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Full Length Research Paper

Alberta Project Performance in Phases 1 And 2: Cost and Scedule Analysis of CII/COAA Database of Alberta Industrial and Pipeline Projects

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Construction Owner Association of Alberta (COAA) and Construction Industry Institute (CII) in collaboration with the University of Calgary conducted a research investigating Alberta project performance. This collaboration was performed in two phases and resulting findings are stated in COAA data base system. This paper analyses the data collected in phases 1 and 2 projects with a view to improve project performance in Alberta. A qualitative research methodology was employed in investigating the project performance. Interviews were conducted with industry practitioners, which contained open - ended questions. The research found that in comparison, the construction cost growth in phase 1 and phase 2 of projects executed in Alberta show higher average construction cost growth in phase 2. The project schedule growth in phases 1 and 2 shows higher average schedule performance in phase 1 than phase 2. This method has the potential to contribute to a reduction in cost and schedule overruns and improves project performance. It is concluded that the comparison of phases 1 and 2 performance in the COAA database system can provide a guide to company to improve project performance in Alberta and possibly in Canada.

Keywords: COAA database, industrial projects, performance and improvement, schedule performance, cost performance

INTRODUCTION

Alberta industrial and pipeline projects are divided into five types, which include upstream and downstream oil and gas, natural gas, pipeline and well site projects. The benchmarking of Alberta projects phase 1 began in 2005 – 2009 and phase 2 in 2010 – 2014 for continuous performance improvement. This paper provides new insights to the results of Alberta's heavy industry sector projects performance. The paper discusses the Alberta project cost growth, project schedule growth, construction

cost growth and engineering completed before construction started in both phases 1 and 2 in the Construction Owners Association of Alberta (COAA) database.

In the COAA database, 17 industry partners provided project data for the analysis. These industry partners include owner (industrial and pipeline) and contractor organizations that initiated a total of 73 Alberta projects in the benchmarking system in the phases 1 and 2. Forty –

three of the 73 projects in this study were related to the Oil Sands sector, Pipeline (14), Natural Gas Processing (3), Oil and Gas Exploration/production (4), Cogeneration (3), Tailing (3), Gas Distribution (1), Oil Refining (1) and Other Heavy Industry (1) sectors.

In the database, about 39% of the projects used a parallel prime delivery method in project performance. Average project cost growth for the Alberta projects in phase 1 are higher than phase 2. On average, phase 1 projects experienced 17.6% project schedule growth, while phase 2 projects experienced 13.7% project schedule growth, respectively. The relationship between percent engineering completed before construction started and construction phase cost growth was established. The paper directly addresses many common perceptions regarding capital major project performance in Alberta.

Background

Alberta construction industry comprises of heavy, light, building and infrastructure. It contributes significantly to Alberta economy and employs more than 300,000 people. The sector is made up of 26,400 businesses that together generate annual revenues of \$78 billion (Alberta Industry, 2012). In 2007, over 240,000 people were engaged in the development of the oil sands resources in Alberta (OSDG, 2008). In fact, construction comprised 9.0% of Alberta's gross domestic product (GDP) in 2007 (AFE, 2008) and increased to 10% of the province's GDP in 2012 (Alberta Industry, 2012). Spending on the Athabasca Oil Sands resource in particular rose to \$37.7 Billion (CDN) in 2007 (*ibid.*). The production of Alberta oil is projected to triple to 3 million of barrels a day by 2015 (Dunbar, Strogran, Chan. and Chan, 2004).

However, this dramatic amount of growth has also brought its challenges. Increasing pressures on capital projects have been created due to significant worldwide cost escalations and labour shortages. This has led to the creation of many perceptions regarding the potential loss of productivity or excessive indirect costs and cost overruns. A common problem relating to the cost and schedule overruns on large oil and gas projects is the lack of proper management of scope, quality, and materials (Jergeas and Ruwanpura, 2009).

In order to reduce the cost and schedule overruns in Alberta industrial and pipeline projects, benchmarking of projects will provide necessary platform to improve performance. Benchmarking is defined as the continuous and systematic process of measuring one's own performance against the results of recognized leaders for the purpose of finding best practices that lead to superior performance when implemented (Nasir et al, 2008). Typically, benchmarking looks at output (results) of a project resulting in lag benchmarks (Anderson and McAdam, 2004). It is a measurement that can be used as

a point of reference for comparative purposes to other organizations. It helps companies to understand what they could be doing better and is a continuous performance improvement tool (Alstete, 2008). It helps in budgeting and planning and is regarded as one of the simplest tools for effective performance improvements (Williams et al, 2012). In the capital projects industry, benchmarking is primarily used at the project level to help participants identify gaps in their work processes, which lead to compromise performance (Brunso, 2003). The only way to truly and objectively know whether or not project execution is improving is through continued measurement (Jergeas, 2008). Benchmarking is a measurement that can be used to continue to improve Alberta projects.

Hierarchical Structure of Alberta Project Types

The hierarchical structure of Alberta project types (levels 1, 2 and 3) can be seen in Table 1 below. According to COAA (2009), Alberta projects are divided into five types (level 1), which include upstream and downstream oil and gas, natural gas and pipeline projects. Level 1 project type is also further broken down to a second level (level 2). For example, upstream oil and gas is divided into oil sands Steam Assisted Gravity Drainage (SAGD) and oil sands mining. This was done for data comparison and analysis purposes.

Projects in the COAA Benchmarking Database

Table 2 shows 73 Alberta-based projects that were established in the Alberta benchmarking system in phase 1 and 2. By the end of December 2009, a total of 26 projects were submitted in phase 1. In phase 2, 17 COAA member companies initiated a total of 47 projects in the database. This includes 10 owner companies and 7 contractors. A trend in phase 2 projects is the increase in the number of pipeline, SAGD and well site projects (Oil and Gas Exploration) being completed accompany by the decrease in the number of oil sands upgrading projects being completed.

RESEARCH METHODOLOGY

There are three principal research approaches that can be employed in the social sciences, namely qualitative, quantitative and mixed methods (Creswell, 2003, Field, 2005). The qualitative methodology was employed and is considered to be the most appropriate strategy in the context of this study for collecting data on Alberta capital project performance. Lincoln and Guba (2000) described the qualitative research approach as an enquiry process of comprehending a social or human problem

Table 1. Hierarchical Structure of Alberta Project Types. Source: COAA (2009)

Level 1	Level 2	Level 3
Upstream (Oil Production) Exploration/	Oil Sands SAGD	Cogeneration
		Central Plant Processing Facilities
		Pad and Gathering
	Oil Sands Mining/ Extraction	Oil Sands Mining
		Central Plant Processing Facilities
Downstream	Oil Sands Upgrading	Naptha Hydrotreater Unit
		Hydrogen Plant
	Oil Refining	Utilities and Offsite
Natural Gas	Natural Gas Processing	
Pipelines		
Well Sites / Well Pads		

Table 2. Submitted Projects by Project Type at Completion and in Progress

Project Types	Number of Projects			In Progress		
	Phase I	Phase II	Total	Phase I	Phase II	Total
Oil Sands SAGD	11	6	17		5	22
Pipeline	2	12	14		1	15
Oil Sands Upgrading	6	2	8		2	10
Cogeneration	1	2	3			3
Oil and Gas Exploration		3	3		1	4
Oil Sands Mining/ Extraction	2	1	3		4	7
Tailing		3	3			3
Natural Gas Processing	2		2		1	3
Other Infrastructure		2	2			2
Electrical Distribution		1	1			1
Gas Distribution	1		1			1
Oil Refining	1		1			1
Other Heavy Industrial		1	1			1
Total	26	33	59		14	73

phenomenon based on building a complex holistic picture formed with words, reporting detailed views of informants and conducted in a natural setting. Patton, (1990), Walker (1997) and Creswell (2003) further described qualitative methodology as explanatory in nature with the principal aim of trying to unearth answers to how? and why? Questions. The method can be used to better understand and to gain new perspectives on issues about which is already known such as COAA benchmarking system. The quantitative approach was not adopted because it would not be sufficient in this case with limited number of oil and gas projects in Alberta. For the purpose of this research, the authors consider qualitative methodology as more suitable to explore the COAA benchmarking system.

Data Collection

Data were collected from the COAA/CII database for analysis. In the COAA database, 17 industry partners

entered 73 projects in the database and 59 projects were completed from the 73 initiated projects. The data concerning general project information, budget, schedule, change orders, rework, safety, and practice use, engineering and construction productivity on the 59 projects in the COAA database were used. In addition, semi-structured interviews were conducted. Interviews were conducted with 17 (seventeen) benchmarking managers, benchmarking associates, estimators, project control analysts, project managers and engineers. The interview was structured, open-ended, and was conducted face to face with experts in the construction industry and oil and gas fields. This technique, which was usually semi-structure, attempts to draw out expert knowledge and elicit gaps from an interviewee (Chapman, 2001).

RESEARCH FINDINGS

This section presents statistical analysis using box and

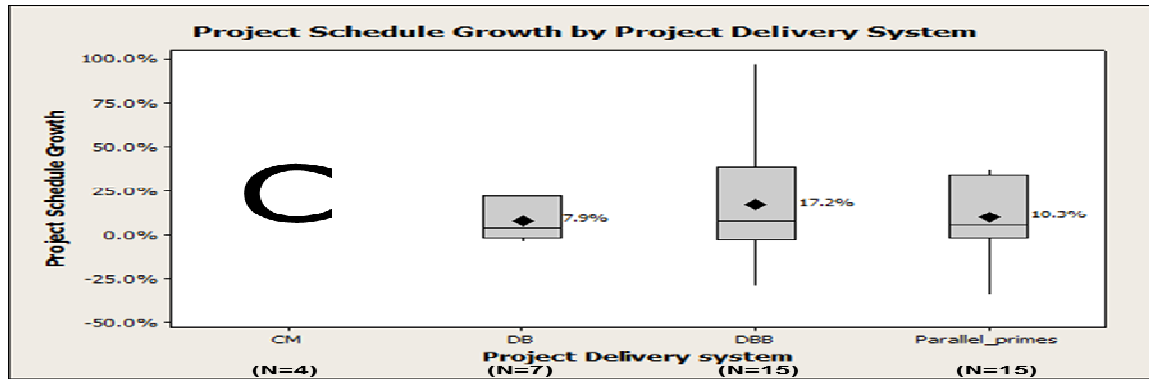


Figure 2. Project Schedule Growth by Project Delivery Systems
Construction Cost Growth by Phase

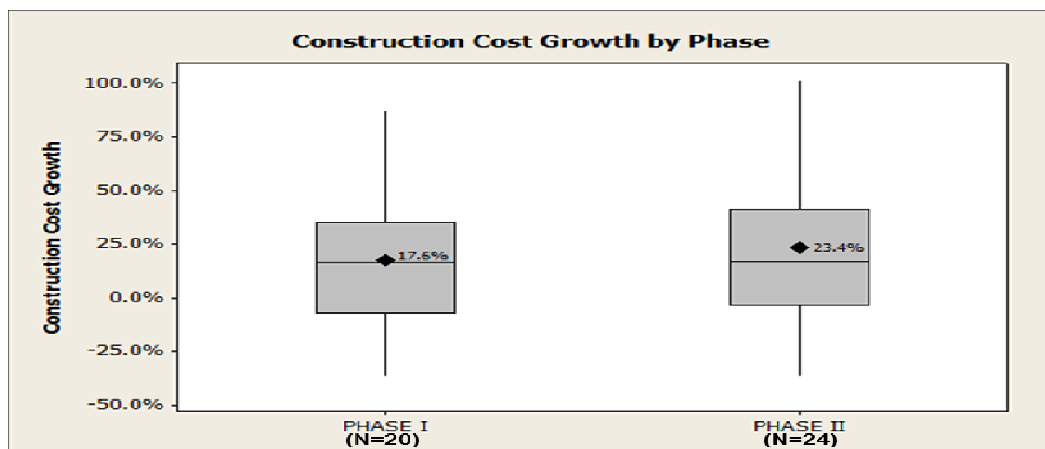


Figure 3. Construction Cost Growth

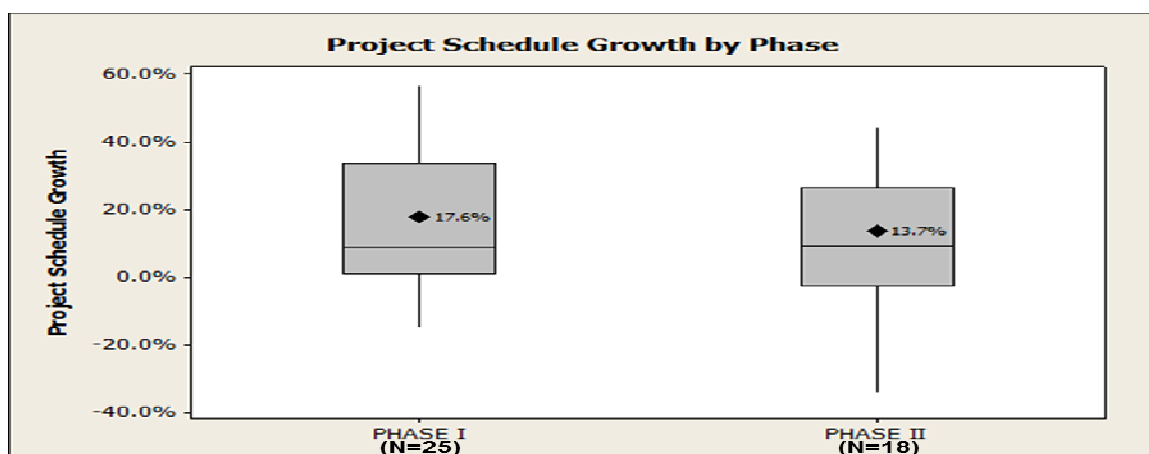


Figure 4. Project Schedule Growth

whisker plots statistical techniques to analyze projects residing in the COAA databases. The box and whisker plots incorporate a variety of test statistics including

analysis of variance (ANOVA) techniques, depending on the number of comparison groups and distribution of sample variances (Agresti and Finlay, 1999).

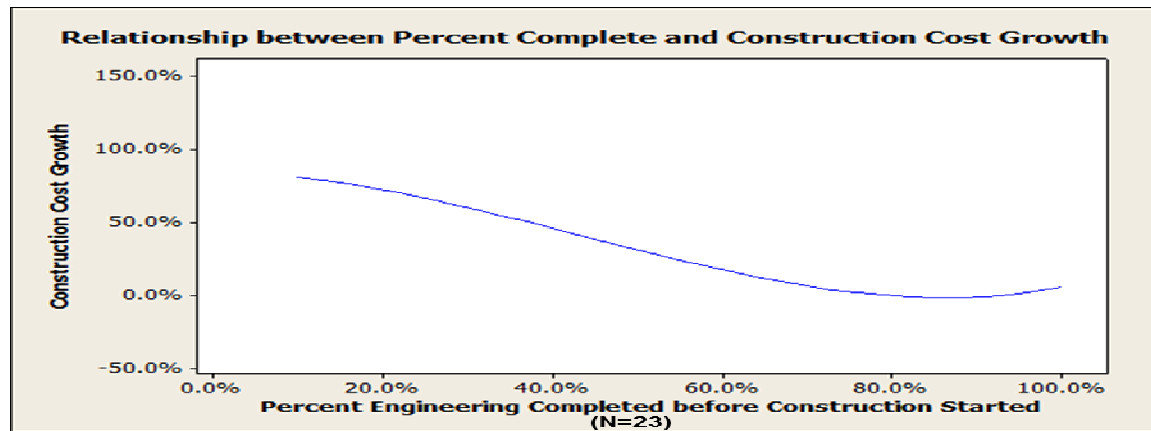


Figure 5. Construction Cost Growth

Project Performance by Project Delivery Systems

Figure 1 compares the effectiveness of design build delivery and all other project delivery methods combined by cost and schedule growth, respectively. The research found that about 39% of the projects in the Alberta benchmarking database used a parallel prime delivery method. Other project delivery methods included traditional design/bid/build (D/B/B), design/build (D/B), multiple parallel primes and construction management (CM).

As shown in Figure 2 below, projects with design-build delivery system have shown smaller schedule growth as compared to other delivery systems. Although this sample is small, the trend to cost being the main driver over schedule is emerging. Parallel primes (N=15) are most popular delivery method for oil and gas projects in Alberta.

Construction Cost Growth by Phase

Figure 3 compares the construction cost growth in phase 1 and phase 2 of projects executed in Alberta. Results show higher average construction cost growth for the Alberta projects in phase 2. These projects also demonstrate that a much wider range of performance exists as well. On average, phase 1 projects experienced 17.6% project cost growth, while phase 2 projects experienced 23.4% cost growth, respectively.

Project Schedule Growth

Figure 4 compares the project schedule growth in phase 1 and phase 2 of projects executed in Alberta. Results show higher average schedule performance for the Alberta projects in phase 1 than phase 2. These projects

also demonstrate that a much wider range of performance exists as well. On average, phase 1 projects experienced 17.6% project schedule growth, while phase 2 projects experienced 13.7% schedule growth, respectively.

Percent Engineering Completed before Construction Started

The relationship between percent engineering completed before construction started and construction phase cost growth can be seen in Figure 5. Figure uses a cubic polynomial pattern due to the fact that as more design is completed before construction begins, the project tends to have less construction phase cost growth. Thus, an optimum value is found at approximately 85% engineering complete. The results are also statistically significant, meaning that a strong relationship exists between the percentage of engineering completed prior to construction start and construction phase cost growth ($R^2 = 0.43$, $p = 0.001$). Likewise, the results also demonstrate a statistically significant correlation with $r = -0.657$, $p = 0.000$.

DISCUSSION OF THE RESULTS

The analysis of phases 1 and 2 of projects executed in Alberta revealed the project performance between 2006 – 2009 and 2010 – 2014 respectively. Interestingly, there is distinct change in the delivery of projects in Alberta in phase 1. The trend indicates that companies seem to be moving from parallel prime methodologies in phase 1 to design bid build methodologies in phase 2. These results show a slight advantage to the use of parallel prime over other delivery methods with respect to project cost, but not with respect to project schedule (in which case design

build projects show a slightly better performance). This finding is interesting, as it appears to suggest that the companies are now using design bid build delivery method for Alberta industrial and pipeline projects.

It can be observed that there are significantly higher average cost growth for the Alberta projects in phase 1 than phase 2. Perhaps this may be an indicative of the fact that the COAA benchmarking systems are being used by trained benchmarking associates to improve project performance in the industrial and pipeline projects. It can be inferred from these results that these projects also demonstrate a much wider range of performance. The relationship between percent engineering completed before construction started and construction phase cost growth was established. The project tends to have less construction phase cost growth. Thus, an optimum value is found at approximately 85% engineering complete. The results are also statistically significant, meaning that a strong relationship exists between the percentages of engineering completed prior to construction start.

In the analysis of the Phase1 and Phase 2 data, some of the project performance metrics are indicating that there is a significant project performance improvement in the Alberta due to COAA benchmarking program. Implied in these results is a tacit recognition that if companies adopt benchmarking for project performance improvement, there will be less cost and schedule overruns in Alberta industrial and pipeline projects.

CONCLUSION

Benchmarking can be recognized as a core component of continuous improvement programs in the capital projects industry in Alberta. The approach will provide the participating companies with a systematic process to measure project performance, enable external comparisons with peers' projects, and establish project objectives. The system can identify areas for Alberta construction projects process improvement.

In comparison of Alberta projects in the COAA database, the construction cost growth in phase 1 and phase 2 of projects executed in Alberta show higher average construction cost growth for the Alberta projects in phase 2. The project schedule growth in phase 1 and phase 2 shows higher average schedule performance for the Alberta projects in phase 1 than phase 2. The relationship between percent engineering completed before construction started and construction phase cost growth is found to be statistically significant. This means that a strong relationship exists between the percentage of engineering completed prior to construction start and construction phase cost growth. ($R^2 = 43.1$, $p = 0.001$). Likewise, the results also demonstrate a statistically significant correlation with $r = -0.657$, $p = 0.000$.

This benchmarking method has the potential to contribute to a reduction in cost and schedule overruns and improves Alberta project performance. The comparison of Alberta phases 1 and 2 project performance in the COAA database system can provide a guide to company to improve project performance in Alberta and possibly in Canada.

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