MALHOTRA, PARTH MAHESHKUMAR. Promoting the use of Construction Industry Institute (CII) Best Practices in the Upstream, Midstream, and Mining (UMM) sector. (Under the direction of Dr. Edward J. Jaselskis and Dr. Alex Albert).

The Construction Industry Institute (CII) defines a best practice as “a process or method that, when executed effectively, leads to enhanced project performance.” CII has conducted comprehensive research on various industry processes and methods which has generated 17 Best Practices. The implementation of the CII Best Practices has been proven to yield significant benefits in terms of cost, schedule and safety for both owners and contractors. However, previous research has highlighted that barriers to implementation exist, and the CII Best Practices remain underutilized. The Upstream, Midstream, and Mining sector (UMM) is a sub sector within CII that is interested in promoting the usage of the CII Best Practices within the sector companies. This research focuses on understanding the usage characteristics of the CII Best Practices within the UMM sector companies and provides recommendations to help the sector companies in achieving higher levels of CII Best Practice Implementation.

The research methodology included literature review to understand the CII Best Practices, and the level of implementation of the CII Best Practices as noted in the previous studies. Subsequent to the literature review, a survey was conducted to collect information concerning the current usage characteristics of the CII Best Practices within the UMM sector companies. 13 UMM sector organizations out of total 32 organizations contacted, participated in the survey resulting in a response rate of 40.6 percent.

The analysis of the survey data indicated that the participating organizations implemented, on average, 6.69 CII Best Practices. Incomplete understanding of the CII Best Practices was identified
as the biggest barrier to implementation, with 69 percent respondents in agreement. A remarkable 92 percent of the survey participants agreed that, learning and sharing of knowledge on CII Best Practices implementation between the member companies would be the best path forward. Subsequently, a knowledge sharing session was conducted where the UMM sector organizations where the various aspects of CII Best Practice implementation were discussed.

Based on the findings of the research study, three recommendations to promote the use of the CII Best Practices were developed. The research study concludes that Establishment of a Knowledge Sharing Program, Development of a Video Repository, and the use of Artificial Intelligence can potentially lead to higher levels of implementation of the CII Best Practices.

It should be noted that the recommendations developed by this research study are applicable across all CII sectors, and their implementation can potentially lead to higher levels of CII Best Practice usage within all CII member companies.
Promoting the use of Construction Industry Institute (CII) Best Practices in the Upstream, Midstream, and Mining (UMM) sector

by
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A thesis submitted to the Graduate Faculty of North Carolina State University in partial fulfillment of the requirements for the degree of Master of Science

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_______________________________
Dr. Min Liu
DEDICATION

To my loving family and my dearest friends.

I will forever be grateful for your love and support.

You are my strength and refuge.

“Breathe in the fresh air, Put your mind at ease.

Let down your hair, let it flow in the breeze.

Let your eyes wander, to all the beauty to be seen.

Focus on your goals, never lose your fight.

It’s time to open new scrolls, everything will be all right.”

- Katy A. Brown
BIOGRAPHY

Parth Maheshkumar Malhotra was born in Ahmedabad, India on March 28th, 1994. He was raised in Anand, India where he graduated from high school in 2011. He received his Bachelor of Technology degree in Civil Engineering from Charotar University of Science and Technology (CHARUSAT) in 2015. During his undergraduate studies, he developed a profound interest in construction management, and decided to augment his knowledge in this discipline. In Spring 2016, he joined the North Carolina State University, and began pursuing his master’s degree in Construction Engineering and Management.

Parth has always been interested in learning the nuances of construction project management, and has always been intrigued by the various elements of a construction project. He has always wanted to gain a comprehensive understanding of factors that lead to successful projects, which are executed within time and budget, along with highest levels of safety.

During his master’s studies at North Carolina State University, he has held teaching assistantship positions, and has been active with various student organizations. He has served as the treasurer for Associated General Contractors (AGC), Construction Management Association of America (CMAA), and NAHB (National Association of Home Builders) student chapters at the North Carolina State University.

He is very inquisitive, and is always interested in learning something new. He is an avid traveler, foodie, and a thorough automotive enthusiast. He is a complete extrovert and generally very outgoing.
Upon graduation, he intends to work in the construction industry and wishes to learn more about the process of construction. He hopes that he can take the knowledge he has gained throughout his educational career, and apply it on construction projects to deliver successful projects in the future, and leave a lasting impact on the industry.
ACKNOWLEDGEMENTS

There are numerous people who have played an important part in my success, and without whom this would have not been possible.

Most importantly, I wish to express the most heartfelt gratitude to Dr. Edward J. Jaselskis and Dr. Alex Albert for their guidance and support. I have been extremely lucky to have had the opportunity to work with them, and I will always be thankful for this wonderful opportunity.

I am grateful to Dr. Edward Jaselskis for providing me with the opportunity to work on this research project, and mentoring me throughout my journey. He has taught me the virtues of kindness, humility, & perseverance. He has always inspired me, and I look up to him as my role model. Furthermore, I am thankful to him for providing me with financial assistance throughout my program.

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I consider myself lucky to have been blessed with wonderful friends who have always supported me and cared for me. My friendship with Ankit, Bhumik, Dhruv, Jagdish, Luv, Meet, Noreen, Sayyam, Samarth, and Vikas has stood the test of time, and I thank them for always being there for me.

I will be forever thankful to my family for their everlasting love and unwavering support. My parents, Mina and Mahesh Malhotra, have inspired me and encouraged me to pursue my dreams. They have supported me at every stage in my life, and have always motivated me to go further. I am thankful to my sister Vinni for always being there for me and showering me with her love, kindness, and support. I am lucky to have an elder sibling like her, knowing that no matter what, she will always be there for me.
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1 Introduction

1.1 Background

The construction industry is currently witnessing a period of robust growth, projected to grow at an annual average of 3.4%, reaching a value of US $10 trillion in 2020 (Timetric, 2016). However, major challenges such as poor productivity, skilled labor shortages, sustainability concerns, safety performance and unsatisfactory project performance remain. The 2015 KPMG Global Construction Survey found that more than half of all construction companies experienced one or more underperforming projects in 2014 (KPMG, 2015). Most megaprojects (~98%) experience cost overruns or delays with an average cost increase of 80% and average schedule slippage of 20 months (Changli et al.; Bechtel, 2016). According to the Construction Industry Institute (CII), only one in every 20 projects meet both its authorized cost and its schedule within an acceptable margin, while almost 14 out of the same 20 projects suffer from more than 10% variation compared to authorized values (CII, 2012a). There is a dire need to ameliorate project performance and improve project outcomes. A considerable amount of research has been conducted by academic scholars and industry partners to improve project performance. Among others, the Construction Industry Institute (CII) has pioneered several research efforts through industry partnership to address practical industry challenges (Kim, 2014).

1.2 Construction Industry Institute

The Construction Industry Institute (CII) is a consortium of leading owner, engineer-contractor and supplier firms that is well-known for producing construction research to solve practical challenges in the industry. Established in 1983 with a membership charter of 28 companies,
today CII has more than 130-member companies that work in partnership with academic scholars to produce research that enhances the safety, business effectiveness and sustainability of capital facility life cycle. (CII, 2017a). The research is conducted by university faculty and graduate students, with industry input (Tucker, 2007). This unique collaboration between the industry and academia has produced a plethora of practical research products that have been proven to improve project outcomes. The owner/contractor construction teams that use CII research have a combined cost advantage of 10% on their capital projects (CII, 2017b).

1.3 CII Best Practices

Since its establishment, CII has conducted comprehensive research on various industry processes and methods which has generated 17 Best Practices through extensive industry use and/or validation. CII defines a best practice as “a process or method that, when executed effectively, leads to enhanced project performance.” The 17 CII Best Practices, as defined by CII are (CII, 2012b):

1. Advanced Work Packaging

“The overall process flow of all the detailed work packages (construction, engineering, and installation work packages). AWP is a planned, executable process that encompasses the work on an EPC project, beginning with initial planning and continuing through detailed design and construction execution. AWP provides the framework for productive and progressive construction, and presumes the existence of a construction execution plan.”

2. Alignment
“Alignment is the condition under which appropriate project participants are working within acceptable tolerances to develop and meet a uniformly defined and understood set of project objectives.”

3. Benchmarking & Metrics

“Benchmarking is the systematic process of measuring an organization’s performance against that of recognized leaders for the purpose of determining best practices that, when adapted and utilized, lead to superior performance.”

4. Change Management

“Change management is an organization’s process of incorporating a balanced change culture of recognizing, planning, and evaluating project changes to effectively manage them. These changes include scope, error, design development, estimate adjustments, schedule adjustment, and changed condition, either elective or required.”

5. Constructability

“Constructability is the optimal use of construction knowledge and experience in planning, design, procurement, and field operations to achieve overall project objectives.”

6. Disputes Prevention & Resolution

“Dispute resolution techniques include the use of a disputes review board as an alternative to litigation. The Dispute Review Board technique provides a process for addressing disputes in their early stages before the dispute affects the progress of the work, creates adversarial positions, and leads to litigation.”

7. Front End Planning
“Front End Planning is the process through which owners develop sufficient strategic information to address risk and commit resources in order to maximize project success. Front End Planning is also known as front end loading, pre-project planning, feasibility analysis, conceptual planning, programming/schematic design, and early project planning.”

8. Implementation of CII Research

“The comprehensive and effective use of proven CII products by member organizations as outlined in the CII Implementation Model.”

9. Lessons Learned

“Lessons learned (LL) program comprises the people, processes, and tools that support an organization’s collection, analysis, and implementation of validated lessons learned. The ultimate goal of this program is to add value to the organization by promoting the communication of information.”

A critical element in the management of institutional knowledge, an effective lesson learned program will facilitate the continuous improvement of processes and procedures and provide a direct advantage in an increasingly competitive industry.

10. Materials Management

“Materials management is a complex and comprehensive process that consists of people, organizations, technology, and processes used to manage the definition, sourcing planning, quantification, supplier qualification, purchasing, supplier QA/QC, expediting, transportation, logistics, and controlling of materials and associated information across the life cycle of a capital project.”
11. Partnering

“A long-term commitment between two or more organizations as in an alliance or it may be applied to a shorter period of time such as the duration of a project. The purpose of partnering is to achieve specific business objectives by maximizing the effectiveness of each participant’s resources.”

12. Planning for Modularization

The evaluation and determination of offsite construction in the front end planning phase to achieve specific strategic objectives and improved project outcomes. Includes developing a business case and execution strategy for large-scale transfer of stick-built construction effort from the jobsite to fabrication shops or yards.

13. Planning for Startup

Startup is defined as the transitional phase between plant construction completion and commercial operations, that encompasses all activities that bridge these two phases, including systems turnover, check-out of systems, commissioning of systems, introduction of feedstocks, and performance testing.

14. Project Risk Assessment

“Project Risk Assessment (PRA) is the process used to identify, assess, and manage risks on a project.”

15. Quality Management

“Quality management incorporates all activities conducted to improve the efficiency, contract compliance and cost effectiveness of design, engineering, procurement, QA/QC, construction, and startup elements of construction projects.”
16. Team Building

“Team building is a project-focused process that builds and develops shared goals, interdependence, trust and commitment, and accountability among team members. It also seeks to improve team members’ problem-solving skills.”

17. Zero Accidents Techniques

“Zero accident techniques include the site-specific safety programs and the implementation, auditing, and incentive efforts undertaken to create a project environment and a level of training that embraces the mindset that all accidents are preventable and that zero accidents is an obtainable goal.”

1.4 Benefits of using CII Best Practices

A positive correlation has been found between the use of CII Best Practices and improved project performance. Cost, schedule, and safety performance improves with the increased usage of CII Best Practices for both owners and contractors. The CII Benchmarking and Metrics Committee has previously conducted a study on over 1,000 projects from the CII Benchmarking and Metrics (BM&M) database to understand the impact of CII Best Practices on project performance. The study found that, depending on industry group and project size, owners can have potential savings ranging from $1.7 million to $3.4 million while contractors can save twice as much, ranging up to $7.2 million for a typical $88 million heavy industrial project. Buildings project owner can also expect a schedule reduction of as much as 16% or 27 weeks, for large projects. The implementation of Zero accident best practice demonstrated a 50% reduction in Recordable incidence rate between 4th quartile (lower best practice use) to 1st quartile (highest use) resulting in potential savings of $200,000 from lost workday cases.
avoided. (CII, 2003). The impact of the eight best practices analyzed in the study, in terms of impact on schedule reduction and cost savings for owners and contractors are illustrated in Figure 1-1 and Figure 1-2.

![Diagram showing the impact of CII best practices on schedule reduction and cost savings](image)

**Figure 1.1** Owner Benefits of CII Best Practice use (CII, 2003)
From 2007 through 2010, CII conducted a Best Practices study among its member companies to measure the level of best practice use and gauge the impact of the best practices on project performance. The results of the study have been published in the CII Value of Best Practices report. 14 CII best practices existed at the time of the study, out of which Disputes Prevention & Resolution, Materials Management, Quality Management, and Implementation of CII Research were not included in the study (CII, 2011). Advanced Work Packaging, Planning for Modularization, and Project Risk Assessment were not instituted as CII Best Practices at the time of the study. The research study included 168 projects from 28 CII member organizations with an average Total Installed Cost (TIC) of $108 million, and an average duration of 188.1
week. (CII, 2011). The results from the research study reinforced the fact that high use of CII best practices results in significant benefits for both owner and contractor companies in terms of cost and schedule performance.

Owner submitted projects with high best practice use had an average cost growth of –2.3 percent, significantly better than the average cost growth of 8.6 percent for projects that with low best practice use. Similarly, owner projects with high best practice use had an average cost growth of 1.8% as compared to an average cost growth of 11.5 percent for projects that had low best practice use. The study also found that the cost growth decreased from 6.3 percent to -1.2 percent for owner projects using planning best practices at the fourth quartile level and the first-quartile level, respectively.

For contractor submitted projects, it was observed that the high use of execution best practices (i.e. Constructability, Project Risk Assessment, and Change Management) resulted in an average cost growth of -3.0 percent as compared to a cost growth of 9.2% for projects having low usage of execution best practices.

The implementation of CII Best Practices can yield significant benefits in terms of cost, schedule and safety thus improving project performance. They might also increase the consistency and predictability of project performance which affords a better chance at improving project performance over the long term (CII, 2011a).
1.5 Barriers to implementation

CII identifies itself as an implementation driven research institute where emphasis is laid on the implementation of its research products. Implementation has been identified as one of the core competencies in CII’s strategic plan (CII, 2001a):

“CII is implementation driven. CII acts as a focal point for collecting from the worldwide construction industry state-of-the-art concepts and practices for improving the quality and the cost effectiveness of the capital investment process. CII is the key in transferring this information for the benefit of the members. CII continuously seeks to support adoption and implementation of best practices by the members.”

In 1994, CII formed the Barriers to Implementation Research Team to identify and study the impacts of barriers to implementation of CII products. With a focus on the barriers of implementation, the team conducted a study on 22 industry projects ranging from $2 million to $600 million in size (CII, 1995). The data collected process included a survey and interviews of the owner, designer, and construction managers. The scope of the study focused on the project level, but the findings turned out to be relevant to organizational implementation as well.

The study identified the following as the main barriers to implementation (CII, 1995):

- Low familiarity with best practices
- Lack of commitment to best practices
- Limited emphasis on training and education of best practices
- Failure to integrate new ideas and recommendations into organization’s procedures
• Limited benchmarking of cost and benefits
• Lack of innovation within industry due to risk aversion.

The research report organized the typical barriers in the following major categories:

• Management leadership: Resource, Communication of value, Commitment.
• Organizational culture: Organizational behavior, structure, and value system.
• Education: Awareness of the available concepts and materials, user level.
• Performance monitoring: Measurement of CII product implementation and benefits.
• Communication: Sharing knowledge, experience and benefits of CII and its products.
• Action: Plans and objectives of implementation.

Comments similar to below quotes were commonly received from the project respondents during the study (CII, 1995):

“We’re doing all of that already!”

“We’re too busy at the project level to be learning new things!”

“Fast-track reimbursable contracts encourage the same old thinking.”

“Who’s going to pay for us to do these things?”

CII concepts and research products have been proven to improve project performance as seen in the previous section. However, barriers to implementation exist, and they always will. There is a need to overcome these barriers to achieve the needed improvement and change.
1.6 CII Implementation Model

CII formed the CII Implementation Strategy Committee (ISC) in 1995 to address implementation and facilitate effective implementation of CII products to overcome implementation barriers (CII, 2001b).

The CII Implementation committee has developed an “Implementation model” that consists of nine steps/recommendations based upon a foundation of CII products, support and benchmarking & metrics data. It is recommended that all CII member organizations use the model to craft their implementation efforts (Kim & Gibson, 2002). The steps involved in the implementation model are illustrated in Figure 1-3.

![Figure 1.3 CII Implementation model (CII, 2001b)](image)

The foundation and nine building blocks of the implementation steps follow the traditional plan-do-check-act continuous improvement model and are defined as follows (CII, 2001b):
1. *A Foundation of CII Products, Support, and Benchmarking & Metrics Data.*

CII products include implementation resources, research summaries and educational materials that can be used to assist individuals in process improvements. The CII Benchmarking and Metrics program provides project performance and process use metrics to assist organizations in understanding improvement opportunities and benefits that result from using CII practices.

2. *Corporate Commitment.*

Any effective corporate implementation effort must begin with a clear and strong management commitment to improve. This commitment may include a statement that clearly informs the employees what the organization expects relative to implementation of CII products along with directives and resources to implement specific CII products into existing processes, procedures, and practices within the organization, while using the implementation model as a guide.

3. *Corporate Implementation Champion. A corporate Implementation Champion*

A corporate Implementation Champion (IC) guides and directs implementation of CII products to maximize organizational benefits. An IC has to provide leadership, disseminate knowledge about the CII Best Practices, facilitate communication of implementation benefits & opportunities, and conduct objective measurement of the results of using CII Best Practices.


Self-audits should be performed periodically to determine the practices that are done well and those that are done poorly to identify opportunities for improvement.
5. **Implementation Plan & Goals.**

In order to implement CII products effectively, an implementation plan should be developed and target goals set by which to measure success. The plan and goals should be based on corporate vision and should focus on integrating the CII Best Practices into the organization’s process, procedures, and culture.

6. **Review Boards/Product Champions.**

A review board facilitates the review of the CII Best Practices and makes recommendations for adoption, based on the understanding of the organization. Product champions are then assigned to facilitate implementation of specific CII Best Practice or products.

7. **Product(s) Training.**

Effective implementation must be accompanied by training developed specifically for the practice to be implemented. This training should provide knowledge necessary for successful implementation, including company specific processes and practices.

8. **Product Implementation.**

The product/practice must be implemented. It is recommended that this occur on a pilot application basis with a good mechanism for measurement.

9. **Measure Results.**

As in the case of implementation of any new tool, technique, or product, results must be measured to make sure that the effort is worthwhile. Measure both utilization of Best Practices and impact of use. Also, participate in surveys conducted by CII
Benchmarking and Metrics Committee or other benchmarking services — the results will give comparison of your efforts with those of other organizations.

10. Celebrate Success.

To effectively integrate the practices into the corporate culture and to inculcate a culture of implementation, celebration of success is an effective tool. Successes in implementation process should be recognized and publicized using media such as newsletters, intranet sites, team meetings, and organization process documentation.

In addition to the implementation model, the CII ISC has also been instrumental in the creation of knowledge base which is an excellent source of information about CII research in a well-organized structure.

1.7 Previous study on CII Best Practices usage

Kim & Gibson have previously conducted a study to evaluate the frequency and degree of CII Best Practice usage within the CII member companies. The study in which 41 organizations participated, encompassed 11 Best Practices that existed at that time (Kim & Gibson, 2002).

The study found that, the participating member companies implemented 5.5 CII Best Practices, on average. There were extremes on both ends of frequency usage, as illustrated in Figure 1-4, with 20 percent of the companies implementing two or fewer CII Best Practices while 27 percent of the participating organizations were using nine or more Best Practices (Kim & Gibson, 2002).
Out of the 11 Best Practices included in the study, Pre-project Planning, Zero Accidents Techniques, and Constructability were the most widely implemented best practices while Materials Management and Dispute Resolution were rarely implemented. The frequency of use of individual best practices is illustrated in Figure 1-5.
The study also assessed the degree of implementation of each Best Practice and found that zero accident techniques, materials management, pre-project planning, and change management had high degree of implementation as compared to alignment, design-effectiveness and team building for which degree of implementation was the lowest. The degree of CII Best Practices implementation is summarized in Table 1.

**Table 1.1 Degree of CII Best Practices Implementation**

<table>
<thead>
<tr>
<th>CII Best Practice</th>
<th>Average Degree of Implementation* (Min. = 0, Max. = 100)</th>
<th>Frequencies of CII BP Usage (%) (N=41)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zero Accidents Techniques</td>
<td>85</td>
<td>26 (63%)</td>
</tr>
<tr>
<td>Materials Management</td>
<td>74</td>
<td>12 (29%)</td>
</tr>
<tr>
<td>Pre-Project Planning</td>
<td>72</td>
<td>33 (80%)</td>
</tr>
<tr>
<td>Change Management</td>
<td>72</td>
<td>23 (56%)</td>
</tr>
<tr>
<td>Quality Management</td>
<td>67</td>
<td>20 (49%)</td>
</tr>
<tr>
<td>Constructability</td>
<td>66</td>
<td>26 (63%)</td>
</tr>
<tr>
<td>Dispute Resolution</td>
<td>63</td>
<td>6 (15%)</td>
</tr>
<tr>
<td>Partnering</td>
<td>59</td>
<td>24 (59%)</td>
</tr>
<tr>
<td>Alignment</td>
<td>53</td>
<td>20 (32%)</td>
</tr>
<tr>
<td>Design-Effectiveness</td>
<td>53</td>
<td>13 (49%)</td>
</tr>
<tr>
<td>Team Building</td>
<td>52</td>
<td>24 (59%)</td>
</tr>
</tbody>
</table>

*Based on the implementation index for each Best Practice when implemented

The research study thus demonstrates that the frequency and degree of implementation of the CII Best Practices is lacking and somewhat unsatisfactory. The study also notes that the potential of the CII Best Practices has been proven through a thorough screening process, and organizations should try to implement more Best Practices (Kim & Gibson, 2002).

### 1.8 Gaps in existing body of knowledge/Summary of literature review

Along with an overall understanding of the Construction Industry Institute (CII) and the CII Best Practices, the literature demonstrates that the use of CII Best Practices can yield
significant benefits in terms of cost and schedule performance and thus improving project performance. In order to promote the implementation of its research, CII has also developed a plethora of research products, tools, and resources. However, there is a dearth of actionable process(es) that could enable the member organizations to assimilate the vast amount of research products and integrate them in their capital projects and their organizational structures. Past research has highlighted that barriers to implementation exist, and the CII Best Practices remain underutilized.

The research study by Kim & Gibson to understand the frequency and the degree of implementation of the CII Best Practices demonstrated that the CII Best Practices were underutilized, and their benefits were unrealized. The study was conducted more than 15 years ago when 11 CII Best Practices were in existence. 17 Best Practices exist currently, along with a multitude of resources and tools that have been developed by CII to aid the implementation of its research products. A study of the current state of the CII Best Practices usage might yield some interesting results that could assist in the efforts to increase the implementation of the CII products.

The Upstream, Midstream, and Mining sector (UMM) is a sub sector within CII that is interested in promoting the usage of the CII Best Practices within the sector companies. The UMM industries include offshore terminals, onshore terminals, oil and gas production, pipelines, and mining. (CII, 2017c). The objective study of the current study is to understand the usage characteristics of the CII Best Practices within the UMM sector companies and provides recommendations to help the sector companies in achieving higher level of CII Best Practice Implementation and realize the goals of improved project performance.
1.9 Thesis outline

This thesis is organized into four chapters and several appendices, containing supporting information and results of data collection and analysis. The current chapter discussed the background of this research and presented a summary of other work related to the implementation of CII Best Practices. The research methods used in this study is presented in Chapter 2, where the development of the survey questionnaire, techniques used to analyze the survey data, and development of the Knowledge sharing session is discussed. Analyses of the survey data, and the proceedings of the Knowledge sharing session are presented in Chapter 3. The conclusions and recommendations are discussed in Chapter 4.
2 Methodology

The research methodology adopted for this study comprised of three main components: (1) literature review; (2) survey questionnaire; (3) data analysis and (4) Knowledge sharing session. As seen in the previous chapter, the literature review provided a better understanding of the CII Best Practices, the level of implementation of the CII Best Practices as noted in the previous studies and the barriers to their implementation. Subsequent to the literature review, a survey was conducted to collect information concerning the current usage characteristics of the CII Best Practices within the UMM sector companies. The data obtained from the survey forms the core of this research effort and was subjected to analysis for validation purposes. Based on the data and feedback received from the survey, a Knowledge sharing session was conducted where one of the UMM sector companies that has achieved a high degree of implementation of CII Best Practices, discussed their efforts and gave an insight into the implementation process of the CII Best Practice.

2.1 Survey Questionnaire

Prior to the development of the survey questionnaire, the initial approach for the research study was to select a CII Best Practice and attempt to customize it to suit the needs of the UMM sector. It was hypothesized that the customized CII Best Practices would lead to increased usage of the CII Best Practices. The idea of customization of the best practices was presented to the UMM sector committee members at a sector meeting in January 2017. Various comments were received from the sub-committee members during the meeting, such as:

“Is this an ideal solution?”
“What exactly do we customize in the best practices, and how much do we customize?”

“Wait! What are we trying to do here?”

“Companies will have to again modify the customized best practices to suit their needs.”

“The upstream, mid-stream and mining sub-sectors within the UMM are very different, and it might not be possible to come up with a customized best practice that satisfies all three sub-sectors.”

“Will this increase the usage of the best practices?”

The feedback received from the UMM sector committee members warranted a reevaluation of the initial proposal to customize the CII Best Practices. Upon further examination, it was realized that customization of the best practices was not the ideal solution to increase the best practice usage within the UMM sector. It was recognized that, in order to develop an effective solution to promote the CII Best Practice usage, the CII Best Practice usage characteristics and the existing challenges to their implementation must be studied. The need to develop a survey questionnaire, thus emerged.

The survey questionnaire used in this research study was developed through multiple iterations, with inputs from the faculty members at North Carolina State University, and a sub-committee consisting of nine UMM sector members.

The survey questionnaire was composed of three main sections, namely Part A, Part B, and Part C.
Part A gathered demographic information about the participating organization. It comprised of four questions that identified the company type, the duration of its association with CII and the approximate revenue generated by the company.

Part B assessed the usage characteristics of the CII Best Practices, the barriers to their implementation, perceived value of the CII Best Practices, and the effectiveness of the CII Knowledge Base for the UMM sector organizations. Part B was divided into three sections, with a total of 60 questions. The first section consisted of questions that identified both, CII and non-CII best practices used by the participants. For each CII Best Practice used by the participants, the frequency of usage at project level, and the degree of implementation was measured using the Likert’s scale. The barriers to implementation of CII Best Practices were also identified in the first section. The second section measured the perceived value of each CII Best Practice from the participants perspective on a five-point Likert scale with an additional ‘Don’t know’ option. The final section of Part B assessed the effectiveness of the CII Knowledge Base from the participants’ perspective, measured on a five-point Likert scale. The CII Knowledge Base is a website developed by CII which provides resources from more than 30 years of research, publications, presentations, and tools.

Part C consisted of two questions that focused on gathering comments and suggestions from the participating organization on achieving greater usage of CII Best Practices in the UMM sector. A copy of the questionnaire which contains all the questions is given in Appendix A.

2.1.1 Data collection/Survey Distribution

Since this research study focused on the UMM sector within CII, the distribution of the survey was limited to the UMM sector member organizations. The survey had response rate of 41
percent, in which 13 out of the total 32 UMM sector organizations participated. The response rate for the survey was in-line with the 45 percent response rate that was observed in a previous research study on Implementation of CII Best Practices conducted by Kim & Gibson (2002).

The survey was delivered electronically through Qualtrics, an online survey platform. Early on during the survey development phase, it was realized that one individual from an organization might not be able to answer all the questions presented in the survey. The requirement for the survey to be collaborative was thus realized. Qualtrics is a feature rich platform that allows multiple people to collaborate on a survey response. A personalized link for each participating organization was generated, which could then be shared by multiple people within the organization, giving them access to the same survey response, thus facilitating collaboration. The use of the established survey platform also afforded the possibility of skip logic integration in the survey, which enabled the possibility of sending the respondents to a future point in the survey based on how they answer a question. The skip logic was extensively used in Part B of the survey.

A fillable Portable Document Format (PDF) version of the survey was also available for participants who would prefer a PDF version, but it is to be noted that all 13 companies completed the survey online. A sample section from the survey website is provided in Figure 2.1.
2.2 Data Analysis

Analyses of the collected data were conducted using different statistical techniques such as independent sample t test and linear regression which are discussed later in this section. The survey consisted of many questions that were subjective in nature, and were measured on a Likert-type scale. The subjective nature of the questions combined with low number of survey responses meant that the analysis of the Likert type data was limited to simple statistical analysis, reported in terms of percentages, and collated into bar charts for visualization of the
survey responses. The simple approach to analysis provided an opportunity to focus on the core issues that hinder greater usage of the CII Best Practices.

2.2.1 Independent sample t-test

The independent-samples t test is used to evaluate whether the mean of a single variable for subjects in one group statistically differs from that in another group. It does this by comparing the difference between the two means with the standard error of the difference in the means of different samples. To be able to perform this test, each case must have at least two variables: the grouping variable and the test variable. The grouping variable divides the cases into two mutually independent groups or samples, while the test variable defines each case on some quantitative measure.

Independent-samples t test was used in analyzing the data for this study such as for evaluation of differences between owners and contractors.

2.2.2 Linear regression analysis

Linear regression attempts to model the relationship between two variables by fitting a linear equation to observed data. One variable is considered to be an explanatory variable, and the other is considered to be a dependent variable. A linear regression line has an equation of the form \( Y = a + bX \), where \( X \) is the explanatory variable and \( Y \) is the dependent variable. The slope of the line is \( b \), and \( a \) is the intercept (the value of \( y \) when \( x = 0 \)).

The coefficient of determination, \( R^2 \) evaluates the scatter of the data points around the fitted regression line. R-squared is a goodness-of-fit measure for linear regression models, and the
percentage of the variance in the dependent variable that the independent variables explain collectively.

2.3 Limitations of Data Analysis

The primary limitation of the data analysis was related to sample size. The UMM sector within the CII consists of 32 organizations, of which 13 organizations participated in the survey. The small number of responses proved to be a limitation in conducting robust statistical tests. It would have been easier to perform more reliable analyses if data from more organizations were available. Also, it is possible that the approximately 40 percent of the UMM sector organizations that completed the survey may be more interested in implementation than others that did not respond, and they may have a better implementation process.

2.4 Knowledge Sharing Session

The analysis of the survey results showed that 92% of survey participants were in favor of sharing knowledge on implementation of the CII Best Practices within the member companies. Based on the response of the participants, an hour-long knowledge sharing session was conducted during the UMM sector face-to-face meeting on October 25th, 2017. The participating organizations discussed certain aspects of the implementation process within their respective organizations which provided an insight on the existing practices within the member companies.

It should be noted that the session was a pilot to gauge the interest of the committee members for future knowledge sharing sessions, and hence the session was mostly informal.
2.5 Summary

This chapter outlined the methodology followed in conducting this study. Data collection was accomplished by an electronically distributed survey, delivered through the online survey platform of Qualtrics. The collected data was subjected to rigorous analysis, the results of which are summarized in the next chapter. The proceedings of the knowledge sharing session are also discussed in the next chapter.
3 Results

This chapter summarizes the data generated from the survey questionnaire. Various aspects of the survey data such as the current level of implementation of the CII Best Practices, the frequency of usage and the degree of implementation of the CII Best Practices are discussed in this chapter. Additionally, the effectiveness of the CII Knowledge Base, the barriers to implementation of the CII Best Practices, and the survey participants’ feedback on the path towards achieving greater usage of CII Best Practices is also summarized.

3.1 Survey Response Rate

13 UMM sector organizations out of the 32 organizations contacted, participated in the survey resulting in a response rate of 40.6 percent. Out of the 13 participating organizations, 8 were owner organizations while 5 were contractor organizations.

3.2 Overall Best Practice usage

The analysis of the survey data indicated that the participating organizations implemented, on average, 6.69 CII Best Practices, which is approximately 40 percent of the 17 CII Best Practices available.

The distribution of the number of CII Best Practices implemented by the participating organizations is shown in Figure 3.1, which demonstrates that there were extremes on both ends of distribution. Some organization were implementing none or a very small number of CII Best Practices, while some organizations were implementing most or all the CII Best Practices.
Figure 3.1 Number of CII Best Practices Implemented

Approximately 39 percent survey participants implemented three or fewer CII Best Practices, while nearly 23 percent of the participants utilized twelve or more CII Best Practices. Since the CII Best Practices have been validated through a rigorous screening process, and their positive impact on project performance is verified, organizations should probably implement more CII Best Practices.

3.3 CII Best Practice usage comparison between Owners and Contractors

Out of the 13 participating organizations, 8 were owner firms and 5 were contractors. Figure 3.2 shows the difference between contractors and owners in terms of average number of Best Practices implemented. The participating contractor organizations implemented 4.7 more Best Practices on average as compared to owners.
In order to test if a statistically significant difference existed between the owners and contractors in terms of CII Best Practice implementation, an independent-sample t test was conducted. A p-value of 0.139 was obtained from the test, demonstrating that the mean difference between owners and contractors in terms of the number of CII Best Practices implemented was not statistically significant. The results from the t-test are shown in Table 3.1, and the statistical differences between owners and contractors is summarized in Table 3.2.

**Figure 3.2** CII Best Practices Usage: Owners versus Contractors

<table>
<thead>
<tr>
<th>Contractors</th>
<th>Owners</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.6</td>
<td>4.875</td>
</tr>
</tbody>
</table>

(N=5) (N=8)

**Table 3.1** Independent t test: Number of Best Practices Implemented: Owners vs. Contractors

<table>
<thead>
<tr>
<th>t test for equality of means</th>
<th>t</th>
<th>df.</th>
<th>Sig. (2-Tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.66</td>
<td>7</td>
<td>0.139</td>
</tr>
</tbody>
</table>
Table 3.2 Statistical differences: Owner vs. Contractors

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Median</th>
<th>Standard Deviation</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owners</td>
<td>4.875</td>
<td>4</td>
<td>4.15</td>
<td>25.56</td>
</tr>
<tr>
<td>Contractors</td>
<td>9.6</td>
<td>10</td>
<td>5.41</td>
<td></td>
</tr>
</tbody>
</table>

3.4 CII Best Practice usage and duration of membership

The survey data demonstrated a positive correlation between the number of best practices implemented by an organization and the duration of its association with CII. Figure 3.3 shows the average number of CII Best Practices implemented by the organizations as compared to the duration of CII membership. The data showed that the organizations that have been CII members longer, generally implement more CII Best Practices.

![Figure 3.3 Number of CII Best Practice implemented versus Duration of CII membership](image-url)
A regression analysis of the number of CII Best Practices implemented by the participating organizations, compared with the duration of their membership with CII, returned an $R^2$ value of 0.51 as shown in Figure 3.4. Additional data might be required to validate this correlation.

![Regression analysis graph](image)

**Figure 3.4** Regression analysis

### 3.5 Usage of 17 Best Practices

The survey also measured which of the 17 CII Best Practices were implemented by the organizations. The distribution of the number of organizations that implemented specific CII Best Practices is shown in Figure 3.3, and the overall usage of the 17 Best practices is summarized in Table 3.3.
Figure 3.5 CII Best Practice usage
Table 3.3 CII Best Practice Usage

<table>
<thead>
<tr>
<th>CII Best Practice</th>
<th>Number of Organizations (n=13)</th>
<th>Percentage*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Front End Planning</td>
<td>10</td>
<td>76.92%</td>
</tr>
<tr>
<td>Constructability</td>
<td>8</td>
<td>61.54%</td>
</tr>
<tr>
<td>Change Management</td>
<td>7</td>
<td>53.85%</td>
</tr>
<tr>
<td>Lessons Learned</td>
<td>7</td>
<td>53.85%</td>
</tr>
<tr>
<td>Zero Accident Techniques</td>
<td>7</td>
<td>53.85%</td>
</tr>
<tr>
<td>Alignment</td>
<td>6</td>
<td>46.15%</td>
</tr>
<tr>
<td>Benchmarking &amp; Metrics</td>
<td>6</td>
<td>46.15%</td>
</tr>
<tr>
<td>Project Risk Assessment</td>
<td>6</td>
<td>46.15%</td>
</tr>
<tr>
<td>Team Building</td>
<td>5</td>
<td>38.46%</td>
</tr>
<tr>
<td>Advanced Work Packaging</td>
<td>4</td>
<td>30.77%</td>
</tr>
<tr>
<td>Planning for Startup</td>
<td>4</td>
<td>30.77%</td>
</tr>
<tr>
<td>Quality Management</td>
<td>4</td>
<td>30.77%</td>
</tr>
<tr>
<td>Disputes Prevention &amp; Resolution</td>
<td>3</td>
<td>23.08%</td>
</tr>
<tr>
<td>Materials Management</td>
<td>3</td>
<td>23.08%</td>
</tr>
<tr>
<td>Planning for Modularization</td>
<td>3</td>
<td>23.08%</td>
</tr>
<tr>
<td>Implementation of CII Research</td>
<td>2</td>
<td>15.38%</td>
</tr>
<tr>
<td>Partnering</td>
<td>2</td>
<td>15.38%</td>
</tr>
</tbody>
</table>

*Percentage of participants that implemented the practice

As described in Table 3.3, Front End Planning was identified as the most widely implemented practice among the survey participants. Constructability, Change Management, Lesson Learned and Zero Accident Techniques were also popular, with more than 50 percent participants implementing them. Some CII Best Practices such as Implementation of CII Research and Partnering were rarely used with just 15 percent of the participating organizations implementing them.
3.5.1 Comparison between Owners and Contractors

Since, the roles and areas of concentration for Owners and Contractors are different, it was expected that there would be different sets of Best Practices in which owners or contractors would be more interested. The number of specific CII Best Practices implemented by the owners and contractors were investigated as summarized in Table 3.4. The difference between the two groups in terms of individual CII Best Practice usage is graphically represented in Figure 3.6

<table>
<thead>
<tr>
<th>CII Best Practice</th>
<th># of C’s¹</th>
<th>% of C’s²</th>
<th># of O’s³</th>
<th>% of O’s⁴</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced Work Packaging</td>
<td>3</td>
<td>60%⁵</td>
<td>1</td>
<td>12.5%</td>
</tr>
<tr>
<td>Alignment</td>
<td>3</td>
<td>60%</td>
<td>3</td>
<td>37.5%</td>
</tr>
<tr>
<td>Benchmarking &amp; Metrics</td>
<td>4</td>
<td>80%⁵</td>
<td>2</td>
<td>25%</td>
</tr>
<tr>
<td>Change Management</td>
<td>3</td>
<td>60%</td>
<td>4</td>
<td>50%</td>
</tr>
<tr>
<td>Constructability</td>
<td>4</td>
<td>80%</td>
<td>4</td>
<td>50%</td>
</tr>
<tr>
<td>Disputes Prevention &amp; Resolution</td>
<td>2</td>
<td>40%</td>
<td>1</td>
<td>12.5%</td>
</tr>
<tr>
<td>Front End Planning</td>
<td>3</td>
<td>60%</td>
<td>7</td>
<td>87.5%⁶</td>
</tr>
<tr>
<td>Implementation of CII Research</td>
<td>2</td>
<td>40%</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Lessons Learned</td>
<td>3</td>
<td>60%</td>
<td>4</td>
<td>50%</td>
</tr>
<tr>
<td>Materials Management</td>
<td>2</td>
<td>40%</td>
<td>1</td>
<td>12.5%</td>
</tr>
<tr>
<td>Partnering</td>
<td>2</td>
<td>40%</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Planning for Modularization</td>
<td>2</td>
<td>40%</td>
<td>1</td>
<td>12.5%</td>
</tr>
<tr>
<td>Planning for Startup</td>
<td>2</td>
<td>40%</td>
<td>2</td>
<td>25%</td>
</tr>
<tr>
<td>Project Risk Assessment</td>
<td>2</td>
<td>40%</td>
<td>4</td>
<td>50%</td>
</tr>
<tr>
<td>Quality Management</td>
<td>3</td>
<td>60%³</td>
<td>1</td>
<td>12.5%</td>
</tr>
<tr>
<td>Team Building</td>
<td>3</td>
<td>60%</td>
<td>2</td>
<td>25%</td>
</tr>
<tr>
<td>Zero Accident Techniques</td>
<td>5</td>
<td>100%³</td>
<td>2</td>
<td>25%</td>
</tr>
</tbody>
</table>

3.6 Frequency of Usage and Degree of Implementation

The data revealed 5 CII Best Practices that were implemented by more than 50 percent of the participating organizations (i.e. 7 or more participating organization used them). These 5 CII Best Practices were Change Management, Constructability, Front End Planning, Lessons Learned and Zero Accident Techniques. Table 3.5 shows the number of organizations implementing each of these five best practices.

This section discusses the frequency of usage and the degree of implementation of these 5 CII Best Practices within the organizations that implemented them. The frequency of usage and
degree of implementation of the 12 other CII Best Practices is not discussed here due to insufficient data.

Table 3.5 Highly implemented CII Best Practices

<table>
<thead>
<tr>
<th>CII Best Practice</th>
<th>Number of Organizations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change Management</td>
<td>7</td>
</tr>
<tr>
<td>Constructability</td>
<td>8</td>
</tr>
<tr>
<td>Front End Planning</td>
<td>10</td>
</tr>
<tr>
<td>Lessons Learned</td>
<td>7</td>
</tr>
<tr>
<td>Zero Accident Techniques</td>
<td>7</td>
</tr>
</tbody>
</table>

3.6.1 Change Management

The survey results showed that 7 out of 13 organizations implemented change management. Among the 7 organizations that implemented this practice, more than 85 percent of the organizations implemented them on most or all projects. While over 70 percent of the respondent used most or all of the body of knowledge on Change Management, 28 percent respondents utilized only a part of the body of knowledge. The frequency of usage and degree of implementation of Change Management is illustrated in Figure 3.7 and Figure 3.8, respectively.
Constructability was identified as the second most commonly used Best Practice with 8 of 13 survey participants implementing it. However, only 50 percent of the organizations implemented Constructability on most or all projects. Similarly, only 50 percent of the organizations utilized most of the body of knowledge on Constructability. The frequency of
usage and degree of implementation of Constructability is summarized in Figure 3.9 and Figure 3.10, respectively.

![Figure 3.9 Frequency of usage – Constructability](image)

![Figure 3.10 Degree of implementation – Constructability](image)

**3.6.3 Front End Planning**

Front End Planning was utilized by 10 of the 13 survey participants and was the most widely used CII Best Practice. The data shows that the participating organizations used Front End Planning on most or all their projects and also utilized a high degree of the body of knowledge.
on the best practice. However, it is worth noting that almost 30 percent of organizations used Front End Planning on only a few of their projects and similarly 30 percent of organizations used only some of the available body of knowledge. Figure 3.11 shows the frequency of usage of Front End Planning, while the degree of implementation is represented in Figure 3.12.

**Figure 3.11** Frequency of usage – Front End Planning

**Figure 3.12** Degree of implementation – Front End Planning
3.6.4 Lessons Learned

Although 7 of the 13 participating organizations utilized Lessons Learned, the data shows that the frequency of usage was low and similarly the utilization of the body of knowledge was also sparse. 57 percent of the participating organizations implemented the Best Practice on only a few of the projects and similarly 57 percent of the organizations utilized only a small part of the available body of knowledge. The frequency of usage and degree of implementation of Lessons Learned is summarized in Figure 3.13 and Figure 3.14, respectively.

![Figure 3.13 Frequency of usage – Lessons Learned](image)

![Figure 3.14 Frequency of usage – Lessons Learned](image)
3.6.5 Zero Accidents Techniques

Zero Accidents Techniques was utilized by 7 participating organizations and it had a high frequency of usage, and the organizations that implemented them used most or all the available body of knowledge. The frequency of usage and degree of implementation of Zero Accidents Techniques is represented in Figure 3.15 and Figure 3.16, respectively.

**Figure 3.15** Frequency of usage – Zero Accidents Techniques

**Figure 3.16** Degree of implementation – Zero Accidents Techniques
As seen in the data above, there are gaps in the frequency of usage and degree of implementation of certain CII Best Practices. In order to realize the full potential of the CII Best Practices, it is essential that the CII Best Practices are fully adopted and integrated in the standard processes of the organizations, and the available body of knowledge is completely utilized.

3.7 Effectiveness of the knowledge base

The survey also investigated the effectiveness of the CII Knowledge Base, which was created by CII to aid the dissemination of knowledge on CII research products. The CII Knowledge Base has been designed to be a rich, engaging interface that encourages exploration and learning.

The survey included four question that measured the effectiveness of the knowledge base. The questions were as follows:

1. Overall how well does the CII Knowledge Base meet your needs?
2. How easy was it to find the information that you were looking for?
3. Did it take you more time or less time than you expected to find what you were looking for?
4. How likely is that you would recommend the CII Knowledge Base to others in the UMM sector?
5. How would you rate the relevance of the information in the CII Knowledge Base to meet your company’s needs?
The survey data demonstrates that the CII Knowledge Base has generally been well received by the participating organizations, and received favorable feedback from majority of the participants. However, certain aspects of the CII Knowledge Base such as the time required to find the required information, and relevance of information received critical feedback from the respondents.

The survey responses for CII Knowledge Base effectiveness are summarized in Figures 3.17 through Figure 3.21.

Figure 3.17 Knowledge Base performance in meeting the needs of the organizations
Figure 3.18 Ease of finding information on the Knowledge Base

Figure 3.19 Time taken to find the required information

Figure 3.20 Likelihood of recommendation
It is worth noting that around 38 percent of the respondents found that it took more than expected time to find information on the knowledge base, and around 46 percent of the respondents gave a score of ‘moderately well’ or lower for the relevance of information.

Few respondents also provided some comments on the Knowledge Base such as:

“The Knowledge Base is typically very basic, and/or the info is sometimes dated.”

“Reformat the Best Practices: Introduction; Best Practice Elements; Supporting Studies, tools, etc.”

“Best Practices need to be distilled to tangible action items”

Although the CII Knowledge Base has received a positive feedback overall, there are certain aspects that needs to be addressed.

### 3.8 Barriers to Implementation

The survey included a multiple-choice question designed to provide information on the barriers to implementation of the CII Best Practices. An insight on the barriers to implementation was
crucial in the development of effective recommendations to increase the usage of CII Best Practices.

Incomplete understanding of CII Best Practices, and lack of CII Best Practice champion in the organization emerged as the two biggest barriers to implementation. 69 percent respondents agreed that Incomplete understanding of the CII Best Practices was a barrier to implementation, while 46 percent respondents indicated that lack of a CII Best Practice champion was a barrier to implementation.

Lack of perceived value, Lack of resources, and Non-customized CII Best Practices were also identified as barriers to implementation, with 38 percent responses identifying them as barriers. The barriers to implementation have been summarized in Figure 3.22.

![Figure 3.22 Barriers to implementation](image-url)
Few respondents provided feedback in form of following comments:

“Difficulty in taking a generic process developed by CII, and implementing for a specific company process...examples of how the practices could be used in real life would be helpful”

“Lack of awareness and not enough facilitators”

The comments indicate a lack of understanding of the best practices, which could be a major reason for the inability to promote the usage the CII Best Practices in the organization. Complete understanding of the CII Best Practice is necessary in understanding the impact on project performance and enable their implementation.

3.9 Path forward

The survey consisted of a multiple-choice question to identify, from the respondents’ perspective, the most favorable path forward to increase the usage of the CII Best Practices.

A remarkable 92 percent of the survey participants agreed that, learning and sharing of knowledge on CII Best Practices implementation between the member companies would be the best path forward.

It is worth noting that only 23 percent of respondents agreed that customization of CII Best Practice would be effective in increasing the usage of the CII Best Practices, supporting the initial decision of this research study to discontinue the initiative of CII Best Practice customization.
Figure 3.23 Path towards greater use of CII Best Practices

Few respondents provided the following comments:

“Reformat the Best Practices: Introduction; Best Practice Elements; Supporting Studies, tools, etc.”

“(Provide) Guides to implementation of best practice”

“Simplify & clarify the best practices”

These comments highlight the fact that, the participating organizations desire to have a better understanding of the CII Best Practices. The respondents are looking for a simple and effective solution that would enable a higher degree of understanding of the CII Best Practices, which would in turn, facilitate greater implementation of the CII Best Practices.
3.10 Knowledge Sharing Session

The knowledge sharing session produced an engaging discussion within the UMM sector members. The organizations that have been using the CII Best Practices for a long time, unanimously agreed that the CII Best Practices have been integrated in their company processes and business practices.

One of the participants discussed that their organization conducts an alignment session before every important project, where they decide which processes must be implemented on that specific project. Managers are subsequently identified for each process who ensure that, the processes are implemented on the project. Each process includes the usage of the CII Best Practices, and the manager is responsible to study the relevant documents and ensure that they are utilized on the project.

The organizations agreed that most topics covered by the CII Best Practices have been integrated in their standard operating procedures. The organizations that been using the CII Best Practices discussed that they regularly referred to the latest publications from CII and compared them with their current procedures to see if the publications introduced new concepts that should be integrated in their processes.

The companies that have recently joined CII discussed that they currently have their own processes in place, and they intend to compare the maturity of the CII Best Practices with the maturity of their existing processes to discover if gaps exist in their current procedures.

A majority of the organizations agreed that, in order to utilize a CII Best Practice, all existing documentation on the CII Best Practice must be studied. The organizations generally have an
implementation team which studies the CII Best Practices and integrates them in their standard operating procedures. The CII Best Practices are generally studied by the implementation team, which works on the implementation of the best practices and converts the information from the CII Best Practices into processes that become a part of the standard operating procedures within the organization. The participants agreed that some CII Best Practice documents needed an update to remain relevant.

One of the member organizations discussed that they followed a novel approach of conducting training sessions on their processes for both, engineering staff and business development personnel. The training of the business development personnel assisted in achieving alignment between business development and engineering, and provided the business development personnel with an insight on the execution process of the project. This insight helps the business development personnel understand what project elements are important for the project management group, and helps them understand the implications of certain project expectations. This insight ultimately guides the business development personnel in making the right decisions for the project and the organization. The other members found the approach of training the business development personnel interesting.

Organizations discussed that directing their employees to access the CII Knowledge Base independently and assimilate information from the CII Best Practices from the available documents has been largely unsuccessful in the past. The employees were mostly unable to understand the body of knowledge on the CII Best Practices, and the organizations were required to develop an internal training processes to familiarize their employees with CII and its research products.
One of the participants shared that managers have traditionally struggled to study the CII documents, and they generally failed to study the CII publications. The participant shared that two years ago, when CII developed two videos on safety, their organization received an overwhelmingly positive response from the managers who subsequently studied the CII documents related to the videos.

The members discussed that majority of their employees who were on the implementation team within their organizations, struggled to understand the knowledge structure within CII. The members suggested that development of tools that would assist in educating their employees on the knowledge areas, CII research products, and organization of information within CII, will be extremely valuable.

3.11 Summary

This chapter analyzed the number of CII Best Practices implemented as well as levels of implementation among participating organizations based on the data obtained from the survey. Front End Planning was identified as the most widely implemented Best Practice among the organizations while the usages of Partnering was the lowest.

This chapter also addressed the frequency of usage and degree of implementation of the 5 most widely used CII Best Practices. The frequency of usage and degree of implementation for certain Best Practices was found to be lacking. The participating organizations found the CII Knowledge Base to be mostly effective, but certain aspects such as time taken to find the required information and the relevance of information need to be addressed. Lack of knowledge was found to be the greatest barrier to implementation of the CII Best Practices,
while 92 percent respondents agreed that learning and sharing of knowledge within the member companies would be the best path towards achieving greater usage of CII Best Practices.

The knowledge sharing session pilot provided an insight on the CII Best Practices implementation process within the member organizations. The discussion also highlighted the need to develop tools to help understand the body of knowledge on the CII Best Practices. Overall, the knowledge sharing session was very productive and provided perceptive information on the existing processes within the member organization.

In the following chapter, conclusions and recommendations are discussed based on the findings from the analysis results.
4 Conclusions and Recommendations

The research study highlighted the current status of implementation of the CII Best Practices in the UMM sector. The data showed that out of the 17 CII Best Practices available, the UMM sector organizations implemented only 6.6 CII Best Practices, on average. The CII Best Practices, are thus underutilized. The research also demonstrated the gaps in the frequency of usage and underutilization of the body of knowledge on the CII Best Practices. The CII Knowledge Base received generally positive reviews, but the relevance of information on Knowledge Base was identified as a shortcoming. From the analysis of the data and the feedback received, the primary reason for the underutilization of the CII Best Practices can be attributed to incomplete understanding of the CII Best Practices, which was identified as the biggest barrier to implementation.

A clear majority of UMM sector members were in favor of a Knowledge sharing program between the UMM sector members to enable an understating of the CII Best Practices and thus promoting its usage. The knowledge sharing session received tremendous response from the UMM sector committee members and they were in favor of continuing the Knowledge sharing sessions on a regular basis. The knowledge sharing session enabled the members to have a practical understanding of CII Best Practices implementation process and thus generating a greater interest amongst the committee members to implement the CII Best Practices.

Based on the survey data and feedback, the following recommendations have been prepared which could lead to a greater level of implementation of the CII Best Practices.
4.1 Knowledge Sharing Program

The knowledge sharing session provided insightful information on the existing implementation processes within the member companies. Different approaches to implementation, and common themes within the member organizations were identified. The knowledge sharing session highlighted the need to develop resources that assist in assimilation of the CII research products.

A formalized program for future knowledge sharing sessions can provide a deeper understanding on the implementation processes within the member companies. Future discussions on various aspects of the CII Best Practices implementation process can provide useful information to the member organizations, from which they can learn innovative approaches to overcome certain barriers. CII can also learn more about the implementation processes within the organizations and identify the gaps in the existing implementation process. Subsequently, tools and resources to bridge the identified gaps can be developed in the future, which can assist the member organization in achieving higher levels of CII Best Practice implementation. CII should consider establishing a formal knowledge sharing program and enable its member organizations to capitalize on the benefits of knowledge sharing and information exchange between its members.

4.2 Development of a Video Repository

The human brain processes imagery 60,000 times faster than text. 90 percent of information send to the brain is visual, and 93 percent of all human communication is visual (Pant, 2015). The Pictorial Superiority Effect indicates that using pictures and words together promotes greater information recall. Specifically, after 3 days, an average human being remembers 10
percent of the information relayed through text, while 65 percent of the information obtained through both, picture and text is retained (Nelson, Reed, & Walling, 1976).

Video is one of the most effective and engaging tools for relaying information. Video combines both audio and visual stimulus, which has been proven to increase message retention. According to Forrester Research's Dr. James McQuivey (2008), "a minute of video is worth 1.8 million words.". A study by Forbes (2010) found that 75 percent of executives watch work related videos at least once a week, and 59 percent of senior executives prefer to watch video instead of reading text, if both are available on the same page.

The use of educational video has risen significantly over the past few years as well. Research has shown that educational videos provide multiple benefits such as (Cruse, 2006):

- Reinforcement of reading and lecture material
- Development of a common base of knowledge among students
- Enhancement of student comprehension and discussion
- Greater accommodation of diverse learning styles
- Increment in student motivation and enthusiasm

Video is a very powerful tool which can be used to generate interest amongst the audience. A video can provide a brief explanation of a subject and develop the viewers’ interest, which could eventually motivate the viewer to do further research in the subject to achieve greater understanding on the subject matter.

CII can leverage the tremendous potential of videos, and create a video repository of explainer videos for the CII research products.
Each CII Best Practice consists of multiple tools and resources such as implementation resources, Education Modules, Research Reports, Research Summaries, and Toolkits. CII can develop short explainer type videos for each CII Best Practice and its constituent resources. These videos can act as a primer for each of these resources. An individual who wishes to gain an understanding of a specific CII Best Practices and its components, can refer to these videos first, understand the concepts and then refer to the actual resources themselves. This would not only develop an understanding of the Best Practice and its component, but also develop an interest amongst the viewers to study the resources in depth. The video repository can also include a series of videos on how different organizations implement the CII Best Practices can be created which could potentially help other organizations in their implementation process.

The use of the video repository can unlock the potential of using data analytics through the viewership data generated from the videos. The number of views, average watch time for each video, popularity of each video, etc. can provide valuable information that could be used to create more effective tools for the CII members. Constructive feedback on the specific resource can be collected through the comment section of the videos, and the members could potentially ask quick questions in the comment section that could be answered by either the community members or the CII staff.

The creation of a video repository would be a worthwhile investment of time and money for the CII, and it might be a gamechanger for the organization.

The researcher developed two short videos to showcase the potential of video as a platform. The videos can be found in Appendix C.
4.3 Use of Artificial Intelligence

To a vast majority of the human population, Artificial Intelligence (AI) might seem like a distant dream which could take decades to develop. That might be partly true, but the advent of artificial intelligence in our day-to-day lives has already begun, and it is now firmly embedded in our daily routines. Maps that compute the optimal driving route for a journey based on current traffic, smart song suggestions from the music application on your phone, friend recommendations, job recommendations, product recommendations based on your purchase history, are all powered by AI. Siri, Cortana and Google assistant are AI assistants that reside in our pockets, and in the recent years, they have improved exponentially (Deloitte, 2016). 2011 IBM Watson defeated the world’s two best players of the Jeopardy quiz show, while in March 2016 Google DeepMind’s AlphaGo defeated 18-time world champion Lee Sedol in a five-game match of Go.

Recently, an AI application called ROSS Intelligence was launched. The program is built on IBM’s Watson super-computer, and it has been designed to provide legal research for law firms (Turner, 2016). ROSS uses natural language processing and machine learning to search through the entire body of law to find relevant answers to legal questions. Legal professionals can ask ROSS a question as they would ask a colleague, after which it reads through the entire body of law to return an answer and topical readings from legislation, case law and secondary sources. In addition, the program continuously monitors the law and notifies if it finds new court decisions that can affect the case. (IBM, 2016)

Google, Microsoft, Apple and Facebook are currently heavily invested in deep learning and neural networks to develop systems that have the ability to read through documents and answers questions
(Murphy, 2015). Creation of intelligent database with artificial intelligence, can enable an interaction between the database and the users to ensure that the returned items (search results) contain the most relevant information possible. This is in contrast with the traditional database, where the mere presence of keywords and phrases in a referenced file does not guarantee that the contents of that file will be relevant in a given context (Rouse, 2015).

The use of Artificial Intelligence in developing an intelligent database which can answer specific questions and return relevant answers through the use of deep neural networks and machine learning can potentially result in an exponential increase in the usage of CII research products. Searching the database will become much quicker, easier, and efficient. Searches will produce relevant results which can be instantly used, rather than going through vast amounts of information to find the right answer.

For example, the use of Artificial Intelligence can help answer questions such as:

“How can I improve safety?” or “What are techniques to improve safety?”

Currently, the above question will either return no search results or produce a list of research documents on the CII search engine. With the application of AI, the search results would directly pull the list of 170 Safety Techniques from Appendix D of Publication 32-1, Zero Accident Techniques and present them to the user.

The application of artificial intelligence will revolutionize the way information is obtained. Its application to the CII database will make the research products more accessible for the end users and potentially increase the adoption and implementation of the CII Best Practices and other CII research products.
Currently, the application of Artificial Intelligence might come across as a far-fetched idea. However, technology is evolving faster than ever. Even though the concept of using Artificial Intelligence may seem impractical in the current environment, there is a possibility that further research might yield some potentially interesting results.

### 4.4 Summary

The development of a knowledge sharing program will enable information exchange between the member organizations, and enable the member organization to identify the existing gaps in the CII Best Practices implementation process. CII can potentially develop additional resources to address the gaps and facilitate the implementation process.

The development of a video repository can potentially lead to an increased understanding of the CII Best Practices. The videos might even generate greater interest for the CII Best Practice implementation amongst the member organizations. It is a simple yet effective solution that addresses the fundamental issue of incomplete understanding of the CII Best Practices. A future study on the impact of the videos on the implementation of the CII Best Practices might provide useful results.

The use of Artificial Intelligence is a long-term solution, which has a tremendous potential but requires further research. Research on how Artificial Intelligence can be applied to the CII database to generate more streamlined results should be further explored.
5 References


http://searchsqlserver.techtarget.com/definition/intelligent-database

Report No. CNO244MR. Timetric


APPENDICES
APPENDIX A: Survey Questionnaire
Promoting the use of CII Best Practices within the UMM Sector

The goal of this survey is to better understand the usage characteristics of CII Best Practices by the UMM sector, identify potential implementation barriers, and provide recommendations to promote greater use.

The specific objectives are as follows:
(1) Identify current best practices used by UMM sector member companies,
(2) Understand reasons/barriers if not using CII Best Practices,
(3) Assess the value of the CII Best Practices for the UMM sector,
(4) Determine the usefulness of the CII Knowledge Base, and
(5) Plan the next steps for achieving greater usage of CII Best Practices in the UMM sector.

The survey comprises two parts as follows:

**PART A** (to be completed by UMM Sector Committee Member):

1. **Company Information**: Gathers demographic information about your company.

**PART B** (to be completed by those most familiar with best practice use within your company)

1. **Current usage characteristics of best practices and implementation barriers**: Collects best practice usage (both CII and non-CII) information within the UMM sector and the barriers to implementation.
3. **Knowledge Base effectiveness**: Evaluates the effectiveness of the CII Knowledge Base for the UMM sector.

**PART C** (to be completed by UMM Sector Committee Member):

1. **Open Comments / Suggestions**: Provides thoughts on what should be done as the next step toward achieving greater use of CII Best Practices in the UMM Sector. Responses are based on findings from Part B.

Your participation in this study is voluntary. You have the right to be a part of this study, to choose not to participate or to stop participating at any time without penalty. There are minimal risks associated with participation in this research. The information in the study records obtained through the survey will be anonymous and confidential. Your participation will give us valuable information about the usage characteristics of the best practices and the results of the survey will potentially help us address the issues being faced by member companies in
implementation of the CII best practices and will increase the usage of the best practices within
the member companies.

Thank you for your time to complete this survey. For questions or additional information,
please contact Dr. Ed Jaselskis (ejjasels@ncsu.edu) (919)-515-1158 or Dr. Alex Albert
(alex_albert@ncsu.edu) (919)-515-7208.

By clicking I Agree, you consent that you are willing to answer the questions in this survey.

○ I agree
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PART A (to be completed by the UMM sector committee member)

Section 1: Company Information

A1.1 Which sub-sector(s) within the UMM sector does your company primarily operate in? (Select all that apply)
☐ Upstream
☐ Midstream
☐ Mining

A1.2 Type of company (Select all that apply):
☐ Owner
☐ Contractor
☐ Other (Please Specify) ____________________

A1.3 Approximately how long has your company been a member of CII? (Please specify the approximate number of years):
☐ 0 to 2 years
☐ 2 to 5 years
☐ 5 to 10 years
☐ 10 to 15 years
☐ 15 to 20 years
☐ More than 20 years

A1.4 What is the approximate annual revenue generated by your company? 
☐ less than $50 million
☐ $50 million to $100 million
☐ $100 million to $200 million
☐ $200 million to $500 million
☐ $500 million to $1 billion
☐ $1 billion to $5 billion
☐ $5 billion to $10 billion
☐ More than $10 billion
PART B
(to be completed by those most familiar with best practice use within your company)

Section 1: Usage characteristics of best practices and barriers to implementation

B1.1 Which of the following CII best practices are used by your company (check all that apply)?
☐ Advanced Work Packaging
☐ Alignment
☐ Benchmarking & Metrics
☐ Change Management
☐ Constructability
☐ Disputes Prevention & Resolution
☐ Front End Planning
☐ Implementation of CII Research
☐ Lessons Learned
☐ Materials Management
☐ Partnering
☐ Planning for Modularization
☐ Planning for Startup
☐ Project Risk Assessment
☐ Quality Management
☐ Team Building
☐ Zero Accidents Techniques

B1.2 Please list other best practices (non-CII) used by your company to more effectively plan and execute capital projects.
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
B1.3 Please rate the degree of implementation for each **CII Best Practice** used by your company (as selected in question B1.1)

*(Respond only for the best practices that are used by your company – as selected in question B1.1)*

---

**Advanced Work Packaging**

How many of your projects use Advanced Work Packaging?
- Few of them
- Most of them
- All of them
- Not sure

How much of the CII Best Practice body of knowledge on Advanced Work Packaging do you use?
- Some of it
- Most of it
- All of it
- Not sure

---

**Alignment**

How many of your projects use Alignment?
- Few of them
- Most of them
- All of them
- Not sure

How much of the CII Best Practice body of knowledge on Alignment do you use?
- Some of it
- Most of it
- All of it
- Not sure
Benchmarking & Metrics

How many of your projects use Benchmarking & Metrics?
- Few of them
- Most of them
- All of them
- Not sure

How much of the CII Best Practice body of knowledge on Benchmarking & Metrics do you use?
- Some of it
- Most of it
- All of it
- Not sure

Change Management

How many of your projects use Change Management?
- Few of them
- Most of them
- All of them
- Not sure

How much of the CII Best Practice body of knowledge on Change Management do you use?
- Some of it
- Most of it
- All of it
- Not sure

Constructability

How many of your projects use Constructability?
- Few of them
- Most of them
- All of them
- Not sure
How much of the CII Best Practice body of knowledge on Constructability do you use?
- Some of it
- Most of it
- All of it
- Not sure

Disputes Prevention & Resolution

How many of your projects use Disputes Prevention & Resolution?
- Few of them
- Most of them
- All of them
- Not sure

How much of the CII Best Practice body of knowledge on Disputes Prevention & Resolution do you use?
- Some of it
- Most of it
- All of it
- Not sure

Front End Planning

How many of your projects use Front End Planning?
- Few of them
- Most of them
- All of them
- Not sure

How much of the CII Best Practice body of knowledge on Front End Planning do you use?
- Some of it
- Most of it
- All of it
- Not sure
Implementation of CII Research

How many of your projects use Implementation of CII Research?
- Few of them
- Most of them
- All of them
- Not sure

How much of the CII Best Practice body of knowledge on Implementation of CII Research do you use?
- Some of it
- Most of it
- All of it
- Not sure

Lessons Learned

How many of your projects use Lessons Learned?
- Few of them
- Most of them
- All of them
- Not sure

How much of the CII Best Practice body of knowledge on Lessons Learned do you use?
- Some of it
- Most of it
- All of it
- Not sure
Materials Management

How many of your projects use Materials Management?
○ Few of them
○ Most of them
○ All of them
○ Not sure

How much of the CII Best Practice body of knowledge on Materials Management do you use?
○ Some of it
○ Most of it
○ All of it
○ Not sure

Partnering

How many of your projects use Partnering?
○ Few of them
○ Most of them
○ All of them
○ Not sure

How much of the CII Best Practice body of knowledge on Partnering do you use?
○ Some of it
○ Most of it
○ All of it
○ Not sure
Planning for Modularization

How many of your projects use Planning for Modularization?
- Few of them
- Most of them
- All of them
- Not sure

How much of the CII Best Practice body of knowledge on Planning for Modularization do you use?
- Some of it
- Most of it
- All of it
- Not sure

Planning for Startup

How many of your projects use Planning for Startup?
- Few of them
- Most of them
- All of them
- Not sure

How much of the CII Best Practice body of knowledge on Planning for Startup do you use?
- Some of it
- Most of it
- All of it
- Not sure
Project Risk Assessment

How many of your projects use Project Risk Assessment?
- Few of them
- Most of them
- All of them
- Not sure

How much of the CII Best Practice body of knowledge on Project Risk Assessment do you use?
- Some of it
- Most of it
- All of it
- Not sure

Quality Management

How many of your projects use Quality Management?
- Few of them
- Most of them
- All of them
- Not sure

How much of the CII Best Practice body of knowledge on Quality Management do you use?
- Some of it
- Most of it
- All of it
- Not sure
Team Building

How many of your projects use Team Building?
- Few of them
- Most of them
- All of them
- Not sure

How much of the CII Best Practice body of knowledge on Team Building do you use?
- Some of it
- Most of it
- All of it
- Not sure

_______________________________

Zero Accidents Techniques

How many of your projects use Zero Accidents Techniques?
- Few of them
- Most of them
- All of them
- Not sure

How much of the CII Best Practice body of knowledge on Zero Accidents do you use?
- Some of it
- Most of it
- All of it
- Not sure

_______________________________
B1.4 Please check all reasons and/or barriers that apply if some or all of the CII Best Practices are not used by your company.

☐ Not enough perceived value
☐ Incomplete understanding of the CII Best Practice
☐ No CII Best Practice champion in our company
☐ Not enough resources/manpower to implement the CII Best Practices
☐ The CII Best Practice(s) do(es) not align with company culture/values/operating procedures
☐ CII Best Practices are not customized to address the unique needs of the UMM sector or our company
☐ Not applicable to our line of business
☐ Other (please specify): _________________________________
PART B
Section 2. Value of the CII Best Practice for the UMM sector
(Please respond for each CII Best Practice)

B3.1 Please rate the value of the following CII Best Practice(s) from your company’s perspective.

Advanced Work Packaging
- Not at all valuable
- Somewhat valuable
- Moderately valuable
- Mostly valuable
- Highly valuable
- Don't know

Alignment
- Not at all valuable
- Somewhat valuable
- Moderately valuable
- Mostly valuable
- Highly valuable
- Don't know

Benchmarking & Metrics
- Not at all valuable
- Somewhat valuable
- Moderately valuable
- Mostly valuable
- Highly valuable
- Don't know
Change Management
○ Not at all valuable
○ Somewhat valuable
○ Moderately valuable
○ Mostly valuable
○ Highly valuable
○ Don't know

Constructability
○ Not at all valuable
○ Somewhat valuable
○ Moderately valuable
○ Mostly valuable
○ Highly valuable
○ Don't know

Disputes Prevention & Resolution
○ Not at all valuable
○ Somewhat valuable
○ Moderately valuable
○ Mostly valuable
○ Highly valuable
○ Don't know

Front-end Planning
○ Not at all valuable
○ Somewhat valuable
○ Moderately valuable
○ Mostly valuable
○ Highly valuable
○ Don't know
Implementation of CII Research
- Not at all valuable
- Somewhat valuable
- Moderately valuable
- Mostly valuable
- Highly valuable
- Don't know

Lessons Learned
- Not at all valuable
- Somewhat valuable
- Moderately valuable
- Mostly valuable
- Highly valuable
- Don't know

Materials Management
- Not at all valuable
- Somewhat valuable
- Moderately valuable
- Mostly valuable
- Highly valuable
- Don't know

Partnersing
- Not at all valuable
- Somewhat valuable
- Moderately valuable
- Mostly valuable
- Highly valuable
- Don't know
Planning for Modularization
○ Not at all valuable
○ Somewhat valuable
○ Moderately valuable
○ Mostly valuable
○ Highly valuable
○ Don't know

Planning for Startup
○ Not at all valuable
○ Somewhat valuable
○ Moderately valuable
○ Mostly valuable
○ Highly valuable
○ Don't know

Project Risk Assessment
○ Not at all valuable
○ Somewhat valuable
○ Moderately valuable
○ Mostly valuable
○ Highly valuable
○ Don't know

Quality Management
○ Not at all valuable
○ Somewhat valuable
○ Moderately valuable
○ Mostly valuable
○ Highly valuable
○ Don't know
Team Building
○ Not at all valuable
○ Somewhat valuable
○ Moderately valuable
○ Mostly valuable
○ Highly valuable
○ Don't know

Zero Accidents Techniques
○ Not at all valuable
○ Somewhat valuable
○ Moderately valuable
○ Mostly valuable
○ Highly valuable
○ Don't know
PART B
Section 3: Knowledge Base effectiveness for UMM sector members

You can refer to the CII Knowledge Base at: https://kb.construction-institute.org

B3.1 Overall how well does the CII Knowledge Base meet your needs?
   ○ Not well at all
   ○ Slightly well
   ○ Moderately well
   ○ Very well
   ○ Extremely well

B3.2 How easy was it to find the information that you were looking for?
   ○ Extremely difficult
   ○ Somewhat difficult
   ○ Neither easy nor difficult
   ○ Somewhat easy
   ○ Extremely easy

B3.3 Did it take you more time or less time than you expected to find what you were looking for?
   ○ Lot more time
   ○ Moderately more time
   ○ Little more time
   ○ As expected
   ○ Less than expected
B3.4 How likely is that you would recommend the CII Knowledge Base to others in the UMM sector?
○ Extremely likely
○ Somewhat likely
○ Neither likely nor unlikely
○ Somewhat unlikely
○ Extremely unlikely

B3.5 How would you rate the relevance of the information in the CII Knowledge Base to meet your company’s needs?
○ Extremely well
○ Very well
○ Moderately well
○ Slightly well
○ Not well at all

B3.6 Please provide suggestions related to improving the CII Knowledge Base:
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
PART C (to be completed by the UMM sector committee member after reviewing comments from Part B)

Section 1: Open Comments/Suggestions:

C1.1 As the next step toward achieving greater usage of CII Best Practices in the UMM Sector, what should be the next step(s) (select all that apply)?
- Conduct a pilot to customize one of the CII Best Practices to suit the UMM sector
  a) Please specify which one(s) to consider:
     ____________________________________________________________
     ____________________________________________________________

- Make changes to the CII Knowledge Base
  b) Please describe the necessary changes:
     ____________________________________________________________
     ____________________________________________________________
     ____________________________________________________________
     ____________________________________________________________

- Learn and share knowledge on how other companies successfully implement the CII Best Practices

C1.2 Please share any other ideas/thoughts/suggestions for the research team to consider:

___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________

88
Please click 'Submit' when you are finished.

The survey must be submitted by the Point of Contact (POC) only.

Please be advised that once you click the 'Submit' button, you will not be able to make any changes to the survey response. If you would like to review your response before submitting the survey or if you want to submit the survey on a later date, please close the window directly. Your progress will be saved.

○ Submit

----- End of Survey ------
Thank you for taking time out to participate in our survey.
We truly value the information you have provided.
APPENDIX B: Subcommittee members for survey development

Dan Gary  
*CCC Group*

Mike Matthews  
*Enstoa, Inc.*

Ray Simonson  
*CoreWorx*

Eddy Sparks  
*WorleyParsons*

Tom Taylor  
*The Williams Companies, Inc.*

Melissa Torbet  
*Occidental Petroleum Corporation*

Bennie Traylor  
*Anadarko Petroleum Corporation*
APPENDIX C: Sample Videos

Two sample videos were created to demonstrate the potential of videos. Video 1 is based on Zero Accident Techniques Best Practices, while Video 2 is based on research summary, RS 32-1 Zero Injury Techniques, which is a part of the Zero Accidents Techniques Best Practices.

Video 1: Zero Accident Techniques

Video 2: Zero Injury Techniques