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Management of Change (MOC) as Technical and Cost Risk Control in FEED–EPCI Transition

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Abstract

The transition from Front-End Engineering Design (FEED) to Engineering, Procurement, and Construction (EPCI) is a critical phase in upstream oil and gas projects, where design maturity, cost, and schedule risks are highly exposed. This study examines the implementation of Management of Change (MOC) as a risk control mechanism during the FEED–EPCI transition phase. Using a qualitative case study approach, this paper analyzes how a structured MOC process supports engineering governance by ensuring systematic evaluation, approval, and traceability of changes. The results show that effective MOC implementation enhances decision-making quality, improves risk visibility, and mitigates potential cost and schedule impacts during project phase transition.

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Abstrak

Transisi dari tahap Front-End Engineering Design (FEED) ke tahap Engineering, Procurement, and Construction (EPCI) merupakan fase krusial dalam proyek hulu minyak dan gas, di mana risiko terkait kematangan desain, biaya, dan jadwal menjadi sangat terbuka. Penelitian ini membahas penerapan Management of Change (MOC) sebagai mekanisme pengendalian risiko pada fase transisi FEED–EPCI. Dengan menggunakan pendekatan studi kasus kualitatif, penelitian ini menganalisis bagaimana proses MOC yang terstruktur dapat mendukung tata kelola rekayasa (engineering governance) melalui evaluasi perubahan yang sistematis, proses persetujuan yang jelas, serta ketertelusuran perubahan. Hasil penelitian menunjukkan bahwa penerapan MOC yang efektif mampu meningkatkan kualitas pengambilan keputusan, memperjelas visibilitas risiko, serta memitigasi potensi dampak terhadap biaya dan jadwal proyek selama fase transisi proyek.

1. INTRODUCTION

Large-scale upstream oil and gas projects are characterized by high technical complexity, multiple stakeholders, and long project lifecycles. One of the most critical periods in such projects is the transition from the Front-End Engineering Design (FEED) phase to the Engineering, Procurement, and Construction (EPCI) phase. During this transition, design maturity is often assumed to be sufficient; however, in practice, design

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changes frequently continue to occur due to technical clarifications, interface alignment, constructability considerations, and evolving project constraints (CII, 2018; AACE, 2019).

Uncontrolled changes during the FEED–EPCI transition can lead to significant risks, including scope creep, cost escalation, schedule delays, and degradation of engineering integrity. While many projects formally implement Management of Change (MOC) procedures, these processes are often treated as administrative or compliance-driven requirements rather than being utilized as an effective risk control mechanism. As a result, changes may bypass proper technical evaluation, impact assessment, and cross-disciplinary review, increasing project exposure to latent risks (Hallowell & Gambatese, 2009; Kletz, 2003).

Management of Change (MOC) is a structured process designed to ensure that any modification to technical, organizational, or procedural aspects of a project is systematically identified, evaluated, approved, and documented prior to implementation. In the context of upstream oil and gas projects, an effective MOC process plays a critical role in maintaining engineering governance and ensuring that changes introduced during project execution do not compromise safety, quality, cost, or schedule objectives (Turner, 2014; PMI, 2021).

This study aims to examine the implementation of Management of Change (MOC) as a risk control tool during the FEED–EPCI transition phase of an upstream oil and gas project. By applying a qualitative case study approach, this study highlights how MOC can function as an engineering risk gate rather than a mere administrative requirement. The findings of this study are expected to provide practical insights for engineers and project practitioners in improving management effectiveness during critical project phase transitions.

2. METHODS

This professional engineering practice was conducted in an upstream oil and gas project undergoing transition from the FEED phase to the EPCI phase. The activity was carried out within the project team responsible for engineering change management and governance (Kerzner, 2017; Smith *et al.,* 2014).

A qualitative case study method was applied, consisting of several implementation stages, including identification of technical changes, initiation of Management of Change (MOC), impact assessment covering technical, cost, and schedule aspects, multidisciplinary review, and formal approval prior to implementation. Data were collected from MOC records, engineering change logs, and project documentation generated during the transition phase. The overall MOC workflow applied in this activity is illustrated using a flowchart to demonstrate its role as a risk control mechanism.

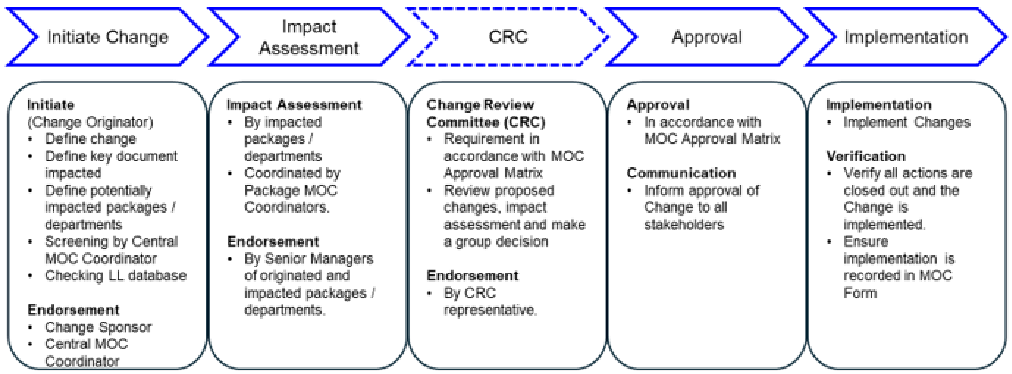

Figure 1.
Management of Change Simplified Overview

3. RESULT AND DISCUSSION

3.1 Overview of FEED–EPCI Transition Challenges

The transition from the Front-End Engineering Design (FEED) phase to the Engineering, Procurement, and Construction (EPCI) phase represents a critical milestone in upstream oil and gas project execution. At this stage, design deliverables are expected to reach sufficient maturity to support procurement and construction activities. However, in practice, design development often continues beyond FEED completion due to technical clarification, interface alignment, constructability review, and evolving project constraints.

During this transition, project exposure to technical, cost, and schedule risks increases significantly (Skogdalen & Vinnem, 2012). Design assumptions made during FEED may no longer fully reflect site conditions, vendor inputs, or execution strategies. As a result, uncontrolled or poorly managed changes can lead to scope creep, rework, contract disputes, and cost overruns.

Based on observations from this professional engineering practice, the FEED–EPCI transition phase exhibits the following characteristics:

- High frequency of design clarification requests
- Increased interface complexity between engineering disciplines and contractors
- Pressure to maintain schedule while design maturity is still evolving
- Potential misalignment between technical intent and construction feasibility

These conditions underline the importance of a structured change control mechanism to ensure that all changes are properly evaluated and governed.

3.2 Classification of Changes Identified During the Project

The analysis of MOC records and project documentation shows that changes occurring during the FEED–EPCI transition can be grouped into three main categories:

3.2.1 Design Clarification Changes

These changes arise due to incomplete or ambiguous FEED deliverables. Examples include:

- Revision of equipment sizing and specifications
- Clarification of design assumptions and operating philosophy
- Alignment of design standards and codes

Such changes are common in large-scale projects and, if not properly controlled, may result in downstream rework or procurement issues.

3.2.2 Interface and Integration Changes

Interface-related changes were found to be one of the dominant contributors to change requests. These typically involved:

- Battery limit mismatches
- Overlapping or unclear scope of work
- Misalignment between engineering disciplines or between FEED and EPCI contractors

These changes highlight the importance of interface management as part of overall project governance.

3.2.3 Constructability and Execution-Driven Changes

Several changes were initiated based on constructability reviews and execution considerations, such as:

- Optimization of installation sequences
- Modification to improve safety and accessibility
- Adjustment of layout to suit construction methodology

Although technically beneficial, these changes often carried cost and schedule implications that required formal evaluation through the MOC process.

3.3 Implementation of Management of Change (MOC)

3.3.1 MOC Workflow and Process

The MOC process applied in this project followed a structured workflow consisting of:

a) **Change Initiation**
Each proposed change was formally documented with technical justification and background.

b) **Impact Assessment**
A multidisciplinary review was conducted to evaluate:
   i. Technical impact
   ii. Cost implication
   iii. Schedule impact
   iv. Safety and operability concerns
   v. Interface and constructability impact

c) **Review and Approval**
The change was reviewed by relevant stakeholders, including engineering, project control, and management representatives, before approval.

d) **Documentation and Traceability**
Approved changes were recorded in the MOC system, ensuring full traceability throughout the project lifecycle.

e) This structured approach ensured that no change was implemented without proper evaluation and authorization.

3.4 Impact of MOC on Cost and Schedule Control

One of the key findings of this study is the significant role of MOC in preventing uncontrolled cost and schedule escalation. Through early identification of impacts, the project team was able to:

- Detect potential cost growth at an early stage
- Differentiate between FEED-related and EPCI-related changes
- Prevent unapproved changes from entering execution
- Support management decision-making with clear technical justification

The MOC process also functioned as a decision gate, ensuring that only changes with justified technical and commercial value were approved.

3.5 MOC as an Engineering Governance Tool

Beyond its operational role, the MOC system served as an important element of engineering governance. It established:

- Clear accountability for decision-making
- Transparency in change evaluation
- Consistency in technical assessment
- Alignment between engineering, cost, and schedule control

The structured documentation produced through the MOC process also provided valuable records for audit, claims management, and lessons learned. Figure 1 illustrates the simplified MOC workflow applied during the FEED–EPCI transition, demonstrating how technical changes were systematically controlled before execution.

3.6 Classification of Changes and Their Impact

Table 1 demonstrates that most changes occurring during the FEED–EPCI transition have direct implications on cost, schedule, and engineering integrity. The MOC process acts as a control mechanism to ensure that each change is assessed and approved before implementation.

Table 1.
Classification of Changes Identified During FEED–EPCI Transition

No	Type of Change	Description	Potential Impact	Risk Mitigation Through MOC
1	Design Clarification	Clarification of technical requirements, design basis, and specifications	Design inconsistency, rework	Technical review & engineering approval
2	Interface Adjustment	Misalignment between disciplines or packages	Scope overlap, rework, delay	Interface coordination & multidisciplinary review
3	Constructability Improvement	Changes to improve constructability and safety	Cost increase, schedule shift	Constructability review & cost evaluation
4	Scope Optimization	Modification to optimize system or layout	Budget deviation	Cost–benefit analysis via MOC
5	Execution-Driven Change	Change due to construction or vendor constraints	Delay and procurement issues	Schedule impact analysis

3.7 Role of MOC in Risk Mitigation and Decision-Making

The implementation of Management of Change (MOC) proved to be effective in reducing uncertainty during the transition phase. By enforcing a formal workflow, the project team was able to:

- Ensure that all changes were technically justified
- Prevent unauthorized or undocumented modifications
- Improve coordination between engineering, construction, and project control teams
- Provide management with clear visibility of potential risks

The MOC process also enabled early detection of risks, allowing corrective actions to be taken before the changes affected project execution.

3.8 Relationship Between MOC and Project Risk Management

Management of Change (MOC) plays a crucial role as an integral component of overall project risk management. In the context of upstream oil and gas projects, risks related to design maturity, constructability, and interface complexity are often interrelated and cannot be effectively managed through isolated control mechanisms.

The findings of this study indicate that MOC functions as a preventive risk control tool rather than a reactive corrective mechanism. By requiring formal evaluation prior to implementation, MOC ensures that potential risks are identified and mitigated before they materialize into cost overruns or schedule delays. This approach aligns with risk management principles described in project management standards, where early risk identification and mitigation are essential to project success.

Furthermore, the integration of MOC with engineering review and approval processes enhances the quality of risk-based decision-making. Each change is assessed not only from a technical standpoint but also in terms of its potential impact on project objectives. As a result, MOC contributes to reducing uncertainty and increasing predictability during the FEED–EPCI transition phase.

From a governance perspective, MOC also supports transparency and accountability by documenting decision rationales, approval authority, and implementation status. This documentation becomes a critical reference during audits, claims evaluation, and project close-out activities.

3.9 Challenges in Implementing MOC During FEED–EPCI Transition

Despite its effectiveness, the implementation of MOC during the FEED–EPCI transition is not without challenges. Several issues were identified during the execution of this professional engineering practice.

3.9.1 Organizational and Cultural Challenges

In some cases, MOC was initially perceived as an administrative burden rather than a value-adding process. This perception may lead to resistance from project teams, particularly when schedule pressure is high.

3.9.2 Time Constraint and Schedule Pressure

During the FEED–EPCI transition, project schedules are often compressed to meet procurement and construction milestones. This condition may encourage informal change implementation if MOC is perceived to slow down decision-making.

3.9.3 Quality of Change Documentation

The effectiveness of MOC heavily depends on the quality of information provided during change initiation. Incomplete technical justification or insufficient impact analysis may reduce the effectiveness of the review process.

3.9.4 Coordination Across Disciplines

MOC requires strong coordination among engineering, construction, cost control, and project management teams. Misalignment between these stakeholders may lead to delays in approval or inconsistent evaluation results. These challenges highlight the importance of management commitment, clear procedures, and continuous awareness to ensure effective MOC implementation.

3.10 Discussion Summary

Based on the analysis presented in this chapter, it can be concluded that the FEED–EPCI transition phase represents a high-risk period requiring strong governance and structured control mechanisms. The implementation of Management of Change has proven to be an effective tool in managing technical uncertainty, improving coordination, and maintaining project integrity.

The findings demonstrate that MOC serves not only as a procedural requirement but also as a strategic mechanism that integrates engineering judgment, risk management, and project control. Its effectiveness depends on early implementation, multidisciplinary involvement, and consistent enforcement throughout the project lifecycle.

4. CONCLUSION AND RECCOMENDATIONS

4.1 Conclusion

Based on the professional engineering practice conducted, it can be concluded that the structured implementation of Management of Change (MOC) during the FEED–EPCI transition phase plays a critical role in controlling technical, cost, and schedule risks in upstream oil and gas projects. The study demonstrates that:

a) The FEED–EPCI transition phase is highly vulnerable to design-related and interface-driven changes.
b) A structured MOC process enables systematic evaluation of proposed changes before implementation.
c) MOC enhances engineering decision-making quality by enforcing multidisciplinary review and formal approval.
d) Early identification of cost and schedule impacts through MOC reduces the risk of uncontrolled changes entering the execution phase.
e) MOC contributes significantly to maintaining engineering integrity and project governance during phase transition.

Overall, MOC should not be viewed merely as an administrative requirement, but rather as a strategic risk control mechanism embedded within the project governance framework.

4.2 Recommendations

Based on the findings of this study, the following recommendations are proposed:

a) Integration of MOC into Engineering Governance
Management of Change should be formally positioned as part of the engineering governance framework, particularly during FEED–EPCI transition phases where design maturity is still evolving.
b) Early Implementation of MOC in Project Lifecycle
MOC should be activated prior to the start of EPCI to ensure that all design changes are properly assessed before execution commitments are made.
c) Strengthening Multidisciplinary Review
The effectiveness of MOC can be enhanced by ensuring active involvement from engineering, cost control, planning, construction, and project management functions.
d) Use of Digital MOC Tracking Systems
Digital MOC systems are recommended to improve traceability, documentation, and transparency of change management activities.
e) Continuous Improvement and Lessons Learned
MOC records should be utilized as a knowledge base for future projects, enabling continuous improvement of engineering and project management practices.

The application of Management of Change in similar upstream oil and gas projects is expected to contribute significantly to improved risk control, enhanced project performance, and stronger engineering governance throughout the project lifecycle.

4.3 Practical Implications for Engineering Projects

The findings of this study provide several practical implications for future upstream oil and gas projects:

a) Early Institutionalization of MOC
MOC should be established at the early stage of project development to prevent late-stage design changes.
b) Alignment Between FEED and EPCI Stakeholders
Clear alignment between FEED engineers and EPCI contractors is essential to reduce interface-related changes.
c) Strengthening Documentation and Traceability
A well-documented MOC system supports auditability, claim management, and continuous improvement.
d) Integration with Cost and Schedule Control
MOC should be integrated with cost control and scheduling systems to ensure holistic decision-making.

4.4 Limitations of the Study

This study was conducted based on a qualitative case study approach within a single upstream oil and gas project. Therefore, the findings may not fully represent all types of projects or contractual arrangements.

Some limitations identified in this study include:

- The analysis relies on project documentation and practitioner observation, which may contain inherent subjectivity.
- Quantitative measurement of cost and schedule impacts was limited due to confidentiality constraints.
- The study focuses primarily on engineering and project management perspectives, while organizational and contractual aspects were not deeply explored.

Despite these limitations, the findings provide valuable insights into practical implementation of MOC during critical project phases.

4.5 Future Research Opportunities

Future studies may explore the following areas to further enhance understanding of MOC implementation:

a) Quantitative analysis of cost and schedule savings resulting from MOC application
b) Comparative studies between projects with and without formal MOC systems
c) Integration of digital tools and automation in MOC workflows
d) Relationship between MOC maturity and project performance indicators

Such studies would contribute to the development of best practices and continuous improvement of change management in engineering projects.

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