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Project Lessons Learned: Implications for an Empirical Study in the Canadian Energy Sector

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Abstract: Oil and gas projects are complex and involve many participants from the engineering, contractor, and owner organizations. As a result, lessons learned may be done haphazardly at best. Not only do lessons learned help assess and improve project performance but they also enable project teams to share what they have learned and can help minimize similar issues on subsequent projects. This paper reviews the literature on lessons learned and relates the findings to the gaps in the project management field. The paper includes a conceptual framework on lessons learned and a design for a research study on upstream project lessons learned in the Canadian energy sector. The paper concludes with implications and study benefits.

1. Introduction

Lessons learned are like a losing football team watching the game film. It can be a very uncomfortable experience but players learn a lot to apply on the next game. With over 80 percent of workplace learning occurring informally versus formally, knowledge-based assets are sources of competitive advantage (Shani and Docherty 2003). We also know that companies can gain higher profits through inter-organizational cooperation (Dyer and Singh 1998) yet in a recent review of the North American construction industry, CEOs and academics concurred that the magnitude of capital projects contributed to the lack of integration between stakeholders and resulted in a fragmented industry (Bannan 2005). Inevitably, crucial knowledge that individuals, project teams, and organizations gain from a project is not always documented or communicated for subsequent use. Often, lessons learned are done superficially and resisted because of time and cost constraints, or because many departments/teams work in siloed environments. These factors contribute to increased project costs, extended schedules, scope creep, a lack of coordination and communication, considerable rework and costly mistakes.

Competitive costs are a reality of the volatile oil and gas industry. As improved project performance (e.g., cost, schedule, scope, success) is vital to many in the energy sector, our objectives are to examine several topics in this conceptual paper. We begin with an overview of energy sector projects and the challenges the industry faces from a project management perspective. Then, we present a critique of the literature on lessons learned and highlight several relevant theoretical foundations. Thereafter we briefly introduce readers to the design of a research study we are working on. We conclude the paper with recommendations for theory, research, and practice.

2. Energy Sector Projects

Upstream projects focus on oil and gas exploration and extraction. Spanning the engineering, procurement, and construction realms, energy sector projects are complex and involve multiple stakeholders and competitive costs (Cobb and Perla 1998). Oil and gas projects involve three key stakeholder groups: 1) *owner-operating firms* that contract their requirements to 2) *engineering firms*, who in turn, subcontract services to 3) *contractors.* During the front-end engineering and design phase, procurement, purchasing, and construction planning occurs, and estimates/schedules are developed. The execution phase involves the remaining engineering and design work along with the actual procurement, construction, transportation, installation, and commissioning, followed by the decommissioning and reclamation phases. Energy sector projects involve stage-gates where decisions are made on whether to advance to the next phase or not. Depending on the deliverables involved, different mixes of project teams are involved in these phases.

As the primary stakeholder, the owner wields the most power and sets out expectations in terms of project performance. However, the engineering firm and contractors also exert their power to ensure that they achieve their business priorities. Sometimes, stakeholder groups may be at odds with each other and have competing priorities, which can impact the degree of cooperation between stakeholders at the expense of joint goals. Most engineering firms have project management offices which help with project processes (Rad and Levin 2002) yet the owner may not have such offices because they are contracting the engineering firm to handle the project. This compounds matters in terms of consistent project management practices used across the project lifecycle, let alone lessons learned not being documented and communicated for reuse purposes.

On energy sector projects, the extent of knowledge sharing is impacted by the contracting arrangements between the primary stakeholder groups and the dynamics among these groups. The contracting arrangements can contribute to inter-organizational cooperation problems that negatively impact project performance. Since contractors and engineering firms do not enjoy the benefits of an employer-employee relationship, their allegiances to the owner (in the case of the engineering firm) and allegiances to the engineering firm (in the case of the contractors) can impact the degree of cooperation between the stakeholders at the expense of joint goals. Contract types (cost reimbursable, lump sum, and unit rate) impact the risk allocation strategy used and then drive the cost and schedule controls required on the part of the owners (Floyd et al. 2003). Contract strategies also impact the degree of cooperation between the stakeholders at the expense of joint performance goals. The bidding process further reduces profit margins. The industry lacks strong integration and comes across as very fragmented, in part because of the diverse stakeholders involved (Freeman 1984). There is a need for schedule integration between the firms involved as well as strong project controls that discourage unnecessary changes. Another challenge within the industry relates to training new workers, especially in light of staff turnover (Bannan 2005).

Considerable research in project management stems from the engineering and operations management disciplines. Large-scale projects use a variety of project management practices and each company involved brings its own tools, techniques, methodologies, and templates to the table, including project processes such as project reviews or lessons learned. Project performance can be evaluated with quantitative measures (on time, within budget, and within scope) as well as subjective satisfaction metrics. Success factors can be further grouped as those which relate to the project, project manager and team, organization, and external environment and critical success factors correlate to project performance (Belassi and Tukel 1996).

One study compared Construction and Research and Development projects (Pinto and Covin 1989). The study confirmed that some success factors were common to projects regardless of project type. For example, project mission was found to be important throughout the life cycle within both industries. However other success factors were specific to project groupings. For construction projects, the key predictors of success during execution were mission, schedule, client consultation and client acceptance. One implication is that different managerial approaches are warranted at different phases of the project. The other implication is that effective lessons learned can enhance project success.

As this overview indicates, project management challenges in the energy sector relate to a myriad factors, including but not limited to - managing stakeholders, competing priorities, the team mix, project management tools and techniques, risk, and contracting strategies. Little research exists on energy sector success factors and our study will address this gap in the context of lessons learned. In light of significant over runs on energy sector projects, we can make significant gains by determining what factors enhance lessons learned and relate to improved project performance. Since the industry is very competitive, improved project performance is a topic of interest to this sector. We support the view that project performance can be improved through the use of lessons learned activities.

As discussed in the next section, lessons learned offer numerous benefits ranging from satisfaction, improved project performance, knowledge sharing, and learning.

3. Lessons Learned Literature Review

Lessons learned involve discussing with the project team, what elements of specific project phases went according to plan, which parts could be improved on, and what plans are going to be put into place to address these matters before moving to the next phase. Most project management publications gave good overviews on the advantages of conducting lessons learned, the challenges involved in doing them, and practical findings from case studies and anecdotes. Despite the burgeoning field of literature on organizational learning (Easterby-Smith et al. 2000) and knowledge management (Spender 1996), very little has been applied to engineering. Furthermore, few of the project management papers addressed theories specific to lessons learned (Disterer 2002; Egbu 2004) or presented empirical works on the topic. As we present this literature review, we will draw some parallels to gaps in the literature that our research study will address.

Advantages of conducting lessons learned include improving customer satisfaction, improving process efficiency and effectiveness (Kamara et al. 2002), identifying best practices (Busby 1999), sharing project “know what” and “know how,” and helping companies remain competitive (Hyland and Beckett 2002). Barriers to lessons learned are similar to the barriers to effective knowledge management practices and include company culture (De Long and Fahey 2000), corporate amnesia/project amnesia (Schindler and Eppler 2003), resistance to learning from the mistakes of others, or not valuing lessons learned. Other barriers include the perception that “knowledge is power,” the “not invented here” syndrome or technophobia (Egbu 2004). Organizational and project structures can also be impediments to effective lessons learned as can virtual team environments. Contractual relationships can also constrain information sharing among participants. Furthermore, people may not have the skills or expertise to conduct lessons learned effectively (Schindler and Eppler 2003). Not only can learning opportunities be both structured and unstructured (informal), but sometimes, companies hinder informal learning though existing systems and processes. Companies may not value such exchanges, or staff may not necessarily seek the information and skills they need.

Organizational learning mechanisms are structures and processes used to “systematically collect, analyze, store, disseminate, and use information that is relevant to the performance of the organization and its members" (Shani and Docherty 2003, p. 16). Examples of engineering learning mechanisms include policies, management systems, project management methodologies, tools and techniques, physical and virtual work spaces practices, lessons learned, Project Management Offices, and project reviews. We propose that firms achieve improved project performance when they use learning mechanisms which go beyond the actual tools and techniques (as captured through codified practices) and when they use informal knowledge sharing practices (Shani and Docherty 2003). In our study, we will assess engineering learning mechanisms to corroborate the extent to which codified knowledge complements the use of tacit knowledge.

The knowledge management literature involves a stream of research on knowledge sharing. The more people one can tap into for help and advice the easier and faster one can get work done. Energy sector projects use variations of project management offices and communities of practice to knowledge that. Much of the knowledge that project teams have is codified (documented and stored in databases) but a lot of it is the know-how that they have developed through experience and practice, and it is hard to write down (tacit knowledge). Team members also share their knowledge informally, as per social capital theory. Social capital is based on mutual friendships, joint venture collaborations, business, and personal connections (Pennings et al. 1998).

Learning is both cognitive and behavioural and involves a feedback process. The lessons learned literature addresses cause-and-effect relationships and involves the use of root cause analysis to help improve practice. We found similarities in the literature as we examined factors influencing the learning curve and compared them to lessons learned. Oil and gas projects teams use quality improvement practices to address efficiency and effectiveness issues. These practices help improve learning and experience curves. The curves are based on quality improvement principles and plot units produced against unit costs to depict cost reductions for each doubling of output (as experience increases) (Lapré et al. 2000). Variables that positively influence the learning curve include labour efficiency (confidence, physical dexterity), standardization and methods improvements, better use of equipment, changes in the resource mix, value chain effects (whereby suppliers and distributors also ride the learning curve) (Louie 2002), and knowledge sharing.

Benchmarking studies can be invaluable to an industry for comparative purposes. Benchmarking provides performance targets and work processes to develop a baseline to work with (Cobb and Perla 1998). Cross-functional collaboration is essential to the effective application of benchmarking. We know that best practices in and of themselves, are not a source of competitive advantage because they simply identify "what" a company does. Project success criteria, performance metrics, and best practices will help develop appropriate energy sector project benchmarks. We did not come across benchmarking studies specific to lessons learned in the energy sector and this is a gap that our study will also address.

Faced with market challenges many companies cut costs, make process improvements, restructure, sell underperforming assets, and outsource non-core practices to remain competitive. Primarily, these practices address two facets of competitive advantage. On one hand, companies improve operational efficiencies and effectiveness to remain viable, that is, they achieve a temporary competitive advantage (Porter 1996). These practices are not effective over the long term because they can be copied by competitors. On the other hand, companies focus on their core competences (Hamel 1994) and dynamic capabilities (Teece et al. 1997) to remain competitive and develop sustained sources of advantage. These practices can be effective over the long term.

According to the Resource Based View from Strategy, sources of sustained competitive advantage primarily stem from practices that are valuable (in economic terms), rare (unique), inimitable (hard to copy) and involve more organizational support (management support) (Barney et al. 2001). "Dynamic capabilities…integrate, build, and reconfigure internal and external competencies to address rapidly changing environments" (Eisenhardt and Martin 2000, p. 1106). The product development literature indicates that cross-functional teamwork is vital for superior products. Mistakes play a role as well. Successes may not engage managers' attention to learn from experiences and large failures may entail defenses that block learning. On the other hand, a moderate number of small mistakes can lead to superior skills in acquisitions. Interestingly the majority of organizational assets that are sources of competitive advantage are knowledge-based. This relates to our premise that "how" oil and gas project lessons learned are conducted and the knowledge shared, along with what is learned from mistakes, can contribute to a company being more successful relative to competitors.

In the course of our review of the literature, we also came across some publications that went beyond descriptive summaries or case studies on lessons learned and integrated the main themes into frameworks. Primarily, the components of the lessons learned frameworks drew from the quality improvement literature, benchmarking concepts and strategy in terms of factors within the firm as well as the environment (Sypsomos 1997). The American Productivity & Quality Centre as well as other publications used a benchmarking framework based on plan, collect, analyze and adapt (Garvin 1993; Kotnour 1999; O'Dell et al. 1999). The framework involved four enablers to the process - strategy and leadership, technology, culture, and measurement (O'Dell et al. 1999). Several other frameworks related to external benchmarking as benchmarking helps companies change practices, identify new ones and determine best practices to see what might be realistically possible (Hyland and Beckett 2002). The Balanced Score Card (Stewart 2001) was another framework used on lessons learned. Several classifications on lessons learned were based on: people, processes, and technology; organizational, technical, methodological, and social (Disterer 2002); and psychological, team, knowledge-utilization, and managerial (von Zedtwitz 2003). Specific to the construction industry, Egbu used an internal and external environment assessment model (Egbu 2004) based on demographics, technology, socio cultural, ecological, political/legal, and economic macro environmental categories. This is similar to the general framework from strategy that consists of the categories legal, economics, societal expectations, environmental concerns, and competition. Another framework that drew from strategy was Porter's value chain and it was applied as a knowledge management framework by several authors (Lee and Yang 2000; Lytras and Pouloudi 2003). And finally, Mamara used a four factor framework consisting of structure, policies, resistors, and enablers (Kamara et al. 2002)

Our assessment of the project management literature was that some of the papers covered the literature of theories specific to lessons learned (Disterer 2002; Egbu 2004; Kotnour 1999; Kotnour and Kurstedt 2000). The majority of project management papers provided practical suggestions on lessons learned and discussed the results of case studies including anecdotal best practices. For example, Kerzner used the project management maturity approach to project management offices and discussed how the offices could take on increasing roles of responsibility in relation to lessons learned (Kerzner 2003). We found that the literature in knowledge management and organizational learning was more rigorous in terms of learning concepts that could be applied to project management.

Based on our assessment of the literature and discussions with industry, we identified several gaps in the literature that our study will address over the project lifecycle: a) oil and gas project best practices; b) oil and gas project critical success factors; c) engineering learning mechanisms; d) advantages and barriers to lessons learned; and e) project performance metrics. These concepts will help us ascertain the relationships between the variables that influence or mediate effective lessons learned so that we can develop a lessons learned framework. These concepts will also help us create a survey instrument.

4. Proposed Research Study on Lessons Learned In the Energy Sector

Based on some of the gaps in the project management literature on lessons learned and the interest from several national oil and gas companies on this research topic, we are in the process of finalizing a study design. We propose to use the following conceptual framework for the study. The overall goal of this research would be to identify the variables that contribute to improved lessons learned as well as the relationship between lessons learned and project performance. Our focus is on upstream projects.

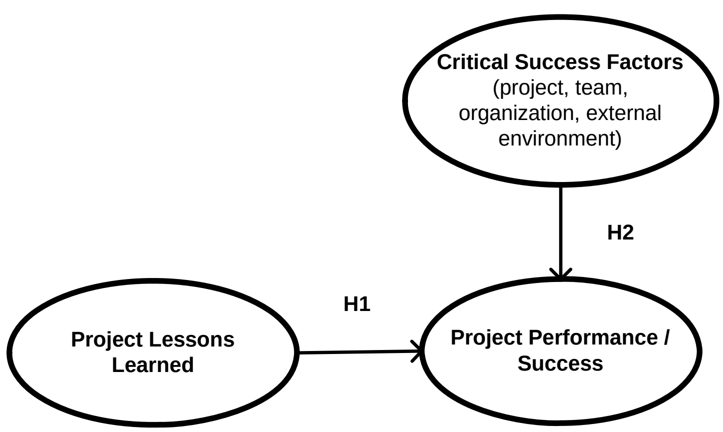

Figure 1: Theoretical Framework on Lessons Learned and Project Performance

Our study hypotheses follow:

H1: Project lessons learned positively predict project performance
H2: Critical success factors positively predict project performance

In the above model, we use ovals to show latent (unobservable) variables. Our dependent variable of interest is project performance. Our independent variables are project lessons learned and critical success factors. As we develop an improved understanding of the concepts and how to measure the constructs, the proposed relationships as depicted with the arrows will change in our final path model. We plan to gather data using survey questions to focus on the concepts behind these latent variables. Based on the literature, we propose that there are relationship between the concepts of organizational culture, stakeholders, contractual arrangements, formal knowledge sharing, informal knowledge sharing, and social capital and lessons learned. Although we cannot present these relationships using hypotheses, we will use exploratory factor analysis to help us discern which constructs are highly correlated with lessons learned. Our specific objectives for the study by Phase are to:

1. **Phase 1**: Use the theoretical model (Figure 1) to investigate the factors contributing to project performance/success by interviewing participants in a cross-section of energy sector companies in Canada and through focus group sessions. We will also use the Delphi technique with a large random sample of energy sector professionals to achieve consensus on the main themes identified through the interviews.
2. **Phase 2**: Use the main factors from the interviews and Delphi to operationalize the constructs for a large-scale web-based survey of Canadian companies in the energy sector. We will use the survey analysis (exploratory factor analysis and multivariate analysis) to develop a path model portraying the relationships between the factors and project management performance. We will use focus group techniques to validate the final path model and study findings with companies.

At this point in time, we are in the process of securing ethics approval for Phase 1. In Phase 1, we plan to conduct 60 semi-structured interviews with experienced upstream project participants. We will identify participants using the snowball technique whereby we will start with a core of experienced professionals we know and ask them for the names of other experienced individuals. The interviews will span the project lifecycle of oil, gas, and oil sands projects and will help identify best practices. We will do these interviews in Alberta because Alberta is a strong economic contributor to the Canadian energy sector. A preliminary set of questions for our interviews follows:

- What kind of projects do you primarily work on (type, size, and phase)
- What does project success look like to you?
- What does the term “project critical success factor” mean to you?
- What are some project critical success factors on your project?
- How do these critical success factors impact the project?
- What is a memorable project war story that you can share with me? What did you learn from this experience? In what way was this important to the project, organization, or your own personal learning?
- What does the term “best practice” mean to you?
- Please describe some of the best practices you have used or observed used on the project. How was this a best practice? How did the practice impact the project?
- What does your company do well on projects?
- What do you do on a project that is different from what your competitors do?
- What project management practices could be improved at your company?
- What does the term “lessons learned” mean to you?
- What value does a lesson learned serve?
- What are some of the reasons lessons learned are not done well at your company?
- How could lessons learned activities be improved at your company?
- What are some lessons learned best practices that you are familiar with?
- Is there anything else you would like to share with me on these topics?

Once the interviews are transcribed, we plan to use textual analysis software such as Atlas-ti® to examine the data and code it for key words and themes. As we review each transcript and relate the codes to the themes to the literature, we will create a qualitative framework on lessons learned. This analysis will also help us develop questions to use in our Delphi.

Following the interview analysis, we will develop and conduct a three-part online survey using the Delphi method. The Delphi method is aimed at achieving consensus on topics and can be highly effective in generating new knowledge (Bickman and Rog 1998). In this phase we will also focus on upstream project personnel. We will administer the survey to participants using mailing lists from oil and gas / engineering associations. This approach will allow us to control the sample population from which we draw our participants and it will help us control for non-response bias. Our unit of analysis will be the individual providing perceptual data on project experiences, particularly “horror” stories as negative project experiences are a useful way to develop best practices. In Part 1 of the Delphi survey, participants will provide input on the top lessons learned in each project phase (initiation, planning, execution, and closeout) for oil, gas, and oil sands projects. We will then analyze the findings and create aggregated lists grouped according to topic. In Part Two of the survey, participants will review the lists and prioritize the items. We will then analyze the findings and create prioritized lists. In Part Three, participants will be given an opportunity to indicate that they agree with the overall prioritized lists and they will be given an opportunity to clarify their differing viewpoints on the lists.

In Phase 2, we plan to use Phase 1 findings to develop a survey instrument. We will develop a web-based survey and administer it to participants selected using mailing lists from petroleum and engineering associations in Canada. This approach will allow us to control the sample population from which we draw our participants and it will help us control for non-response bias. Our unit of analysis will be the individual providing perceptual data on upstream project experiences. We will distribute the survey to 4,000 participants of which we estimate that a subset (n=400, 10%) will consent to participate and comprise our population of interest. To minimize retrospective bias, we will ask participants to respond to the survey in the context of projects within the past year. We will conduct the Delphi at two to three month intervals as we will need time to analyze the data and develop the next part of the Delphi questions.

We plan on engaging graduate engineering students in the study as research assistants. In Phase 1, students will learn how the university research ethics process works and develop an appreciation for the steps taken to ensure confidentiality and anonymity. Students will assist with interview instrument and Delphi instrument development including pilots. They will learn the importance of pre-testing instruments and conducting validity and reliability checks, and the importance of planning a study well. Students will participate in conducting the interviews, Delphi, and they will help with data analysis. This will give them experience with textual analysis software such as Atlas-ti® and they will learn how to develop survey items using the literature and interview/Delphi findings. In Phase 2, students will help us develop the quantitative survey instrument. Students will assist with the pilot and they will help us determine a sample population using mailing lists. Students will learn how to conduct a web-based survey. They will also learn how to develop a data dictionary, conduct some data entry, clean a large data file and conduct statistical analyses. These experiences will help them appreciate how time consuming and methodical data collection/analysis can be as one of the best ways to learn data analysis is by practicing with real data. Throughout the study, students will assist with writing reports and academic publications.

5. STUDY IMPLICATIONS AND PAPER CONCLUSIONS

The main theoretical implication of our paper is that we found the project management field to be lacking in terms conceptual papers on lessons learned. In the project management literature, we also found that there was a dearth of empirical papers on lessons learned that used a theoretical foundation. We did however find that there were useful frameworks on project success that we could adapt for our research (e.g. Pinto, Belassi). Our assessment indicated that by drawing from the knowledge management, organizational learning, and strategy fields, we can identify valuable concepts for our empirical study on lessons learned in the energy sector. For example, we plan to examine relationship between the concepts of organizational culture, stakeholders, contractual arrangements, formal knowledge sharing, informal knowledge sharing, and social capital and lessons learned. Our study will therefore contribute to theoretical frameworks on lessons learned.

From a research perspective, our study will make a contribution to the project management field on an important topic. We anticipate contributing to the field by explaining the relationships between the variables that influence or mediate effective lessons learned. The project is also valuable because it will improve our understanding of the relationship between effective lessons learned and project performance.

Practically, our study will help identify best practices within the energy sector so that improved inter-organizational project performance can be achieved. The study will contribute to the development of industry standards. We will also develop benchmarks to improve project productivity and address issues that currently contribute to reduced project efficiencies and effectiveness. This study will help identify lessons learned triggers that impact low project performance and help enhance the competitive advantage of petroleum engineering projects by enabling them to align stakeholders, project management practices, knowledge sharing practices, and critical success factors. Our research will also deliver an integrated framework on lessons learned. Benefits to the scientific/engineering discipline are that engineering project lessons learned span technology, innovation, design, construction, installation practices, and operations management so these topics will also be addressed. Innovation and technology are key to how we will address efficient and effective oil and gas production in light of depleting reserves and the limitations of existing technologies.

Upstream energy sector projects are complex undertakings and there is much work to be done to improve practices in terms of efficiencies and effectiveness. This research will help foster collaboration between industry and academia, focus on a relevant topic to the energy sector, and help improve how lessons learned are done, which in turn, will help improve project performance. Improved lessons learned can also enable project teams to share what they have learned and can help minimize similar issues on subsequent projects. To summarize, this paper provided a short overview of the energy sector followed by a literature review on lessons learned, including advantages and challenges. The paper also presented a conceptual framework on lessons learned that we plan on testing empirically in 2006. We look forward to sharing empirical findings from Phase 1 of this study in 2007.

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