<tr>
<td>At 60% model review all vendor data for major equipment are received and pipe rack modules can be defined.</td>
<td>Process</td>
</tr>
<tr>
<td>Maybe 2 months after 60% model review could be a good point to convert the contract.</td>
<td>Process</td>
</tr>
<tr>
<td>Bulk materials</td>
<td>Descriptive</td>
</tr>
<tr>
<td>“Major part of civil work should be done before conversion.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>Early conversion will result in higher conversion factor.</td>
<td>Descriptive</td>
</tr>
<tr>
<td>“I have not used PDRI before, but the concept seems a very good and reliable metrics for measuring scope definition.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>“If EPC contractor (because of fast-tracking) is forced to start construction earlier, it means that he will get subcontractor’s bids earlier and will have realized the actual cost of construction to convert earlier.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>“Risk profile of the project and quantitative risk assessment could be another indicator to decide time of conversion.”</td>
<td>In vivo</td>
</tr>
</tbody>
</table>
Table 4.2. Open coding: coding raw data collected by interview 2.

<table>
<thead>
<tr>
<th>Interview No.: 2</th>
<th>Position: Engineering Manager</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interviewee Code: AL</td>
<td>Experience: 17 years</td>
</tr>
<tr>
<td>Type of Organization: EPC Contractor</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Coding Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lump sum turnkey contract</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Open Book Estimate (OBE)</td>
<td>Process</td>
</tr>
<tr>
<td>“Around 55%–60% of engineering could be suitable to convert, but generally is about to define the scope of work.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>Contract conversion</td>
<td>Process</td>
</tr>
<tr>
<td>Degree of engineering development</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Material take off (MTO)</td>
<td>Process</td>
</tr>
<tr>
<td>Reliability in MTO</td>
<td>Descriptive</td>
</tr>
<tr>
<td>“8–10 months after starting detailed engineering, you will be more confident about the quantities (for conversion to lump sum).”</td>
<td>In vivo</td>
</tr>
<tr>
<td>Piping and instrumentation diagrams (P&amp;IDs) mechanization</td>
<td>Process</td>
</tr>
<tr>
<td>3D model reviews</td>
<td>Process</td>
</tr>
<tr>
<td>Definition of quantities</td>
<td>Process</td>
</tr>
<tr>
<td>Scope of work</td>
<td>Descriptive</td>
</tr>
<tr>
<td>“I have never used PDRI before but the concept is more comprehensive than other indicators.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>Site construction constraints</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Fabrication constraints</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Local transportation and logistics costs and actual risks</td>
<td>Descriptive</td>
</tr>
<tr>
<td>“Purchase orders (POs) for long lead items (LLIs) should be placed before conversion.”</td>
<td>In vivo</td>
</tr>
</tbody>
</table>
Costs risk associated with construction site, logistic, and transportation constraints | Descriptive

Fast-tracking | Process

“POs for steel structure and piping also should be placed before conversion.” | In vivo

FEED | Process

Range of contingency (5%–10%) | Descriptive

| Table 4.3. Open coding: coding raw data collected by interview 3 |
|--------------------|----------------|
| **Interview No.: 03** | **Position: Company Representative** |
| **Interviewee Code: TS** | **Experience: 14 years** |
| **Type of Organization: Owner Company** | |
| Code | Coding Method |
| Scope is immature at FEED level | Descriptive |
| Converting the contract after FEED | Process |
| “In this case (conversion after FEED), immature scope would result in a price too high for the client to accept.” | In vivo |
| “I would say conversion after FEED is too early for both parties to agree on a lump sum price.” | In vivo |
| Unit rate (contract type) | Descriptive |
| Accuracy of estimate | Descriptive |
| Risk of quantities (MTO) | Descriptive |
| Risk of unit rates (by subcontractors) | Descriptive |
| “From a client’s perspective, conversion after around 60% engineering completeness is too late.” | In vivo |
| POs for all LLIs | Process |
| Phased conversion | Process |
Risk of productivity
Alliancing strategy
“I believe engineering completeness is a reliable indicator because it gives you confidence about the quantities and reasonable allowances.”
Bulk materials estimation
60% model review session
“We are using benchmarking for scope definition, but I am not familiar with PDRI.”
Early conversion
Contingency
“At 60% conversion, acceptable contingency for engineering and procurement would be in the range of 5%–10% and higher for construction.”
“Middle of (detailed) engineering could be the optimal point to convert.”
Early involvement of main parties in the project

<table>
<thead>
<tr>
<th>Table 4.4. Open coding: coding raw data collected by interview 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Interview No.: 04</strong></td>
</tr>
<tr>
<td><strong>Interviewee Code: SR</strong></td>
</tr>
<tr>
<td><strong>Position: Vice President</strong></td>
</tr>
<tr>
<td><strong>Experience: 38 years</strong></td>
</tr>
<tr>
<td><strong>Type of Organization: Consulting Company</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Coding Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detailed engineering</td>
<td>Process</td>
</tr>
<tr>
<td>Cost reimbursable</td>
<td>Descriptive</td>
</tr>
<tr>
<td>“Detailed engineering should be almost complete before conversion.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>“In project X, the conversion was at 90% model review.”</td>
<td>In vivo</td>
</tr>
</tbody>
</table>
“In many disputes cases (75% of cases) engineering incompleteness is an issue.”

| Cost overrun                       | Descriptive |
| Dispute (contractual)             | Descriptive |
| Risk of performance and productivity | Descriptive |
| “In a market like Alberta issues such as labour supply and productivity are significant risks.” | In vivo |
| Local market and economy          | Descriptive |
| Risks associated with lump sum approach | Descriptive |
| AACE International cost estimate classification | Process |
| Level of engineering completeness | Descriptive |
| Accuracy of the estimate          | Descriptive |
| The amount of contingency         | Descriptive |
| “There have been a lot of lump sum projects in Canada.” | In vivo |
| “The main concern (in Alberta) is poor productivity and efficiency.” | In vivo |

Table 4.5. Open coding: coding raw data collected by interview 5

| Interview No.: 05 | Position: Project Manager |
| Interviewee Code: PB | Experience: 9 years |
| Type of Organization: EPC Contractor | |

<table>
<thead>
<tr>
<th>Code</th>
<th>Coding Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Engineering definition is for sure an indication to know if it is the right time to convert the contract.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>Freezing the design basis</td>
<td>Process</td>
</tr>
<tr>
<td>“Scope definition is a key driver to decide conversion time.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>Number of interfaces between EPC contractor and third parties</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Uncertainty</td>
<td>Descriptive</td>
</tr>
<tr>
<td>----------------------------------------------------------------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>Management of contingencies</td>
<td>Process</td>
</tr>
<tr>
<td>Placing 70% of the POs for equipment</td>
<td>Process</td>
</tr>
<tr>
<td>Placing 50% of the POs of the bulk material</td>
<td>Process</td>
</tr>
<tr>
<td>60% of detailed engineering</td>
<td>Descriptive</td>
</tr>
<tr>
<td>P&amp;ID-IFH (Issue for HAZOP)</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Vendor data</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Fabrication and construction</td>
<td>Process</td>
</tr>
<tr>
<td>Site preparation</td>
<td>Process</td>
</tr>
<tr>
<td>Civil works</td>
<td>Process</td>
</tr>
<tr>
<td>Concrete and piling works</td>
<td>Process</td>
</tr>
<tr>
<td>Weather constraints</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Uncertain quantities</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Phased conversion (engineering and procurement (E&amp;P) earlier and construction (C) later)</td>
<td>Process</td>
</tr>
<tr>
<td>Reimbursable</td>
<td>Descriptive</td>
</tr>
<tr>
<td>PDRI</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Fast-tracking/overlapping</td>
<td>Process</td>
</tr>
<tr>
<td>“It’s too risky to convert the contract after FEED.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>Contingency range</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Open Book Estimate (OBE)</td>
<td>Process</td>
</tr>
<tr>
<td>Efficiency</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Productivity</td>
<td>Descriptive</td>
</tr>
<tr>
<td>“The level of interfering of the client in managing the project should be limited in a lump sum contract.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>“Canadian market should be adapted to lump sum approach.”</td>
<td>In vivo</td>
</tr>
</tbody>
</table>
Table 4.6. Open coding: coding raw data collected by interview 6

<table>
<thead>
<tr>
<th>Interview No.: 06</th>
<th>Interviewee Code: PA</th>
<th>Position: Engineering Manager</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of Organization: EPC Contractor</td>
<td>Experience: 18 years</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Coding Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPC converted lump sum</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Engineering and procurement (E&amp;P) prior to conversion</td>
<td>Process</td>
</tr>
<tr>
<td>Alberta labour cost</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Low productivity (Alberta)</td>
<td>Descriptive</td>
</tr>
<tr>
<td>“My view is that it is not a good idea to convert E&amp;P earlier and separately.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>“In small projects we have more flexibility with contract types. But, in mega projects the level of complexity is too high. Cost certainty is very important.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>Site preparation</td>
<td>Process</td>
</tr>
<tr>
<td>Structural steel activities</td>
<td>Process</td>
</tr>
<tr>
<td>Productivity</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Piping and welding</td>
<td>Process</td>
</tr>
<tr>
<td>Model review</td>
<td>Process</td>
</tr>
<tr>
<td>“Electrical discipline is another influencing discipline in lump sum estimate.”</td>
<td>In vivo</td>
</tr>
</tbody>
</table>
Table 4.7. Open coding: coding raw data collected by interview 7

<table>
<thead>
<tr>
<th>Interview No.: 07</th>
<th>Position: CEO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interviewee Code: LS</td>
<td>Experience: 35 years</td>
</tr>
<tr>
<td>Type of Organization: Consulting Company</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Coding Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decision gates strategy</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Front End Loading phases</td>
<td>Process</td>
</tr>
<tr>
<td>“If FEED will be done completely and accurately we can go with</td>
<td>In vivo</td>
</tr>
<tr>
<td>lump sum even from the start of EPC.”</td>
<td></td>
</tr>
<tr>
<td>“I suggest cost reimbursable contract price arrangement for pre-</td>
<td>In vivo</td>
</tr>
<tr>
<td>FEED and FEED phases.”</td>
<td></td>
</tr>
<tr>
<td>“Detailed engineering can be done under lump sum.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>Freezing the scope design</td>
<td>Process</td>
</tr>
<tr>
<td>Effective management of changes in lump sum stage</td>
<td>Process</td>
</tr>
<tr>
<td>“LLIs should be purchased up to the end of FEED phase.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>Collaborative environment</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Trust and transparency</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Relational strategies</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Partnership</td>
<td>Descriptive</td>
</tr>
<tr>
<td>“The level of relationships between contracting parties is very</td>
<td>In vivo</td>
</tr>
<tr>
<td>important. Convertible contracts need a collaborative environment</td>
<td></td>
</tr>
<tr>
<td>established based on trust and transparency for open book estimation</td>
<td></td>
</tr>
<tr>
<td>and fair price arrangement. Relational strategies such as partnership</td>
<td></td>
</tr>
<tr>
<td>would help to provide the required environment for convertible</td>
<td></td>
</tr>
<tr>
<td>contracts.”</td>
<td></td>
</tr>
<tr>
<td>Minimizing overlapping (fast-tracking)</td>
<td>Process</td>
</tr>
<tr>
<td>Systematic decision making process</td>
<td>Process</td>
</tr>
</tbody>
</table>
Table 4.8. Open coding: coding raw data collected by interview 8

<table>
<thead>
<tr>
<th>Interview No.: 08</th>
<th>Position: Project Manager</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interviewee Code: EZ</td>
<td>Experience: 22 years</td>
</tr>
<tr>
<td>Type of Organization: EPC Contractor</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Coding Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Risk is the key factor.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>“Based on my experience, the conversion period must be between 60% and 90% model review.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>Early work construction under unit rate</td>
<td>Process</td>
</tr>
<tr>
<td>Two-round conversion</td>
<td>Process</td>
</tr>
<tr>
<td>Acceptable range of contingency</td>
<td>Descriptive</td>
</tr>
<tr>
<td>“LLI items should be purchased before conversion for sure.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>“Bulk material piping and steel structural should be purchased before conversion.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>“I have not used PDRI in previous projects.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>High level of uncertainty in civil works (e.g., subsurface condition)</td>
<td>Descriptive</td>
</tr>
</tbody>
</table>

Table 4.9. Open coding: coding raw data collected by interview 9

<table>
<thead>
<tr>
<th>Interview No.: 09</th>
<th>Position: Project Control Manager</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interviewee Code: DG</td>
<td>Experience: 16 years</td>
</tr>
<tr>
<td>Type of Organization: Owner Company</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Coding Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>“We studied this strategy from 2 years ago, and we found development of detailed engineering as one of the important parameters in deciding conversion points.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>Vendor data</td>
<td>Descriptive</td>
</tr>
<tr>
<td>85% of equipment</td>
<td>Descriptive</td>
</tr>
<tr>
<td>60% of bulk material</td>
<td>Descriptive</td>
</tr>
<tr>
<td>----------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>“After 90% model review is the perfect time to convert the contract to lump sum.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>“If you are new (contractor) in the market, conversion at 60% means a lot of risks.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>Availability of skilled resources</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Risk premium</td>
<td>Descriptive</td>
</tr>
<tr>
<td>“You need to consider more risk premiums in this market condition.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>“To me conversion is all about how much risk contractor is able to take.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>“Less interface (between EPC contractor and third parties) is better in convertible contracts.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>“LLIs must be purchased before conversion.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>Productivity risks</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Contingency</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Strict risk management is required in convertible contracts</td>
<td>Process</td>
</tr>
<tr>
<td>Civil works</td>
<td>Process</td>
</tr>
<tr>
<td>Site preparation IFC drawings</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Unit rate (contract)</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Reimbursable contract</td>
<td>Descriptive</td>
</tr>
<tr>
<td>“In construction, if site preparation IFC drawings are available, we can do civil works under unit rate.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>“Piling and concrete are straightforward and can be done under unit rate.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>Module fabrication under unit rate</td>
<td>Process</td>
</tr>
<tr>
<td>Pipe fabrication under unit rate</td>
<td>Process</td>
</tr>
<tr>
<td>Code</td>
<td>Coding Method</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>---------------</td>
</tr>
<tr>
<td>“Phased contract price arrangements can be proposed based on the level of engineering and scope definition.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>Contract models</td>
<td>Descriptive</td>
</tr>
<tr>
<td>EPC phases</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Engineering services</td>
<td>Process</td>
</tr>
<tr>
<td>Procurement services</td>
<td>Process</td>
</tr>
<tr>
<td>Cost-plus fee</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Unit rate</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Reimbursable</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Subcontract packages</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Purchase of equipment</td>
<td>Process</td>
</tr>
<tr>
<td>Purchase of bulk materials</td>
<td>Process</td>
</tr>
<tr>
<td>90% model review</td>
<td>Process</td>
</tr>
<tr>
<td>Fabrication</td>
<td>Process</td>
</tr>
<tr>
<td>P&amp;ID-IFD</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Equipment data sheet</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Piping isometric (ISO) drawings</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Site preparation</td>
<td>Process</td>
</tr>
<tr>
<td>------------------</td>
<td>---------</td>
</tr>
<tr>
<td>Underground (UG) works</td>
<td>Process</td>
</tr>
<tr>
<td>Piling installation</td>
<td>Process</td>
</tr>
<tr>
<td>P&amp;ID-IFC</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Module assembly</td>
<td>Process</td>
</tr>
<tr>
<td>Finalized vendor data</td>
<td>Descriptive</td>
</tr>
</tbody>
</table>

### Table 4.11. Open coding: coding raw data collected by interview 11

<table>
<thead>
<tr>
<th>Interview No.: 11</th>
<th>Position: Project Manager</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interviewee Code: EF</td>
<td>Experience: 20 years</td>
</tr>
<tr>
<td>Type of Organization: EPC Contractor</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Coding Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>“There is no point to converting the contract where the market is not ready for lump sum.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>“As long as you can reasonably manage the risk, you can convert the contract. If not, you can’t.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>“Engineering definition is required to define the quantities, but nothing to do with execution strategy.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>Issues: unions, labour availability, logistic constraints</td>
<td>Descriptive</td>
</tr>
<tr>
<td>“It’s always about risk management, not engineering level.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>There is risk associated with local market, labour, environment, equipment, regulations, permits, etc.</td>
<td>Descriptive</td>
</tr>
<tr>
<td>“Metrics like PDRI are just supports for making decision. But it’s more reliable than just engineering maturity.”</td>
<td>In vivo</td>
</tr>
</tbody>
</table>
Table 4.12. Open coding: coding raw data collected by interview 12

<table>
<thead>
<tr>
<th>Code</th>
<th>Coding Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uniqueness of project</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Cultural differences</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Technical capability</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Experience in conversion contracts</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Understanding of the other organization (owner and contractor)</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Decision making</td>
<td>Process</td>
</tr>
<tr>
<td>Negotiated quotes from main equipment suppliers</td>
<td>Descriptive</td>
</tr>
<tr>
<td>About 70–80% of equipment purchase orders</td>
<td>Process</td>
</tr>
<tr>
<td>“Contractor will typically have to place orders before conversion.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>Detail design of all major items</td>
<td>Process</td>
</tr>
<tr>
<td>Level of the work breakdown structure (WBS)</td>
<td>Descriptive</td>
</tr>
<tr>
<td>“I have seen PDRI in the literature and suggest the definition index at conversion needs to be 70%–80%.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>“Site preparation can be done as a separate contract by the owner.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>Accuracy of cost estimate</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Contingency (for risk and uncertainty)</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Allowance (to cover known costs that have not been estimated in detail)</td>
<td>Descriptive</td>
</tr>
<tr>
<td>3–5% range of contingencies</td>
<td>Descriptive</td>
</tr>
</tbody>
</table>
### Table 4.13. Open coding: coding raw data collected by interview 13

<table>
<thead>
<tr>
<th>Code</th>
<th>Coding Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowing scope is important in convertible contracts</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Actual IFC drawing</td>
<td>Descriptive</td>
</tr>
<tr>
<td>“Used PDRI a number of times. A correctly completed PDRI can be a very valuable tool in the decision to convert.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>“All long leads, all tagged equipment, and at least a 60% (ideally 90%) takeoff bought in bulk (should be purchased before conversion to lump sum).”</td>
<td>In vivo</td>
</tr>
<tr>
<td>“Site preparation, deep undergrounds, shallow undergrounds and piling should be subcontracted before conversion. Foundations can be in or out.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>Site preparation – unit rates</td>
<td>Process</td>
</tr>
<tr>
<td>Piling – unit rates</td>
<td>Process</td>
</tr>
<tr>
<td>Concrete foundations – unit rates</td>
<td>Process</td>
</tr>
<tr>
<td>Module installation – lump sum</td>
<td>Process</td>
</tr>
<tr>
<td>“The more the overlap the less chance of a successful conversion. Overlap will lead to later conversion and may even preclude it.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>Physical engineering progress (actual IFCs)</td>
<td>Descriptive</td>
</tr>
<tr>
<td>“Contingency required on a project is directly linked to commitments and to incurred costs to date.”</td>
<td>In vivo</td>
</tr>
</tbody>
</table>

**Interview No.: 13**  
**Interviewee Code: PD**  
**Type of Organization: Owner Company**  
**Position: Director**  
**Experience: 38 years**
Table 4.14. Open coding: coding raw data collected by interview 14

<table>
<thead>
<tr>
<th>Code</th>
<th>Coding Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Most of risk and cost escalation come with cost of labour.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>Converting E&amp;P in advance</td>
<td>Process</td>
</tr>
<tr>
<td>“Early EP conversion may result in getting engineering and procurement done cheaply but not necessarily to the full satisfaction of construction objectives.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>Converting EP and C together</td>
<td>Process</td>
</tr>
<tr>
<td>Cost reimbursable provides more flexibility.</td>
<td>Descriptive</td>
</tr>
<tr>
<td>“In order to get to lump sum you have to understand quantities.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>Piping and electrical disciplines are critical.</td>
<td>Descriptive</td>
</tr>
<tr>
<td>“For conversion, more important than percentages of engineering progress or other values is when you have enough information to reasonably assess the risk.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>“60% model review is a reasonable point to start conversion.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>Specific components of PDRI should be taken into consideration not just the overall score.</td>
<td>Descriptive</td>
</tr>
<tr>
<td>“70%–80% of dollar value of equipment should be placed order before conversion.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>Risk assessment</td>
<td>Process</td>
</tr>
<tr>
<td>Contingency estimation</td>
<td>Process</td>
</tr>
</tbody>
</table>
Table 4.15. Open coding: coding raw data collected by interview 15

<table>
<thead>
<tr>
<th>Code</th>
<th>Coding Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>“In my previous experience, there was not a systematic approach to determine the conversion points. The contract was converted simply after placing POs for LLIs.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>Engineering maturity</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Cost reimbursable</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Unit price</td>
<td>Descriptive</td>
</tr>
<tr>
<td>“60% model review would be a reasonable point to convert the contract since the majority of bulk materials are defined as well as major equipment.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>“At 90% model review you would have all MTOs with high level of accuracy, but conversion can be done earlier after 60% and at an optimal point.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>“By converting the contract at 60% engineering completion, you may accept around 10% contingency in lump sum price.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>“At the end of FEED the contingency is around 15%.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>Site preparation</td>
<td>Process</td>
</tr>
<tr>
<td>Construction early works</td>
<td>Process</td>
</tr>
<tr>
<td>PDRI</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Execution strategy</td>
<td>Descriptive</td>
</tr>
<tr>
<td>“When you do fast-tracking you will increase the level of risks but I don’t think it will affect converting the contract.”</td>
<td>In vivo</td>
</tr>
</tbody>
</table>
Table 4.16. Open coding: coding raw data collected by interview 16

<table>
<thead>
<tr>
<th>Interview No.: 16</th>
<th>Interviewee Code: BR</th>
<th>Position: Project Manager</th>
<th>Experience: 20 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of Organization: Owner Company</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Coding Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>“It’s important to know the link between design maturity and specific equipment and bulk material.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>Cost certainty</td>
<td>Descriptive</td>
</tr>
<tr>
<td>“So, from my perspective both technical and commercial maturity are needed to come together to have potentially a successful conversion.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>EPC lump sum</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Commitment in implementation of the (convertible) model</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Environment (market) readiness for lump sum</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Relationship and trust</td>
<td>Descriptive</td>
</tr>
<tr>
<td>“So, another influencing factor is experience of the past and knowing how you do it (convertible contract).”</td>
<td>In vivo</td>
</tr>
<tr>
<td>Productivity risk</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Owner experience in managing lump sum</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Conversion period</td>
<td>Process</td>
</tr>
<tr>
<td>“As the owner, I would prefer to purchase specific LLIs before conversion.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>Weather condition</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Shortage of skilled resources</td>
<td>Descriptive</td>
</tr>
</tbody>
</table>
Table 4.17. Open coding: coding raw data collected by interview 17

<table>
<thead>
<tr>
<th>Code</th>
<th>Coding Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Completeness of detailed engineering</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Model reviews (30%–60%, 90%)</td>
<td>Process</td>
</tr>
<tr>
<td>Defining of quantities</td>
<td>Process</td>
</tr>
<tr>
<td>“At 60% model review the quality of engineering is not enough (for conversion) because vendor data is not included.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>“Early conversion to lump sum means lots of contingency.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>Engineering, procurement, and construction management (EPCM) contractor</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Incomplete FEED</td>
<td>Process</td>
</tr>
<tr>
<td>The risk of productivity</td>
<td>Descriptive</td>
</tr>
<tr>
<td>“Conversion timing depends on the performance of the contractor.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>Lump sum commitment from local subcontractors</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Uncertain subsurface condition</td>
<td>Descriptive</td>
</tr>
<tr>
<td>“In a lump sum scheme, owner shouldn’t dictate its approach to the contractor.”</td>
<td>In vivo</td>
</tr>
</tbody>
</table>
### Table 4.18. Open coding: coding raw data collected by interview 18

<table>
<thead>
<tr>
<th>Interview No.: 18</th>
<th>Position: Business Manager</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interviewee Code: FK</td>
<td>Experience: 16 years</td>
</tr>
<tr>
<td>Type of Organization: EPC Contractor</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Coding Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>“I highly believe that scope definition is the most important factor in deciding conversion.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>AACE International estimation classification system can be used to recognize the level of scope definition for a desired estimate accuracy at conversion time.</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Freezing design basis</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Bidding/award strategy</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Performing FEED and EPC with the same contractor</td>
<td>Process</td>
</tr>
<tr>
<td>FEED validation</td>
<td>Process</td>
</tr>
<tr>
<td>Less interface management</td>
<td>Process</td>
</tr>
<tr>
<td>Contractor early involvement</td>
<td>Process</td>
</tr>
<tr>
<td>Influencing factor on building range of contingencies:</td>
<td>Descriptive</td>
</tr>
<tr>
<td>- Organizational culture of the company and contractor</td>
<td></td>
</tr>
<tr>
<td>- Project complexity/using new technology</td>
<td></td>
</tr>
<tr>
<td>- Level of competition in the market</td>
<td></td>
</tr>
<tr>
<td>Availability of skilled labour</td>
<td>Descriptive</td>
</tr>
<tr>
<td>“Fast-tracking may delay the conversion time because it will result in more changes, errors, and reduce the productivity.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>“From a commercial point of view, contractor should guarantee its profit. So, the contractor should be rewarded for taking high levels of costs and productivity risks.”</td>
<td>In vivo</td>
</tr>
</tbody>
</table>
Table 4.19. Open coding: coding raw data collected by interview 19

<table>
<thead>
<tr>
<th>Interview No.: 19</th>
<th>Position: Engineering Manager</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interviewee Code: TF</td>
<td>Experience: 35 years</td>
</tr>
<tr>
<td>Type of Organization: EPC Contractor</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Coding Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>“If you want to implement convertible contracts, you need a definitive scope and frozen design basis before conversion.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>“So, the trust and collaborative relationship between contracting parties is a vital requirement for implementation of convertible contract. I would support partnership strategies based on the concept of pain share – gain share for convertible contracts.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>The AACE International cost estimate classification can be used to measure the level of scope definition. Would say conversion should be after level 4 estimate. Conversion after detailed engineering would be ideal. But considering schedule constraints it may happen earlier.</td>
<td>Descriptive</td>
</tr>
<tr>
<td>“I would not do conversion before 60% definitely.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>“Effective change management and change control is very important in managing convertible contracts.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>The range of estimate accuracy</td>
<td>Descriptive</td>
</tr>
<tr>
<td>“For construction, understanding the local market is very important. You need to have established relationship with local subcontractors and trades and have a good level of control in supply chain.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>Major risks in Alberta:</td>
<td>Descriptive</td>
</tr>
<tr>
<td>• Lack of skilled resources in Alberta</td>
<td></td>
</tr>
<tr>
<td>• Low productivity in Alberta</td>
<td></td>
</tr>
<tr>
<td>Advanced CWP for modularization</td>
<td>Process</td>
</tr>
</tbody>
</table>
Table 4.20. Open coding: coding raw data collected by interview 20

<table>
<thead>
<tr>
<th>Code</th>
<th>Coding Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>“To get cost certainty in lump sum contract you need high level of scope definition.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>Involvement of the contractor in the pre execution phases can help EPC contractor to provide more reliable lump sum bid.</td>
<td>Descriptive</td>
</tr>
<tr>
<td>“Conversion from cost reimbursable or unit rate to the lump sum can be done at 70%, 80%, or 90% of engineering completeness, but the main driver is the level of risk.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>“Critical equipment such as LLIs should be purchased before conversion in early stages even during the DBM phase, and the majority of equipment should be purchased during the EDS phase.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>“POs for structural steels and cables can be placed during the EDS, but IFC drawings for module fabrication need substantial engineering definition.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>The amount of contingencies depends on the level of engineering definition.</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Different work packages with different complexity can be converted at different levels of scope definition during the project life cycle.</td>
<td>Process</td>
</tr>
<tr>
<td>Construction work packages with less complexity such as civil works can be converted earlier but those with more complexity that need more scope definition such as I&amp;C can be converted later.</td>
<td>Process</td>
</tr>
<tr>
<td>Contractor efficiency is very important when converting to the lump sum.</td>
<td>Descriptive</td>
</tr>
</tbody>
</table>
Table 4.21. Open coding: coding raw data collected by interview 21

<table>
<thead>
<tr>
<th>Interview No.: 21</th>
<th>Interviewee Code: MM</th>
<th>Type of Organization: Owner</th>
<th>Position: Project Manager</th>
<th>Experience: 24 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code</td>
<td>Coding Method</td>
<td>------------------------------</td>
<td>---------------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>In a lump sum contract, risk of productivity and cost certainty is on contractor’s shoulder.</td>
<td>Descriptive</td>
<td>------------------------------</td>
<td>---------------------</td>
<td></td>
</tr>
<tr>
<td>The risk of scope uncertainty is owned by the project owner.</td>
<td>Descriptive</td>
<td>------------------------------</td>
<td>---------------------</td>
<td></td>
</tr>
<tr>
<td>“In my view, the success of a lump sum contract is based on the level of scope definition, and it is the most important factor in deciding conversion point.”</td>
<td>In vivo</td>
<td>------------------------------</td>
<td>---------------------</td>
<td></td>
</tr>
<tr>
<td>“There is not a certain answer for conversion time. It depends on the project priorities and engineering and construction schedule.”</td>
<td>In vivo</td>
<td>------------------------------</td>
<td>---------------------</td>
<td></td>
</tr>
<tr>
<td>Around class 3 of cost estimate system could be an optimal point to convert the contract.</td>
<td>Process</td>
<td>------------------------------</td>
<td>---------------------</td>
<td></td>
</tr>
<tr>
<td>The more involvement of the owner in management of the project means more risk of changes and relevant issues.</td>
<td>Descriptive</td>
<td>------------------------------</td>
<td>---------------------</td>
<td></td>
</tr>
<tr>
<td>“It’s very important that owner and EPC contractor have matching organizational culture.”</td>
<td>In vivo</td>
<td>------------------------------</td>
<td>---------------------</td>
<td></td>
</tr>
<tr>
<td>Adversarial project environment is one of the major risks.</td>
<td>Descriptive</td>
<td>------------------------------</td>
<td>---------------------</td>
<td></td>
</tr>
<tr>
<td>Continuous changes of the scope by the client are a major risk to convertible lump sum contract.</td>
<td>Descriptive</td>
<td>------------------------------</td>
<td>---------------------</td>
<td></td>
</tr>
<tr>
<td>“I believe that the healthy relationship between contracting parties is a vital requirement for the success of the project.”</td>
<td>In vivo</td>
<td>------------------------------</td>
<td>---------------------</td>
<td></td>
</tr>
<tr>
<td>During the lump sum stage, owner involvement should be limited in the management of the project.</td>
<td>Descriptive</td>
<td>------------------------------</td>
<td>---------------------</td>
<td></td>
</tr>
<tr>
<td>EPC contractor in this market doesn’t have lump sum experience. International EPC contractor with experience around the world can bring lump sum experience to this market.</td>
<td>Descriptive</td>
<td>------------------------------</td>
<td>---------------------</td>
<td></td>
</tr>
</tbody>
</table>
Table 4.22. Open coding: coding raw data collected by interview 22

<table>
<thead>
<tr>
<th>Code</th>
<th>Coding Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firmness and level of detail in the design are the most important factors in deciding the conversion points in convertible contracts.</td>
<td>Descriptive</td>
</tr>
<tr>
<td>“If the design has potential to change then there will either be many change orders or construction will be difficult to price and a fixed price contract won’t be possible.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>The engineering completeness would be a reliable indicator to decide the conversion time depending on how detailed the project plan is and/or how well the scope is defined.</td>
<td>Descriptive</td>
</tr>
<tr>
<td>The better the project scope is defined the better it will be to develop the project plan and the easier it will be to determine the percentage of engineering completion. This would then allow a more deterministic approach to decide on the conversion point.</td>
<td>Descriptive</td>
</tr>
<tr>
<td>If the lead times of equipment and materials are long, then the amount of POs placed would be related to procurement lead times. These purchases though could be added to the fixed price portion of the contract as part of the estimation process or could be separated out as a different part of the contract.</td>
<td>Process</td>
</tr>
<tr>
<td>“The earlier the conversion time the less accurate the cost estimate will be for the fixed price portion and the greater the contingency that would need to be added.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>Depending on the conversion time, less emphasis will have to be placed on price and more emphasis will have to be placed on technical, management, and quality evaluations of qualified contractors.</td>
<td>Process</td>
</tr>
<tr>
<td>An objective method of determining the fixed price for that portion of</td>
<td>Descriptive</td>
</tr>
</tbody>
</table>

Interview No.: 22
Interviewee Code: SZ
Type of Organization: Consulting Company
Position: President
Experience: 37 years
the contract would have to be established.

From the contractor’s point of view, converting too early when there is still substantial uncertainty in the scope and design could carry the risk of under bidding and thus incurring a loss. This could also be a risk to the owner if early conversion results in financial difficulty to the contractor.

From the owner’s perspective, converting later creates a greater challenge for cost control and has a greater chance of cost overruns and thus financial risks for the owner.

Acceptable contingencies would depend on the conversion time, planning detail, and scope definition.

### Table 4.23. Open coding: coding raw data collected by interview 23

<table>
<thead>
<tr>
<th>Code</th>
<th>Coding Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>The level of project definition at different stages of design will drive conversion decision.</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Early conversion is risky.</td>
<td>Descriptive</td>
</tr>
<tr>
<td>If the scope is well defined, the FEED can be performed under cost reimbursable and EPC under lump sum contract.</td>
<td>Process</td>
</tr>
<tr>
<td>Previous experience in similar projects, market condition, and the level of competition are also important factors in conversion timing.</td>
<td>Descriptive</td>
</tr>
<tr>
<td>“A robust and effective change management system should be in place to address the changes after conversion to lump sum.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>Conversion should happen during the detailed engineering and between 40% and 50% engineering completion.</td>
<td>Process</td>
</tr>
</tbody>
</table>
From project control point of view, it is important to monitor the project performance trend and link it to the project risk and based on it decide the conversion timing.

| "In general, SPI* and CPI* greater than 1 means that the conversion can be done earlier." | Descriptive |
| It’s better to get budgetary quotes for major items before conversion to lump sum. | Process |
| Critical bulk materials to be ordered before conversion to lump sum are structural steel, cables, and piping materials. | Process |
| "The range of acceptable contingency amount can be between 5% and 15%." | In vivo |
| "Market environment in North America is not ready for lump sum." | Descriptive |
| Project owners in North America have a tendency to have more control in the project. More involvement of the client will result in more changes that would be the source of claim and disputes in a lump sum contract. | Descriptive |
| "The risk of lump sum should be transferred to subcontractors and suppliers through LDs*." | In vivo |

*SPI, schedule performance index; CPI, cost performance index; LD, liquidated damages
Table 4.24. Open coding: coding raw data collected by interview 24

<table>
<thead>
<tr>
<th>Interview No.: 24</th>
<th>Position: Engineering Manager</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interviewee Code: TC</td>
<td>Experience: 24 years</td>
</tr>
<tr>
<td>Type of Organization: EPC Contractor</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Coding Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Based on my experience, the most important factor in successfully management of convertible contracts is trust and respect between owner and EPC contractor.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>In Canadian oil and gas projects, it is very common that owners want to have high control in management of project. This would be an issue in convertible lump sum contract.</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Collaboration between the owner and EPC contractor at high levels of organization is essential to establish a win–win culture in the project environment.</td>
<td>Descriptive</td>
</tr>
<tr>
<td>“I worked in a project with alliancing relational strategy which was a successful experience.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>One option is to convert the contract after the FEED. But it is a high risk scenario.</td>
<td>Process</td>
</tr>
<tr>
<td>One option is to convert the engineering to lump sum at the end of FEED, and use a mixed contract price arrangement for different work packages until around 80% of engineering, and at that point convert the rest of the project to a single lump sum contract.</td>
<td>Process</td>
</tr>
<tr>
<td>Inadequate skilled worker, labour productivity, site condition, project remote locations are major risks in Alberta and Canadian oil and gas industry.</td>
<td>Descriptive</td>
</tr>
<tr>
<td>One of the highest risks in convertible contracts is scope management and continuous change. Scope should be frozen by the owner.</td>
<td>Descriptive</td>
</tr>
<tr>
<td>“Considering the proper planning and having engineering completeness around 80%, the contingency can be between 7% and 10%.”</td>
<td>In vivo</td>
</tr>
</tbody>
</table>
Table 4.25. Open coding: coding raw data collected by interview 25

<table>
<thead>
<tr>
<th>Interview No.: 25</th>
<th>Position: Engineering Manager</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interviewee Code: MP</td>
<td>Experience: 28 years</td>
</tr>
<tr>
<td>Type of Organization: EPC Contractor</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Coding Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>“I think that any contracts are based on one simple formula: risk associated, timing, and quality.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>Later conversion and more engineering completeness means less contingency and risk premium and early conversion needs more contingency to cover the higher risks.</td>
<td>Descriptive</td>
</tr>
<tr>
<td>Important factors that influence the conversion strategy are project priorities defined by the owner and execution strategies such as fast-tracking. Changing strategies by the owner is a major risk in lump sum contracts.</td>
<td>Descriptive</td>
</tr>
<tr>
<td>“In my view, a successful lump sum contract has zero changes in scope.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>“The level of complexity of the project is also an important factor in deciding the conversion points.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>Theoretically, around 60% of engineering progress would be an optimal point to convert to lump sum.</td>
<td>Process</td>
</tr>
<tr>
<td>Developing advanced construction work packages can enhance the modularization and minimize the cost risk of lump sum associated with site construction.</td>
<td>Process</td>
</tr>
</tbody>
</table>
Table 4.26. Open coding: coding raw data collected by interview 26

<table>
<thead>
<tr>
<th>Interview No.: 26</th>
<th>Position: Technical Manager</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interviewee Code: AK</td>
<td>Experience: 15 years</td>
</tr>
<tr>
<td>Type of Organization: EPC Contractor</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Coding Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering progress, 3D model review completeness and accuracy of extracted MTOs, Placement of POs for long lead items and major equipment are the most important factors in deciding the conversion points in convertible contracts.</td>
<td>Descriptive</td>
</tr>
<tr>
<td>The percentage of engineering progress must be considered as a major indicator to decide the conversion points however it should be considered in conjunction with procurement progress, fabrication / construction strategy and SOW.</td>
<td>Descriptive</td>
</tr>
<tr>
<td>“A reliable tool to measure the level of project scope definition is PDRI.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>POs for long lead items and all major equipment that require to be engineered must be placed before conversion to lump sum as well as structural steel and piping bulk items.</td>
<td>Process</td>
</tr>
<tr>
<td>The main construction packages that should be subcontracted prior to conversion are site preparation, undergrounds and piling. The fabrication of pipe-rack and equipment modules also should be in place.</td>
<td>Process</td>
</tr>
<tr>
<td>“OBEs are effective tool to estimate quantities.”</td>
<td>In vivo</td>
</tr>
<tr>
<td>The major risks includes introducing late changes to the project scope by client, not freezing the basis of design at early stages of the project engineering and lack of trust between parties.</td>
<td>Descriptive</td>
</tr>
<tr>
<td>In convertible contracts if conversion points principles and associated risks are respected, contingency should be under 15%.</td>
<td>Descriptive</td>
</tr>
</tbody>
</table>
Table 4.27. Open coding: coding raw data collected by interview 27

<table>
<thead>
<tr>
<th>Interview No.: 27</th>
<th>Position: Engineering Manager</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interviewee Code: AT</td>
<td>Experience: 15 years</td>
</tr>
<tr>
<td>Type of Organization: Engineering Consulting</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Coding Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>I would suggest the following conversion points:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Process</td>
</tr>
<tr>
<td>- End of FEED (depending on the number if items in the punch list prepared as the result of FEED endorsement)</td>
<td></td>
</tr>
<tr>
<td>- Finalizing geotechnical investigations</td>
<td></td>
</tr>
<tr>
<td>- Finalizing LLIs and selecting vendors for them</td>
<td></td>
</tr>
<tr>
<td>- Finalizing P&amp;IDs</td>
<td></td>
</tr>
</tbody>
</table>

| The conversion points must be decided based on the maturity and completeness of the scope at each stage. | Descriptive |
| “Being able to carry out more robust and reliable estimates is the key.” | In vivo |
| I would suggest the LLIs to be excluded from the scope of the lump sum general contract. | Process |
| I would suggest the early works such as site preparation and infrastructure outside the main area to be awarded before the overall lump sum contract. | Process |
| Under certain circumstances, OBE could be a reasonable approach. For example, when the client and the prospective contractor have worked many times together in the past and there is enough benchmark in place for comparison. | Descriptive |
| The criteria (for conversion) should be jointly developed considering particulars of the project rather than being imposed by the owner. | Process |
| Sometimes owners push for conversion when the scope is not yet well developed and this would cause major problems down the track. I would suggest a maximum 15% contingency is reasonable. | Descriptive |
Step 2: Categorizing identified codes and concepts

After giving the conceptual names to the raw data, they were categorized to more abstract terms presenting higher levels of concepts by the constant comparisons process. As a result, identified codes were grouped in eight categories as shown in Tables 4.28 to 4.35. Also, to develop the concepts and illustrate their properties and dimensions, some memos and diagrams were created for established categories.

Table 4.28. Open coding: “Scope Definition” category

<table>
<thead>
<tr>
<th>Scope Definition Category</th>
<th>Identified Codes</th>
<th>Interview No.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>“It (conversion process) is much more on scope completion rather than engineering completion.”</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>“Around 55%–60% of engineering could be suitable to convert, but generally is about to define the scope of work.”</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>“We are using benchmarking for scope definition, but I am not familiar with PDRI.”</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>“Scope definition is a key driver to decide conversion time.”</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Freezing the scope design is critical in convertible lump sum contracts.</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>“I have not used PDRI in previous projects.”</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>“Phased contract price arrangements can be proposed based on the level of engineering and scope definition.”</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>“Metrics like PDRI are just supports for making decision. But it’s more reliable than just engineering maturity.”</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Knowing scope is important in convertible contracts.</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>“Used PDRI a number of times. A correctly completed PDRI can be a very valuable tool in the decision to convert.”</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Specific components of PDRI should be taken into consideration, not</td>
<td>14</td>
</tr>
<tr>
<td>Identified Codes</td>
<td>Interview No.</td>
<td></td>
</tr>
<tr>
<td>------------------</td>
<td>--------------</td>
<td></td>
</tr>
<tr>
<td>just the overall score.</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>• “I highly believe that scope definition is the most important factor in deciding conversion.”</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>• Freezing design basis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• “If you want to implement convertible contracts, you need a definitive scope and frozen design basis before conversion.”</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>• “To get cost certainty in lump sum contract you need high level of scope definition.”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• “In my view, the success of a lump sum contract is based on the level of scope definition and it is the most important factor in deciding conversion point.”</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>• The risk of scope uncertainty is owned by the project owner.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Continuous changes of the scope by the client are a major risk to convertible lump sum contract.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• The better the project scope is defined the better it will be to develop the project plan and the easier it will be to determine the percentage of engineering completion.</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>• The level of project scope definition at different stages of design will drive conversion decision.</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>• One of the highest risks in convertible contracts is scope management and continuous change.</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>• In convertible lump sum contracts, design basis should be frozen early by the owner.</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>• “In my view, a successful lump sum has zero changes in scope.”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• “A reliable tool to measure the scope definition is PDRI.”</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>• The conversion points must be decided based on the maturity and completeness of the scope at each stage.</td>
<td>27</td>
<td></td>
</tr>
</tbody>
</table>
Analytic memo: Most participants believe that only a percentage of engineering completion cannot be a reliable factor to determine the conversion points in convertible contracts. Scope is a more comprehensive concept and reliable indicator to form the conversion process during the project life cycle. While engineering completeness only presents the level of engineering definition, scope covers a broader area of project concerns such as business objectives, design basis, execution strategy, technology, and site location. Some participants emphasized the importance of freezing design basis before conversion.

Few participants were aware of the Project Definition Rating Index (PDRI) developed by the Construction Industry Institute (CII) to evaluate the level of scope definition in industrial projects. However, after presenting PDRI elements, most of the participants confirmed that PDRI can be used as a reliable tool to measure the level of project definition and help decision makers in determining conversion points.

Table 4.29. Open coding: “Contract Price Arrangement” category

<table>
<thead>
<tr>
<th>Identified Codes</th>
<th>Interview No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Lump sum price</td>
<td>1</td>
</tr>
<tr>
<td>• Lump sum turnkey contract</td>
<td>2</td>
</tr>
<tr>
<td>• Unit rate (contract type)</td>
<td>3</td>
</tr>
<tr>
<td>• Cost reimbursable</td>
<td>4</td>
</tr>
<tr>
<td>• “I suggest cost reimbursable contract price arrangement for pre-FEED and FEED phases.”</td>
<td>7</td>
</tr>
<tr>
<td>• “Detailed engineering can be done under lump sum.”</td>
<td></td>
</tr>
<tr>
<td>• “Piling and concrete are straightforward and can be done under unit rate.”</td>
<td>9</td>
</tr>
<tr>
<td>• Module fabrication under unit rate</td>
<td></td>
</tr>
</tbody>
</table>
### Contract Price Arrangement Category

<table>
<thead>
<tr>
<th>Identified Codes</th>
<th>Interview No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Pipe fabrication under unit rate</td>
<td></td>
</tr>
<tr>
<td>• Cost-plus fee/Unit rate/Reimbursable</td>
<td>10</td>
</tr>
<tr>
<td>• “Site preparation can be done as a separate contract by the Owner.”</td>
<td>12</td>
</tr>
<tr>
<td>• I suggest following contract types for specified work packages:</td>
<td>13</td>
</tr>
<tr>
<td>• Site preparation – unit rates</td>
<td></td>
</tr>
<tr>
<td>• Piling – unit rates</td>
<td></td>
</tr>
<tr>
<td>• Concrete foundations – unit rates</td>
<td></td>
</tr>
<tr>
<td>• Module installation – lump sum</td>
<td></td>
</tr>
<tr>
<td>• Cost reimbursable provides more flexibility.</td>
<td>14</td>
</tr>
<tr>
<td>• Cost reimbursable/Unit price</td>
<td>15</td>
</tr>
<tr>
<td>• EPC lump sum</td>
<td>16</td>
</tr>
<tr>
<td>• Uncertain subsurface condition urges unit rate contracts for civil works.</td>
<td>17</td>
</tr>
<tr>
<td>• Different work packages with different complexity may have</td>
<td>20</td>
</tr>
<tr>
<td>different contract price arrangements and can be converted at</td>
<td></td>
</tr>
<tr>
<td>different levels of scope definition during the project life cycle.</td>
<td></td>
</tr>
<tr>
<td>• Critical bulk materials to be ordered before conversion to lump sum</td>
<td>23</td>
</tr>
<tr>
<td>are structural steel, cables, and piping materials.</td>
<td></td>
</tr>
<tr>
<td>• One option is to convert the engineering to lump sum at the end of FEED, and</td>
<td>24</td>
</tr>
<tr>
<td>use a mixed contract price arrangement for different work packages until</td>
<td></td>
</tr>
<tr>
<td>around 80% of engineering, and at that point convert the rest of the project</td>
<td></td>
</tr>
<tr>
<td>to a single lump sum contract.</td>
<td></td>
</tr>
</tbody>
</table>
**Analytic memo:** The phased contract price arrangement is an essential concept in convertible contracts. It means different contract types can be used during the project life cycle to optimize risk taking/rewarding by contracting parties. The project contract price arrangement can be changed between cost reimbursable, unit rate, and lump sum through the project phases.

Some participants specified the proper contract price arrangements for particular phases or deliverables during the project life cycle. The proposed contract price arrangements were mainly based on the level of scope definition, engineering completeness, and level of uncertainties at different stages of project execution.

Table 4.30. Open coding: “Conversion Strategy” category

<table>
<thead>
<tr>
<th>Conversion Strategy Category</th>
<th>Identified Codes</th>
<th>Interview No.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Between 50% and 60% engineering most of critical decisions are made.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>• “Maybe 2 months after 60% model review could be a good point to convert the contract.”</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• “If EPC contractor (because of fast-tracking) is forced to start construction earlier, it means that he will get subcontractor’s bids earlier and will have realized actual cost of construction to convert earlier.”</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• “Around 55%–60% of engineering could be suitable to convert, but generally is about to define the scope of work.”</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>• “8–10 months after starting detailed engineering, you will be more confident about the quantities (for conversion to lump sum).”</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• “I would say conversion after FEED is too early for both parties to agree on a lump sum price.”</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>• “From a client’s perspective, conversion after around 60% engineering completeness is too late.”</td>
<td></td>
</tr>
</tbody>
</table>
### Conversion Strategy Category

<table>
<thead>
<tr>
<th>Identified Codes</th>
<th>Interview No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>• “Middle of (detailed) engineering could be the optimal point to convert.”</td>
<td></td>
</tr>
<tr>
<td>• “Detailed engineering should be almost complete before conversion.”</td>
<td>4</td>
</tr>
<tr>
<td>• “It’s too risky to convert the contract after FEED.”</td>
<td>5</td>
</tr>
<tr>
<td>• Phased conversion (E&amp;P earlier and C later)</td>
<td></td>
</tr>
<tr>
<td>• “My view is that it is not a good idea to convert E&amp;P earlier and separately.”</td>
<td>6</td>
</tr>
<tr>
<td>• Decision gates strategy can help the conversion process.</td>
<td>7</td>
</tr>
<tr>
<td>• “If FEED will be done completely and accurately we can go with lump sum even from the start of EPC.”</td>
<td></td>
</tr>
<tr>
<td>• “Based on my experience, the conversion period must be between 60% and 90% model review.”</td>
<td>8</td>
</tr>
<tr>
<td>• Two-round conversion</td>
<td></td>
</tr>
<tr>
<td>• “After 90% model review is the perfect time to convert the contract to lump sum.”</td>
<td>9</td>
</tr>
<tr>
<td>• “If you are new (contractor) in the market, conversion at 60% means a lot of risks.”</td>
<td></td>
</tr>
<tr>
<td>• Phased contract price arrangements can be proposed based on the level of engineering and scope definition.”</td>
<td>10</td>
</tr>
<tr>
<td>• “The more the overlap the less chance of a successful conversion. Overlap will lead to later conversion and may even preclude it.”</td>
<td>13</td>
</tr>
<tr>
<td>• “Early EP conversion may result in getting done engineering and procurement cheaply but not necessarily to the full satisfaction of construction objectives.”</td>
<td>14</td>
</tr>
<tr>
<td>• “60% model review is a reasonable point to start conversion.”</td>
<td></td>
</tr>
<tr>
<td>• “In my previous experience, there was not a systematic approach to</td>
<td>15</td>
</tr>
<tr>
<td>Identified Codes</td>
<td>Interview No.</td>
</tr>
<tr>
<td>------------------</td>
<td>---------------</td>
</tr>
<tr>
<td>determine the conversion points. The contract was converted simply after placing POs for LLIs.”</td>
<td>132</td>
</tr>
<tr>
<td>“60% model review would be a reasonable point to convert the contract since the majority of bulk materials are defined as well as major equipment.”</td>
<td></td>
</tr>
<tr>
<td>“At 90% model review you would have all MTOs with high level of accuracy, but conversion can be done earlier after 60% and at an optimal point.”</td>
<td></td>
</tr>
<tr>
<td>“When you do fast-tracking you will increase the level of risks but I don’t think it will affect on converting the contract.”</td>
<td></td>
</tr>
<tr>
<td>“So, another influencing factor is experience of the past and knowing how you do it (convertible contract).”</td>
<td>16</td>
</tr>
<tr>
<td>“Conversion timing depends on the performance of the contractor.”</td>
<td>17</td>
</tr>
<tr>
<td>“Fast-tracking may delay the conversion time because it will result in more changes, errors, and reduce the productivity.”</td>
<td>18</td>
</tr>
<tr>
<td>“I would not do conversion before 60% definitely.”</td>
<td>19</td>
</tr>
<tr>
<td>“Effective change management and change control is very important in managing convertible contracts.”</td>
<td></td>
</tr>
<tr>
<td>“Conversion from cost reimbursable or unit rate to the lump sum can be done at 70%, 80%, or 90% of engineering completeness but the main driver is the level of risk.”</td>
<td>20</td>
</tr>
<tr>
<td>When the accuracy of estimate is around class 3 of cost estimate system, it could be an optimal point to convert the contract.</td>
<td>21</td>
</tr>
<tr>
<td>From the contractor’s point of view, converting too early when there is still substantial uncertainty in the scope and design could carry the risk of under bidding and thus incurring a loss. This could also be a risk to the owner if early conversion results in financial difficulty to the contractor. From the owner’s perspective, converting later</td>
<td>22</td>
</tr>
<tr>
<td>Conversion Strategy Category</td>
<td></td>
</tr>
<tr>
<td>-----------------------------</td>
<td></td>
</tr>
<tr>
<td><strong>Identified Codes</strong></td>
<td><strong>Interview No.</strong></td>
</tr>
<tr>
<td>creates a greater challenge for cost-control and has a greater chance of cost overruns and thus financial risks for the owner.</td>
<td></td>
</tr>
</tbody>
</table>
| - Previous experience in similar projects, market condition, and the level of competition are also important factors in conversion timing.  
  - Conversion should happen during the detailed engineering and between 40% and 50% engineering completion. | 23 |
| - One option is to convert the contract after the FEED. But it is a high risk scenario. One option is to convert the engineering to lump sum at the end of FEED, and use a mixed contract price arrangement for different work packages until around 80% of engineering, and at that point convert the rest of the project to a single lump sum contract. | 24 |
| - “The level of complexity of the project is also an important factor in deciding the conversion points.”  
  - Theoretically, around 60% of engineering progress would be an optimal point to convert to lump sum. | 25 |
| - Engineering progress, 3D model review completeness and accuracy of extracted MTOs, Placement of POs for long lead items and major equipment are the most important factors in deciding the conversion points in convertible contracts. | 26 |
| I would suggest the following conversion points: | 27 |
| - End of FEED (depending on the number if items in the punch list prepared as the result of FEED endorsement)  
  - Finalizing geotechnical investigations  
  - Finalizing LLIs and selecting vendors for them  
  - Finalizing P&IDs |
Analytic memo: Conversion strategy was a challenging subject in all interviews. Phased conversion was suggested by most of the participants by which engineering and procurement phases can be converted to a single lump sum contract earlier and the construction phase in later stages of the project. Also, a mixed contract price arrangement including cost reimbursable, unit rate, and lump sum was suggested for different work packages before converting the whole contract to a single lump sum contract.

Most experts proposed different conversion periods and strategies based on their experience in previous or current projects. The proposed conversion strategies could mainly fall into one of the following strategies:

- Proposing a mixed contract price arrangement up to the end of the FEED and a single lump sum contract for the whole EPC
- Proposing a mixed contract price arrangement up to the 60% model review session and a single lump sum contract for the rest of the project
- Proposing a mixed contract price arrangement up to the 90% model review session and a single lump sum contract for the rest of the project

However, most participants believed that conversion to a single lump sum contract after FEED is highly risky and an EPC contractor may not be able to manage these high levels of risk and uncertainties. Although the conversion strategy is highly related to the risk attitude of contracting parties, the collected data show that between 60% and 90% model review sessions might be a more reasonable conversion period.
### Table 4.31. Open coding: “Engineering Completeness” category

<table>
<thead>
<tr>
<th>Identified Codes</th>
<th>Interview No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>• “To me engineering progress is a good indicator (to determine the conversion points)”</td>
<td>1</td>
</tr>
<tr>
<td>• 30%, 60%, and 90% model review sessions</td>
<td></td>
</tr>
<tr>
<td>• Degree of engineering development</td>
<td>2</td>
</tr>
<tr>
<td>• “8–10 months after starting detailed engineering, you will be more confident about the quantities (for conversion to lump sum).”</td>
<td></td>
</tr>
<tr>
<td>• 3D model reviews</td>
<td></td>
</tr>
<tr>
<td>• 60% engineering completeness</td>
<td>3</td>
</tr>
<tr>
<td>• 60% model review session</td>
<td></td>
</tr>
<tr>
<td>• 90% model review</td>
<td>4</td>
</tr>
<tr>
<td>• “Engineering definition is for sure an indication to know if it is the right time to convert the contract.”</td>
<td>5</td>
</tr>
<tr>
<td>• 60% of detailed engineering</td>
<td></td>
</tr>
<tr>
<td>• Between 60% to 90% model review</td>
<td>8</td>
</tr>
<tr>
<td>• 30%, 60%, 90% model review</td>
<td>9</td>
</tr>
<tr>
<td>• 60% model review</td>
<td>14</td>
</tr>
<tr>
<td>• Engineering maturity</td>
<td>15</td>
</tr>
<tr>
<td>• Incomplete FEED</td>
<td>17</td>
</tr>
<tr>
<td>• FEED validation</td>
<td>18</td>
</tr>
<tr>
<td>• “I would not do conversion before 60% engineering completeness definitely.”</td>
<td>19</td>
</tr>
<tr>
<td>• “Conversion from cost reimbursable or unit rate to the lump sum can be done at 70%, 80%, or 90% of engineering completeness but the main driver is the level of risk.”</td>
<td>20</td>
</tr>
<tr>
<td>• Firmness and level of detail in the design are the most important</td>
<td>22</td>
</tr>
</tbody>
</table>
Engineering Completeness Category

<table>
<thead>
<tr>
<th>Identified Codes</th>
<th>Interview No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>factors in deciding the conversion points in convertible contracts.</td>
<td></td>
</tr>
<tr>
<td>• Conversion should happen during the detailed engineering and between 40% and</td>
<td>23</td>
</tr>
<tr>
<td>50% engineering completion.</td>
<td></td>
</tr>
<tr>
<td>• “Considering the proper planning and having engineering completeness around</td>
<td>24</td>
</tr>
<tr>
<td>80%, the contingency can be between 7% and 10%.”</td>
<td></td>
</tr>
<tr>
<td>• Theoretically, around 60% of engineering progress would be an optimal point to</td>
<td>25</td>
</tr>
<tr>
<td>convert to lump sum.</td>
<td></td>
</tr>
<tr>
<td>• The percentage of engineering progress must be considered as a major indicator</td>
<td>26</td>
</tr>
<tr>
<td>to decide the conversion points however it should be considered in conjunction</td>
<td></td>
</tr>
<tr>
<td>with procurement progress, fabrication / construction strategy and SOW.</td>
<td></td>
</tr>
</tbody>
</table>

Analytic memo: The basic level of concepts extracted from interviews and relevant documents indicates that the level of engineering maturity is an essential factor in deciding conversion points. The reliability of material take off (MTO) and subsequently the accuracy of estimating highly depend on the level of engineering definition.

Although most experts have emphasized that the degree of engineering completeness is not the only factor to decide the conversion time and project scope as a whole should be taken into consideration, there are several in vivo codes that suggest specific engineering milestones to convert the contract. In particular, end of the FEED or start of detailed engineering when engineering completeness is around 30%, after 60% Plant 3D model review (MR) session, between 60% and 90% MR sessions, or after 90% MR session are engineering milestones frequently suggested to convert the contract.
Figure 4.1 provides a pictorial support for the written memo for the Engineering Completeness category.

Figure 4.1. Open coding: Analytic diagram for “Engineering Completeness” category

Table 4.32. Open coding: “Major Deliverables” category

<table>
<thead>
<tr>
<th>Major Deliverables Category</th>
<th>Identified Codes</th>
<th>Interview No.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Vendor data</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>• Major equipment, pipe rack modules, bulk materials</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• “Major part of civil work should be done before conversion.”</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• “Purchase orders (POs) for long lead items (LLIs) should be placed before conversion.”</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>• “POs for steel structure and piping also should be placed before conversion.”</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• POs for all LLIs</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>• Placing 70% of the POs for equipment</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>• Placing 50% of the POs of the bulk material</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Site preparation, structural steel activities, piping and welding</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>• “Electrical discipline is another influencing discipline in lump sum estimate.”</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• “LLIs should be purchased up to the end of FEED phase.”</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>• “LLI items should be purchased before conversion for sure.”</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>• “Bulk material piping and steel structural should be purchased before conversion.”</td>
<td></td>
</tr>
<tr>
<td>Major Deliverables Category</td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Identified Codes</strong></td>
<td><strong>Interview No.</strong></td>
<td></td>
</tr>
<tr>
<td>85% of equipment, 60% of bulk material</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>“LLIs must be purchased before conversion.”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Site preparation IFC drawings, piling and concrete, module fabrication, pipe fabrication, mechanical installation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction work packages (CWPs), Field installation work packages (FIWPs)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subcontract packages, purchase of equipment, purchase of bulk materials, fabrication</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>P&amp;ID-IFD, P&amp;ID-IFC, equipment data sheet, piping isometric drawings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Site preparation, underground works, piling installation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Module assembly</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Finalized vendor data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>About 70%–80% of equipment purchase orders</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>“Contractor will typically have to place orders before conversion.”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Site preparation, piling, concrete</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Module installation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Piping and electrical disciplines are critical.</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>“70%–80% of dollar value of equipment should be placed order before conversion.”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Site preparation, construction early works</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>“As the owner, I would prefer to purchase specific LLIs before conversion.”</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Vendor data</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>Modularized construction</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>“Critical equipment such as LLIs should be purchased before conversion in early stages even during the DBM phase, and majority</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Major Deliverables Category</td>
<td>Interview No.</td>
<td></td>
</tr>
<tr>
<td>-----------------------------</td>
<td>--------------</td>
<td></td>
</tr>
<tr>
<td>Identified Codes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>of equipment should be purchased during the EDS phase.”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- “POs for structural steels and cables can be placed during the EDS, but IFC drawings for module fabrication need substantial engineering definition.”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- If the lead times of equipment and materials are long, then the amount of POs placed would be related to procurement lead times. These purchases, though, could be added to the fixed price portion of the contract as part of the estimation process or could be separated out as a different part of the contract.</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>- It’s better to get budgetary quotes for major items before conversion to lump sum.</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>- Critical bulk materials to be ordered before conversion to lump sum are structural steel, cables, and piping materials.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Early finalization of procurement strategy is an important factor in expediting conversion process. Critical items and not just LLIs have great influence on construction costs.</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>- POs for long lead items and all major equipment that require to be engineered must be placed before conversion to lump sum as well as structural steel and piping bulk items.</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>- The main construction packages that should be subcontracted prior to conversion are site preparation, undergrounds and piling. The fabrication of pipe-rack and equipment modules also should be in place.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- I would suggest the LLIs to be excluded from the scope of the lump sum general contract.</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>- I would suggest the early works such as site preparation and infrastructure outside the main area to be awarded before the overall lump sum contract.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Analytic memo:** Some specific engineering, procurement, fabrication, construction, and installation deliverables were frequently mentioned by participants to justify their proposed conversion points. Piping and instrumentation diagrams (P&IDs), piling and foundation design for pipe racks and equipment, equipment data sheets, and piping isometric drawings are examples of these deliverables.

Similarly, purchase orders (POs) for piping and structural steel materials and POs for long lead items (LLIs) are significant procurement activities which influence on deciding conversion time.

Specific fabrication, construction, and installation activities also impact on the conversion process. The level of uncertainty in site preparation, piling, and concrete civil works is quite high owing to weather conditions and productivity issues in Alberta. Piping fabrication, pipe racks module assembly, equipment module assembly, and equipment installation are other important deliverables to be considered in deciding contract price arrangement. The major deliverables influencing conversion process were identified as follows:

- **Engineering:**
  - Piping and instrumentation diagrams (P&IDs)
  - Equipment data sheets
  - Grading/Paving/Underground (UG) Drawings
  - Piling design for pipe racks
  - Piling design for equipment
  - Foundation design for pipe racks
  - Foundation design for equipment
  - Piping isometrics (ISOs) for pipe racks
- Piping ISOs for on-module piping
- Piping ISOs for off-module piping
- Vendor data

- Procurement
  - Piping materials POs
  - Structural steel materials POs
  - Equipment POs
  - LLIs POs

- Fabrication
  - On-module piping fabrication
  - Off-module piping fabrication
  - Pipe rack module assembly
  - Equipment module assembly

- Construction
  - Site preparation
  - Pile installation
  - Foundations for pipe racks and equipment
  - Equipment and module installation
### Table 4.33. Open coding: “Estimating” category

<table>
<thead>
<tr>
<th>Estimating Category</th>
<th>Identified Codes</th>
<th>Interview No.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Open Book Estimate (OBE)</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>• Material take off (MTO)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Reliability in MTO</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Definition of quantities</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Accuracy of estimate</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>• Risk of quantities (MTO)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Bulk materials estimation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• AACE cost estimate classification provides a good correlation between the level of engineering completeness, accuracy of the estimate, and the amount of contingency.</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>• Open Book Estimate (OBE)</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>• “Convertible contracts need a collaborative environment established based on trust and transparency for open book estimation and fair price arrangement.”</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>• Accuracy of cost estimate</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>• AACE International estimation classification system can be used to recognize the level of scope definition for a desired estimate accuracy at conversion time.</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>• The AACE International cost estimate classification can be used to measure the level of scope definition. Would say conversion should be after level 4 estimate. Conversion after detailed engineering would be ideal. But considering schedule constraints it may happen earlier.</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>• Involvement of the contractor in the pre execution phases can help EPC contractor to estimate a more reliable lump sum price.</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>• When the accuracy of estimate is around class 3 of cost estimate</td>
<td>21</td>
</tr>
</tbody>
</table>
Estimating Category

<table>
<thead>
<tr>
<th>Identified Codes</th>
<th>Interview No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>system, it could be an optimal point to convert the contract.</td>
<td></td>
</tr>
<tr>
<td>• “The earlier the conversion time the less accurate the cost estimate will be for the fixed price portion and the greater the contingency that would need to be added.”</td>
<td>22</td>
</tr>
<tr>
<td>• “OBEs are effective tool to estimate quantities.”</td>
<td>26</td>
</tr>
<tr>
<td>• Under certain circumstances, OBE could be a reasonable approach. For example, when the client and the prospective contractor have worked many times together in the past and there is enough benchmark in place for comparison.</td>
<td>27</td>
</tr>
</tbody>
</table>

**Analytic memo:** Considering its importance, developing an effective and systematic estimating process to reach a more accurate lump sum price in a convertible contract would be a potential subject for a future study on convertible contracts. Those participants who had practical experience in convertible contracts suggested open book estimation methodology to estimate the lump sum price. In an OBE, both contractor and owner participate in developing the estimate and have full access to all cost information. An effective OBE relies upon a well-developed cost breakdown structure and an accurate estimate of quantities.

Also, the cost estimate classification system developed by AACE International was suggested by some of the participants to measure the accuracy of the estimate at different levels of project scope definition and through the design development phases.
### Table 4.34. Open coding: “Risk/Contingencies” category

<table>
<thead>
<tr>
<th>Identified Codes</th>
<th>Interview No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>More engineering means less contingency in lump sum price.</td>
<td>1</td>
</tr>
<tr>
<td>“Risk profile of the project and quantitative risk assessment could be another indicator to decide time of conversion.”</td>
<td></td>
</tr>
<tr>
<td>Costs risk associated with site construction, logistic, and transportation constraints.</td>
<td>2</td>
</tr>
<tr>
<td>Range of contingency (5%–10%)</td>
<td></td>
</tr>
<tr>
<td>Risk of quantities (MTO), risk of unit rates (by subcontractors)</td>
<td>3</td>
</tr>
<tr>
<td>“At 60% conversion, acceptable contingency for engineering and procurement would be in the range of 5%–10% and higher for construction.”</td>
<td></td>
</tr>
<tr>
<td>Risk of performance and productivity</td>
<td>4</td>
</tr>
<tr>
<td>“In a market like Alberta issues such as labour supply and productivity are significant risks.”</td>
<td></td>
</tr>
<tr>
<td>Local market and economy risks</td>
<td></td>
</tr>
<tr>
<td>Management of contingencies, contingency range</td>
<td>5</td>
</tr>
<tr>
<td>Acceptable range of contingency</td>
<td>8</td>
</tr>
<tr>
<td>“You need to consider more risk premiums in this market condition.”</td>
<td>9</td>
</tr>
<tr>
<td>“To me conversion is all about how much risk contractor is able to take.”</td>
<td></td>
</tr>
<tr>
<td>Risk of availability of skilled resources</td>
<td></td>
</tr>
<tr>
<td>“It’s always about risk management, not engineering level.”</td>
<td>11</td>
</tr>
<tr>
<td>There is risk associated with local market, labour, environment, equipment, regulations, permits, etc.</td>
<td></td>
</tr>
<tr>
<td>Allowance (to cover known costs that have not been estimated in detail)</td>
<td>12</td>
</tr>
<tr>
<td>3%–5% range of contingencies</td>
<td></td>
</tr>
</tbody>
</table>
## Risk/Contingencies Category

<table>
<thead>
<tr>
<th>Identified Codes</th>
<th>Interview No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>• “Contingency required for a project is directly linked to commitments and to incurred costs to date.”</td>
<td>13</td>
</tr>
<tr>
<td>• “Most of risk and cost escalation come with cost of labour.”</td>
<td>14</td>
</tr>
<tr>
<td>• “By converting the contract at 60% engineering completion, you may accept around 10% contingency in lump sum price.”</td>
<td>15</td>
</tr>
<tr>
<td>• “At the end of FEED the contingency is around 15%.”</td>
<td></td>
</tr>
<tr>
<td>• Risks of weather condition and shortage of skilled resources</td>
<td>16</td>
</tr>
<tr>
<td>• “Early conversion to lump sum means lots of contingency.”</td>
<td>17</td>
</tr>
<tr>
<td>• Influencing factors on building range of contingencies are organizational culture of the company and contractor, project complexity/using new technology, and level of competition in the market.</td>
<td>18</td>
</tr>
<tr>
<td>• Major risks in Alberta: lack of skilled resources in Alberta and low productivity in Alberta</td>
<td>19</td>
</tr>
<tr>
<td>• The amount of contingencies depends on the level of engineering definition.</td>
<td>20</td>
</tr>
<tr>
<td>• In a lump sum contract, risk of productivity and cost certainty is on the contractor’s shoulder. The risk of scope uncertainty is owned by the project owner.</td>
<td>21</td>
</tr>
<tr>
<td>• Adversarial project environment is one of the major risks.</td>
<td></td>
</tr>
<tr>
<td>• The more involvement of the owner in management of the project means more risk of changes and relevant issues.</td>
<td></td>
</tr>
<tr>
<td>• Continuous changes of the scope by the client are a major risk to convertible lump sum contract.</td>
<td></td>
</tr>
<tr>
<td>• “If the design has potential to change then there will either be many change orders or construction will be difficult to price and a fixed price contract won’t be possible.”</td>
<td>22</td>
</tr>
</tbody>
</table>
### Risk/Contingencies Category

<table>
<thead>
<tr>
<th>Identified Codes</th>
<th>Interview No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Acceptable contingencies would depend on the conversion time, planning detail, and scope definition.</td>
<td></td>
</tr>
<tr>
<td>- “The range of acceptable contingency amount can be from 5% and 15%.”</td>
<td>23</td>
</tr>
<tr>
<td>- Project owners in North America have a tendency to have more control in the project. More involvement of the client will result in more changes that would be the source of claim and disputes in a lump sum contract.</td>
<td></td>
</tr>
<tr>
<td>- “The risk of lump sum should be transferred to subcontractors and suppliers through liquidated damages.”</td>
<td></td>
</tr>
<tr>
<td>- Inadequate skilled worker, labour productivity, site condition, project remote locations are major risks in Alberta and Canadian oil and gas industry.</td>
<td>24</td>
</tr>
<tr>
<td>- One of the highest risks in convertible contracts is scope management and continuous change. Scope should be frozen by the owner.</td>
<td></td>
</tr>
<tr>
<td>- Changing strategies by the owner is a major risk in lump sum contracts.</td>
<td>25</td>
</tr>
<tr>
<td>- The major risks includes introducing late changes to the project scope by client, not freezing the basis of design at early stages of the project engineering and lack of trust between parties.</td>
<td>26</td>
</tr>
<tr>
<td>- In convertible contracts if conversion points principles and associated risks are respected, contingency should be under 15%.</td>
<td></td>
</tr>
<tr>
<td>- Sometimes owners push for conversion when the scope is not yet well developed and this would cause major problems down the track.</td>
<td>27</td>
</tr>
<tr>
<td>- I would suggest a maximum 15% contingency is reasonable.</td>
<td></td>
</tr>
</tbody>
</table>
Analytic memo: Most participants believed that strict and effective risk management is vital in successful management of convertible contracts. Project risks should be monitored closely and evaluated through a reliable risk assessment and quantitative analysis to accurately estimate the amount of risk and required contingencies.

Participants mentioned following major and high level risks in application of convertible contracts in Canada and in particular in the Alberta oil and gas market:

- Lack of readiness in the market for lump sum model
- Lack of skilled workforce
- Low productivity in construction
- Harsh weather conditions, environmental issues, and seasonal work
- Site construction, logistic, and transportation limitations
- Strict permission and regulatory requirements

It was discovered that taking the commitment of lump sum contract while not having the same commitment by local subcontractors is a highly risky business for the EPC contractors. Especially, international EPC contractors with a lack of experience in the Alberta market are more at risk in convertible contracts.

Participants suggested a range of contingencies to be included in the lump sum price to address the risk and uncertainties associated with the conversion process. There are different types of contingencies. The focus of this study is limited to the contingencies to be added to the lump sum price to address the risks of inaccurate cost estimate and within the project scope. There are other risks at the corporate level or even market level that should be addressed with additional management reserves. The proposed contingencies were mainly located within the
range of 5% to 15% based on the level of scope definition, engineering completeness, and residual risks at the time of conversion.

Table 4.35. Open coding: “Owner and Contractor Relationships” category

<table>
<thead>
<tr>
<th>Identified Codes</th>
<th>Interview No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Early involvement of main parties in the project</td>
<td>3</td>
</tr>
<tr>
<td>• Dispute (contractual)</td>
<td>4</td>
</tr>
<tr>
<td>• “The level of interfering of the client in managing the project should be limited in a lump sum contract.”</td>
<td>5</td>
</tr>
<tr>
<td>• “The level of relationships between contracting parties is very important. Convertible contracts need a collaborative environment established based on trust and transparency for open book estimation. Relational strategies such as partnership would help to provide the required environment for convertible contracts.”</td>
<td>7</td>
</tr>
<tr>
<td>• “Less interface (between EPC contractor and third parties) is better in convertible contracts.”</td>
<td>9</td>
</tr>
<tr>
<td>• Understanding of the other organization (owner and contractor)</td>
<td>12</td>
</tr>
<tr>
<td>• Relationship and trust</td>
<td>16</td>
</tr>
<tr>
<td>• Commitment in implementation of the (convertible) model</td>
<td></td>
</tr>
<tr>
<td>• Less interface management</td>
<td>18</td>
</tr>
<tr>
<td>• Organizational culture of the company and contractor</td>
<td></td>
</tr>
<tr>
<td>• Bidding/award strategy</td>
<td></td>
</tr>
<tr>
<td>• “So, the trust and collaborative relationship between contracting parties is a vital requirement for implementation of convertible contract. I would support partnership strategies based on the concept of pain share – gain share for convertible contracts.”</td>
<td>19</td>
</tr>
<tr>
<td>• “It’s very important that owner and EPC contractor have matching organizational culture.”</td>
<td>21</td>
</tr>
</tbody>
</table>
Owner and Contractor Relationships Category

<table>
<thead>
<tr>
<th>Identified Codes</th>
<th>Interview No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Adversarial project environment is one of the major risks.</td>
<td></td>
</tr>
<tr>
<td>• “I believe that the healthy relationship between contracting parties is</td>
<td></td>
</tr>
<tr>
<td>a vital requirement for the success of the project.”</td>
<td></td>
</tr>
<tr>
<td>• During the lump sum stage, owner involvement should be limited in</td>
<td></td>
</tr>
<tr>
<td>the management of the project.</td>
<td></td>
</tr>
<tr>
<td>• Project owners in North America have a tendency to have more</td>
<td>23</td>
</tr>
<tr>
<td>control in the project. More involvement of the client will result in</td>
<td></td>
</tr>
<tr>
<td>more changes that would be the source of claim and disputes in a lump sum</td>
<td></td>
</tr>
<tr>
<td>contract.</td>
<td></td>
</tr>
<tr>
<td>• “Based on my experience, the most important factor in successfully</td>
<td>24</td>
</tr>
<tr>
<td>management of convertible contracts is trust and respect between owner and</td>
<td></td>
</tr>
<tr>
<td>EPC contractor.”</td>
<td></td>
</tr>
<tr>
<td>• In Canadian oil and gas projects, it is very common that owners want to</td>
<td></td>
</tr>
<tr>
<td>have high control in management of project. This would be an issue in convertible</td>
<td></td>
</tr>
<tr>
<td>lump sum contract.</td>
<td></td>
</tr>
<tr>
<td>• Collaboration between the owner and EPC contractor at high levels of</td>
<td></td>
</tr>
<tr>
<td>organization is essential to establish a win–win culture in the project.</td>
<td></td>
</tr>
</tbody>
</table>

**Analytic memo:** Engagement of the contractor in early stages of the project and design development provides some benefits to the project. This approach enables the contractor to have better understanding of the project quantities, select the subcontractor earlier, and estimate cost packages more accurately. Involvement of the contractor in the FEED eliminates the long and difficult EPC tendering process and provides opportunity for early conversion. However, using different contractor in the execution phase enables the owner to validate the FEED package. Since the conversion process needs a high level of cooperation and transparent interactions between contracting parties, alliancing and partnering strategies were recommended by some
participants to establish the required project environment. The open book estimation process to estimate lump sum price requires trustworthy and collaborative relationships between contracting parties. These relational strategies build effective communications and trust between the project owner and the EPC contractor and expedite the conversion process.

4.1.2 Axial Coding

Axial coding, as a form of intermediate coding, facilitates exploring the interconnections among categories. During the axial coding memos and diagrams were created to develop the concepts and provide more abstract terms by discovering the interconnections between categories. Following are memos and diagrams created to search the relationships between categories.

Analytic memo: Interconnections between Scope Definition and Engineering

Completeness categories

Most participants believe that although the percentage of engineering completion is a major indicator in deciding conversion points, the level of scope definition as a more comprehensive factor should be taken into consideration. In fact, engineering development is a major element of the project scope, but there are other important aspects such as market condition, execution strategy, and the level of complexity that may affect conversion decisions. The following codes help to better understand the relationships between scope definition and engineering completeness.

- “Around 55%–60% of engineering could be suitable to convert, but generally is to define the scope of work.”
- “Phased contract price arrangements can be proposed based on the level of engineering and scope definition.”
• “The level of engineering is one parameter to convert, but in my opinion it’s always definition of the scope which is the driver not the maturity of the engineering.”

• “Engineering definition is required to define the quantities, but nothing to do with execution strategy.”

• “Another element, which by the way affects the engineering definition, is the level of consolidation of design basis (scope definition) by the client.”

• “I think PDRI is a very good tool to support conversion decision which covers all important factors in the project.”

These codes clearly explain how the degree of engineering completeness and scope definition are connected to each other. However, just a few participants were familiar with the concept of Project Definition Rating Index (PDRI) as a tool to measure project definition.

**Analytic memo: Interconnections between Engineering Completeness and Major Deliverables categories**

To justify proposed engineering milestones to convert the contract, most participants linked those milestones to some specific engineering, procurement, fabrication, and construction deliverables. For instance, the following sentences extracted from interview transcripts explain why after the 60% model review session would be a proper time to convert the contract:

• “Placing 70% of the value of equipment and 50% of the value of the bulk material could be a reasonable amount of procurement before conversion. This can happen after 60% plant model review which is 60% of detailed engineering.”

• “At 60% model review you could have all vendor data for major equipment and can define module fabrication quite well and 90% pipe rack modules as well. So, you can place orders for around 80% of equipment.”
“60% model review is a reasonable point to have enough material for construction.”

These examples explore the relationships between engineering progress and specific deliverables that influence deciding the conversion points during the conversion process.

Based on the above analytic memo, Figure 4.2 illustrates how the major deliverables that influence conversion process are linked to specific engineering milestones.

**Figure 4.2. Interconnections between “Engineering Completeness” and “Major Deliverables” categories**
Analytic memo: Interconnections between Scope Definition and Accuracy of Estimate categories.

By developing design phases and completing the project definition, the accuracy of estimate will be increased at major engineering milestones and decision gates. Some participants illustrated the correlation between the level of scope definition and the accuracy of estimate. In particular, the AACE International cost estimate classification system was suggested as a useful tool that provides the range of cost estimate accuracy at different levels of project definition.

AACE International (2005) has developed a cost estimate classification system as a recommended practice that maps the phases and stages of project cost estimating. In this system, only the level of project definition determines the estimate class, and other characteristics are generally correlated with the level of project definition. The cost estimates covered by this system are for engineering, procurement, and construction (EPC) work in the process industries.

Some of the identified codes discover the link between the level of project definition and accuracy of lump sum estimate at the time of conversion. Following are some examples of captured codes that explore the link between these categories:

- “After FEED, the accuracy of estimate is about 25%.”
- AACE International estimation classification system can be used to measure the accuracy of estimate at different levels of project scope.
- “Up to a certain point (80% of bulk material quantity), there is a linear link between engineering (project) definition and the accuracy of estimate. The rest can be captured by contingency.”
These codes emphasize the relationships between scope definition, engineering completeness, and estimating accuracy.

As shown in Figure 4.3, the range of estimate accuracy proposed by AACE International (2005) has been combined with the concept developed in the above memo to illustrate the explored relationships between these two categories.

![Diagram of FEED PHASE and EPC PHASES]

**30% MR**
- **End of FEED** Estimate Accuracy:
  - L: −10% to −20%
  - H: +10% to +30%
- **After 60% MR** Estimate Accuracy:
  - L: −5% to −15%
  - H: +5% to +20%
- **After 90% MR** Estimate Accuracy:
  - L: −3% to −10%
  - H: +3% to +15%

**Figure 4.3. Axial Coding: Correlation of estimate accuracy and project definition**

**Analytic memo: Interconnections between Conversion Strategy and Engineering Completeness categories**

According to the codes and concepts extracted from collected data, conversion strategy is highly influenced by the level of engineering maturity. The correlation between these two concepts was recognized by most participants. Some of identified codes in support of this argument are as follows:

- “Maybe 2 months after 60% model review could be a good point to convert the contract.”
- “Around 55%–60% of engineering could be suitable to convert, but generally is about to define the scope of work.”
• “Middle of (detailed) engineering could be the optimal point to convert.”
• “Detailed engineering should be almost complete before conversion.”
• “Based on my experience, the conversion period must be between 60% and 90% model review.”
• “After 90% model review is the perfect time to convert the contract to lump sum.”
• “60% model review is a reasonable point to start conversion.”
• “60% model review would be a reasonable point to convert the contract since the majority of bulk materials are defined as well as major equipment.”
• “At 90% model review you would have all MTOs with high level of accuracy, but conversion can be done earlier after 60% and at an optimal point.”
• “I would not do conversion before 60% definitely.”

Above concepts extracted from raw data confirms the significance of engineering completeness in deciding conversion points in convertible contracts. This exploration shows that the period between 60% and 90% of engineering completion has been frequently suggested to convert the contract to a single lump sum scheme.

Analytic memo: Interconnections between Conversion Strategy and Risk and Contingencies categories

The philosophy behind the convertible contracts is to optimize the risk balance between contracting parties. Generally, the project owner is supporting early conversion to increase the cost certainty and transfer the risk of productivity to the EPC contractor. However, too early conversion means inadequate scope definition and high levels of risk and uncertainties. These high levels of uncertainties are usually addressed by including a high amount of contingencies and risk premiums in the lump sum price.
The relationships between conversion strategy, risk, and contingencies were explored by extracting the specific codes and concepts from raw data. Some examples of the identified codes are as follows:

- “I would say conversion after FEED is too early (risky) for both parties to agree on a lump sum price.”
- “It’s too risky to convert the contract after FEED.”
- “If you are new (contractor) in the market, conversion at 60% means a lot of risks.”
- “Early EP conversion may result in getting done engineering and procurement cheaply but not necessarily to the full satisfaction of construction objectives (considering the high level of construction risks and its severe impacts on project success).”
- “Fast-tracking may delay the conversion time because it will result in more changes, errors, and reduce the productivity (subsequent risks).”
- “As long as you can reasonably manage the risk, you can convert the contract. If not, you can’t.”
- “It’s always about risk management not engineering level.”
- “There is risk associated with local market, labour, environment, equipment, regulations, permits, etc.
- “At 60% conversion, acceptable contingency for engineering and procurement would be in the range of 5%–10% and higher for construction.”
- “By converting the contract at 60% engineering completion, you may accept around 10% contingency in lump sum price.”
- “At the end of FEED the contingency is around 15%.”
• “If FEED and EPC will be performed by the same contractor, the contingency would be around 5%. Otherwise, 10% contingencies should be considered when converting to the lump sum.”

• “If you start conversion after FEED you might consider 25–30% contingency because of high uncertainties while at 60% it may be 5–10% for E&P, but for construction you may have bigger percentage.”

• “If you convert at 60% model review, you might consider around 15% contingency, but if you convert at 90% model review, you may just need 7% contingency.”

Therefore, the risk attitude of contracting parties and the acceptable range of contingencies by the project owner are key drivers in conversion strategies and in deciding conversion timing.

**Analytic memo: Interconnections between Major Deliverables and Contract Price Arrangements categories**

Exploring the relationship between the “major deliverables” and “contract price arrangements” categories provides the flexibility of using fitting contract types for different work packages in a convertible contract model. Based on the level of scope definition and engineering progress, different contract types including cost reimbursable, unit rate, and lump sum can be used for the following work packages and project phases:

- Engineering services
- Procurement services
- Purchase of bulk materials
- Purchase of equipment
- Fabrication
Module assembly

Construction

Installation

Following are some examples of identified codes that support the interconnections between these two categories:

- “Site preparation should be done under unit rate contract because quantities are totally uncertain.”
- “LLIs should be purchased before conversion (i.e., cost reimbursable) for sure.”
- “Unit rate would be the proper contract for fabrication.”
- Site preparation: unit rates
- Piling: unit rates
- Concrete foundations: unit rates
- Module installation: lump sum

Analytic memo: Interconnections between Relationships between Owner and EPC Contractor, Estimating, and Risk and Contingencies categories

The intent of convertible contracts is the fair allocation of project risks and proper compensation by choosing the fit contract price arrangement through the project phases. Optimizing the concept of risk taking/rewarding requires a robust relationship between the owner and EPC contractor based on trust and collaboration. Adversarial environment has been one of the main reasons for inappropriate risk allocation and subsequently lots of claims and disputes in traditional contracts.

However, important elements of convertible contracts such as open book estimation (OBE) process and allocation of contingencies requires a collaborative project environment
established based on trust and fairness. The interconnections between these important concepts have been captured in this study. Following are some examples of identified codes from raw data that support the connections between “Relationships between Owner and EPC Contractor”, “Estimating”, and “Risk and Contingencies” Categories:

- “So, the trust and collaborative relationship between contracting parties is a vital requirement for implementation of convertible contract. I would support partnership strategies based on the concept of pain share – gain share (risk/opportunities) for convertible contracts.”

- “The level of relationships between contracting parties is very important. Convertible contracts need a collaborative environment established based on trust and transparency for open book estimation and fair price arrangement. Relational strategies such as partnership would help to provide the required environment for convertible contracts.”

- “It’s very important that owner and EPC contractor have matching organizational culture.”

- Adversarial project environment is one of the major risks.

- “I believe that the healthy relationship between contracting parties is a vital requirement for the success of the project.”

Therefore, relational strategies such as partnership or alliencing help contracting parties to reach a more reliable lump sum price through the OBE process and allocate a reasonable amount of contingency to it.
4.1.3 **Selective Coding**

According to Corbin and Straus (2015) selective coding is an advanced coding process to identify a core category which has the greatest explanatory power and the ability to link all other categories to each other. As explained in Chapter 3. Research Methodology, the following criteria was used to select the core category:

1. It must be sufficiently abstract so that it can be used as the overarching explanatory concept tying all the other categories together.

2. It must appear frequently in the data. This means that within all, or almost all, cases there are indicators that point to that concept.

3. It must be logical and consistent with the data. There should be no forcing.

4. It should be sufficiently abstract so that it can be used to do further research leading to development of general theory.

5. It should grow in depth and explanatory power as each of the other categories is related to it through statements of relationships.

Referring to memos and diagrams created through the open coding and axial coding processes, “conversion strategy” meets important requirements of the core category.

The results of analyzing collected data through open coding and axial coding show that the conversion strategy is the core category that can be used as a central explanatory concept tying all other categories together. Most codes and concepts extracted from different categories can be linked together through justifying the conversion timing. Figure 4.4 depicts examples of identified codes and concepts in different categories that commonly support the concept of conversion strategy.
Figure 4.4. Selective coding: “Conversion Strategy” category tying other categories

Also, the concept of conversion process has been mentioned in most interviews.

Figure 4.5 provides the appearing frequency of concepts in collected data. This figure shows that the highest number and percentage of extracted codes point to the conversion concept.
In fact, inherent meaning extracted from actual data represents the conversion strategy as
the principal explanatory concept, and selecting this category as the core concept has not been
forced by the researcher. In other words, choosing conversion strategy is consistent with the
collected data and fulfills the third requirement of the selection criteria.

There is a strong relationship between the conversion category and other categories.
Deciding conversion points are highly influenced by the level of engineering completeness.
Significant engineering milestones were frequently mentioned as the potential indicators to
determine the timing of the conversion process. Also, the level of scope definition is a key driver
in conversion strategy. In addition to engineering, other important aspects of the project are
covered by the concept of scope definition and influence on conversion decisions. Through the
axial coding process, the interconnections between the conversion strategy and delivery of
critical items during the EPC phases were also explored. Similarly, it was learned that there is a
correlation between the conversion timing and the amount of contingencies included in the lump sum estimate. In fact, the conversion strategy is linked to the accuracy of the estimate, the level of risks, and the acceptable range of contingencies. Finally, it was illustrated that the performance of the conversion process and OBE is highly related to the quality of relationships between the project owner and contractor.

All of these statements show the relationships between the conversion strategy and other categories are strong enough and ensure that the concept of conversion strategy is sufficiently abstract and can be used to do further research leading to construct the theoretical framework.

4.1.4 *Theoretical Integration*

The last step to construct the theoretical framework is the integration of the findings through open coding, axial coding, and selective coding. As discussed in Chapter 3, three factors are proposed by Birks and Mills (2015) as necessary requirements for the integration of a grounded theory:

1. An identified core category
2. Theoretical saturation of major categories
3. An accumulated bank of analytical memos

In section 4.1.3 and through the selective coding process, the conversion strategy was selected as the core category among the all eight categories, as shown in Figure 4.6.
Figure 4.6. Identifying the core category

The theoretical saturation occurred with 24 interviews, and after that further data collection failed to add properties or dimensions to established categories.

Also, several memos and diagrams were created during open coding, axial coding, and selective coding in analyzing collected data. Therefore, the essential requirements for theoretical integration have been met in this study.

There are several analytic techniques that can be used to facilitate integration process (Corbin & Strauss, 2015) and serve as a bridge between analysis and theory (Birks & Mills,
Writing descriptive/conceptual summary memos (story line) and integrative diagrams are among these techniques suggested by Corbin and Strauss (2015). Following summary memo was created to aid theoretical integration in this study.

**Theoretical Integration Summary Memo:** This research is about managing convertible contracts in fast-track oil and gas projects. Through this study, influencing concepts in constructing a theoretical framework to implement the application of convertible contracts in oil and gas projects were identified, developed, and linked through data analysis.

Identified concepts were grouped through open coding in main categories of

- scope definition
- contract price arrangement
- major EPC deliverables
- conversion strategy
- engineering completeness
- major deliverables
- estimating
- risk/contingencies
- owner and contractor relationships

The phased contract price arrangement is an essential concept in convertible contracts. It means different contract types can be used during the project life cycle to optimize risk allocation between contracting parties. Cost reimbursable, unit rate, and lump sum are main contract price arrangements that can be used through the project phases. The level of risk and uncertainty is a key driver in managing convertible contracts. The risk attitude of contracting
parties is an influencing factor in deciding conversion strategy. Also, acceptable range of contingencies by the project’s owner is a key element in convertible contracts.

Deciding the conversion points between different contract types during the conversion process is a challenging exercise in management of convertible contracts. The conversion process may occur from the FEED and through the EPC phases depending on the level of contractor involvement in project phases. Most often the project scope is not mature enough after the FEED to estimate a reliable lump sum price, and converting the contract to a single lump sum scheme for the whole EPC is a highly risky approach.

Conversion strategy is highly influenced by the level of engineering completeness. Certain engineering milestones, including end of FEED phase, after 60% model review session, between 60% and 90% model review sessions, and after 90% model review session are proposed milestones/periods to convert the contracts. These suggested points for conversion have been justified by linking the level of engineering completeness to the estimate of project quantities and delivery of major procurement and construction components. In fact, selecting contract types during the conversion is highly related to the level of residual risks at conversion points, which is driven by engineering progress. Based on the level of engineering definition during the conversion, different contract price arrangements may be used for the same deliverables, work packages, or project phases.

The OBE methodology has been suggested to estimate the lump sum price during the conversion period. The OBE is driven by definition of quantities through the material take off (MTO) activities. MTO is part of the engineering phase, and its reliability is highly linked to the engineering completeness.
There are different bidding/award approaches to involve the contractor. In general, involvement of the EPC contractor in the early stages of the project may expedite the conversion process. Effective management of convertible contracts needs collaborative relationships and a high level of trust in the project environment. Partnering and alliancing strategies can improve the performance of convertible contracts.

After the concepts were categorized, the interconnections between them were explored through the axial coding. Axial coding helped to understand how the categories interact and influence each other. Subsequently and through the selective coding process, “Conversion Strategy” was identified as the core category of this study. Several memos and diagrams were created during data analysis to support the theorizing process and to construct the grounded theory from the basic level of concepts to the more abstract concepts. The theorizing process constructed an explanatory scheme that systematically relates all categories of concepts to each other around the category of conversion strategy. In other words, the explanatory components of the theoretical framework were constructed through the data analysis process by following open coding, axial coding, and selective coding steps.

As the main deliverable of this research program, and the final product of the grounded theory study, the theoretical framework has been presented in the Chapter 5.
CHAPTER 5. THE THEORETICAL FRAMEWORK

As shown in Figure 5.1, the theoretical framework as the final product of this study consists of four main modules.

- **Module One:** Conversion Process
- **Module Two:** Estimating Strategy
- **Module Three:** Potential Risks
- **Module Four:** Collaborative Strategy

**Figure 5.1. Modules of theoretical framework**

- The first module is focused on the conversion process.
- The second module illustrates a dynamic and flexible cost estimation approach to address the complexity of the conversion process in a convertible contract.
- The third module presents the potential risks of using convertible contracts in Canada.
- The fourth module focuses on a collaborative strategy to enhance the relationships in convertible contracts.
5.1 Module One: Conversion Process

Deciding the conversion points is one of the main challenges in managing convertible contracts. This module introduces the most important factors that influence conversion timing and determining the conversion points. Major recommendations by experts who participated in this study have also been provided in this module. In addition, and based on the results of the study, this module presents some preferred strategies for converting the contract. The main content and results of this module have been published by the researcher (Moazzami et al., 2015).

5.1.1 Important factors that influence deciding the conversion points

The results of this study show that the main factors that influence determining the timing of conversion and conversion points are as follows:

- Deciding conversion points is highly influenced by the risk attitude of contracting parties. The readiness and experience of the contractor in taking and managing risks and the acceptable range of contingencies by the owner are significant factors in the conversion process.

- The degree of engineering completeness is one of the most important factors in deciding the conversion points. The level of certainty in project quantities and the reliability of material take off (MTO) are directly linked to the level of engineering maturity.

- Significant engineering milestones such as conducting model review sessions at 30%, 60%, and 90% of engineering completeness are key indicators in deciding conversion points.
• Particular **deliverables** in engineering, procurement, and construction phases such as issue of P&IDs, MTOs for bulk piping and structural steels, ordering LLIs, and subcontracting civil works can influence deciding the conversion points.

• Engineering development is a major indicator to determine the conversion timing, but there are other important aspects such as market condition, execution strategy, and the level of complexity that may affect the conversion strategy.

• The value of purchase orders (POs) for **major equipment** and key **bulk materials** that should be ordered before conversion influence deciding the conversion points.

• The number of **construction** and **installation** work packages that should be subcontracted before conversion influence deciding the conversion points.

• The results of the project risk assessment including the **residual risks** and **contingency amounts** influence deciding the conversion points.

• **Fast-tracking** and the level of **overlapping** engineering, procurement, and construction phases/activities can affect the conversion timing.

• The level of involvement of the EPC contractor in **pre-execution phases** of the project can affect the conversion timing.

### 5.1.2 Recommendations

Based on the analysis of data collected through interviews with oil and gas experts who participated in this study, this section provides a collection of recommendations to enhance the conversion process in convertible contracts. The major recommendations are as follows:

• Although the percentage of engineering completion is an important indication to determine the conversion points, the level of scope definition as a more comprehensive factor should be taken into consideration.
The Project Definition Rating Index (PDRI) covers the most significant elements in project definition and, so, as a reliable tool to measure the level of scope definition is recommended to support decision makers in the conversion process.

Measuring engineering completeness should be based on the production of actual issued for construction (IFC) drawings that are used in MTOs and construction.

Certain engineering milestones, including end of the Front End Engineering Design (FEED) phase, between 60% and 90% model review sessions, and after 90% model review sessions, are proposed milestones/periods to convert the contracts.

Conversion to a single lump sum contract after FEED is too risky and usually will result in allocating a high amount of contingencies in the lump sum price.

An experienced EPC contractor, having done enough similar projects in the market, may be able to take the risk of early conversion to lump sum.

Using the same contractor for both FEED and EPC phases can result in early conversion and less contingency in lump sum price.

It is recommended to place POs for all LLIs before conversion to the single lump sum contract.

It is recommended to place POs for structural steel and piping bulk materials before conversion to the single lump sum contract.

Placing 70%–80% of equipment POs and 50%–60% of bulk materials POs could be a reasonable amount before conversion to lump sum. This usually happen between 60% and 90% engineering completeness.
• It is suggested that owing to a high level of uncertainty, civil works such as site preparation, piling, and concrete works should be performed under a unit rate scheme before converting the whole project to lump sum.

• Unit rate is also recommended for pipe and module fabrication activities before conversion to lump sum.

5.1.3 Conversion strategies

The results of the study and use of the analytical memos and diagrams created through the data analysis conclude that some of the preferred strategies to convert the contract are as follows:

Strategy 1: In this approach, as shown in Figure 5.2, the contractor is engaged at the pre-execution phase of the project to be involved in the planning and design development process. There are different bidding award approaches to execute oil and gas projects based on the owner preference and the transition strategy from the FEED phase to the execution or EPC phase of the project (Moazzami et al., 2011c).
The EPC bidding/award process is omitted through this strategy, and the owner continues the execution of the project with the same contractor who performed the FEED. Involvement of the EPC contractor in the FEED phase provides early communication between the owner and the contractor to expedite the conversion process and estimating the lump sum price. Also, avoiding the long and difficult EPC tendering process provides a significant reduction in overall project duration.

As shown in Figure 5.3, this strategy suggests two contractual stages. The first stage covers the FEED phase of the project with a mixed contract price arrangement. In the second stage the entire EPC will be performed under a single lump sum contract. In the first stage, cost reimbursable is recommended to compensate engineering services, procurement services,
purchasing materials, and supplying equipment whereas unit rate is the suggested compensation method for fabrication, construction, and installation activities.

Since the contractor has been engaged in the design development phase before EPC, it is possible to achieve 30% engineering level by the end of FEED. At this level, engineering information is sufficient to issue POs for LLIs during FEED. Also, subcontract packages for site preparation and underground activities can be finalized during the first stage.

However, scope definition is not mature enough at the end of FEED to estimate a confident lump sum price for the entire fast-track EPC with overlapping phases. By purchasing major bulk materials, such as piping and structural steel, and performing fabrication, construction, and installation activities under a lump sum contract, the contractor takes a high level of cost risk in the execution phase. In this case, the lump sum price usually includes a range of 15% to 20% contingencies to address the high level of risk and uncertainties.
Figure 5.3. Strategy 1: Conversion process

- **Stage 1:**
  - **Management:** Unit Rate
  - **Engineering:** Unit Rate
  - **Procurement Services:** Unit Rate
  - **Materials and Equipment Purchase:** Cost Reimbursable
  - **Fabrication:** Unit Rate
  - **Construction:** Unit Rate

- **Stage 2:**
  - **Single Lump Sum Contract**
  - 15%–20% Contingencies

- **Saved time due to eliminating competitive bidding process to select EPC contractor.**

- **Engineering Milestone**
- **Subcontract Milestone**

- **Engineers Activity**
- **Procurement Activity**
- **Fabrication Activity**
- **Construction Activity**
**Strategy 2:** In this approach, as shown in Figure 5.4, the contractor may or may not have been engaged in pre-execution phases.

![Diagram of Strategy 2: Bidding/award approach](image)

**Figure 5.4. Strategy 2: Bidding/award approach**

By this strategy, as shown in Figure 5.5, the conversion to the single lump sum contract occurs after 60% engineering completion. With contractor involvement after a formal bidding/award process and from the start of the EPC, the 30% engineering level is more likely to be achieved during the detailed engineering.

Based on the results of the study, by achieving the 60% engineering milestone, approximately 70% of equipment and 50% of bulk materials can be estimated and purchased and major civil works, including piling and foundations for pipe racks and equipment, have been subcontracted. At 60% engineering, the level of accuracy in estimating is high enough to bid a reliable lump sum price for the rest of the project works. The suggested contingency amount in the lump sum price at this point of conversion is between 10% and 15%.
Figure 5.5. Strategy 2: Conversion process

Stage 1:
Management:
- Unit Rate
Engineering:
- Unit Rate
Procurement Services:
- Unit Rate
Materials and Equipment Purchase:
- Cost Reimbursable
Fabrication:
- Unit Rate
Construction:
- Unit Rate

Stage 2:
Single Lump Sum Contract
10%–15% Contingencies

Bidding process to select EPC contractor.

30% MR

60% MR

90% MR

P&ID-IFD

P&ID-IFC

Piping ISOs-IFC

Structural Steels-IFC

Grading/UG-IFC

Piling Design-IFC

Foundation Design-IFC

LLIs POs

Steel Materials POs

Equipment POs

Piping Materials POs

Site Preparation/UG

Piping Fabrication

Pile Installation

Steel Fabrication

Foundations

Module Assembly

Equipment & Module Installation
Strategy 3: In this approach, the engagement of the EPC contractor is similar to strategy 2. However, this approach offers three contract phases during the project life cycle. As shown in Figure 5.6, the first phase covers the FEED phase of the project. The second phase will be between the start of detailed engineering and the 90% model review session, and the last phase will be after the 90% model review session to the end of the EPC. The suggested contingency amount in the lump sum estimate at 90% engineering would be between 5% and 7%. Similar to previous strategies, it should be taken into consideration that the suggested range of contingencies for this strategy is based on collected data through interviews and qualitative analysis. The validity and accuracy of the suggested contingency amounts should be examined by conducting a quantitative analysis when enough data are available. In Chapter 7, a correlational study has been suggested for the relevant research in the future to predict the correlation between optimum time of conversion, contingency amount and other influencing variables in conversion process. Although late conversion to the lump sum price is not a favorable option for the client, a higher level of scope definition minimizes the contingency and risk premiums included in the lump sum price by the contractor.
Bidding process to select EPC contractor.

Stage 1:
Management: Unit Rate
Engineering: Unit Rate
Procurement Services: Unit Rate
Materials/ Eq. Purchase: Cost Reimbursable
Fabrication: Unit Rate
Construction: Unit Rate

Stage 2:
Engineering: Lump Sum
Procurement: Lump Sum
Fabrication: Unit Rate
Construction: Unit Rate

Stage 3:
Single Lump Sum Contract
5%–7% Contingencies

Figure 5.6. Strategy 3: Conversion Process
The amount of contingencies should be adequate to address the actual risk and uncertainties in oil and gas projects. According to Jergeas and Ruwanpura (2008), it is not uncommon for oil sands mega projects to experience cost overruns of up to 100% of the original cost estimates.

It should be taken into consideration that the suggested range of contingencies for each of proposed strategies in this study are based on collected data through interviews and qualitative analysis. So far, few oil and gas projects have used convertible contracts. The validity and accuracy of the suggested contingency amounts should be examined by conducting a quantitative analysis when enough actual data for convertible contracts are available. In Chapter 7, a correlational study has been suggested for the relevant research in the future to predict the correlation between optimum time of conversion, contingency amount and other influencing variables in conversion process.

Each of these proposed conversion strategies might be chosen based on the risk attitude of contracting parties, level of scope definition, and the acceptable range of contingencies.
5.2 Module Two: Estimation Strategy for Convertible Contracts

A dynamic and flexible estimation approach is required to address the complexity of the conversion process in a convertible contractual framework. The focus of this module is to illustrate an effective estimating strategy for convertible contracts. The main content of this module has been previously published by the researcher (Moazzami et al., 2013c).

Most of project experts who participated in this research program suggested open book estimate (OBE) for convertible contracts. OBE is an effective method to estimate a more accurate and reliable EPC lump sum price (Patty & Denton, 2010). In an OBE, both contractor and owner participate in developing the estimate and have full access to all cost information. An effective OBE relies upon a well-developed cost breakdown structure (CBS), an accurate estimate of quantities, pre-agreed compensation methods for project items, and a realistic estimation of contingencies and lump sum price. These steps have been illustrated as follows:

5.2.1 Developing cost breakdown structure

There are different approaches to develop a project CBS. The main cost categories can be identified based on the project work breakdown structure (WBS). Figure 5.7 presents a high-level WBS for a typical project in the oil and gas industry.
An effective OBE needs a detailed cost classification covering all project key disciplines and their subdivisions, including management, engineering, procurement, and construction.

Cost categories should be identified in each discipline based on the experience and available data in similar previous projects. Each cost category can be divided into several subcategories and cost items. Table 5.1 shows a sample cost breakdown, structured in three levels: Cost Category (discipline), Cost Sub-Category (subdivision), and Cost Item.
Table 5.1. Developing cost breakdown structure (CBS)

<table>
<thead>
<tr>
<th>Cost Category</th>
<th>Cost Sub-Category</th>
<th>Cost Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Management</td>
<td>1.1: Project management</td>
<td>1.1.1: Home office</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.1.2: Site</td>
</tr>
<tr>
<td></td>
<td>1.2: Project planning, control, and administration</td>
<td>1.2.1: Home office</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.2.2: Site</td>
</tr>
<tr>
<td></td>
<td>1.3: Project quality management</td>
<td>1.3.1: Home office</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.3.2: Site</td>
</tr>
<tr>
<td></td>
<td>1.4: Project health, safety, and environment (HSE)</td>
<td>1.4.1: Home office</td>
</tr>
<tr>
<td></td>
<td>management</td>
<td>1.4.2: Site</td>
</tr>
<tr>
<td></td>
<td>1.5: Construction management</td>
<td>1.5.1: Home office</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.5.2: Site</td>
</tr>
<tr>
<td>2: Engineering</td>
<td>2.1: Design basis memorandum (DBM)</td>
<td></td>
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<tr>
<td></td>
<td>2.2: Engineering design specification (EDS)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.2: Front End Engineering and Design (FEED)</td>
<td></td>
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<tr>
<td></td>
<td>2.3: Detailed design package</td>
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<tr>
<td>3: Procurement</td>
<td>3.1: Procurement services</td>
<td>3.1.1 Home office</td>
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<td></td>
<td></td>
<td>3.1.2 Site</td>
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<tr>
<td></td>
<td>3.2: Supply of bulk materials</td>
<td>3.2.1 Piping/Pipeline</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.2.2 Structural steel</td>
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<td></td>
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<td>3.2.3 Electrical</td>
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<td>3.2.4 Instrumentation</td>
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<td>3.2.5 Chemicals</td>
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<td></td>
<td></td>
<td>3.2.6 Transportation</td>
</tr>
<tr>
<td>Cost Category</td>
<td>Cost Sub-Category</td>
<td>Cost Item</td>
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<tr>
<td>---------------</td>
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</tr>
<tr>
<td>3.3: Supply of equipment</td>
<td>3.3.1 Pumps</td>
<td>3.3.2 Compressors</td>
</tr>
<tr>
<td></td>
<td>3.3.3 Mixers</td>
<td>3.3.4 Ejectors</td>
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<tr>
<td></td>
<td>3.3.5 Heaters/Boilers</td>
<td>3.3.6 Heat exchangers</td>
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<td></td>
<td>3.3.7 Tanks</td>
<td>3.3.8 Vessels/Towers</td>
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<tr>
<td></td>
<td>3.3.9 Spare parts</td>
<td>3.3.10 Transportation</td>
</tr>
<tr>
<td>4: Construction</td>
<td>4.1: Fabrication</td>
<td>4.1.1 Modules</td>
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<tr>
<td></td>
<td>4.1.2 Structural</td>
<td>4.1.3 Piping</td>
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<tr>
<td></td>
<td>4.1.4 Elect./Inst.</td>
<td>4.2: Temporary construction facilities</td>
</tr>
<tr>
<td></td>
<td>4.2.1 Site facilities</td>
<td>4.2.2 Site utilities</td>
</tr>
<tr>
<td>4.3: Site accommodations/camp</td>
<td>4.4: Site construction and installation</td>
<td>4.4.1 Civil works</td>
</tr>
<tr>
<td></td>
<td>4.4.2 Equipment</td>
<td>4.4.3 Tanks</td>
</tr>
<tr>
<td></td>
<td>4.4.4 Piping/ Insulation</td>
<td>4.4.5 Elect./Inst.</td>
</tr>
<tr>
<td></td>
<td>4.4.6 Painting</td>
<td>4.4.7 Inspection and test</td>
</tr>
</tbody>
</table>
5.2.2 *Estimating material quantities and creating equipment list*

Measurement of project quantities is a key factor in estimating project costs. The accuracy of measuring project quantities or material take-off (MTO) strongly depends on the level of engineering and design development at the time of estimation. Engineering drawings and documents are the basis for estimating quantities. A sample list of the main engineering documents that can be used in MTO is shown in Table 5.2.

### Table 5.2. Key documents required for MTO

<table>
<thead>
<tr>
<th>Discipline</th>
<th>Key Documents Required for MTO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piping</td>
<td>• Plot plans&lt;br&gt;• Piping and instrumentation diagrams (P&amp;IDs)&lt;br&gt;• Piping specification&lt;br&gt;• 3D Model</td>
</tr>
<tr>
<td>Civil and Steel Structure</td>
<td>• Plot plans&lt;br&gt;• Topographical survey&lt;br&gt;• Geotechnical reports&lt;br&gt;• Civil specifications&lt;br&gt;• Geometrical Characteristics of the Structures</td>
</tr>
<tr>
<td>Discipline</td>
<td>Key Documents Required for MTO</td>
</tr>
<tr>
<td>---------------------</td>
<td>--------------------------------</td>
</tr>
<tr>
<td>Instrumentation</td>
<td>• Plot plans</td>
</tr>
<tr>
<td></td>
<td>• Piping and instrumentation diagrams (P&amp;IDs)</td>
</tr>
<tr>
<td></td>
<td>• Building layouts</td>
</tr>
<tr>
<td></td>
<td>• Inputs/Outputs list</td>
</tr>
<tr>
<td></td>
<td>• Cable schedule</td>
</tr>
<tr>
<td></td>
<td>• Preliminary cable route studies</td>
</tr>
<tr>
<td></td>
<td>• Instrumentation specifications</td>
</tr>
<tr>
<td>Electrical</td>
<td>• Plot plans</td>
</tr>
<tr>
<td></td>
<td>• Piping and instrumentation diagrams (P&amp;IDs)</td>
</tr>
<tr>
<td></td>
<td>• Single Line diagram</td>
</tr>
<tr>
<td></td>
<td>• Electrical load list</td>
</tr>
<tr>
<td></td>
<td>• Preliminary cable route studies</td>
</tr>
<tr>
<td></td>
<td>• Preliminary cable sizing</td>
</tr>
<tr>
<td></td>
<td>• Cable schedule</td>
</tr>
<tr>
<td></td>
<td>• Earthling system studies</td>
</tr>
<tr>
<td></td>
<td>• Electrical specifications</td>
</tr>
</tbody>
</table>

Incomplete engineering at the time of conversion and design changes are both potential risks affecting the accuracy of the estimate. These risks should be addressed by considering pre-agreed percentages as the technical design allowances (TDAs) in estimating project quantities.

The list of required equipment to be supplied will be generated based on the main process and engineering documents such as process flow diagrams (PFDs) and general plot plans. Subsequently, compensation for construction activities will be based on the estimated construction man-hours items to be fabricated, constructed, or installed.
5.2.3 *Pre-agreed compensation methods*

In section 5.1.3, the appropriate contract price arrangements are proposed for different contractual stages. In addition, and based on the results of interviews and project document reviews, this section provides the compensation method for cost categories and sub-categories.

- **Management, engineering, and procurement services**

Management, engineering, and procurement services can be compensated during the pre-conversion and lump sum stages as follows:

**A) Compensation during the pre-conversion stage**

- Home office: \[(\text{Actual home office man-hours}) \times (\text{Pre-agreed home office unit rate}) + (\text{Pre-agreed percentage for the home office}) + (\text{Benefits (Pre-agreed percentage for the home office)})\]

- Site: \[(\text{Actual site man-hours}) \times (\text{Pre-agreed site unit rate}) + (\text{Overheads (pre-agreed percentage for the site)}) + (\text{Benefits (Pre-agreed percentage for the site)})\]

**B) Compensation during the lump sum stage**

Compensation of management, engineering, and procurement services after the conversion is on a lump sum basis. Earned value analysis (EVA) is the proper tool to forecast the required man-hours to complete the above activities in the project. In fact, EVA provides the opportunity to consider the productivity factor in estimating the expected man-hours required to perform the rest of the work. Compensation will be based on the estimate to complete (ETC) man-hours resulting from EVA at the time of conversion to the lump sum and pre-agreed fixed rates of home office and site activities for each category.
Compensation method:

- Home office: (ETC of home office man-hours at the time of conversion) * (Pre-agreed home office unit rate) + Overheads (Pre-agreed percentage for the home office) + Benefits (pre-agreed percentage for the home office)

- Site: (ETC site man-hours at the time of conversion) * (Pre-agreed site unit rate) + Overheads (Pre-agreed percentage for the site) + Benefits (Pre-agreed percentage for the site)

- **Supply of bulk materials**

  The proposed compensation methods to purchase bulk materials during the pre-conversion and lump sum stages are as follows:

  **A) Compensation during the pre-conversion stage**

  The EPC contractor can be reimbursed for supplying the bulk material during the pre-conversion period based on actual cost of purchased materials plus pre-agreed overhead costs and benefits. The contractor estimates material quantities based on available engineering information and the last MTO. In accordance with the OBE strategy, the owner has full access to the unit-price lists generated from vendor quotes and compensation can be as follows:

  (Actual amount of POs for purchased materials up to the time of conversion) + Overheads (Pre-agreed percentage for the bulk materials) + Benefits (Pre-agreed percentage for the bulk materials)

  **B) Compensation during the lump sum stage**

  Incomplete engineering at the time of conversion, design changes after conversion and technical complexity are potential risks that will affect the accuracy of the estimate. These risks should be addressed by considering the pre-agreed percentage of applicable allowances in
estimating lump sum price of material, equipment, and construction activities at the time of conversion. The main categories of allowances that should be taken into considerations are as follows:

- Design allowances
- MTO allowances
- Overbuy allowances
- Damage allowances
- Allowances for undefined major items

Compensation of bulk materials “to be supplied” after conversion will be on a lump sum basis and based on the last MTO of the bulk item at the time of conversion and available unit price lists generated from vendor quotes in accordance with OBE strategy. Also, applicable allowances percentage will be considered in a compensation formula as follows:

\[ \text{(Bulk MTO at the time of conversion)} \times \text{(Unit price decided in OBE)} \times \text{Allowances \%} \]

- **Supply of equipment**

It is proposed that the supply of equipment be compensated during the pre-conversion and lump sum stages as follows:

**A) Compensation during the pre-conversion stage**

Compensation of supplied equipment during the pre-conversion period is based on a cost reimbursable scheme. Based on the OBE method, the owner has full access to the vendor bids for the equipment.

\[
\text{(Actual amount of purchase order for purchased equipment up to the time of conversion)} \]

+ Overheads (Pre-agreed percentage for the equipment) + Benefits (Pre-agreed percentage for the equipment)
**B) Compensation during the lump sum stage**

Compensation of equipment “to be purchased” after the conversion will be on a lump sum basis and based on the estimated quantities of the equipment at the time of conversion and available vendor bids in accordance with OBE strategy. Also, the applicable allowances percentage will be considered in a compensation formula as follows:

\[(\text{Equipment quantity estimate at the time of conversion}) \times (\text{Vendor bid decided in OBE}) \times \text{Allowances \%}\]

- **Construction**

**A) Compensation during the pre-conversion stage**

The EPC contractor will be reimbursed for the fabrication and site activities during the pre-conversion period based on unit rates and cost reimbursable schemes. In accordance with the OBE strategy, the owner has full access to the unit rates quoted by subcontractors for performing CWPs.

**Compensation method:**

- Fabrication: \((\text{Actual yard/shop man-hours}) \times (\text{EPC contractor unit rate or unit rates quoted by subcontractors for the fabrication}) + \text{Overheads (Pre-agreed percentage for the fabrication)} + \text{Benefits (Pre-agreed percentage for the fabrication)})\)

- Installation: \((\text{Actual site man-hours}) \times (\text{EPC contractor unit rate or unit rates quoted by subcontractors for the installations}) + \text{Overheads (Pre-agreed percentage for the installations)} + \text{Benefits (Pre-agreed percentage for the installations)})\)

- Construction: \((\text{Actual site man-hours}) \times (\text{EPC contractor unit rate or unit rates quoted by subcontractors for the construction}) + \text{Overheads (Pre-agreed...} \)
percentage for the construction) + Benefits (Pre-agreed percentage for the construction)

**B) Compensation during the lump sum stage**

Compensation of construction activities after conversion will be on a lump sum basis and based on the estimated construction man-hours for “to be fabricated/constructed/installed/” items.

**Compensation method:**

(Estimated man-hours for “to be fabricated/constructed/installed/” items at the time of conversion) * Allowances % * (Fabrication/Construction/installation rates decided in OBE)

Conducting an effective OBE through steps mentioned above will increase the accuracy of the EPC lump sum price and will result in a smooth conversion from a cost reimbursable/unit rate contract to the lump sum scheme. This methodology addresses one of the main concerns of contracting parties in applying convertible contracts.

The proposed compensation methods before and after conversion to lump sum for different cost categories have been summarized in Table 5.3.
### Table 5.3. Proposed compensation methods before and after conversion to lump sum

<table>
<thead>
<tr>
<th>Cost Category</th>
<th>Compensation during the Pre-Conversion Stage</th>
<th>Compensation after Conversion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management, engineering, and</td>
<td>Home office: (Actual home office man-hours) * (Pre-agreed home office unit rate) + Overheads (Pre-agreed percentage for the home office) + Benefits (Pre-agreed percentage for the home office)</td>
<td>Home office: (ETC of home office man-hours at the time of conversion) * (Pre-agreed home office unit rate) + Overheads (Pre-agreed percentage for the home office) + Benefits (pre-agreed percentage for the home office)</td>
</tr>
<tr>
<td>procurement services</td>
<td>Site: (Actual site man-hours) * (Pre-agreed site unit rate) + Overheads (pre-agreed percentage for the site) + Benefits (Pre-agreed percentage for the site)</td>
<td>Site: (ETC site man-hours at the time of conversion) * (Pre-agreed site unit rate) + Overheads (Pre-agreed percentage for the site) + Benefits (Pre-agreed percentage for the site)</td>
</tr>
<tr>
<td>Supply of bulk materials</td>
<td>(Actual amount of POs for purchased materials up to the time of conversion) + Overheads (Pre-agreed percentage for the bulk materials) + Benefits (Pre-agreed percentage for the bulk materials)</td>
<td>(Bulk MTO at the time of conversion) * (Unit price agreed in OBE) * Allowances %</td>
</tr>
<tr>
<td>Supply of equipment</td>
<td>(Actual amount of purchase order for purchased equipment up to the time of conversion) + Overheads (Pre-agreed percentage for the equipment) + Benefits (Pre-agreed percentage for the equipment)</td>
<td>Equipment quantity estimate at the time of conversion) * (Vendor bid decided in OBE) * Allowances %</td>
</tr>
<tr>
<td>Cost Category</td>
<td>Compensation during the Pre-Conversion Stage</td>
<td>Compensation after Conversion</td>
</tr>
<tr>
<td>---------------</td>
<td>---------------------------------------------</td>
<td>--------------------------------</td>
</tr>
<tr>
<td>Fabrication</td>
<td>Fabrication: (Actual yard/shop man-hours)*(EPC contractor unit rate or unit rates quoted by subcontractors for the fabrication) + Overheads (Pre-agreed percentage for the fabrication) + Benefits (Pre-agreed percentage for the fabrication)</td>
<td>(Estimated man-hours for “to be fabricated” items at the time of conversion) * Allowances % * (Fabrication/Construction/installation rates decided in OBE)</td>
</tr>
<tr>
<td>Installation</td>
<td>Installation: (Actual site man-hours)*(EPC contractor unit rate or unit rates quoted by subcontractors for the installations) + Overheads (Pre-agreed percentage for the installations) + Benefits (Pre-agreed percentage for the installations)</td>
<td>(Estimated man-hours for “to be installed” items at the time of conversion) * Allowances % * (Fabrication/Construction/installation rates decided in OBE)</td>
</tr>
<tr>
<td>Construction</td>
<td>Construction: (Actual site man-hours)*(EPC contractor unit rate or unit rates quoted by subcontractors for the construction) + Overheads (Pre-agreed percentage for the construction) + Benefits (Pre-agreed percentage for the construction)</td>
<td>(Estimated man-hours for “to be constructed” items at the time of conversion) * Allowances % * (Fabrication/Construction/installation rates decided in OBE)</td>
</tr>
</tbody>
</table>
5.2.4 Realistic estimation of contingencies and lump sum price

Rapid changes in oil and gas market conditions, political issues, material cost variations, labour market changes, inflation, and escalation are major commercial and management risks. In order to minimize the risk of project cost overrun and to provide a more realistic lump sum price at the time of conversion, reasonable risk reserves and contingencies should be considered in estimating the lump sum price. The main risk reserve components that should be considered in the lump sum price are as follows:

- **Contingency reserve**: Contingency is the estimated amounts included in the lump sum price to cover works that have been accidentally overlooked from plan, inherent inaccuracy, and risk associated with unforeseen occurrences. Contingency does not include changes in scope or unforeseeable major events such as strikes or earthquakes. The following factors should be considered in estimating contingencies:
  - Organizational culture of the company and contractor
  - Project complexity/using new technology
  - Level of competition in the market
  - Level of cost estimate development
  - Level of scope definition

- **Management reserve**: Management reserve is additional capital under direct control of upper-level company management. It is used to prevent a project from overrunning the project budget and can apply to those unforeseen events that are not within the realm of contingency use, including
  - Variations to the scope, design, execution
  - Events that are likely to occur but cannot be specifically identified
5.3 Module Three: Potential Risks in Applying Convertible Contracts in Canada

Risk is a key driver in managing convertible contracts. Risk of cost, performance, and productivity will be transferred to the contractor after conversion to lump sum. Convertible contracts require an extremely strict risk management approach. Realistic risk analysis is essential in successfully managing convertible contracts. This module presents the potential risks in applying convertible contracts in Canadian oil and gas projects that have been identified during the study. Also, the appropriate mitigation approaches have been proposed to mitigate the impact of cost risks in estimating the lump sum price.

5.3.1 Major risks areas

As shown in Figure 5.8, the major risks of applying convertible contracts in Canadian oil and gas projects have been identified in six areas as follows:
Market condition

1. Lack of readiness for the convertible/lump sum approach: Participants in the research program believe that since cost reimbursable has been a more commonly used contract type in Canadian oil and gas market, the environment is still not well prepared for the convertible lump sum approach. Project owners prefer to have a high level of interfering in managing the project under cost reimbursable contracts. However, this approach is not well appreciated by an EPC contractor in a convertible lump sum contract. In order to implement successful convertible contracts, the organizational culture of project owners and contractors should be adapted accordingly. EPC contractors should be given more freedom to implement their management strategies after the conversion to lump sum to achieve the expected profits while meeting project requirements with minimum scope changes.

2. Strict permitting and regulatory requirements: Technical and HSE requirements in Canada and in particular Alberta are relatively high, and meeting them needs adequate efforts and resources. In some cases, the EPC contractor needs to involve professional organizations with special expertise to address these requirements. The required time, resources, and budget to satisfy permitting and regulatory requirements should be allocated in the project schedule and cost estimation. The cost of hiring third-party organizations that help the EPC contractor in the permitting and regulatory process is a major cost element and should be considered at conversion to single lump sum stage.
Shortage of skilled resources at different labour, management, and executive levels: Almost all participants in this research believed that the Canadian oil and gas sector is suffering from gaps in skills required to execute the projects. Although the shortage of skilled labour has been highlighted more, this issue also exists at the management level. Existing gaps in management and labour skills impact on the rate of productivity in engineering and construction phases of the projects. A realistic productivity rate should be considered for Canadian projects when estimating engineering and construction man-hours and lump sum price at conversion point. The Canadian oil and gas market needs to establish an environment for human resources to incorporate their existing skills in design, construction, and operation of projects. It is also required to develop a systematic process to enhance the level of expertise among labours, engineers, and managers. By implementing best practices, owner and contractor companies can significantly improve the level of competencies among their employees.

Lack of a systematic learning process to avoid repeating past mistakes: Most of the oil sands projects in Alberta have similar problems. However, there is no a systematic approach to use the lessons learned in other projects to avoid similar mistakes. Therefore, similar mistakes are repeated in a costly manner. Lack of sharing project management experience and knowledge obtained is an issue in the Canadian oil and gas industry and the source of repeating similar mistakes. Unlike cost reimbursable, cost effectiveness is a major element of convertible lump sum contracts. Therefore, avoiding to repeat costly mistakes in previous and similar projects highly influence the performance of the projects under convertible
contracts. Past mistakes can be avoided through a formal learning strategy to save time and cost of execution. A dedicated centre such as a project management office (PMO) in oil and gas companies should be in charge of collecting and communicating the project lessons learned within the organization as well as the entire industry.

- **High cost of doing business and not being internationally competitive**: Because of the high cost of execution, oil and gas projects in Canada are economically viable only when the oil price is relatively high. Dramatic changes in oil price significantly impact on the whole supply chain in the Canadian market. Project experts with international experience believe that the cost of project execution in Canada is significantly higher than the international benchmarks. The high cost of labour should be considered in estimating lump sum price at the point of conversion. Strategic planning to increase the availability of skilled human resources, implementing industry best practices, value engineering, optimal modularization, and effective workforce planning can help the Canadian oil and gas market to target international benchmarks and be more competitive.

- **Fast-tracking strategy**: Most oil and gas projects in Alberta are driven by fast schedules. Starting the construction phase or activities without complete scope and engineering will increase the risk of numerous changes and reworks. Poor scope definition, inadequate execution plan, unrealistic cost estimation, and dependency on the cost reimbursable contract are among the usual consequences of a fast-tracking approach. Therefore, fast-tracking may result in more costs and even longer project duration. Oil companies should reassess their approach in
fast-tracking and contractors should consider the risk of fast-tracking in estimating lump sum price in convertible contracts. Project scope and engineering information should be mature enough to provide a reliable MTO for purchasing materials and equipment and to minimize construction reworks.

- **High turnover rate**: According to the participants in the study, the rate of employee turnover is significantly high in the Canadian oil and gas sector. Compare to the cost reimbursable, convertible and lump sum contracts need more stability and discipline in project organization to keep the required efficiency for managing the lump sum stage. To minimize turnover rate and successfully recruit and retain employees, strategic workforce planning and innovative attraction and retention solutions are key.

The potential risks in the area of “market condition” and suggested mitigation strategies have been summarized in Table 5.4.

**Table 5.4. Potential risks in the area of “market condition”**

<table>
<thead>
<tr>
<th>Potential Risk</th>
<th>Suggested Mitigation Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of readiness for the convertible/lump sum approach</td>
<td>EPC contractors should be given more freedom to implement their management strategies after the conversion to lump sum to achieve the expected profits while meeting project requirements with minimum scope changes.</td>
</tr>
<tr>
<td>Strict permitting and regulatory requirements</td>
<td>The required time, resources, and budget to satisfy permitting and regulatory requirements should be allocated in the project schedule and cost estimation.</td>
</tr>
<tr>
<td>Shortage of skilled resources</td>
<td>Establishing an environment for human resources to incorporate their existing skills</td>
</tr>
</tbody>
</table>
### Market Condition

<table>
<thead>
<tr>
<th>Potential Risk</th>
<th>Suggested Mitigation Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developing a systematic process to enhance the level of expertise. Implementing best practices to significantly improve the level of competencies among employees.</td>
<td></td>
</tr>
<tr>
<td>Lack of a systematic learning process to avoid repeating past mistakes</td>
<td>A dedicated centre such as a project management office (PMO) in oil and gas companies should be in charge of collecting and communicating the project lessons learned within the organization as well as the entire industry.</td>
</tr>
<tr>
<td>High cost of doing business and not being internationally competitive</td>
<td>Strategic planning to increase the availability of skilled human resources, implementing industry best practices, value engineering, optimal modularization, and effective workforce planning can help the Canadian oil and gas market to target international benchmarks and be more competitive.</td>
</tr>
<tr>
<td>Fast-tracking strategy</td>
<td>Oil companies should reassess their approach in fast-tracking. Project scope and engineering information should be mature enough to provide a reliable MTO for purchasing materials and equipment and to minimize construction reworks.</td>
</tr>
<tr>
<td>High turnover rate</td>
<td>To minimize turnover rate and successfully recruit and retain employees, strategic staffing planning and innovative attraction and retention solutions are key.</td>
</tr>
</tbody>
</table>

- **Scope**
  - **Unclear objectives and priorities**: Owing to the fast-track strategy, most oil and gas projects in Alberta are suffering from poor initiation, unclear objectives, and incomplete scope definition. Most often, project priorities are not set appropriately by project owners, which may delay making critical decisions. Project priorities should be set out in line with the main characteristics of
convertible contracts including optimizing the risk taking/rewarding concept and improving the cost certainty and efficiency.

- **Poor scope definition and continuous changes**: Incomplete scope definition means more risks, uncertainties, and changes in later stages of the project. The project scope should be well defined by the project owner before starting the execution. In a convertible lump sum contract, continuous changing of the project scope would be a major source of claims, disputes, and project failure. To mitigate the risk, the design basis should be frozen before starting project execution and the scope should be managed and controlled strictly. Effective change management is very important in managing convertible contracts.

- **Inadequate Front End Loading (FEL) and incomplete FEED**: Most of the participants in this study believed that very few oil and gas projects in Canada complete FEL and FEED before the final investment decision (FID). Therefore, the budget approved for expenditure in many projects is not based on complete front-end work and often is less than the actual cost of execution. This issue has been one of the main reasons for project cost and schedule overruns in the Canadian oil and gas industry. This would be a greater problem when the project is converted to the lump sum scheme. Inadequate FEL and FEED do not allow the contractor to obtain a reliable estimate and may result in higher risk premiums and contingencies in the lump sum price. Fast-tracking has been the most common reason for failing to complete pre-execution phases. This problem can be avoided by allocating enough time and resources to complete FEL and FEED before FID.
The potential risks in the area of “scope” and suggested mitigation strategies have been summarized in Table 5.5.

Table 5.5. Potential risks in the area of “scope”

<table>
<thead>
<tr>
<th>Potential Risk</th>
<th>Suggested Mitigation Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unclear objectives and priorities</td>
<td>Project priorities should be set out in line with the main characteristics of convertible contracts including optimizing the risk taking/rewarding concept and improving the cost certainty and efficiency.</td>
</tr>
<tr>
<td>Poor scope definition and continuous changes</td>
<td>The design basis should be frozen before starting project execution, and the scope should be managed and controlled strictly. Effective change management is very important in managing convertible contracts.</td>
</tr>
<tr>
<td>Inadequate FEL and incomplete FEED</td>
<td>Allocating enough time and resources to complete FEL and FEED before final investment decision (FID).</td>
</tr>
</tbody>
</table>

- **Engineering**
  - *Engineering slippage:* In Canadian oil and gas projects engineering milestones are accomplished late. Also, vendor data are usually incorporated very late into engineering performed by the EPC contractor. The late engineering delays purchase of materials and equipment; however; the start of construction and site activities will not usually change. Therefore, engineering and construction phases will be more overlapped, which means higher risk of changes and reworks. In fact, late engineering can delay the conversion process owing to the lack of information required to conduct a reliable MTO and estimate a realistic lump sum price. Overlapping engineering and construction should be minimized to mitigate the risk of late engineering.
o **Ineffective engineering progress measurement techniques:** Conventional approaches such as EVA do not necessarily reflect the real engineering progress in the project. As a result, engineering milestones cannot be reliable indications to determine the conversion points. Some participants in the study suggested IFC level of drawings and engineering documents as the more accurate metrics to measure the engineering maturity.

The potential risks in the area of “engineering” and suggested mitigation strategies have been summarized in Table 5.6.

**Table 5.6. Potential risks in the area of “engineering”**

<table>
<thead>
<tr>
<th>Potential Risk</th>
<th>Suggested Mitigation Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering slippage</td>
<td>Overlapping engineering and construction should be minimized to mitigate the risk of late engineering.</td>
</tr>
<tr>
<td>Ineffective engineering progress measurement techniques</td>
<td>IFC level of drawings and engineering documents are suggested as the more accurate metrics to measure the engineering maturity.</td>
</tr>
</tbody>
</table>

- **Supply of materials and equipment**
  - **High cost of manufacturing and supply of materials/equipment:** Cost of manufacturing materials and equipment is relatively high in Canada. Therefore, EPC contractors mostly prefer to supply the required materials and equipment from other parts of the world. Also, manufacturing requirements are very high and meeting them requires additional time, human resources, and money. Most often, these issues delay the procurement process. Manufacturing requirements in Canada should be revised based on international benchmarks. In a convertible
lump sum contract, these additional time and costs to meet higher requirements should be considered in estimating the lump sum price.

- **Transportation constraints**: Transportation constraints in terms of dimension and weight limit the module fabrication. Transportation limits should be taken into consideration in estimating project time and lump sum price in convertible contracts. Revising the transportation limitations without compromising safety measures can help optimal modularization.

The potential risks in the area of “supply of materials and equipment” and suggested mitigation strategies have been summarized in Table 5.7.

**Table 5.7. Potential risks in the area of “supply of materials and equipment”**

<table>
<thead>
<tr>
<th>Potential Risk</th>
<th>Suggested Mitigation Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>High cost of manufacturing and supply of materials/equipment</td>
<td>Manufacturing requirements in Canada should be revised based on international benchmarks. In a convertible lump sum contract, these additional time and costs to meet higher requirements should be considered in estimating the lump sum price.</td>
</tr>
<tr>
<td>Transportation constraints</td>
<td>Revising the transportation limitations (dimension and weight) without compromising safety measures can help optimal modularization.</td>
</tr>
</tbody>
</table>

- **Fabrication, installation, and construction**

  - **Shortage of skilled labour**: Almost all participants in this research believed that shortage of a skilled workforce is one of the major risks in the construction phase of oil and gas projects in Canada. This issue should be taken into consideration in
estimating the cost of construction activities in the single lump sum stage of the project. The Canadian oil and gas industry should have an effective strategic plan to address this critical issue. Recruiting skilled foreign workers would be a temporary solution to fill this gap. However, there should be an effective staffing plan to recruit, train, and maintain local human resources to address this issue in the whole value chain of the Canadian oil and gas industry.

- **Low productivity**: Low productivity has been one of the main concerns in the Canadian oil and gas industry. The productivity factor is highly important in estimating the lump sum price in convertible contracts. Although low productivity has been frequently linked to labour skills and adverse weather conditions, some of participants in the study believed that it is related more to poor project management and inadequate workforce planning. Conducting the best practices of project management and adequate workforce planning can improve the productivity of construction in oil and gas projects. Modularization is a common manufacturing strategy to improve productivity and lower the labour costs in Canada by pre-fabricating the selected sections of the plant in a more convenient environment and specialized module yards. Module fabrication accommodates the needs for fast-tracking and reduces the impact of adverse weather conditions and insufficient labour. Also, indirect costs associated with construction camps, scaffolding, machines, and small tools will be cut by modularization. In view of the significant benefits of modularization in Canada, module fabrication capability would be a critical competitive advantage for the competent EPC contractors in the market.
Weather conditions: Adverse weather conditions in Canada have been one of the main constrains in the construction phase of oil and gas projects. The EPC contractor should consider weather and environmental constraints in the estimation and execution plan. Effective seasonal work planning and optimal modularization to minimize site activities would be practical solutions to mitigate the weather impacts on construction activities.

Ineffective modularization approach: Modularization improves constructability; however, it has unique design complications and requires more advanced methods of construction compared with the stick-built approach. Important factors such as module dimension and weight limits, maintenance accessibility, and time of delivery will affect the degree of modularization. Avoiding construction reworks and site changes is highly critical in convertible lump sum contracts. Adequate efforts on developing engineering work packages (EWPs), construction work packages (CWPs), advanced CWPs, and field installation work packages (FIWPs) minimize the risk of poor modularization and site issues.

Subcontracting contracts: In construction, one the main challenges (risks) for the EPC contractor is that it has to commit on quantities and productivity under the lump sum contract while it does not necessarily have the same commitment from subcontractors. The risk/reward of lump sum contract should be shared with subcontractors appropriately. The contractual terms and conditions between the EPC contractor and subcontractors or suppliers should be adjusted with the concept of a convertible contract between the EPC contractor and the owner.
The potential risks in the area of “supply of materials and equipment” and suggested mitigation strategies have been summarized in Table 5.8.

**Table 5.8. Potential risks in the area of “fabrication, installation, and construction”**

<table>
<thead>
<tr>
<th>Potential Risk</th>
<th>Suggested Mitigation Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shortage of skilled labour</td>
<td>There should be an effective staffing plan to recruit, train, and maintain local human resources</td>
</tr>
<tr>
<td>Low productivity</td>
<td>Conducting the best practices of project management and adequate workforce planning.</td>
</tr>
<tr>
<td></td>
<td>Modularization is a common manufacturing strategy to improve productivity and lower the labour costs at site.</td>
</tr>
<tr>
<td>Weather conditions</td>
<td>Effective seasonal work planning and optimal modularization</td>
</tr>
<tr>
<td>Ineffective modularization approach</td>
<td>Adequate efforts on developing engineering work packages (EWPs), construction work packages (CWPs), advanced CWPs, and field installation work packages (FIWPs) to minimize the risk of poor modularization and site issues.</td>
</tr>
<tr>
<td>Subcontracting contracts</td>
<td>The risk/reward of lump sum contract should be shared with subcontractors appropriately.</td>
</tr>
<tr>
<td></td>
<td>The contractual terms and conditions between the EPC contractor and subcontractors or suppliers should be adjusted with the concept of a convertible contract between the EPC contractor and the owner.</td>
</tr>
</tbody>
</table>

- **Project environment**
  - *High level of interfering of the project owner in managing the project*: Most of the oil and gas projects in Canada have been performed under a cost reimbursable scheme. This form of contracts needs more involvement of the owner in management of the project and monitoring the contractor’s approach and
performance. Therefore, a high level of involvement of the project owner has been a common strategy in management of oil and gas projects. However, the EPC contractor needs more independency in a lump sum convertible contract. While meeting the owner and project requirements, the EPC contractor should optimize design and construction methods to minimize the cost and maximize its profit under a fixed price contract. A high level of interfering of project owners in management and control of the project was identified as a risk in convertible lump sum contracts. The culture of owner organizations should be adapted to convertible lump sum contracts by avoidance of too much involvement in management of the project.

- **Blaming and distrustful project environment**: Some of interviewees believe that the conventional approach in shifting the project risks to the other party has resulted in mistrust and adversarial relationships in Canadian oil and gas projects. In this situation, contracting parties are more focused on blaming each other for the poor performance of the project rather than collaborating to resolve the issues. Implementing convertible contracts with inherent challenges in conversion process and conducting OBE approach in estimating project costs needs a high level of trust between contracting parties and collaborative project environment. Relational strategies such as “Alliancing” can help contracting parties to establish a collaborative environment based on trust and cooperation.

The potential risks in the area of “project environment” and suggested mitigation strategies have been summarized in Table 5.9.
### Table 5.9. Potential risks in the area of “project environment”

<table>
<thead>
<tr>
<th>Potential Risk</th>
<th>Suggested Mitigation Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>High level of interfering of the project owner in managing the project</td>
<td>The culture of owner organizations should be adapted to convertible lump sum contracts by avoidance of too much involvement in management of the project.</td>
</tr>
<tr>
<td>Blaming and distrustful project environment</td>
<td>Relational strategies such as “Alliancing” can help contracting parties to establish a collaborative environment based on trust and cooperation.</td>
</tr>
</tbody>
</table>
5.4 Module Four: Collaborative Strategy to Enhance the Relationships in Convertible Contracts

The performance of the conversion process is highly affected by the level of relationships between contracting parties. A successful conversion process requires a collaborative and trustworthy environment. Some of the project experts who participated in this study suggested relational strategies such as alliancing or partnership to provide the required collaborative environment for convertible contracts.

This module proposes a strategy to manage important challenges of convertible contracts in a collaborative manner from the start of the project. The proposed strategy is to organize a project collaboration centre (PCC) with focus on critical activities/decisions before and after conversion to lump sum. Figure 5.9 shows the main areas that should be addressed by a PCC before and after conversion to the full lump sum price.

Figure 5.9. PCC focus areas
The PCC is staffed by key personnel from owner and EPC contractor organizations and should be supported by high levels of management in both organizations.

5.4.1 **PCC focus areas before conversion to the single lump sum scheme**

Defining the project scope, deciding the conversion points, approving the OBE strategy, conducting a realistic risk assessment, and estimating and accepting the contingencies are critical areas that need to be managed properly during the first stage of contract life cycle and before conversion to a single lump sum contract. This needs a close collaboration between the project owner and the EPC contractor working in the PCC.

*Scope freezing:* To avoiding the high cost of late changes and reworks, project design basis should be frozen and the project scope should be well defined before starting the execution of the project. The level of scope can be communicated and evaluated in a joint and collaborative effort by a PCC organization to ensure the maturity and adequacy of project scope required for a convertible lump sum contract.

*Deciding the conversion points:* PCC members should define the major parameters and milestones to determine the conversion points during stage 1. Appropriate contract price arrangements for different work packages can be specified by the PCC before conversion to lump sum.

*Open book estimation strategy:* The detailed procedure and schedule for conducting the OBE process should be clearly defined by the PCC to facilitate and expedite the estimation and conversion process. It is vital to agree on the level of details and frequency of conducting an OBE during the stage 1.

*Risk and contingency:* Collaboration of the owner and the EPC contractor in identifying and evaluating the potential risks in the project would result in a reliable risk assessment.
Because effective risk management in a convertible contract is highly important, a PCC would add great value to the project by conducting a joint risk assessment process. As a result, the estimation and allocation of contingencies would be based on the results of a risk evaluation that has been performed and approved by both owner and EPC contractors.

5.4.2 **PCC focus areas after conversion to the single lump sum scheme**

After conversion to the single lump sum contract, the focus of the PCC should be on productivity, scope deviations, schedule, and interface management.

**Productivity management:** The project performance should be monitored by using reliable tools and techniques such as earned value analysis (EVA). Earned value analysis is a planning and control tool to measure the project performance by integrating scope, cost, and schedule metrics. According to Fleming and Koppelman (2002), the earned value (EV) concept has three main dimensions:

1. The planned value (PV) or Budgeted Cost of Work Scheduled (BCWS), which is the total authorized budget for all project work packages scheduled to be performed in a given time frame.

2. The earned value (EV) or Budgeted Cost of Work Performed (BCWP), which is the total budget for completed work packages.

3. The actual cost (AC) or Actual Cost of Work Performed (ACWP), which is the actual cost incurred to perform the work scheduled in a given time frame.

Based on these three major quantities, cost variance (CV), schedule variance (SV), and other significant indicators can be calculated to measure the project performance.

Measuring cost and schedule performance and deviations from the project baseline can help the PCC to better identify productivity issues. The PCC should ensure the application of
best practices during the execution to increase the productivity and minimize the cost of project. To be more competitive, international productivity benchmarks should be taken into consideration. Effective workforce planning and efficient execution should be monitored by the PCC to ensure the effectiveness and efficiency of the project team during the lump sum stage.

**Change management:** Unlike cost reimbursable, a lump sum contract is not flexible for design and scope changes during the execution of the project. Any deviation from the project scope and its impact on time, cost, and quality should be evaluated precisely. The owner and EPC contractor members in the PCC should cooperate in assessment of the scope changes. This joint effort and collaborative approach minimizes the risk of claims and disputes in the project.

**Time management:** After conversion to the lump sum contract, the contract value is fixed and the project cost is supposed to be within the approved budget. Yet project schedule and on-time completion of the project is a major concern. Therefore, achieving the project milestones and delivery of major components should be closely monitored by the PCC. The results of EVA in terms of schedule variance (SV) and schedule performance index (SPI) should be analyzed by the SAC for the required corrective actions.

**Interface management:** Because of the size and complexity of oil and gas projects, several subcontractors, suppliers, and third parties are involved in the project execution. Management of the interface between these entities is highly important and requires a lot of time and effort. Lack of a systematic interface management process and clear procedure will result in conflicts and inefficiency. The PCC should monitor the critical interfaces and resolve possible conflicts between different parties.
CHAPTER 6. VALIDITY OF THE STUDY

The validity of a research highly depends on the reliability of data collection instruments and also the validity of the research method. By focusing on these two aspects, this chapter defends the validity of this research project as a whole.

6.1 Validity of Data Collection Instruments

The validity of a data collection method is the extent to which that method or instrument can measure what it is supposed to measure. As explained in Chapter 3, interview was chosen as the major instrument to collect the required data and information. Besides, an in-depth review of project documents was conducted to obtain required information.

According to Thomson (2011), interview is one of the most frequently used methods of data collection in grounded theory study. Following the concept of theoretical sampling, two rounds of interviews were conducted. The gathering of data based on analysis of previous data is termed Theoretical Sampling (Corbin & Strauss, 2015). In the first round, a group of 14 project experts was selected to provide the first set of data. Data analysis was practically started when the first pieces of data were collected and continued in parallel with data collection. The second round of interviews was conducted and continued during the analysis until the theoretical saturation was achieved. With more than 13 interviews and after 27 in total, data collection did not add properties or dimensions to recognized categories.

Also, the key documents of oil and gas projects, including companies’ procedures, contracts, lessons learned, risk registers, and other related documents, were scrutinized to obtain required data and examine the validity of the collected information through the interviews.
6.2 Validity of the Research Method

The validity of the research method concerns the accuracy, meaningfulness, and credibility of the research project as a whole (Leedy & Ormrod, 2013). The validity of the measurement instrument in collecting data and the validity of the research approach allow us to defend the trustworthiness of the results of the study.

Developed by Guba (1981) and suggested by Bitsch (2005), the trustworthiness of a qualitative research can be examined by its credibility (internal validity), transferability (external validity), dependability (reliability), and conformability (objectivity).

6.2.1 Credibility or internal validity

According to Leedy and Ormrod (2013) the internal validity of a research study is to ensure that the research results are truly warranted by the collected data and information. Since the construction of the framework in this study is highly based on the actual data collected through the interviews, this research has a high level of internal validity.

6.2.2 Transferability or external validity

The external validity of a research study is the extent to which its results and conclusions apply to situations beyond the study itself and can be generalized to other contexts (Leedy and Ormrod, 2013). Addressing the external validity of this study, the proposed theoretical framework should be applicable in management of all convertible contracts in oil and gas projects. Although the focus of the study was on oil and gas projects in Canada, most of participants in the research project shared their international experience in oil and gas projects around the world. Therefore, the theoretical framework and the results of the study can be generalized to other circumstances.
6.2.3 Dependability or reliability

Dependability refers to the stability of findings over time and ensures that the research results would be the same if the study was replicated with the same or similar participants in a similar context (Bitsch, 2005). Reliability of the findings highly depends on the strength of the research methodology and process. Choosing Grounded Theory study as one of the most powerful qualitative research designs and fulfilling of all of its requirements guarantee the reliability of the findings of this study.

6.2.4 Confirmability or objectivity

According to Bitsch (2005), confirmability is parallel to objectivity and deals with the issue of bias and prejudices of the researcher. In fact, conformability is to examine whether the findings of the study will be confirmed by other researchers using with the same data. Publication of the results of the study in peer reviewed publications confirms the confirmability of the research methodology and the objectivity of the findings of the study.

6.3 Methods Used to Validate the Findings of the Study

Among several strategies suggested by Leedy and Ormrod (2013) to validate a qualitative research, the following methods were used in this study to support the validity of the study and fulfill the credibility, transferability, dependability, and conformability of the results.

6.3.1 Respondent validation

One of the methods used to validate a qualitative research is to send the research findings back to the participants to determine whether they agree or disagree with the conclusions.

Accordingly, the findings of the study were sent back to the participants in the study to examine to see if they agree with the presented results in the theoretical framework. The
theoretical framework as the main deliverable of the study was sent to the participants along with four basic questions to examine the validity of the research, as follows:

1. To what extent do you agree that the results of the research reflect the actual discussion through the interview?
2. To what extent do you agree that essential elements of convertible contracts have been addressed in the framework?
3. To what extent do you agree that the results of the study reflect the real issues/challenges in the practical world?
4. To what extent do you agree that the results of this study can be generalized to all convertible contracts in the oil and gas industry?

Questions 1 and 4 examine internal and external validity of the results. An example of responses received is shown below:

**Participant’s Position: Managing Director**

**Organization Type: Project Management Consultancy**

**Years of Experience: 35**

1. To what extent do you agree that the results of the research reflect the actual discussion through the interview?
   - o Strongly agree □
   - o Agree ☒
   - o Undecided □
   - o Disagree □
   - o Strongly disagree □
2. To what extent do you agree that essential elements of convertible contracts have been addressed in the framework?
   - Strongly agree ☒
   - Agree ☐
   - Undecided ☐
   - Disagree ☐
   - Strongly disagree ☐

3. To what extent do you agree that the results of the study reflect the real issues/challenges in practical world?
   - Strongly agree ☐
   - Agree ☒
   - Undecided ☐
   - Disagree ☐
   - Strongly disagree ☐

4. To what extent do you agree that the results of this study can be generalized to all convertible contracts in the oil and gas industry?
   - Strongly agree ☐
   - Agree ☒
   - Undecided ☐
   - Disagree ☐
   - Strongly disagree ☐
Comments:

“The study has been thoroughly done and is well thought through. The recommendations are sound. Although the study is applicable to all oil and gas projects some of the recommendations are specific to Canada. Strategy 1 is reasonably common especially where limited technology is available, e.g., LNG. Strategy 1 is also easily adapted to competitive FEED.”

6.3.2 Feedback from others

The results of the study were also shared with some oil and gas experts who did not participate in the study to examine whether they agree or disagree with the findings of the study. This approach is called “feedback from others” by Leedy and Ormrod (2013). Feedback from others were received through following questions:

- To what extent do you agree that the results are logically sound?
- To what extent do you agree that the results of the study reflect the real issues/challenges in practical world?
- To what extent do you agree that the results of this study can be generalized to convertible contracts in the oil and gas industry?

Responses received from participants in the research project and feedback from others confirm the high level of validity of the findings of the study. Some of collected responses and feedbacks are attached in Appendix C. Figures 6.1 to 6.4 show the breakdown of responses to validation questions. The breakdown of the responses to questions confirms the high level of validity of the results.
Figure 6.1. Breakdown of participants’ responses to question 1

Figure 6.2. Breakdown of responses to question 2
Figure 6.3. Breakdown of responses to question 3

Figure 6.4. Breakdown of responses to question 4
6.3.3  **Triangulation**

Triangulation is a commonly used method to validate qualitative research. In this method, multiple sources of data are collected with the hope that they will all converge to support a particular theory (Leedy and Ormrod, 2013).

Since the theoretical framework was mainly constructed based on analysis of collected data through interviews, the researcher used other source of data (three oil and gas projects with convertible contracts) to examine the validity of the proposed framework and its main components. Two of these projects were completed in Canada during this study, and one of them had been started in the Middle East before the study. Conversion process and estimation strategies of these projects have been discussed and compared with the results of the study, as follows:

**Case 1 Project: Building a 360,000 bpd gas condensate refinery in the Middle East**

The objective of the project was to build a gas condensate refinery with a nameplate capacity of processing 360,000 bpd of gas condensate to produce finished products (mainly gasoline, gasoil, and jet fuel).

The FEED phase was performed by the project owner, and the contract was awarded through an international competitive bid and structured as a Converted Lump Sum EPC contract. The main components of the contract in the Case 1 Project and relevant modules and propositions in the theoretical framework have been compared as follows:

- **Conversion Timeline**

  As specified in the contract of the Case 1 Project, the estimated time for completion of the works was 35 months from the effective date of the contract, and the final conversion to the lump sum was expected within 12 months. Based on the project schedule, the last engineering
deliverable was planned to be delivered in month 24. Therefore, the conversion point was expected to be in the middle of the engineering duration. Figure 6.5 depicts the expected point of conversion in Case 1 Project schematically.

![Conversion timeline in the Case 1 Project](image)

**Figure 6.5. Conversion timeline in the Case 1 Project**

The engineering progress at the middle of detailed engineering is often more than 50%. Compare with the theoretical framework, the conversion strategy in the Case 1 Project confirms the proposed Strategy 2 of the conversion process in the theoretical framework, as shown in Figure 6.6.

![Conversion process: Strategy 2 in the theoretical framework](image)

**Figure 6.6. Conversion process: Strategy 2 in the theoretical framework**

Although the contract scope in the Case 1 Project is limited to EPC and does not cover the FEED phase, the conversion strategy is similar to the proposed Strategy 2.
**Estimating Strategy**

Table 6.1 compares the compensation methods for the main cost items between the contractual terms in the Case 1 Project and the theoretical framework.

**Table 6.1. Compensation Methods: Case 1 Project vs. theoretical framework**

<table>
<thead>
<tr>
<th>Case 1 Project Contract</th>
<th>Theoretical Framework</th>
<th>Comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering and procurement services for the complete project on a fixed lump sum basis</td>
<td>Module Two (Estimating Strategy): Management, engineering, and procurement services can be compensated during the pre-conversion and lump sum stages as follows: Compensation during the pre-conversion stage: unit rate Compensation after conversion: lump sum</td>
<td>While in the Case 1 project a lump sum price has been considered for engineering and procurement services for the entire project duration, the theoretical framework proposes a unit rate scheme for pre-conversion and lump sum price for the rest of the project. In fact, the theoretical framework provides a more flexible arrangement with less risk.</td>
</tr>
<tr>
<td>Supply of equipment and materials, construction activities, and management services on a Converted Lump Sum basis in accordance with the pre-agreed OBE.</td>
<td>Module Two (Estimating Strategy): The proposed compensation methods to purchase bulk materials, supply equipment, and construction activities in the theoretical framework is on a convertible lump sum basis in accordance to OBE strategy.</td>
<td>The proposed compensation methods to supply bulk materials and equipment and to perform construction activities are similar to the model that was used in the Case 1 Project in accordance to OBE methodology.</td>
</tr>
</tbody>
</table>

According to the above discussion and comparisons, the main components of the Case 1 Project confirm the validity of the relevant components of the theoretical framework.
Case 2 Project: Development of a 60,000 bpd oil sands project in Alberta, Canada

The objective of the project was to produce 60,000 bpd of bitumen. The FEED phase was performed by the project owner and the contract was awarded to a contractor to perform the engineering, procurement, and construction (EPC) activities.

The main components of the contract in the Case 2 Project and relevant modules and propositions in the theoretical framework have been compared as follows:

- Conversion Timeline

Based on the project schedule, the estimated time for completion of the works was 38 months, and the contract was expected to be converted to the lump sum price around 2 months after 90% model review milestone. Since the 90% model review was planned to be completed at the end of month 16, the conversion point to the lump sum contract was expected to be done at the end of month 18 of the project. Figure 6.7 depicts the expected point of conversion in the Case 2 Project schematically.

![Conversion Timeline Diagram]

**Figure 6.7. Conversion timeline in the Case 2 Project**

When compared with the theoretical framework, the conversion strategy in the Case 2 Project confirms the proposed Strategy 3 of the conversion process in the theoretical framework, as shown in Figure 6.8.
Figure 6.8. Conversion Process: Strategy 3 in the theoretical framework

- Estimating Strategy

Table 6.3 compares the compensation methods for the main cost items between the contractual terms in the Case 2 Project and the theoretical framework.

The comparison column of Table 6.3 shows that the proposed estimating strategy in the theoretical framework is confirmed by the estimating strategy in the Case 2 Project.

Based on the above discussion and comparisons, the main modules of the theoretical framework are validated by the actual contractual terms and conversion strategy in the Case 2 Project.
Table 6.2. Compensation Methods: Case 2 Project vs. theoretical framework

<table>
<thead>
<tr>
<th>Cost Item</th>
<th>Case 2 Project</th>
<th>Theoretical Framework</th>
<th>Comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering and procurement services:</td>
<td>Lump sum and unit rates before conversion to lump sum</td>
<td>Unit rate and lump sum before conversion to lump sum</td>
<td>Both use mixed contract price arrangements before conversion</td>
</tr>
<tr>
<td>Supply of equipment</td>
<td>Lump sum for the entire project duration</td>
<td>Cost reimbursable before conversion to lump sum</td>
<td>Theoretical framework provides more flexible price arrangement</td>
</tr>
<tr>
<td>Supply of bulk materials</td>
<td>Cost reimbursable before conversion to lump sum</td>
<td>Cost reimbursable before conversion to lump sum</td>
<td>Same price arrangements</td>
</tr>
<tr>
<td>Fabrication</td>
<td>Unit rate before conversion to lump sum</td>
<td>Unit rate before conversion to lump sum</td>
<td>Same price arrangements</td>
</tr>
<tr>
<td>Construction</td>
<td>Unit rate before conversion to lump sum</td>
<td>Unit rate before conversion to lump sum</td>
<td>Same price arrangements</td>
</tr>
</tbody>
</table>

**Case 3 Project: Development of a 44,000 bpd oil sands project in Alberta, Canada**

The objective of the project was to produce 44,000 bpd of bitumen. The FEED phase was awarded to a contractor that had the opportunity to perform the EPC phases after FID by the owner company. Although the owner company decided not to proceed with the EPC phases, the estimating and conversion strategies were decided during the FEED phase.

The main components of the contract in the Case 3 Project and relevant modules and propositions in the theoretical framework have been compared as follows:
• **Conversion Timeline**

Contracting parties decided to convert the contract to a single lump sum scheme after completion of the FEED and before starting the EPC. Based on the project schedule, the FEED and EPC phases were planned to be completed in 8 and 36 months, respectively. A 6-month conversion period was considered between the FEED and the start of the EPC to prepare the conversion proposal and final OBE by the contractor and approval process by the owner company. Figure 6.9 depicts the expected point of conversion in Case 3 Project schematically.

![Conversion Timeline Diagram](image-url)

**Figure 6.9. Conversion timeline in the Case 3 Project**

The conversion strategy in the Case 3 confirms the proposed Strategy 1 of the conversion process in the theoretical framework, as shown in Figure 6.10.

![Conversion Process Diagram](image-url)

**Figure 6.10. Conversion Process: Strategy 1 in the theoretical framework**

*Saved time due to eliminating competitive bidding process to select EPC contractor.*
**Estimating Strategy**

Open Book Estimate (OBE) was used in the Case 3 Project to estimate the lump sum price at the point of conversion. Table 6.4 compares the compensation methods for the main cost items between the contractual terms in the Case 3 Project and the theoretical framework.

**Table 6.3. Compensation Methods: Case 3 Project vs. theoretical framework**

<table>
<thead>
<tr>
<th>Cost Item</th>
<th>Case 3 Project</th>
<th>Theoretical Framework</th>
<th>Comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management, Eng., Proc. services</td>
<td>Unite rate before conversion</td>
<td>Unit rate before conversion</td>
<td>Same strategy</td>
</tr>
<tr>
<td>Supply of bulbs and equipment</td>
<td>Cost reimbursable before conversion</td>
<td>Cost reimbursable before conversion</td>
<td>Same strategy</td>
</tr>
<tr>
<td>Fabrication</td>
<td>No fabrication activity before conversion</td>
<td>Unit rate before conversion</td>
<td>Framework proposes unit rate</td>
</tr>
<tr>
<td>Construction</td>
<td>No construction activity before conversion to lump sum</td>
<td>Unit rate before conversion to lump sum</td>
<td>Framework proposes unit rate</td>
</tr>
</tbody>
</table>

Based on the above discussion and comparisons, the main modules of the theoretical framework are validated by the actual contractual terms and conversion strategy in the Case 3 Project.

By conducting respondent validation, feedback from others, and triangulation methods, the and besides validating data collection methods, the whole research project and its results were validated.
CHAPTER 7. CONCLUSION

During the literature review stage of the research, it was found that conventional forms of contract cannot address the dynamic and unpredictable environment of fast-track projects in the oil and gas industry. Using a single contract type such as cost reimbursable or lump sum for the whole project life cycle shifts the project risks to the owner or the contractor inequitably. Inappropriate risk assignments in conventional contractual relationships result in more risk premiums and contingencies, which will end with greater overall project cost. It was also found that convertible contracts have been used in few oil and gas projects as an alternate contracting strategy to optimize risk taking/rewarding between contracting parties.

However, it was discovered that very few industrial papers have discussed only general characteristics of the convertible contracts, and since convertible contracts are new in the oil and gas industry, there is a significant gap in academic studies addressing the most challenging issues in managing convertible contracts. This identified gap led the researcher to design the research questions as follows:

- How to determine the conversion points during the conversion process?
- What is the most effective methodology to estimate prices in convertible contracts?
- What are the major risks in application of convertible contracts in Canadian oil and gas projects?
- What is the most effective relational strategy in managing convertible contracts?

By addressing the research questions, the main objective of this research was to develop a theoretical framework for implementing convertible contracts in oil and gas projects.
Since the research questions were quite interpretive and investigative and the main objective of this study was developing a theoretical framework, a grounded theory study was chosen as the main qualitative research design to develop the anticipated framework.

As one of the most frequently used method of data collection in grounded theory study, interview was the major instrument to collect the required data and information. Interviewees were selected among those who represent the typical perceptions and perspectives of the research scope. Executive managers, project managers, technical mangers, project consultants, and project control managers participated in the study. In compliance with an acceptable sample size for grounded theory methodology, 27 interviews were conducted to achieve the theoretical saturation. Besides, an in-depth review of project documents was conducted. Companies’ procedures, work instructions, contracts, lessons learned, risk registers, and other related documents of oil and gas projects were scrutinized to obtain required information.

The collected data were analyzed through open coding, axial coding, selective coding, and theoretical integration to develop a theoretical framework for convertible contracts.

7.1 Research Results

As the main deliverable of the study, the theoretical framework consists of four main modules: Conversion Process, Estimating Strategy, Potential Risks, and Collaborative Strategy (Figure 5.1). The major findings of each module have been presented as follows:

7.1.1 Major findings of Module One: Conversion Process

To optimize the conversion process in convertible contracts, this module provides:

- Important factors that influence deciding the conversion points
- Practical recommendations to enhance the conversion process
- Possible conversion strategies in application of convertible contracts
To optimize the risk taking/rewarding concept, a phased conversion approach is suggested to use cost reimbursable, unit rate, and lump sum contract price arrangements through the project phases. The contract price arrangement can be converted to lump sum earlier for engineering and procurement activities and later for fabrication, installation, and construction work packages.

The results of this study indicate that the engineering completeness is an essential factor in conversion process. The reliability of material take off (MTO) and the accuracy of estimating lump sum price greatly depend on the level of engineering maturity. Major engineering milestones at the end of the FEED phase and 60% and 90% of engineering progress are key indicators in deciding the conversion points. However, the degree of engineering completeness is not the only factor to decide the conversion time, and the level of scope definition as a whole should be taken into consideration.

Although project owners prefer early conversion to minimize the costs risk, immature scope definition may result in higher contingency in the lump sum estimate. The acceptable range of contingency by the project owner is an important factor in deciding the early conversion. Conversion to a single lump sum contract after the FEED phase and from the start of EPC is a highly risky approach.

It is recommended to purchase all long lead items (LLIs) and important bulk materials, including piping and structural steels, before conversion to the lump sum. Also, it is recommended to perform the civil work packages including site preparation, piling, and concrete pouring under the unit rate contract.

An effective risk management approach and realistic risk assessment are vital in successful management of convertible contracts and deciding the right conversion strategy.
Project risks should be monitored closely and evaluated through a reliable risk analysis process to accurately estimate the amount of required contingencies.

Since the conversion process needs a high level of cooperation and transparent interactions between contracting parties, Alliancing and Partnering strategies are recommended to establish the required project environment. These strategies build effective communications and trust between the project owner and the EPC contractor and expedite the conversion process.

In addition, the theoretical framework presents three possible conversion strategies through the project life cycle (Figures 5.3, 5.5, and 5.6). Contract price arrangements fit for different scopes of work are suggested in different stages based on the level of scope definition and engineering completeness. Also, the acceptable range of contingencies is suggested for each strategy.

7.1.2 Major findings of Module Two: Effective Estimating Strategy for Convertible Contracts

Most of the project experts who participated in this research program suggested the Open Book Estimate (OBE) method as an effective way to estimate a more accurate and reliable lump sum price at the time of conversion. In an OBE, both contractor and owner participate in developing the estimate and have full access to all cost information. An effective OBE relies upon a well-developed cost breakdown structure (CBS), an accurate estimate of quantities, and pre-agreed compensation methods for project items. These steps have been illustrated as follows:

- Developing cost breakdown structure

  An effective OBE needs a detailed cost classification covering all project key disciplines and their subdivisions, including management, engineering, procurement, and construction. Cost categories should be identified in each discipline based on the experience and available data in
similar previous projects. Each cost category can be divided into several sub-categories and cost items (Table 5.1).

- **Estimating material quantities and creating equipment list**

  The accuracy of measuring project quantities or MTO strongly depends on the level of engineering and design development at the time of estimation. Engineering drawings and documents are the basis for estimating quantities (Table 5.2).

  The potential risks affecting the accuracy of the estimate should be addressed by considering pre-agreed percentages as the technical design allowances (TDAs) in estimating project quantities. The list of equipment to be supplied will be generated based on the main process and engineering documents such as process flow diagrams (PFDs) and general plot plans.

- **Defining compensation methods**

  In this section, compensation methods have been proposed for the following cost categories:

  - Management, engineering, and procurement services
  - Supply of bulk materials
  - Supply of equipment
  - Fabrication, installation, and construction activities

  For each category, the compensation methods have been defined for two contractual stages: mixed contract price arrangements (pre-conversion) and single lump sum stage (Table 5.3).
• **Realistic estimation of contingencies and lump sum price**

To provide a more realistic lump sum price at the time of conversion, reasonable risk reserves and contingencies should be considered in estimating the lump sum price. The main risk reserve components that should be considered in the lump sum price are as follows:

- **Contingency reserve**: Contingency is the estimated amounts included in the lump sum price to cover works that have been accidentally overlooked from plan, inherent inaccuracy, and risk associated with unforeseen occurrences. Contingency does not include changes in scope or unforeseeable major events such as strikes or earthquakes.

- **Management reserve**: Management reserve is additional capital under direct control of upper-level company management. It is used to prevent a project from overrunning the project budget and can apply to those unforeseen events that are not within the realm of contingency use, including
  - Variations to the scope, design, execution
  - Events that are likely to occur but cannot be specifically identified

7.1.3 **Major findings of Module Three: Potential Risks in Applying Convertible Contracts in Canada**

Realistic risk analysis is essential in successfully managing convertible contracts. This module presents the potential risks in applying convertible contracts and the appropriate mitigation strategies to mitigate the impact of cost risks in estimating the lump sum price.
As a result of interviews with participants in the research, the major risks of applying convertible contracts in Canadian oil and gas projects have been identified in six areas (Figure 5.8). The identified risks for each category are as follows:

- **Market condition**
  - Lack of readiness for the convertible/lump sum approach
  - Strict permitting and regulatory requirements
  - Shortage of skilled resources
  - Lack of a systematic learning process to avoid repeating past mistakes
  - High cost of doing business and not being internationally competitive
  - Fast-tracking strategy
  - High turnover rate

- **Scope**
  - Unclear objectives and priorities
  - Poor scope definition and continuous changes
  - Inadequate front-end loading and incomplete FEED

- **Engineering**
  - Engineering slippage
  - Ineffective engineering progress measurement techniques

- **Supply of materials and equipment**
  - High cost of manufacturing and supply of materials/equipment
  - Transportation constraints

- **Fabrication, installation, and construction**
  - Shortage of skilled labour
o Low productivity
o Weather conditions
o Ineffective modularization approach
o Subcontracting contracts

- **Project environment**
  
o High level of interfering by the project owner in managing the project
  
o Blaming and distrustful project environment

The identified risks and corresponding mitigation strategies for each category have been summarized in Module Three of the theoretical framework (Tables 5.4 to 5.9).

### 7.1.4 Major findings of Module Four: Collaborative Strategy to Enhance the Relationships in Convertible Contracts

A successful conversion process requires a collaborative and trustworthy environment. This module proposes a strategy to manage important challenges of convertible contracts in a collaborative manner from the start of the project. The proposed strategy is to organize a project collaboration centre (PCC) with focus on critical activities/decisions before and after conversion to lump sum (Figure 5.9).

The main areas that should be addressed by a PCC before and after conversion are as follows:

- **PCC focus areas before conversion to the single lump sum scheme**

  **Scope freezing**: To avoiding the high cost of late changes and reworks, project design basis should be frozen and the project scope should be well defined before starting the execution of the project.
**Deciding the conversion points:** PCC members should define the major parameters and milestones to determine the conversion points during the first contractual stage (before conversion).

**Open book estimation strategy:** The detailed procedure and schedule for conducting the OBE process should be clearly defined by the PCC to facilitate and expedite the estimation and conversion process.

**Risk and contingency:** Since risk management in a convertible contract is highly important, a PCC would add great value to the project by conducting a joint risk assessment process. As a result, the estimation and allocation of contingencies would be based on the results of a risk evaluation that has been performed and approved by both owner and EPC contractors.

- **PCC focus areas after conversion to the single lump sum scheme**

  **Productivity management:** The PCC should ensure the application of best practices during the execution to increase the productivity and minimize the cost of project. Effective workforce planning and efficient execution should be monitored by the PCC to ensure the effectiveness and efficiency of the project team during the lump sum stage.

  **Change management:** Unlike cost reimbursable, a lump sum contract is not flexible for design and scope changes during the execution of the project. The owner and EPC contractor members in the PCC should cooperate in assessment of the scope changes. This joint effort and collaborative approach minimizes the risk of claims and disputes in the project.

  **Time management:** After conversion to the lump sum contract, the contract value is fixed and the project cost is supposed to be within the approved budget. Yet project schedule and on-time completion of the project is a major concern. Therefore, achieving the project milestones and delivery of major components should be closely monitored by the PCC.
**Interface management**: Because of the size and complexity of oil and gas projects, several sub-contractors, suppliers, and third parties are involved in the project execution. Lack of a systematic interface management process and clear procedure will result in conflicts and inefficiency. The PCC should monitor the critical interfaces and resolve possible conflicts between different parties.

### 7.2 Validity of the Results

The findings of the study have been validated by examining the validity of data collection instruments and research method.

The validity of a data collection method is the extent to which that method or instrument can measure what it is supposed to measure. As one of the most commonly used methods of data collection in grounded theory study, Interview was chosen as the major instrument to collect the required data. Besides, an in-depth review of project documents was conducted to obtain required information.

The validity of a qualitative research can be examined by its internal validity (credibility), external validity (transferability), reliability (dependability), and objectivity (confirmability). To satisfy these criteria, the following methods were used in this study:

- Respondent validation
- Feedback from others
- Triangulation

### 7.3 Research Contributions

The research contributions to theory, research methodology and practice are as follows:

- **Contribution to theory:**
  - Presents a unique and new subject in academia
Delivers a framework for convertible contracts by presenting:

- 10 influencing factors in deciding conversion points
- 12 recommendations to enhance conversion process
- 3 conversion strategies
- Procedural open book estimate (OBE) process/compensation formulas
- Major risks of implementing convertible contracts/mitigation strategies
- A project collaboration centre (PCC) to enhance relationships

- **Contribution to research methodology:**

  - Applied a systematic grounded theory research design in the area of contract management which can be repeated by other researchers in the future

- **Contribution to practice:**

  - Addresses challenging issues of implementing convertible contracts in the industry including: execution strategy, conversion process, estimating strategy, potential risks, and relational strategies.

  - Helps minimizing contractual problems of oil and gas projects regarding:

    - Unbalanced risk allocation, fast-tracking/incomplete scope, unrealistic cost estimation, and adversarial environment.

### 7.4 Potential Research in the Future

So far, few projects have been implemented under convertible contracts and there is not enough data available to conduct a quantitative study to determine the optimal time of conversion based on actual project information. By having enough data required to perform correlational studies, it is possible to develop a regression model that predicts the optimum time of conversion based on the significant variables, including:
• level of scope definition (PDRI),
• percentage of engineering completeness,
• contingency amount
• cost performance index (CPI), and
• schedule performance index (SPI) at the time of conversion.

Also, investigating the implementation of convertible contracts in other industry sectors such as power sector would be another potential research area in the future.
REFERENCES


doi:http://dx.doi.org/10.19030/jber.v5i3.2532.


APPENDIX A

Consent Form

Name of Researcher, Faculty, Department, Telephone & Email:
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Supervisor:
Supervisor: Dr. Janaka Ruwanpura, Vice-Provost (International)
Co-supervisor: Dr. George Jergeas, Department of Civil Engineering

Title of Project:
A Theoretical Framework for Implementing Convertible Contracts in Oil and Gas Projects

Sponsor:
NSERC

This consent form, a copy of which has been given to you, is only part of the process of informed consent. If you want more details about something mentioned here, or information not included here, you should feel free to ask. Please take the time to read this carefully and to understand any accompanying information.

The University of Calgary Conjoint Faculties Research Ethics Board has approved this research study.

Purpose of the Study
Convertible contracts have been recently used in some oil and gas projects to combine the initial flexibility of the cost reimbursable with succeeding cost certainty of the lump sum contracts. However, deciding the optimum time of conversion and effective conversion mechanism are the main challenges for project owners and contractors. The purpose of this study is to provide an analytical framework to determine the time of conversion in convertible contracts.

What Will I Be Asked To Do?
In this research, you’ll be asked for discussing your own opinions about the most important factors in deciding the conversion time in convertible contracts. This can take about one hour of your time.

Your participation in this research is voluntary and you may refuse to participate altogether, may refuse to participate in parts of the study, or may withdraw from the study at any time. In this case your data will not be used in the study.
You might be asked to participate in a focus group workshop in a later stage of study. In that case, a separate consent form will be sent out to invite you to the workshop. There will be no follow up sessions in addition to the above sessions.

What Type of Personal Information Will Be Collected?
No personal identifying information will be collected in this study. The only information that will be collected is the position (e.g. Project Manager, Technical Manager) and the type of organizations (e.g. owner, contractor, consulting).
I grant permission to be audio taped: Yes: ___ No: ___

Are there Risks or Benefits if I Participate?
This research brings no risks or direct benefits to you. However, the results of the study can be shared with you if you are interested. These results might help you to manage contractual aspects of oil and gas projects in a more effective way.

What Happens to the Information I Provide?
The collected data will be used to inform the researchers’ Doctoral project. The raw data are only accessed by the researcher and his supervisors. However, the results of the study will be published as papers and PhD thesis and can be used for possible research in the future based on the policy of the University of Calgary.

There will be no confidential data in the research.

Although the nature of collected data is not confidential, following security provisions will be considered to limit the access to the research information.

Electronic Security: all electronic information will be secured in a password-protected file.

Physical Security: all paper documents such as interviews questions and notes will be secured in a locked cabinet in my office at the university.

The raw data will be stored and used just for the current research. There is no plan to use the raw data in any future research.

However, the results of the study will be published as papers and PhD thesis and can be used for possible research use in the future based on the policy of the University of Calgary. I don’t have any plan to destroy the data.

Signatures
Your signature on this form indicates that 1) you understand to your satisfaction the information provided to you about your participation in this research project, and 2) you agree to participate in the research project.
In no way does this waive your legal rights nor release the investigators, sponsors, or involved institutions from their legal and professional responsibilities. You are free to withdraw from this
research project at any time. You should feel free to ask for clarification or new information throughout your participation.

Participant’s Name: (please print) _____________________________________________
Participant’s Signature: ___________________________________ Date: ______________
Researcher’s Name: (please print) __________________ ______________________________
Researcher’s Signature: ___________________________________ Date: ______________

Questions/Concerns
If you have any further questions or want clarification regarding this research and/or your participation, please contact:
Mr. Mohammad Moazzami Goudarzi, Shulich School of Engineering, Department of Civil Engineering, Phone: (403) 891 4178, email: mmoazzam@ucalgary.ca

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Dr. George Jergeas, Shulich School of Engineering, Department of Civil Engineering, Phone: (403) 220-8135, email: jergeas@ucalgary.ca

If you have any concerns about the way you’ve been treated as a participant, please contact the Research Ethics Analyst, Research Services Office, University of Calgary at (403) 210-9863; email cfreb@ucalgary.ca.

A copy of this consent form has been given to you to keep for your records and reference. The investigator has kept a copy of the consent form.
APPENDIX B

Interview Transcripts

Interview No: 01

Interviewee Code: MT

Type of Organization: EPC Contractor

Position: Project Manager

Experience: 16 years

Interview transcripts:

1. To me engineering progress is a good indicator. The further engineering definition means more certainty in quantities. More engineering means less contingency in your price. The 50% -60% engineering concepts is when most of critical decisions are made.

2. It’s much more on scope completion rather than engineering completion. If we are in detailed engineering and scope is still open and client is changing the scope, it's difficult to convert to the lump sum regardless of the engineering progress.

3. The logical points are 30%, 60%, and 90% Model review which are linked to quantiles. Because these actives are collaborative with client. Ideal spot depends on the level of risk and contingency that client wants to take.

4. At 60% model review you could have all vendor data for major equipment and can define module fabrication quite well and 90% pipe rack modules as well. So, you can place order for around 80% of equipment.

5. Maybe 2 months after 60% model review could be a good point to convert the contract.

6. Placing order for 80% of equipment means most of bulk materials are already estimated.

7. In construction, major part of civil work should be done before conversion. I would convert the construction phase at the end of piling.

8. I have not used PDRI before, but the concepts seem very good and reliable metrics.

9. Fast-tracking: It might not affect to the time of conversion directly, but might result in higher conversion factor to cover the risks of rework and possible changes due to start of construction without engineering completion. However, if EPC contractor is forced to start construction earlier, it means that he will get subcontractor's bids earlier and will have realize actual cost of construction to convert earlier.
10. Logically by early conversion you would have higher conversion factor.

11. Contingency calculated based on risk profile of the project quantitative risk assessment could be another indicator to decide time of conversion. The acceptable range of contingency to convert the contract is totally dependent of the client risk taking attitude.
Interview No: 02

Interviewee Code: AL

Type of Organization: EPC Contractor

Position: Engineering Manager

Experience: 17 years

Interview transcripts:

1. One of my previous projects was project X with Y company (in the Middle East) which was exactly a conversion of contract which started on a reimbursable basis and then converted to an EPC lump sum contract. So, I personally have experience in working in projects with this type of contracts.

2. To me and based on my experience the most important factor is the degree of development of engineering for reliability in material take off. Because development in engineering month by month gives you certainty in material take off. So, this is the first basis to start an open book estimate and then to have a conversion to a lump sum price.

3. As an aggressive approach, after 6-8 months from the start of detailed engineering (in a typical 36 months project with 16 months engineering), when you have run 2 P&ID mechanization, the first one commented by client, and if you have manage with client two 3D model review, that provides a good basis for a lump sum cost estimate. But, after 8-10 months you will be more confident about the quantities.

4. So the driver is the definition of quantities. Around 55%-60% of engineering could be suitable to convert, but generally is to define the scope of work.

5. Out of engineering, for sure, there are other parameters that needs to taking into consideration. One of the most is logistics. Understanding what are site, construction, and fabrication constrains. Transportation of procured equipment and material. Generally, an effective execution strategy and study of transportation and logistics give you the correct idea about the cost and actual risks associated to the work. Clear understanding of above items let us to convert earlier.

6. LLIIs order should be placed before conversion. Purchase Orders (POs) for steel structure and piping also should be placed before conversion.

7. I have never used Project definition rating index (PDRI) before but the concept seems more comprehensive than other indicators.
8. I don't see direct link between the level of overlapping and time of conversion. If we start construction when engineering is not mature enough, there won't be enough construction work front.

9. Up to a certain point (80% of bulk material quantity), there is a linear link between engineering definition and accuracy of estimate. The rest can be captured by contingency.

10. In X2 project contingency was less than 5% after one year FEED by us. If FEED was done by other parties maybe higher (10%).
Interview No: 03

Interviewee Code: TS

Type of Organization: Owner Company

Position: Company Representative

Experience: 14 years

Interview transcripts:

1. We have two parties with different view of risk. From Client side you would like to convert early and from contractor side you would like to have scope as mature as possible.

2. In our experience (Project X), we asked contractor to convert after the FEED. At the FEED you have immature scope. Therefore, contractor had to take a lot of risk. Because contractor has to rely on assumptions. For example civil works. In this case if the contractor wants to do the construction under the lump sum umbrella then he needs to take lots of risks. Specially after the FEED when you don't have details. You just have budgetary quotes but those are not binding. So, contractor binds itself to a lump sum price to client but doesn't have enough information for this.

3. In this case (conversion after FEED), Immature scope would result in a price too high for the client to accept. So, I would say conversion after FEED is too early for both parties to agree on a lump sum price. The level of uncertainties is too high.

4. Conversion should happen when client is comfortable with the price and contractor does not take too much risk.

5. You need to have identified quantities on a level that makes you comfortable along with uncertainties factors.

6. After FEED the accuracy of estimate is about 30%, therefore conversion at this point might result the same amount of risk premium.

7. The risk on quantities and the risk on unit rates (subcontractors) should be considered.

8. From a client side, if contractors fail to convert after 50-60% of engineering, it does not make sense to convert. I mean it's too late.

9. I would say, around 60% you have ordered POs for all LLI and estimation of quantities is mature enough. For procured items you have enough information.
10. Also unit rates or lump sum factors that contractor receive from subcontracting market should be considered and will affect on conversion decision. To address this issue we may have phased conversion. It means E&P lump sum and construction unit rate.

11. It's all about taking the risk and if convert too late there is no value for conversion. From client side, ideal conversion should happen at early engineering.

12. In construction, the main challenge (risk) for contractor is that he has to commit on quantities and productivity but he does not have necessarily the same commitment from its subcontractor.

13. Alliancing concept: If contractor has strong engineering and procurement organization, it gives more confident about estimation of quantities and availability of materials and equipment. Then alliancing with a strong construction organization can result in managing this risk appropriately. This requires early involvement of construction entity.

14. I believe engineering completeness is a reliable indicator because it gives you confident about the quantities and reasonable allowances.

15. For the green field project in Alberta, procurement cost is around 40% of the project cost, so you need to have certainty about procurement. You don't need to have them necessarily ordered, but you need to have price information for LLI. For bulk material at 60% MD Review could be a good point.

16. We are using benchmarking for scope definition, but I am not familiar with PDRI.

17. Generally, early conversion results in more contingency. If you start conversion after FEED you might consider 25-30% contingency because of high uncertainties while you at 60% it maybe 5-10% for E and P but for construction you may have bigger percentage.

18. Middle of engineering could be the optimal point to convert, but involvement of the main parties on board as early as possible. Particularly, involvement of the main subcontractors provides higher confidence about productivity risk and to bid the lump sum price.
Interview No: 04

Interviewee Code: SR

Type of Organization: Consulting Company

Position: Vice President

Experience: 38 years

Interview transcripts:

1. Design might be reasonably complete. I know that in project X, the conversion was at 90% model review.

2. Engineering in my mind is small component from cost point of view, but has a significant impact on construction.

3. It makes sense to perform engineering under cost reimbursable. Detailed engineering should be almost complete before conversion.

4. In many disputes cases (75% of cases) engineering incompleteness is an issue.

5. COAA benchmarking provides statistics show that engineering incompleteness is one of the major sources of cost overrun and disputes.

6. Risk of performance and productivity will be transferred to contractor after conversion.

7. Both parties should know how much risks are taken. In a market like Alberta issues such as labour supply and productivity are significant risks. Local market and economy could have an important role to consider the amount of risks associated with lump sum approach.

8. AACE cost estimate classification provides a good correlation between the level of engineering completeness, accuracy of the estimate and the amount of contingency.

9. There have been a lot of lump sum projects in Canada. I think most of people understand the process of lump sum. I think the culture is there and ready for lump sum. But in Alberta we are struggling with productivity. The main concern is poor productivity and efficiency.
Interview No: 05

Interviewee Code: PB

Type of Organization: EPC Contractor

Position: Project Manager

Experience: 9 years

Interview transcripts:

1. Engineering definition is for sure an indication to know if it is the right time to convert the contract.

2. Another element, which by the way affects the engineering definition, is the level of consolidation of design basis (scope definition) by the client. For instance, some clients consider SRU plant from the beginning in a SAGD plant, but others consider SRU in later phases which will affect the accuracy of the estimate.

3. You can convert the contract to the lump sum only when the scope is frozen up to a certain point which eventually will affect to the level of engineering.

4. So, scope definition is a key driver to decide conversion time.

5. Another important factor is the number of interfaces. More interfaces between EPC contractor with other parties means more uncertainty and risks that cannot be controlled at project level. In fact more interfaces means less chance to complete the scope and early conversion.

6. Another important point is the willingness of the client to allocate the management of the contingency to the contractor instead of keeping it in its pocket. More certainty and more level of definition means less contingency. The amount of contingency that can be accepted by client is another important factor in deciding time of conversion.

7. Procurement: PO values: Placing 70% of the value of equipment and 50% of the value of the bulk material could be a reasonable amount of procurement before conversion. This can happen after 60% plant model review which is 60% of detailed engineering. This is also after first HAZOP on P&ID of LLI including vendor data.

8. Construction: Site preparation should be done under unit rate. Because quantities are totally uncertain. Civil works mainly concrete and piling due to weather constrains are very uncertain, so the minimum level of definition for these activities are 80%.

9. Phased conversion: Two months after 60% model review we can convert E&P to lump sum by keeping construction reimbursable and then after 85% of the completion of civil
work convert also the remaining part of fabrication and construction. (60% or 70% of module fabrication).

10. Commissioning support should be done under reimbursable.

11. I think PDRI is a very good tool to support conversion decision which covers all important factors in the project.

12. Fast tracking or high level of overlapping might help earlier conversion because if you start the site construction or fabrication place material and services contracts earlier, you realize the actual cost of construction earlier. So, it expedites the conversion, but with more risks that can be addressed by more contingency.

13. It's too risky to convert the contract after FEED. From both client and contractor sides it's better to convert when there are enough information (as mentioned in point 9) to bid a more confident fixed price with less contingency (max 5% or 6%).

14. A certain amount of contingency can be agreed by both parties for conversion and through open book estimates during the EPC and based on risk profile the conversion can be done when we reach to the agreed amount of contingency.

15. EV analysis and performance indicators will affect the accuracy of the estimate by knowing the efficiency and productivity.

16. The level of interfering of the client in managing the project should be limited in a lump sum contract. Contractor should be free to choose vendors/ subcontractors and subcontractors from approved list. Canadian market should be adapted to lump sum approach.
Interview No: 06

Interviewee Code: PA

Type of Organization: EPC Contractor

Position: Engineering Manager

Experience: 18 years

Interview transcripts:

1. It can be EPC converted lump sum or E&P prior conversion and then Construction conversion to lump sum.

2. In the Alberta market the question is really where the risk is. Engineering and procurement man-hours are a small portion of project cost. Most of the cost and risks grow in the Alberta market in labour cost, ability to attract quality labour, and productivity.

3. If we convert E&P in advance, there is a risk of providing poor engineering which may not satisfy construction requirements with highly labour costs. If a single entity convert the whole EPC phases to a lump sum contract, probably E&P have been defined enough to meet construction success criteria. So, my view is that it is not a good idea to convert E and P earlier and separately.

4. It is also related to the size of project. In small projects we have more flexibility with contract types. But, in mega projects the level of complexity is too high. Cost certainty is very important.

5. Convertible lump sum experience in project X3 shows that poor engineering and early estimating not only resulted in cost overrun but also in missing schedule milestones with liquidated damages. This situation also affected on relationship between contracting parties.

6. In order to get into lump sum you have to understand quantities. Especially quantities which have more influence on the volume of the labours.

7. Site preparation and structural steel activities are not significantly affecting the productivity while welding and piping are critical activities. It is important to know when we have enough information in our model review to estimate the required labour for the piping discipline.

8. Instrumentation is not a big issue but electrical discipline is another influencing discipline in lump sum estimate.
Using transition from one gate to gate: I believe project planning through the Front End Loading phases and decision gates strategy is critical for success of EPC projects in execution. If FEED will be done completely and accurately we can go with lump sum even from the start of EPC.

2. So, it’s important to finish FEED actually before jump to the EPC.

3. Pre-FEED and Feed reimbursable: I suggest cost reimbursable contract price arrangement for pre-FEED and FEED phases. Detailed engineering can be done under lump sum.

4. It is very important to freeze design basis before conversion to lump sum.

5. Effective management of changes in lump sum stage would be a critical requirement in convertible contracts. Design should be frozen during the reimbursable phase to minimize the changes after conversion.

6. LLIs should be purchased up to the end of FEED phase.

7. The level of relationships between contracting parties is very important. Convertible contracts need a collaborative environment established based on trust and transparency for open book estimation and fair price arrangement. Relational strategies such as partnership would help to provide the required environment for convertible contracts.

8. Minimize the overlapping engineering and construction: fast-tracking strategy is a major source of cost overrun and increase the risk of construction due to incomplete design and inadequate information.

9. Decision records what are the impacts: effective conversion process and determining conversion points EPC project requires a systematic decision making process.
Interview No: 08

Interviewee Code: EZ

Type of Organization: EPC Contractor

Position: Project Manager

Experience: 22 years

Interview transcripts:

1. You need to weight the risk. So, risk is the key factor.

2. Based on my experience, the conversion period must be between 60% to 90% model review.

3. Because main uncertainty is quantities. If you are at 90% model review you basically know 95% of quantities. So, the risk related to quantities is limited.

4. So, if the construction schedule allows you to wait until 90% model review, this is the best point to convert the contract. You can start some early work construction under unit rate if there is a specific request to start construction earlier.

5. You can consider two rounds. You can start conversion activities at 60% model review and as soon as you reach to 90%, update the quantities.

6. Acceptable range of contingency could be another factor. If you convert at 60% model review, you might consider around 15% contingency for quantities, but if you convert at 90% model review, you may just need 7% contingency for quantities.

7. In order to convert, you need to have enough construction work front that will guarantee you will never stop. So, you need to have enough material to have enough construction work in front.

8. 60% model review is a reasonable point to have enough material available for construction.

9. LLI items should be purchased before conversion for sure. But, for bulk material piping and steel structural should be purchased before conversion.

10. I have not used PDRI in previous projects.

11. You need to measure the risk values. Contingency is independent from the profit. If the profit range is 5%-10%, the contingency would be around 2%-3% (monetary value).
12. Construction: civil works are easy to do but lots of uncertainties such as subsurface condition. For other disciplines, if it is green filed, less risk is involved. If the subcontractor is reasonably good the risk is manageable.
Interview No: 09

Interviewee Code: DG

Type of Organization: Owner Company

Position: Project Control Manager

Experience: 16 years

Interview transcripts:

1. We studied this strategy from 2 years ago and we found development of detailed engineering as one of important parameters in deciding conversion points.

2. After 90% Model Review is the perfect time to convert the contract to lump sum. At 90% detailed engineering you have ordered around 85% of equipment with vendor data including final dimensions and weights and required information for key deliverables. Because before 90% MD you have to do HAZOP and for that you need vendor data. Also more than 60% of bulk have been ordered.

3. If you are an experienced EPC Contractor having done 5,6 SAGD projects, you may do conversion at 60% MD. As an experienced contractor, you may know what happens between 60% and 90% and take the risk. But if you are new in the market, conversion at 60% means a lot of risks.

4. Another influencing factor is availability of skilled resources at the time of conversion to perform the job. Suppose you are executing your project in Fort McMurray and at the time of conversion there are many other projects under construction. In this situation, the big risk is lack of skilled people and therefore higher labour cost. So, you need to consider more risk premiums in this market condition.

5. To me conversion is all about how much risk contractor is able to take.

6. The less interface is better. In a good market, you may have one contractor to perform mechanical installation, piling installation, and E&I installation by a lump sum contract.

7. LLIs must be purchased before conversion.

8. At 60% MD conversion the risk premium would be around 40% and at 90% around 20%. After 90% MD you won't have risk in quantities, but still you have productivity risks, constructability issues, unpredictable issues at site, and etc. So, you cannot say at 90%, I just need 5% contingency.

9. In convertible contracts we need a very strict risk management. We need to monitor project risks very closely.
10. In construction, if site preparation IFC drawings are available, we can do civil works under unit rate. But if we are in FEED and IFC drawings are not available yet, civil works should be performed under reimbursable scheme.

11. Piling and concrete are straightforward and can be done under unit rate.

12. Module fabrication, I would always do it under unit rate. For pipe fabrication also unit rate is feasible if you have a good definition and unit rate tables.

13. For mechanical installation and piping installation at site if you have a good definition of CWPs and FIWPs you can do installation under reimbursable.

14. E&I can be under unit rate.
Interview No: 10

Interviewee Code: KK

Type of Organization: EPC Contractor

Position: Head of Project Management Department

Experience: 17 years

Interview transcripts:

1. Phased contract price arrangements can be proposed based on the level of engineering and scope definition.

2. In a typical oil and gas project with 32 months duration, we can consider following contract model options.
   
   - Option 1:
     o EPC phase (up to MC) under unit rate
     o Startup activities (if any): reimbursable

   - Option 2:
     o Reimbursable model for engineering and procurement services; cost plus fee for purchases, unit rate for subcontracts and construction
     o Lump sum price for the rest of EPC (after conversion period)

   - Option 3:
     o Reimbursable for engineering and procurement services; cost plus fee for purchases; unit rate for subcontracts and construction
     o Performing EPC up to 90% model review with following contract price arrangements: lump sum price for engineering and procurement services, and purchase of equipment; reimbursable for purchase of bulk material; unit rate for subcontracts, fabrication, and construction.
     o Lump sum price for the rest of EPC after 90% model review
Interview No: 11

Interviewee Code: EF

Type of Organization: EPC Contractor

Position: Project Manager

Experience: 20 years

Interview transcripts:

1. Is the environment (local market) ready (mature enough) to accept the convertible contract (lump sum scheme)? There is no point to convert the contract where the market is not ready for lump sum. Canada Market is not so much ready for lump sum contract.

2. Project has different phases and lump sum contract means taking risk against execution of the scope and contingency is the price of that risk. So, as long as you can reasonably manage the risk, you can convert the contract. If not, you can't.

3. Assuming breakdown the contract into 3 classical phases (EPC), the level of engineering is one parameter to convert the contract, but in my opinion it's always definition of the scope which is the driver not the maturity of the engineering.

4. Engineering definition is required to define the quantities, but nothing to do with execution strategy (e.g. offshore projects).

5. Similarly for procurement, it's not engineering maturity, it's scope definition. You need to know what you need to do and what you need to buy.

6. Construction, much more difficult. Construction is not driven by the level of engineering. You could have all engineering done and you will never take lump sum risk on construction. Because there are issues like unions, labour availability, logistic constrains, that you cannot absorb even though you know perfectly what you have to do.

7. If you know the environment, subcontractors, and rules of the game you can take construction under the lump sum without engineering. If the labour market is ready and available you can do it.

8. It's always about risk management not engineering level. You have to be confident that you can manage the risk of lump sum contract. The key driver is the risk.

9. Metrics like PDRI are just supports for making decision. But it's more reliable than just engineering maturity.
10. The first thing is quantities based on engineering definition, the rest is risk associated with local market, labour, environment, equipment, regulations, permits, etc.
Interview No: 12

Interviewee Code: PL

Type of Organization: Project Management Consultancy

Position: Director

Experience: 35 years

Interview transcripts:

1. What are the most important factors in deciding conversion time in convertible contracts? And why?
   - Uniqueness of project e.g. as opposed to one which is a replication of a train;
   - Level of communication between owner and contractor:
     o Cultural differences (common language, standards, trust);
     o Owner/contractor sophistication (technical capability, experience in conversion contracts, understanding of the other organization);
     o Location/co-location of owner/contractor teams, including final users;
     o Decision making, particularly by end-users and Owners Procurement Organization and clarity of the Sponsor (Change Board responsible for final investment decision).

2. Do you think the engineering completion percentage is a reliable indicator to decide the conversion time? Why?
   40-50% but it is important to have negotiated quotes from main equipment suppliers which will potentially be very time consuming. Need detail design of all major items e.g. Main Heat Exchanger, Refrigerant Compressor Package, Gas Turbine Generators, Compressors/ Gas Turbine, ,Expanders Columns, Structural Steel, Boilers etc.

3. What would be the amount of Purchase Orders (POs) that can be placed before conversion?
   Varies widely with type of projects but about 70–80% of equipment purchase orders. Why? Some Long Lead Items will have been purchased by the Owner after Basic/FEED to be Owner Furnished Equipment or to be novated to the Contractor to maintain time targets. Contractor will typically have to place orders before Conversion.

4. What would be the amount of construction sub-contract packages that can be subcontracted before conversion?
This depends on the level of the WBS used to sub-contract. Assuming an EPC Contractor has Level 1 as Design, Procurement, Construction, Commissioning then if the contracts within the Construction element are:

i. Level 2 All

ii. Level 2 & 3 30-40% of packages (irrespective of value)

iii. Level 2, 3 & 4 5-10% of packages (irrespective of value)

5. How is the conversion time linked to the level of project definition? Totally! To what extent you are familiar with Project Definition Rating Index (PDRI)? Have you ever used this tool in current or previous projects?

I have seen the literature and suggest the definition index at conversion needs to be 70-80%. No, I am aware of Statoil using it on a project I was associated with for project x5.

6. How the level of overlapping engineering and construction phases/activities will affect on deciding the time of conversion in convertible contracts?

Site Preparation can be done as a separate contract by the Owner. Provided the mobilization work by the Contractor is Cost reimbursable (and the Owner has appropriate levels of management) it should be OK.

7. How the accuracy of cost estimate is linked to the conversion time and conversion factor?

Accuracy of cost estimate to be + -5%

8. How do you use the results of risk analysis (risk profile, contingency,…) in deciding the conversion time and conversion factor?

They should be a direct input for justifying the contingency. This is an example of a subject which is often confused by different use of language e.g. contingency (for risk uncertainty) as opposed to allowance (to cover known costs which have not been estimated in detail). What are the acceptable risk area and contingencies to convert the contract? 3-5%
Interview No: 13

Interviewee Code: PD

Type of Organization: Owner Company

Position: Director

Experience: 38 years

Interview transcripts:

1. In your view, what are the most influencing factors in deciding conversion points in convertible contracts? Why?
   
   Known Scope. Then you know what needs to be designed on needs to be built

2. Do you think the percentage of engineering completion is a reliable indicator to decide the conversion points? Why?
   
   No. Engineering progress is usually based on earned value while construction uses actual IFC drawing to do the final takeoffs. It should be based on quantities IFC’s which is not a conventional engineering progress tracking tool

3. How do you link the level of project scope definition to conversion timing? To what extent you are familiar with Project Definition Rating Index (PDRI)? Have you ever used this tool in current or previous projects?
   
   Used PDRI a number of times. A correctly completed PDRI can be a very valuable tool in the decision to convert

4. Which major equipment and bulk materials should be purchased before conversion to lump sum? Why?
   
   All long leads, all tagged equipment and at least a 60% (ideally 90%) takeoff bought on bulks. This proves that the design is developed substantially

5. Which construction sub-contract packages should be subcontracted before conversion?
   
   Site prep, deep undergrounds, shallow undergrounds and piling. Foundations can be in or out

6. What would be the proper contract type for different construction work packages such as site preparation, piling, concrete foundations, piping, and module installation in a hybrid contractual framework and why?
   
   Site Prep – Unit rates
   Piling – Unit rates
   Concrete foundations – unit rates
For the 3 above. Contractors know what their productivities are and can bid this unit rates. Then they do not take the quantity change risk

Module installation – LS. Scope is well known
Piping – depending on market conditions, engineering development etc.

7. How the level of overlapping engineering, procurement, and construction phases/activities impacts on deciding the time of conversion in convertible contracts?

The more the overlap the less chance of a successful conversion. Overlap will lead to later conversion and may even preclude it.

8. How the accuracy of cost estimate is linked to the conversion time and contingencies in lump sum price?

Accuracy of the cost estimate is 100% dependent on scope development (physical engineering progress) similarly to the timing of the conversion

9. What are the major risks in applying convertible contracts in Canadian oil and gas projects?

Nearly every project overstates engineering progress. The conversions will be based on engineering progress claims and there will like be severe disputes when the engineering finally get done.

10. How do you use the results of risk analysis such as risk profile and contingency amount in deciding the conversion time? What is the acceptable range of contingencies in conversion to lump sum?

Contingency required on a to-go basis on a project is directly linked to commitments and to incurred costs to date. This is kind of similar than the accuracy of the cost forecast and the progress on engineering comments above.
1. In Alberta market the main question is that where the risk is. If you look at where you could get growth in cost, engineering and procurement man hours growth are small portions of the overall project cost. Most of risk and cost escalation come with cost of labor, ability to attract quality labor and making sure that all of elements are in place for that labor to succeed and be productive.

2. Getting strong capable team that can actually do the work in a productive way and providing all required material and information for them is critical.

3. So, in a convertible model, the real question is that if I convert E & P in advance, am I rushing and providing a poor project that’s going to hinder the ability the labour to succeed down the road in construction and create more risk?

4. So, my view typically is you don’t want to necessarily do an early lump sum EP conversion. Because, in this particular market, early EP conversion may result in getting done engineering and procurement cheaply but not necessarily to the full satisfaction of construction objectives.

5. If you are converting EP and C together and the same contractor has all the objective of success then that’s different. Because then the contractor wants to do the right things in EP to make sure that the construction will succeed and they look at the overall cost picture from EPC perspective. So, it’s highly important to provide the required information and materials to avoid the major costs risk in construction.

6. The size of project also is important. In small projects you might convert earlier with less risk of labour in construction but in traditional mega projects with high level of complexity you need higher flexibility in contract to fix issues. So, cost reimbursable provides this flexibility to solve issues.

7. Owners are looking for cost certainty. If the contractor has done several similar projects and has control on labour and materials in the market, probably it can manage the job under lump sum. However, if you look at Project Z (in Alberta) which contractor was
supposed to complete the job under convertible lump sum, but couldn’t complete the project with the lump sum value and the project cost was much higher.

8. In order to get to lump sum you have to understand quantities. Especially those which most influence the volume of the labour.

9. The things which influence on productivity are not civil works (site preparation), but challenging disciplines such as piping and availability of welders. When do I have sufficient definition in key volume of piping that’s going to find required the labour. Also, when I do understand enough about electrical discipline. So, if you catch information those two disciplines, they are driver to being successful in lump sum job. Because you can accurately estimate the labour.

10. At 30% we have a rough estimation of large bore piping but at 60% we are more confident about most of large bore piping and close to P&ID IFC. However, electrical information is not enough. So, 60% model review is a reasonable point to start conversion.

11. I think all high dollar value equipment should be purchased before conversion. Procurement is a significant cost in the project (30%-40%). 70%-80% of dollar value of equipment should be placed order before conversion.

12. For subcontract construction packages: if you have quantities, you can ask for lump sum bides. If you don’t, you can ask for unit rate bids.

13. In Alberta, those EPC contractors who perform jobs under lump sum, usually self-perform core construction activities which are critical such as piping, E&I, Iron work, structural steel erection, and equipment installation.

14. PDRI is a helpful tool to show what is the level of information. But regardless of the total PDRI score, you need to look at specific components of PDRI which more influence on the cost of project and construction phase.

15. Risk assessment and contingency estimation can work but we need to look at the entire risk profile not contingency as a single point.
Interview No: 15

Interviewee Code: BS

Type of Organization: Owner Company

Position: Project Manager

Experience: 15 years

Interview transcripts:

1. In my previous experience, there was not a systematic approach to determine the conversion points. The contract was converted simply after placing POs for LLIs.

2. So, basically the POs for those items with more cost risks were placed during the reimbursable stage and non-critical items were purchased during lump sum stage. By this strategy, EPC contractor tried to delay conversion to lump sum as late as possible to take less lump sum risk. So, we as the owner expected conversion to lump sum at around 60% engineering completion, but in reality reimbursable stage was extended far beyond that point.

3. I believe reaching to a certain engineering maturity would be an essential factor to decide the conversion points.

4. To the point of conversion you would use cost reimbursable or unit price. After conversion you take the risk of lump sum.

5. 60% model review would be a reasonable point to convert the contract since the majority of bulk materials are defined as well as major equipment.

6. The intent of convertible model is to transfer the costs risk to contractor, but engineering definition should be mature enough to enable the contractor to bid a realistic lump sum price.

7. At 90% model review you would have all MTOs with high level of accuracy, but conversion can be done earlier after 60% and at an optimal point.

8. By converting the contract at 60% engineering completion, you may accept around 10% contingency in lump sum price.

9. At the end of FEED the contingency is around 15%.

10. In construction, I believe the early works and site preparation should be done under reimbursable. Site preparation cannot be part of lump sum for sure. The rest of construction activities can be done under lump sum.
11. I think that’s smart to go with PDRI to measure the project scope definition. I don’t have a specific PDRI score in my mind to offer for converting the contract.

12. In addition to scope, execution strategy is also important to make decision in convertible contracts.

13. When you do fast-tracking you will increase the level of risks but I don’t think it will affect on converting the contract.
Interview No: 16

Interviewee Code: BR

Type of Organization: Owner Company

Position: Project Manager

Experience: 20 years

Interview transcripts:

1. From contractor point of view, you need to know what you are going to do. That’s why you need a reliable and mature design behind that. It’s important to know the link between design maturity and specific equipment and bulk material.

2. You need to know the quantity as much as what it is. The actual items. Also, you need to know the standards of the technical requirements of those items.

3. So, you need to know what you have to buy and install and how you are going to install.

4. From owner side, I need to know cost certainty.

5. So, from my perspective both technical and commercial maturity are needed to come together to have potentially a successful conversion.

6. Another important factor that has been really missed is human factor. I think the relationship between contracting parties is a key. You have to have parties who have commitment in implementation of the model and what agreed on. Otherwise, you enter to a model which is supposed to be converted to lump sum, but ultimately it not to be and the likelihood of going back to that model is low. So, another influencing factor is experience of the past and knowing how you do it.

7. In the Middle East most of projects are lump sum. So, they are not even converted lump sum, but pure EPC lump sum for the whole EPC because that environment is ready for lump sum.

8. As owner we want to minimize the costs risks. We also want to transfer the risk of productivity to the contractor. In reimbursable, we as the owner carry all the risk of productivity.

9. So, the intent of the owner to enter to the convertible contract is to find a balance by minimalizing the risk premiums due to uncertainties and at the same time transfer the productivity risk to the contractor.

10. At the end of FEED, the level of definition is even less than 25%.
11. There is another alternative to separate EP and C. Or, we may get back to the traditional approach Design-Bid-Build instead of Design-Build.

12. Even by using international EPC contractors with good experience in lump sum, the owner organizations in Alberta do not have the experience in managing lump sum contracts.

13. You need to buy the equipment that retain your critical path and increase the cost certainty.

14. As the owner I would prefer to purchase specific LLIs before conversion whether through the EPC contractor or by novating contracts.

15. During the conversion period we would be looking for quotations and POs to evaluate the level of confidence in cost certainty based on the evidence.

16. Alberta weather condition and multiple construction seasons should be taken into consideration in evaluating construction risks.

17. Shortage of skilled resources is another major risk in Alberta market condition.
Interview No: 17

Interviewee Code: SS

Type of Organization: Owner Company

Position: Project Manager

Experience: 23 years

Interview transcripts:

1. The major one (factor influencing the conversion) is the completeness of detailed engineering.

2. We have model reviews (30%- 60%, 90%) to see plant 3D view and MTOs required for the procurement. To evaluate the required engineering deliverables required for plant completion.

3. Definition of quantities is an important element. The level of engineering should be enough to push procurement and construction out.

4. At 60% model review the quality of engineering is not enough because vendor data is not included.

5. Early conversion to lump sum means lots of contingency. So, it’s all about acceptable range of contingency.

6. One issue that I have seen in SAGD projects is that we do not rely on FEED package.

7. The level of definition at the end of FEED is not enough for execution and it needs to be validated during the detailed engineering maybe for 6 months.

8. The other problem is that most of EPC contractors are not construction company. They subcontract construction packages to subcontractors. In fact, they are EPCM rather than EPC. So, the take the risk of construction under lump sum while they don’t perform the construction themselves.

9. In our contract there was no obligation to convert to lump sum. So, we had the flexibility to whether to convert to lump sum or not.

10. At 90% engineering completion we decided to convert the contract by accepting the risk premiums associated to the cost uncertainty. The risk of productivity was transferred to the contractor.
11. Convertible contracts to me are certainty in cost and schedule. Conversion timing depends on the performance of the contractor. At 60% engineering completion you can evaluate the performance of the contractor.

12. Half of the market is prepared for the lump sum and the other half is not. For construction, one major risk that impacted our project was that EPC contractor did not have the same lump sum commitment from local subcontractors.

13. In a project that I was involved, the owner decided to perform civil works itself to minimize the risk premiums due to subsurface condition and uncertain quantities.

14. Another risk is that in a lump sum scheme owner shouldn’t dictate its approach to the contractor and level of interfere should be much less than reimbursable.
Interview No: 18

Interviewee Code: FK

Type of Organization: EPC Contractor

Position: Business Manager

Experience: 16 years

Interview transcripts:

1. I highly believe that scope definition is the most important factor in deciding conversion.

2. After class 3 estimate (AACEI estimate classification) the level of definition is high enough to convert the contract.

3. AACE International estimation classification system can be used to recognize the level of scope definition for a desired estimate accuracy at conversion time.

4. Design basis is an important requirement of scope definition that should be frozen before project execution.

5. Conversion can happen when you have a clear understanding of the scope of work and can price it accurately.

6. Also bidding/award strategy is important. If you want to do the FEED and EPC with the same contractor or with different contractors will affect on your conversion strategy.

7. Selecting a single contractor provides some advantages such as less interface management and incorporating contractor’s experience in design development by early involvement, however, using different contractor for the execution helps the owner for validating the design.

8. In complex and mega projects, there are lots of unknown risks which may results large amount of contingency when contractor take the risk of performing the job under lump sum.

9. Instead of giving the range of contingencies, I think it’s better to talk about the factors that build the contingencies:
   - The range of contingencies is highly dependent to the organizational culture of the company and contractor.
   - One of the major elements in building contingencies is the level of project complexity and using new technology.
   - The other element that influence the amount of contingency is the level of competition in the market. How many competitors are bidding?
10. The other factor is the availability of skilled labour or materials and equipment in the market condition. For instance, availability of skilled labour in Alberta is a major risk.

11. Fast-tracking may delay the conversion time because it will result in more changes, errors, and reduce the productivity.

12. From commercial point of view, contractor should guarantee its profit. So, the contractor should be rewarded for taking high levels of costs and productivity risks.

13. Although in cost reimbursable it seems that contractor does not have a motivation to cut the costs, its credit for the future business in the market is a strong factor to be efficient in performing the job and reducing the cost.
Interview No: 19

Interviewee Code: TF

Type of Organization: EPC Contractor

Position: Engineering Manager

Experience: 35 years

Interview transcripts:

1. The key factor in the concept of convertible lump sum contract is that how definitive is the project scope. You have to make sure that you have a definitive scope before converting the contract to lump sum.

2. I guess it’s very important that in your schedule you have a milestone for “design freezing”. Freezing design prevents scope changes in later stages.

3. So, if you want to implement convertible contracts, you need a definitive scope and frozen design basis before conversion.

4. According to my experience, one of the major problems in lump sum contracts is relationships between the owner and the contractor. In fact, lack of the trust is an important issue. They usually do not share the risk appropriately. Owner tries to transfer the risk to contractor as much as he can and in response, contractor protects himself by putting high amount of risk premium in the contract price.

5. As a result of unfair risk allocation and in the absence of trust and transparent relationships, contractor may raise lots of claims for changes which may result in disputes and adversarial relationships.

6. So, the trust and collaborative relationship between contracting parties is a vital requirement for implementation of convertible contract. I would support partnership strategies based on the concept of pain share-gain share for convertible contracts.

7. I think partnership strategies are very important for project management and for successful convertible contracts cooperative relationship is critical.

8. The AACE International cost estimate classification can be used to measure the level of scope definition. Would say conversion should be after level 4 estimate. Conversion after detailed engineering would be ideal. But considering schedule constraints it may happen earlier.
9. As the contractor, you need to review the risk accurately. There should be a risk assessment jointly performed by owner and contractor to estimate a realistic lump sum price.

10. I would not do conversion before 60% definitely.

11. The main reasons for cost overruns are continuous changes in project scope. So, effective change management and change control is very important in managing convertible contracts.

12. The range of estimate accuracy by an experienced is not usually too wide. The main problem is continuous changes.

13. Usually the materials and equipment that should be purchased are driven by schedule. Unlike contractors, owner prefers more project money to be committed to the lump sum stage.

14. Usually in EPCM contracts, EP are under reimbursable and C is lump sum that to be subcontracted to the subcontractors.

15. For construction, understanding the local market is very important. You need to have established relationship with local subcontractors and trades and have a good level of control in supply chain.

16. Lack of skilled resources is a major risk in this market condition which will impact on your estimate. Also, low productivity is another issue that should be taken into consideration. Lots of mitigations have been done in the market to address the productivity and labour market issues such as minimizing site works and maximizing modularization.
Interview No: 20

Interviewee Code: SA

Type of Organization: Owner

Position: Project Manager

Experience: 19 years

Interview transcripts:

1. To get cost certainty in lump sum contract you need high level of scope definition but many times we see poor FID at the end of EDS phase. At the end of EDS, engineering is about 30% complete.

2. In some of previous projects we involved the contractor before EPC in design review, constructability review sessions, and construction execution plan which was a successful experience in developing scope in a collaborative manner. This helps EPC contractor to bid a realistic lump sum price for the EPC phases.

3. Conversion from cost reimbursable or unit rate to the lump sum can be done at 70%, 80%, or 90% of engineering completeness but the main driver is the level of risk.

4. It is important to specify in procurement strategy before starting the execution.

5. Critical equipment such as LLIs should be purchased before conversion in early stages even during the DBM phase and majority of equipment should be purchased during the EDS phase.

6. POs for structural steels and cables can be placed during the EDS but IFC drawings for module fabrication need substantial engineering definition.

7. We do risk assessment based on the concept of Monte Carlo simulation to estimate the contingency in the risk profile.

8. In cost reimbursable, the risks are mainly transferred to the owner while in lump sum contractor mainly takes the risk of cost and performance. Therefore, if the level of engineering definition is not high enough, the amount of risk premiums and contingencies will be higher.

9. Different work packages with different complexity can be converted at different levels of scope definition during the project life cycle.
10. Construction work packages with less complexity such as civil works can be converted earlier but those with more complexity which need more scope definition such as I&C can be converted later.

11. Contractor efficiency is very important when converting to the lump sum. In a previous project, poor performance of the contractor resulted in around 15% cost overrun.
Interview No: 21

Interviewee Code: MM

Type of Organization: Owner

Position: Project Manager

Experience: 24 years

Interview transcripts:

1. From risk allocation point of view, scope uncertainty lands on owner side and the risk of productivity and cost certainty in lump sum lands on contractor side.

2. Contractor is in a better position to manage the productivity and owner is in better position to define the scope.

3. In my view, the success of a lump sum contract is based on the level of scope definition and it is the most important factor in deciding conversion point.

4. There is not a certain answer for conversion time. It depends on the project priorities and engineering and construction schedule.

5. AACE cost estimate classification system can help to link the accuracy of the estimate and scope definition. Around class 3 of cost estimate system could be an optimal point to convert the contract.

6. Around 15% estimate accuracy would be a reasonable point to convert.

7. Interfering of the owner in management of the project has been a culture in Alberta market.

8. The more involvement of the owner in management of the project means more risk of changes and relevant issues.

9. One of the major risks for convertible lump sum is the owner culture which has been adopted for reimbursable contract scheme.

10. Collaboration between contracting parties is essential for a healthy contractual relationship. A project cannot be successful without a trustworthy environment.

11. Adversarial project environment is one of the major risks.

12. Relational strategies such as alliancing can help the establishment of a collaborative and trustworthy environment in the project.
13. Continuous change of the scope by the client is a major risk to convertible lump sum contract.

14. Also, EPC contractor in this market don’t have lump sum experience. International EPC contractor with experience around the world can bring lump sum experience to this market.
Interview No: 22

Interviewee Code: SZ

Type of Organization: Consulting Company

Position: Project Manager

Experience: 37 years

Interview transcripts:

1. What are the most important factors in deciding the conversion points in convertible contracts? Why? Firmness and level of detail in the design. If the design has potential to change then there will either be many change orders or construction will be difficult to price and a fixed price contract won’t be possible.

2. Do you think the percentage of engineering completion is a reliable indicator to decide the conversion points? Why? This could be reliable depending on how detailed the project plan is and/or how well the scope is defined. If the project plan is detailed enough then essentially counting up the number of tasks completed (or using earned value or similar) will be a good representation of the amount of the design completed and the level of uncertainty in the design. If the project plan is not detailed enough then percentage completion would be based on engineering judgement and this may not be sufficiently reliable. The accuracy, completeness and detail of the project plan depend on how well the project scope is defined.

3. How the conversion time is linked to the level of project scope definition? How do you measure the level of scope definition? Have you ever used Project Definition Rating Index (PDRI)? The better the project scope is defined the better it will be to develop the project plan and the easier it will be to determine the percentage of engineering completion. This would then allow a more deterministic approach to decide on the conversion point. I use a more subjective judgement approach to decide on the level of scope definition and provide for contingency if the scope is not adequately defined. No I have not used PDRI.

4. What would be the amount of Purchase Orders (POs) for major equipment and bulk materials that should be placed before conversion to lump sum? Why? If firm quotes with long enough validity can be obtained, then essentially no purchase orders need to be placed before conversion. If the lead times of equipment and materials are long, then the amount of PO’s placed would be related to procurement lead times. These purchases though could be added to the fixed price portion of the contract as part of the estimation process or could be separated out as a different part of the contract.
5. What would be the amount of construction sub-contract packages that can be subcontracted before conversion? I can’t see stating an amount here that would universally apply to all projects. This would have to be determined on a project-by-project basis.

6. How the accuracy of cost estimate is linked to the conversion time? Obviously the earlier the conversion time the less accurate the cost estimate will be for the fixed price portion and the greater the contingency that would need to be added.

7. Are you familiar with Open Book Estimation (OBE) process? If so, do you believe that it’s an effective estimation process for convertible contracts? I am not familiar with OBE.

8. What is the best Bidding/Award approach to involve the main contractor in a convertible contract? Depending on the conversion time, less emphasis will have to be placed on price and more emphasis will have to be placed on technical, management and quality evaluations of qualified contractors. Proposed pricing schemes and rates of the contractors would have to be considered and rated. An objective method of determining the fixed price for that portion of the contract would have to be established.

9. What would be the best strategy to establish the required relationships between contracting parties in a convertible contract? Not sure what you are asking here? To me it seems that convertible contracts apply best to owner-EPC firm relationships. If the owner deals separately (ie has separate contracts) with engineering, procurement and construction firms the three could not be one convertible contract and in fact a convertible contract would not be very workable.

10. What are the major risks in applying convertible contracts in oil and gas projects? What is the acceptable range of contingencies in convert contracts? From the contractor’s point of view, converting too early when there is still substantial uncertainty in the scope and design could carry the risk of under bidding and thus incurring a loss. This could also be a risk to the owner if early conversion results in financial difficulty to the contractor. From the owner’s perspective, converting later creates a greater challenge for cost-control and has a greater chance of cost overruns and thus financial risks for the owner. Acceptable contingencies would depend on the conversion time, planning detail, and scope definition. These could range from 100% early on to a few 10’s of percent as the engineering design nears completion and the scope becomes firm.
Interview No: 23

Interviewee Code: KH

Type of Organization: EPC Contractor

Position: Project Control Manager

Experience: 16 years

Interview transcripts:

1. The level of project definition at different stages of design including: pre-FEED, EDS, and detailed engineering will drive conversion decision.

2. Early conversion is risky, but if the scope is well defined, the FEED can be performed under cost reimbursable and EPC under lump sum contract.

3. Previous experience in similar projects is important. For example, if an EPC contractor has done some SAGD projects, it is more confident to enter to a convertible contract and take the risk of lump sum contract.

4. Market condition and the level of competition is also an important factor. Compare to North America, there are more EPC contractor in the Middle East who are competing in bidding process under lump sum contracts.

5. Conversion to lump sum would be a good strategy to motivate the contractor to cut the cost of the project and reduce the project duration.

6. A robust and effective change management system should be in place to address the changes after conversion to lump sum.

7. Conversion should happen during the detailed engineering and between 40% and 50% engineering completion.

8. From project control point of view, it is important to monitor the project performance trend and link it to the project risk and based on it decide the conversion timing. In general, SPI and CPI greater than 1 means that the conversion can be done earlier.

9. It’s better to get budgetary quotes for major items before conversion to lump sum.

10. Critical bulk materials to be ordered before conversion to lump sum are: structural steel, cables, and piping materials.

11. We can perform equipment installation under lump sum if we have POs and we know the weight and other vendor data.
12. The contingency of lump sum price should be estimated based on quantitative risk analysis and risk profile.

13. The range of acceptable contingency amount can be between 5% and 15%.

14. In addition to consider contingency at project level, management reserve should be considered at corporate level.

15. Environment of the North America is not ready for lump sum. Project owners in North America have a tendency to have more control in the project. More involvement of the client will result in more changes which would be the source of claim and disputes in a lump sum contract.

16. The risk of lump sum should be transferred to subcontractors and suppliers through LDs.
Interview No: 24

Interviewee Code: TC

Type of Organization: EPC Contractor

Position: Engineering Manager

Experience: 27 years

Interview transcripts:

1. Based on my experience, the most important factor in successfully management of convertible contracts is trust and respect between owner and EPC contractor.

2. In Canadian oil and gas projects, it is very common that owners want to have high control in management of project. This would be an issue in convertible lump sum contract.

3. Collaboration between the owner and EPC contractor at high levels of organization is essential to establish a win-win culture in the project environment.

4. I worked in a project with Alliancing relational strategy which was a successful experience.

5. Conversion points can be decided based on some key milestones.

6. One option is to convert the contract after the FEED. But it is a high risk scenario.

7. One option is to convert the engineering to lump sum at the end of FEED, and use a mixed contract price arrangement for different work packages until around 80% of engineering, and at that point convert the rest of the project to a single lump sum contract.

8. It is important that both parties follow a collaborative approach to decide which risk areas should be taken by each party and what would be rewarding/compensation.

9. Inadequate skilled worker, labour productivity, site condition, project remote locations are major risks in Alberta and Canadian oil and gas industry.

10. One of the highest risks in convertible contracts is scope management and continues change. Scope should be frozen by the owner.

11. One of the main issues is reducing the scope in a short period of time to reduce the estimated cost meet the budget cap. Therefore, the reduced cost is not a realistic estimation.

12. Considering the proper planning and having engineering completeness around 80%, the contingency can be between 7% and 10%. 
Interview No: 25

Interviewee Code: MP

Type of Organization: EPC Contractor

Position: Engineering Manager

Experience: 28 years

Interview transcripts:

1. I think that any contracts are based on one simple formula: risk associated, timing, and quality.

2. Normal approach of conversion is related the associated risk that contractor want to take whether it is at 50%, 60%, or 90% of engineering progress.

3. Later conversion and more engineering completeness means less contingency and risk premium and early conversion needs more contingency to cover the higher risks.

4. In convertible lump sum contracts, design basis should be frozen early by the owner.

5. Early finalization of procurement strategy is an important factor in expediting conversion process.

6. Critical items and not just LLIs have great influence on construction costs.

7. Important factors that influence the conversion strategy are project priorities defined by the owner and execution strategies such as fast-tracking.

8. Changing strategies by the owner is a major risk in lump sum contracts.

9. In my view, a successful lump sum contract has zero changes in scope.

10. It is important to understand drivers of the project including time, cost, and quality by both parties of the client and contractor.

11. The level of complexity of the project is also an important factor in deciding the conversion points.

12. Theoretically, around 60% of engineering progress would be an optimal point to convert to lump sum.

13. Developing advanced construction work packages and can enhance the modularization and minimize the cost risk of lump sum associated to site construction.
14. The convertible lump sum contract can offer not only cost certainty but also higher productivity and efficiency in the project.
Interview No: 26

Interviewee Code: AK

Type of Organization: EPC Contractor

Position: Technical Manager

Experience: 15 years

Interview transcripts:

1. 1-What are the most important factors in deciding the conversion points in convertible contracts? Why?
   Engineering progress, 3D model review completeness and accuracy of extracted MTOs, Placement of POs for long lead items and major equipment. Without sufficient progress of these activities the risk of under/over estimations are increased.

2. 2-Do you think the percentage of engineering completion is a reliable indicator to decide the conversion points? Why?
   The percentage of engineering progress must be considered as a major indicator to decide the conversion points however it should be considered in conjunction with procurement progress, fabrication / construction strategy and SOW.

3. 3-How is the conversion time linked to the level of project scope definition? How do you measure the level of scope definition? Have you ever used Project Definition Rating Index (PDRI)?
   The level of project scope definition links back to conversion time in terms of level of the risk that Contractor and/or Client are exposed to at certain cut-off. A reliable tool to measure the level of project scope definition is PDRI. PDRI is developed by ranking main elements of project such as project objectives, basis of design definition and execution strategy through the life cycle of the project. I have contributed to develop the PDRI in some major oil and gas EPSC projects.

4. 4-What would be the amount of purchase orders (POs) for major equipment and bulk materials that should be placed before conversion to lump sum? Why?
   The POs for long lead items and all major equipment that require to be engineered must be placed before conversion to lump sum as well as structural steel and piping bulk items. This means the level of uncertainty and possibility of major changes in design have been significantly reduced, no change is expected in major equipment, and bulk material MTOs have been generated with acceptable margins thus reducing the conversion risks.

5. 5-What would be the amount of construction subcontract packages that can be subcontracted before conversion?
The main construction packages that should be subcontracted prior to conversion are site preparation, undergrounds and piling. The fabrication of piperack and equipment modules also should be in place.

6. How is the accuracy of cost estimate linked to the conversion time?
   Cost estimate accuracy links directly to conversion through engineering level of completeness and associated contingencies and allowances that are built to it.

7. Are you familiar with the Open Book Estimate (OBE) process? If so, do you believe that it’s an effective estimation process for convertible contracts?
   Yes, OBEs are effective tool to estimate quantities are they developed during the project lifecycle by contribution and sharing between both contractor and client.

8. What is the best bidding/award approach to involve the main contractor in a convertible contract?
   The contract should not bind contractor to implement his management strategy towards conversion within reasonable limits of risk and expected margin of profit.

9. What would be the best strategy to establish the required relationships between contracting parties in a convertible contract?
   The risks in such contracts should be agreed and shared by both parties.

10. What are the major risks in applying convertible contracts in oil and gas projects? What is the acceptable range of contingencies in convert contracts?
    The major risks includes introducing late changes to the project scope by client, not freezing the basis of design at early stages of the project engineering and lack of trust between parties.
    In convertible contracts if conversion points principles and associated risks are respected should be under 15%.
1. What are the most important factors in deciding the conversion points in convertible contracts? Why?
   The conversion points must be decided based on the maturity and completeness of the scope at each stage. In addition, quality of the available data plays an important role in identifying conversion points. Being able to carry out more robust and reliable estimates is the key. I would suggest the following conversion points:
   - End of FEED (depending on the number if items in the punch list prepared as the result of FEED endorsement)
   - Finalizing geotechnical investigations
   - Finalizing LLIs and selecting vendors for them
   - Finalizing P&IDs

2. Do you think the percentage of engineering completion is a reliable indicator to decide the conversion points? Why?
   Not necessarily! It is an important factor but not the only factor. Imagine the engineering is complete but there isn’t a reliable vendor available to supply an of the important LLI package of the project. This fact could affect the decision about the conversion points.

3. How is the conversion time linked to the level of project scope definition? How do you measure the level of scope definition? Have you ever used Project Definition Rating Index (PDRI)?
   I haven’t used PDRI. However, I believe completeness of the scope at each stage is the key to the decision. Obviously, the more complete the scope is, the more reliable the estimates would be.

4. What would be the amount of purchase orders (POs) for major equipment and bulk materials that should be placed before conversion to lump sum? Why?
   I cannot pick a number as it would depend on the project size and monetary value. However, I would suggest the LLIs to be excluded from the scope of the lump sum general contract. In most cases, this is a more reliable approach to manage the risks. I
am not much in favor of excluding bulk material from the scope of lump sum contract unless a major risk is foreseen. For example, if the risk of shortage can be predicted the owner can buy the bulk material upfront to secure the supply of bulk material during construction.

5. What would be the amount of construction subcontract packages that can be subcontracted before conversion?
   *I cannot pick a number as it would depend on the project size and monetary value. However, I would suggest the early works such as site preparation and infrastructure outside the main area to be awarded before the overall lump sum contract.*

6. How is the accuracy of cost estimate linked to the conversion time?
   *Conversion should only happen when reliable estimates are available. This will be possible when the scope is defined with high level of accuracy so stable and valid assumptions can be made for estimating cost and time. Conversion should be made only if a bottom-up estimate is feasible.*

7. Are you familiar with the Open Book Estimate (OBE) process? If so, do you believe that it’s an effective estimation process for convertible contracts?
   *I certainly am. I was involved in intensive negotiations of a major LNG project using open book approach. Under certain circumstances, this could be a reasonable approach. For example, when the client and the prospective contractor have worked many times together in the past and there is enough benchmark in place for comparison. However, I believe competitive procurement would result in a better outcome for the project owner.*

8. What is the best bidding/award approach to involve the main contractor in a convertible contract?
   *I believe design-build is the best approach for the main contractor for converting to fixed price.*

9. What would be the best strategy to establish the required relationships between contracting parties in a convertible contract?
   *I believe a convertible contract would require a great deal of negotiation between the owner and the contractor. Both parties must agree on the criteria for selection the conversion points well in advance to avoid any conflicts when the conversion is to happen. The criteria should be jointly developed considering particulars of the project rather than being imposed by the owner.*

10. What are the major risks in applying convertible contracts in oil and gas projects? What is the acceptable range of contingencies in convertible contracts?
    *Picking up the wrong conversion point is the major risk in my view. Sometimes owners push for conversion when the scope is not yet well developed and this would cause major problems down the track. Given that the conversion is supposed to happen at the right
time, the level of uncertainty should be lower and the risks should be more manageable. I would suggest a maximum 15% contingency is reasonable.
APPENDIX C

Participants Position: Managing Director

Organization Type: Project Management Consultancy

Years of Experience: 35

- To what extent do you agree that the results of the research reflect the actual discussion through the interview?
  - Strongly agree □
  - Agree ☒
  - Undecided □
  - Disagree □
  - Strongly disagree □

- To what extent do you agree that essential elements of convertible contracts have been addressed in the framework?
  - Strongly agree ☒
  - Agree □
  - Undecided □
  - Disagree □
  - Strongly disagree □

- To what extent do you agree that the results of the study reflect the real issues/challenges in practical world?
  - Strongly agree □
  - Agree ☒
  - Undecided □
- To what extent do you agree that the results of this study can be generalized to all convertible contracts in the oil and gas industry?

  - Strongly agree ☒
  - Agree ☒
  - Undecided ☐
  - Disagree ☐
  - Strongly disagree ☐

**Comments:**

The study has been thoroughly done and is well thought through. The recommendations are sound.

Although the study is applicable to all oil and gas projects some of the recommendations are specific to Canada. Strategy 1 is reasonably common especially where limited technology is available e.g. LNG. Strategy 1 is also easily adopted to competitive FEED.
Participants Position: Engineering Manager

Organization Type: EPC Contractor

Years of Experience: 17 years

- To what extent do you agree that the results of the research reflect the actual discussion through the interview?
  
  • Strongly agree ☒
  • Agree □
  • Undecided □
  • Disagree □
  • Strongly disagree □

- To what extent do you agree that essential elements of convertible contracts have been addressed in the framework?
  
  • Strongly agree ☒
  • Agree □
  • Undecided □
  • Disagree □
  • Strongly disagree □

- To what extent do you agree that the results of the study reflect the real issues/challenges in practical world?
  
  • Strongly agree □
  • Agree □
  • Undecided □
  • Disagree □
  • Strongly disagree □
- To what extent do you agree that the results of this study can be generalized to all convertible contracts in the oil and gas industry?

  - Strongly agree ☒
  - Agree ☐
  - Undecided ☐
  - Disagree ☐
  - Strongly disagree ☐

**Comments:**

Based on my experience on two previous convertible contracts, I believe that this study is focusing on the real aspects of the decision making process in defining the correct time for conversion during the whole Project life.
Participants Position: Project Manager

Organization Type: EPC Contractor

Years of Experience: 20 years

- To what extent do you agree that the results of the research reflect the actual discussion through the interview?
  - Strongly agree □
  - Agree ☑
  - Undecided □
  - Disagree □
  - Strongly disagree □

- To what extent do you agree that essential elements of convertible contracts have been addressed in the framework?
  - Strongly agree □
  - Agree ☑
  - Undecided □
  - Disagree □
  - Strongly disagree □

- To what extent do you agree that the results of the study reflect the real issues/challenges in practical world?
  - Strongly agree □
  - Agree ☑
  - Undecided □
  - Disagree □
  - Strongly disagree □
- To what extent do you agree that the results of this study can be generalized to all convertible contracts in the oil and gas industry?

- Strongly agree □
- Agree ☒
- Undecided □
- Disagree □
- Strongly disagree □

Comments:
Participants Position: Project Manager

Organization Type: Owner

Years of Experience: 23 years

- To what extent do you agree that the results of the research reflect the actual discussion through the interview?
  - Strongly agree ☐
  - Agree ☐ x
  - Undecided ☐
  - Disagree ☐
  - Strongly disagree ☐

- To what extent do you agree that essential elements of convertible contracts have been addressed in the framework?
  - Strongly agree ☐
  - Agree ☐ x
  - Undecided ☐
  - Disagree ☐
  - Strongly disagree ☐

- To what extent do you agree that the results of the study reflect the real issues/challenges in practical world?
  - Strongly agree ☐
  - Agree ☐ x
  - Undecided ☐
  - Disagree ☐
  - Strongly disagree ☐
- To what extent do you agree that the results of this study can be generalized to all convertible contracts in the oil and gas industry?

- Strongly agree ☐
- Agree ☐ x
- Undecided ☐
- Disagree ☐
- Strongly disagree ☐

Comments:
Participants Position: Technical Manager / Project Engineering Manager

Organization Type: EPC

Years of Experience: 35 years

- To what extent do you agree that the results of the research reflect the actual discussion through the interview?
  - Strongly agree □
  - Agree ☒
  - Undecided □
  - Disagree □
  - Strongly disagree □

- To what extent do you agree that essential elements of convertible contracts have been addressed in the framework?
  - Strongly agree ☒
  - Agree □
  - Undecided □
  - Disagree □
  - Strongly disagree □

- To what extent do you agree that the results of the study reflect the real issues/challenges in practical world?
  - Strongly agree □
  - Agree ☒
  - Undecided □
  - Disagree □
  - Strongly disagree □
To what extent do you agree that the results of this study can be generalized to all convertible contracts in the oil and gas industry?

- Strongly agree □
- Agree ☒
- Undecided □
- Disagree □
- Strongly disagree □

**Comments:**

The concept of convertible concept may only be effective when applied to large scale EPC contracts.
Participants Position: Corporate Systems Specialist

Organization Type: Oil & Gas EPC

Years of Experience: 35

- To what extent do you agree that the results of the research reflect the actual discussion through the interview?
  - Strongly agree □
  - Agree □
  - Undecided □
  - Disagree □
  - Strongly disagree □

- To what extent do you agree that essential elements of convertible contracts have been addressed in the framework?
  - Strongly agree □
  - Agree □
  - Undecided □
  - Disagree □
  - Strongly disagree □

- To what extent do you agree that the results of the study reflect the real issues/challenges in practical world?
  - Strongly agree □
  - Agree □
  - Undecided □
  - Disagree □
  - Strongly disagree □

- To what extent do you agree that the results of this study can be generalized to all convertible contracts in the oil and gas industry?
  - Strongly agree □
  - Agree □
  - Undecided □
  - Disagree □
  - Strongly disagree □

Comments: None to add
Participants Position: Project Engineering Manager

Organization Type: EPCM

Years of Experience: 25 years

- To what extent do you agree that the results of the research reflect the actual discussion through the interview?
  - Strongly agree □
  - Agree ☒
  - Undecided □
  - Disagree □
  - Strongly disagree □

- To what extent do you agree that essential elements of convertible contracts have been addressed in the framework?
  - Strongly agree □
  - Agree ☒
  - Undecided □
  - Disagree □
  - Strongly disagree □

- To what extent do you agree that the results of the study reflect the real issues/challenges in practical world?
  - Strongly agree □
  - Agree ☒
  - Undecided □
  - Disagree □
  - Strongly disagree □
To what extent do you agree that the results of this study can be generalized to all convertible contracts in the oil and gas industry?

- Strongly agree □
- Agree ☒
- Undecided □
- Disagree □
- Strongly disagree □

Comments:

To be successful, the Open Book Estimate approach described requires a high degree of execution maturity from both parties. This is not always available.

The unknown impact of adverse weather (e.g. too warm in winter for construction in muskeg, too cold for workers to be outdoors or unexpectedly high amounts of rain in a short time period) are next to impossible to estimate and therefore mitigate. In the OBE model some sort of mechanism should be added to allow blame free extension to schedule and or budget when specified weather events occur.
Participants Position: Project Manager

Organization Type: Oil&Gas Company

Years of Experience:

- To what extent do you agree that the results of the research reflect the actual discussion through the interview?
  
  - Strongly agree ☒
  
  - Agree □
  
  - Undecided □
  
  - Disagree □
  
  - Strongly disagree □

- To what extent do you agree that essential elements of convertible contracts have been addressed in the framework?
  
  - Strongly agree ☒
  
  - Agree □
  
  - Undecided □
  
  - Disagree □
  
  - Strongly disagree □

- To what extent do you agree that the results of the study reflect the real issues/challenges in practical world?
  
  - Strongly agree ☒
  
  - Agree □
  
  - Undecided □
  
  - Disagree □
  
  - Strongly disagree □
To what extent do you agree that the results of this study can be generalized to all convertible contracts in the oil and gas industry?

- Strongly agree □
- Agree ☒
- Undecided □
- Disagree □
- Strongly disagree □

Comments:

This study is very well prepared and is a valuable tool for all Project Management members approaching a Convertible Contract strategy.
Participants Position: Consulting Engineer/Project Manager

Organization Type: Engineering Consultant

Years of Experience: 30+

- To what extent do you agree that the results of the research reflect the actual discussion through the interview?
  - Strongly agree □
  - Agree □ X
  - Undecided □
  - Disagree □
  - Strongly disagree □

- To what extent do you agree that essential elements of convertible contracts have been addressed in the framework?
  - Strongly agree □
  - Agree □ X
  - Undecided □
  - Disagree □
  - Strongly disagree □

- To what extent do you agree that the results of the study reflect the real issues/challenges in practical world?
  - Strongly agree □
  - Agree □ X
  - Undecided □
  - Disagree □
  - Strongly disagree □

- To what extent do you agree that the results of this study can be generalized to all convertible contracts in the oil and gas industry?
  - Strongly agree □
  - Agree □
  - Undecided □ X
  - Disagree □
  - Strongly disagree □
Comments:

I found this to be a very good discussion of the issues involved with convertible contracts.

It is important to realize that much of the concept of convertible contracts discussed in the thesis was based on an Owner-EPC type contract relationship and assumed a good relationship between the Owner and EPC firm. Also, the context tended to focus on plant-infrastructure projects.

Where the Owner has a multi-contract multi-party structure for a project, convertible contracts may be more difficult to implement. Also, a translation of the concepts may be required to projects that are different from engineering and construction of plant-infrastructure.
Participants Position: Project Manager

Organization Type: EPC

Years of Experience: 14 years

- To what extent do you agree that the results are logically sound?
  - Strongly agree □
  - Agree ☒
  - Undecided □
  - Disagree □
  - Strongly disagree □

- To what extent do you agree that the results of the study reflect the real issues/challenges in practical world?
  - Strongly agree □
  - Agree ☒
  - Undecided □
  - Disagree □
  - Strongly disagree □

- To what extent do you agree that the results of this study can be generalized to convertible contracts in the oil and gas industry?
  - Strongly agree □
  - Agree □
  - Undecided ☒
  - Disagree □
  - Strongly disagree □
Comments:

Presents a realistic, practical view of the contractual framework within an EPC project. Analysis seems to point to the key areas.

Generalizing results to convertible contracts in the Oil and Gas Industry is very difficult. The results summarize 3 potential conversions models but I believe that there can be endless modifications to these based on the specifics of the project being considered and tendencies of the owner and EPC contractor.
Participants Position: Process and Engineering Manager

Organization Type: EPC and EPFC

Years of Experience: 28

- To what extent do you agree that the results of the research reflect the actual discussion through the interview?
  
  • Strongly agree □
  
  • Agree ☒
  
  • Undecided □
  
  • Disagree □
  
  • Strongly disagree □

- To what extent do you agree that essential elements of convertible contracts have been addressed in the framework?
  
  • Strongly agree □
  
  • Agree ☒
  
  • Undecided □
  
  • Disagree □
  
  • Strongly disagree □

- To what extent do you agree that the results of the study reflect the real issues/challenges in practical world?
  
  • Strongly agree □
  
  • Agree ☒
  
  • Undecided □
  
  • Disagree □
  
  • Strongly disagree □
To what extent do you agree that the results of this study can be generalized to all convertible contracts in the oil and gas industry?

- Strongly agree □
- Agree ☒
- Undecided □
- Disagree □
- Strongly disagree □

Comments:
Participants Position: Project Manager

Organization Type: EPC Contractor

Years of Experience: 12 years

- To what extent do you agree that the results are logically sound?
  - Strongly agree ☐
  - Agree ☒
  - Undecided ☐
  - Disagree ☐
  - Strongly disagree ☐

- To what extent do you agree that the results of the study reflect the real issues/challenges in practical world?
  - Strongly agree ☐
  - Agree ☒
  - Undecided ☐
  - Disagree ☐
  - Strongly disagree ☐

- To what extent do you agree that the results of this study can be generalized to convertible contracts in the oil and gas industry?
  - Strongly agree ☐
  - Agree ☒
  - Undecided ☐
  - Disagree ☐
  - Strongly disagree ☐
Participants Position: Vice President

Organization Type: Consultant

Years of Experience: 38

- To what extent do you agree that the results of the research reflect the actual discussion through the interview?
  
  • Strongly agree ☐
  • Agree ☒
  • Undecided ☐
  • Disagree ☐
  • Strongly disagree ☐

- To what extent do you agree that essential elements of convertible contracts have been addressed in the framework?
  
  • Strongly agree ☒
  • Agree ☐
  • Undecided ☐
  • Disagree ☐
  • Strongly disagree ☐

- To what extent do you agree that the results of the study reflect the real issues/challenges in practical world?
  
  • Strongly agree ☐
  • Agree ☒
  • Undecided ☐
  • Disagree ☐
  • Strongly disagree ☐
- To what extent do you agree that the results of this study can be generalized to all convertible contracts in the oil and gas industry?

• Strongly agree ☐

• Agree ☒

• Undecided ☒

• Disagree ☐

• Strongly disagree ☐

Comments:
From what I have read I am impressed with what has been done. I am undecided on the last question as I would like to see the recommendations tested several times before I would consider one approach fits all.
Participants Position: Vice President

Organization Type: Owner Company

Years of Experience: 39 years

- To what extent do you agree that the results of the research reflect the actual discussion through the interview?
  
  • Strongly agree □
  
  • Agree ☒
  
  • Undecided □
  
  • Disagree □
  
  • Strongly disagree □

- To what extent do you agree that essential elements of convertible contracts have been addressed in the framework?
  
  • Strongly agree ☒
  
  • Agree □
  
  • Undecided □
  
  • Disagree □
  
  • Strongly disagree □

- To what extent do you agree that the results of the study reflect the real issues/challenges in practical world?
  
  • Strongly agree □
  
  • Agree ☒
  
  • Undecided □
  
  • Disagree □
  
  • Strongly disagree □
- To what extent do you agree that the results of this study can be generalized to all convertible contracts in the oil and gas industry?

- Strongly agree □
- Agree ☒
- Undecided □
- Disagree □
- Strongly disagree □

Comments:

This is a very good piece of work!
Participants Position: Project Controls Manager

Organization Type: EPC Contractor

Years of Experience: 16 years

- To what extent do you agree that the results of the research reflect the actual discussion through the interview?
  
  • Strongly agree ☒
  • Agree □
  • Undecided □
  • Disagree □
  • Strongly disagree □

- To what extent do you agree that essential elements of convertible contracts have been addressed in the framework?
  
  • Strongly agree ☒
  • Agree □
  • Undecided □
  • Disagree □
  • Strongly disagree □

- To what extent do you agree that the results of the study reflect the real issues/challenges in practical world?
  
  • Strongly agree ☒
  • Agree □
  • Undecided □
  • Disagree □
  • Strongly disagree □
To what extent do you agree that the results of this study can be generalized to all convertible contracts in the oil and gas industry?

- Strongly agree ☒
- Agree ☐
- Undecided ☐
- Disagree ☐
- Strongly disagree ☐

Comments: I enjoyed reading the findings and proposed recommendations of this research topic as this addresses the real issues industry faces these days. In particular to oil industry, due to challenges and fluctuations in commodity pricing, this framework can potentially provide a reliable scheme (both theoretical and practical) to elevate certainty in cost estimation by clients and contractors. Improvements are not happening all of the sudden in a short time due to cultural issues as rightly stated in the summary, however, this provides a good road map to systematically reduce inefficiencies in cost estimation and forecasting. Good job in the research and putting the findings together Dr. Mohammad!
Participants Position: Area Contract Manager

Organization Type: International EPC contractor

Years of Experience: almost 10 years

- To what extent do you agree that the results are logically sound?
  - Strongly agree ☒
  - Agree ☐
  - Undecided ☐
  - Disagree ☐
  - Strongly disagree ☐

- To what extent do you agree that the results of the study reflect the real issues/challenges in practical world?
  - Strongly agree ☐
  - Agree ☒
  - Undecided ☐
  - Disagree ☐
  - Strongly disagree ☐

- To what extent do you agree that the results of this study can be generalized to convertible contracts in the oil and gas industry?
  - Strongly agree ☐
  - Agree ☒
  - Undecided ☐
  - Disagree ☐
  - Strongly disagree ☐
Participants Position: Project Controls Consultant

Organization Type: Owner

Years of Experience: 16

- To what extent do you agree that the results of the research reflect the actual discussion through the interview?
  
  • Strongly agree ☒
  
  • Agree □
  
  • Undecided □
  
  • Disagree □
  
  • Strongly disagree □

- To what extent do you agree that essential elements of convertible contracts have been addressed in the framework?
  
  • Strongly agree □
  
  • Agree ☒
  
  • Undecided □
  
  • Disagree □
  
  • Strongly disagree □

- To what extent do you agree that the results of the study reflect the real issues/challenges in practical world?
  
  • Strongly agree ☒
  
  • Agree □
  
  • Undecided □
  
  • Disagree □
  
  • Strongly disagree □
To what extent do you agree that the results of this study can be generalized to all convertible contracts in the oil and gas industry?

- Strongly agree □
- Agree ☒
- Undecided □
- Disagree □
- Strongly disagree □

Comments:
Participants Position: Regional Engineering Manager (North America)

Organization Type: EPC Contractor

Years of Experience: 28 years

- To what extent do you agree that the results of the research reflect the actual discussion through the interview?

  - Strongly agree ☒
  - Agree □
  - Undecided □
  - Disagree □
  - Strongly disagree □

- To what extent do you agree that essential elements of convertible contracts have been addressed in the framework?

  - Strongly agree ☒
  - Agree □
  - Undecided □
  - Disagree □
  - Strongly disagree □

- To what extent do you agree that the results of the study reflect the real issues/challenges in practical world?

  - Strongly agree ☒
  - Agree □
  - Undecided □
  - Disagree □
  - Strongly disagree □
- To what extent do you agree that the results of this study can be generalized to all convertible contracts in the oil and gas industry?

  - Strongly agree □
  - Agree ☒
  - Undecided □
  - Disagree □
  - Strongly disagree □

Comments:
Participants Position: System (Project) Engineer

Organization Type: EPC

Years of Experience: 15

- To what extent do you agree that the results are logically sound?
  
  • Strongly agree ☒
  
  • Agree ☐
  
  • Undecided ☐
  
  • Disagree ☐
  
  • Strongly disagree ☐

- To what extent do you agree that the results of the study reflect the real issues/challenges in practical world?
  
  • Strongly agree ☒
  
  • Agree ☐
  
  • Undecided ☐
  
  • Disagree ☐
  
  • Strongly disagree ☐

- To what extent do you agree that the results of this study can be generalized to convertible contracts in the oil and gas industry?
  
  • Strongly agree ☐
  
  • Agree ☒
  
  • Undecided ☐
  
  • Disagree ☐
  
  • Strongly disagree ☐
Comments: Well studied and written research.
Participants Position: Engineer/Manager of Western Australia Division

Organization Type: Consulting Engineers

Years of Experience: 15

- To what extent do you agree that the results are logically sound?
  - Strongly agree ✓
  - Agree □
  - Undecided □
  - Disagree □
  - Strongly disagree □

- To what extent do you agree that the results of the study reflect the real issues/challenges in practical work?
  - Strongly agree ✓
  - Agree □
  - Undecided □
  - Disagree □
  - Strongly disagree □

- To what extent do you agree that the results of this study can be generalized to convertible contracts in the oil and gas industry?
  - Strongly agree □
  - Agree ✓
  - Undecided □
  - Disagree □
  - Strongly disagree □
Comments:

I have been involved in several projects in which the wrong pricing arrangement has led to several performance issues. The methodology suggested here can overcome some of the challenges project managers face in the oil and gas industry.
Participants Position: Project Manager, Major Projects

Organization Type: Owner Company

Years of Experience: 20 years

- To what extent do you agree that the results of the research reflect the actual discussion through the interview?
  
  • Strongly agree ☒
  • Agree ☐
  • Undecided ☐
  • Disagree ☐
  • Strongly disagree ☐

- To what extent do you agree that essential elements of convertible contracts have been addressed in the framework?
  
  • Strongly agree ☒
  • Agree ☐
  • Undecided ☐
  • Disagree ☐
  • Strongly disagree ☐

- To what extent do you agree that the results of the study reflect the real issues/challenges in practical world?
  
  • Strongly agree ☒
  • Agree ☐
  • Undecided ☐
  • Disagree ☐
  • Strongly disagree ☐
- To what extent do you agree that the results of this study can be generalized to all convertible contracts in the oil and gas industry?

- Strongly agree ☐
- Agree ☐
- Undecided ☒
- Disagree ☐
- Strongly disagree ☐

**Comments:**

The factors influencing a facility price will vary by type of facility and location as well. Within each of the major categories of construction such as camp housing, admin and other non-process buildings, industrial complexes and infrastructure, there are smaller segments which have very different environments with regard to price setting. However, all pricing arrangements have some common features in the form of the legal documents binding the owner and the supplier(s) of the facility. Without addressing special issues in various industry segments, the most common types of pricing arrangements and convertible contract issues are well covered in the results of this study.
Participants Position: Lead Partner

Organization Type: Consulting

Years of Experience: 35

- To what extent do you agree that the results are logically sound?
  - Strongly agree ☒
  - Agree ☐
  - Undecided ☐
  - Disagree ☐
  - Strongly disagree ☐

- To what extent do you agree that the results of the study reflect the real issues/challenges in practical world?
  - Strongly agree ☐
  - Agree ☒
  - Undecided ☐
  - Disagree ☐
  - Strongly disagree ☐

- To what extent do you agree that the results of this study can be generalized to convertible contracts in the oil and gas industry?
  - Strongly agree ☐
  - Agree ☒
  - Undecided ☐
  - Disagree ☐
  - Strongly disagree ☐

Comments:
Participants Position: Director (Contracts and Commercial Manager)
Organization Type: Consulting Company (previously with both Owners and Contractors - Internationally)

Years of Experience: 24

- To what extent do you agree that the results are logically sound?
  - Strongly agree ☒
  - Agree □
  - Undecided □
  - Disagree □
  - Strongly disagree □

- To what extent do you agree that the results of the study reflect the real issues/challenges in practical world?
  - Strongly agree □
  - Agree ☒
  - Undecided □
  - Disagree □
  - Strongly disagree □

- To what extent do you agree that the results of this study can be generalized to convertible contracts in the oil and gas industry?
  - Strongly agree □
  - Agree ☒
  - Undecided □
  - Disagree □
  - Strongly disagree □
Comments:

The main issue with the use of convertible lump sum contracts in Canada is the lack of experience personnel who truly understand their nature and have the capability to effectively manage them. The contracting relationship between a true EPC contractor (ie construction in house) and an EP + C contractor and the associated residual risk which we may pass to the Construction contractor must also be considered.