International journal of management and economics invention
||Volume||1||Issue||07||Pages-356-366||Sept-2015|| ISSN (e): 2395-7220
www.rajournals.in DOI : 10.18535/ijmei/v1i7.02

Development Of New Metrics For Benchmarking Steam Assisted Gravity Drainage (Sagd) Projects In Alberta Oil And Gas Industry

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ABSTRACT

In Alberta, oil & gas industry is the driving economic force for economy. The trend of growth in oil and gas sector in Alberta has created tremendous economic opportunities but has also posed a number of challenges, including less than anticipated performance during the construction of project. The success of this energy sector can be improved by improving the project performance of SAGD projects. The research reviewed and analysed project performance and proposed new metrics in addition to the COAA existing metrics to benchmark SAGD projects. A qualitative research methodology was employed in investigating the project performance. Interviews were conducted with industry practitioners, which contained open - ended questions. The result found and proposed 9 metrics in addition to the COAA existing metrics specifically to benchmark SAGD projects effectively. This method has the potential to contribute to a reduction in cost and schedule overruns and improves SAGD project performance. It is concluded that the results of the study will help in achieving a higher rate of productivity in the Alberta oil and gas industry.

Key words: project performance, benchmarking, metrics and SADG improvement

INTRODUCTION

Benchmarking looks at output (results) of a project resulting in lag benchmarks (Anderson & McAdam, 2004). It is regarded as one of the simplest tools for effective performance improvements (Williams etal, 2012). Construction benchmarking facesmany challenges include incomplete or non-existent data(Mohammed, 1996).Future project performance measurement should be based upon sound benchmarking system(Aminah, 2006). Construction benchmarking will be successful if consistent methods of measuring performance are developed and used(Mohammed, 1996). Adopting and implementing the right practices is essential to attaining world-class performance (Saunders, 2008).

The paper focuses on the development of new metrics tobenchmark SAGD projects in Alberta oil and gas industry to improve project performance. The paper discusses the COAA existing metrics in order to develop additional specific metrics for SAGD projects,which would be very beneficial to project owners and the EPC contractors in effectively executing and completing their projects on time and within budget especially SAGD projects. It further discusses in details SAGD process in Alberta oil and gas industry.It presents qualitative analysis of the data on SAGD projects metrics. It concludes that the results of the study will help in achieving a higher rate of productivity in the Alberta oil and gas industry.

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BACKGROUND

Construction industry contributes significantly to Alberta economy and employed more than 231,300 people. The sector is made up of 26,400 businesses that together generate annual revenues of over $78 billion and comprised 10.5% of Alberta's gross domestic product (GDP) in 2013 (Alberta Industry, 2014). The Alberta oil and gas which is part of the industry production is projected to triple to 3 million of barrels a day by 2015 (Dunbar, Strogran, Chan. & Chan, 2004).In terms of composition, the oil sands are a combination of bitumen (heavy oil), sand, andwater (Gaviria, Santos, & Rivas, 2007).According to Almoor (2010), 80% of these oil sands deposits in reservoirs contain oil that is deeper than 75 meters below the earth's surface, making it extremely difficult to mine at such depths. Consequently, in situ, or "in place", extraction methods have been developed over time, and has become a predominant method in Alberta to recover the oil from the reservoirs (CAPP, 2009a). Among the numerous in situ extraction methods currently available, such as Cyclical Steam Stimulation (CSS), Vapour Extraction (VAPEX), Toe to Heel Air Injection (THAI), and others, the Steam Assisted Gravity Drainage (SAGD) method has proven to be a reliable technology (Alnoor, 2010).

Due to the depth of oil sands in Alberta, SAGD is future technology for the upcoming projects. SAGD is a relatively new method of oil extraction and recovery but the number of new SAGD plants in Alberta is expected to increase within this decade (Government of Alberta, 2009/2010).The trend of significant growth in oil and gas sector in Alberta, has created tremendous economic opportunities but has also posed a number of challenges, including less than anticipated performance during the construction of project (Aminah, 2006). Considering that many recent large oil & gas projects in Alberta have had significant cost overruns (Jergeas, 2008), a great deal of attention will be focused by project owners, contractors, suppliers, and academia on how to make the project management of SAGD projects more effective.

SAGD PROCESS

In the SAGD process, a pair of wellbores is drilled into the oil sands reservoirs (Alnoor, 2010). As shown in Figure1 below, these two pipes are horizontally parallel to each other. High - pressure steam is injected in the pipe, which is sitting above the other pipeline. Injected steam heats up the reservoir, which eventually melts the bitumen. This melted bitumen is collected by gravity into the second horizontal pipe and stored in the huge tanks.This process has proven to be an economically proven process to extract heavy oil from the reservoirs that are deeper than 75 meters below the surface of the earth (Alnoor, 2010).

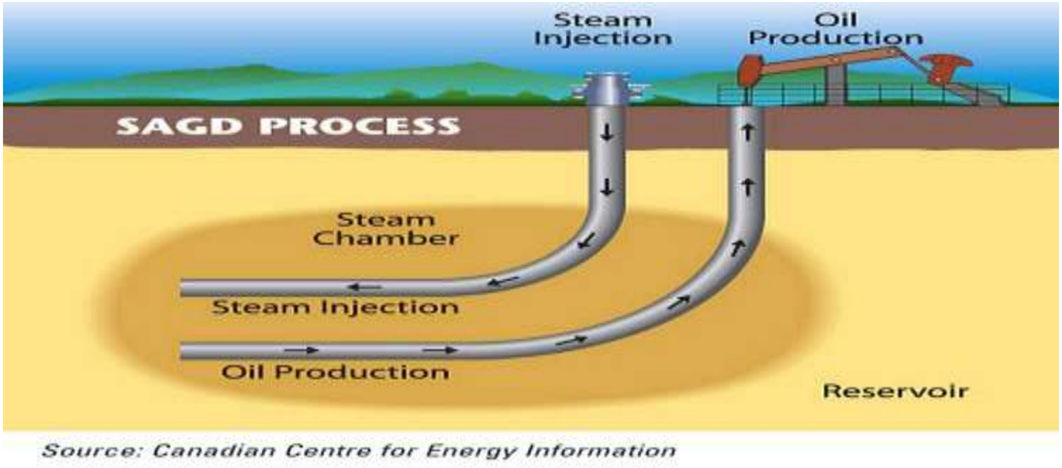

Figure 1. SAGD Project Process: Source: Alnoor (2010)

As shown in Figure 2 below,The SAGD project consists of following main components:

- Central Processing Facility (CPF) includes the facilities to process and treat the produced bitumen and produce solvent steam.
- Well Pads is the bases of the injection area. Each well pad has several well pairs which is combination of injection and production wells. Through the injection wellheads steam is injected into reservoir; from the production well-produced bitumen is sent to surface and collected in tank in tankage area.
- Source and disposal water wells as the name indicates well from where raw water is taken to produce the steam. After bitumen production, some portion water mixed oil cannot be further used and this water is disposed off in the disposal water wells.
- Offsite pipeline and services includes the pipelines running between the SAGD central plant and the well pads. These pipelines are used to transport steam from CPF to well pads and produced product from well pads to CPF.
- Utilities include power lines running from CPF plant to well pads or wells or vice versa.

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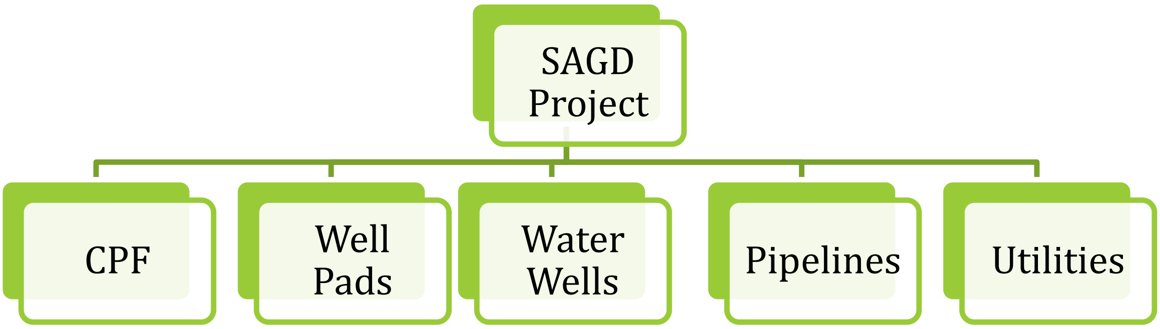

Figure 2. SAGD Project

METRICS

Metrics are defined as ratios of work hours (WH) to quantities (CII, 2008). The metrics in the COAA benchmarking system are visually displayed in quartiles in reports and graphs. The visual display is enhanced through the use of a colour code for the four quartiles as demonstrated in Figure 3.

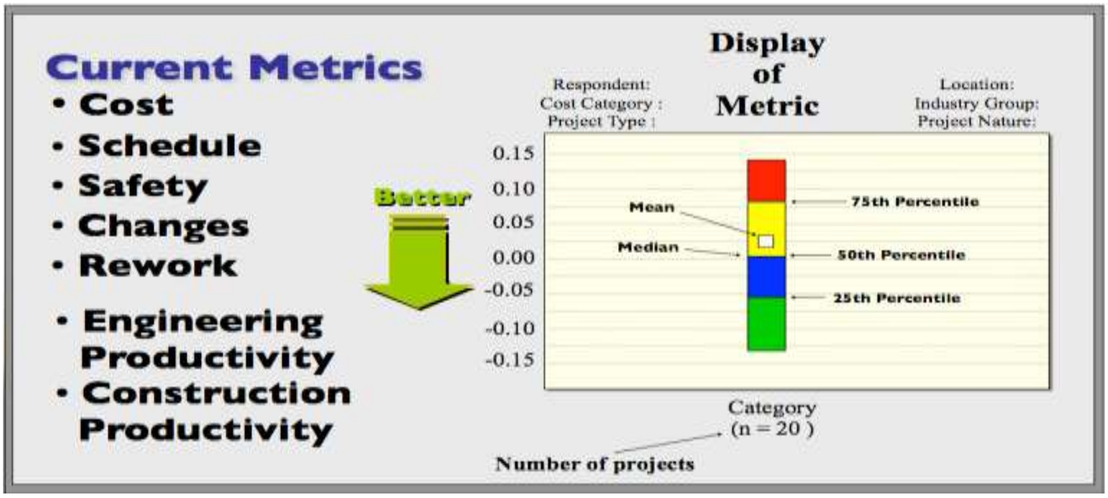

Figure 3: Visual Display of Quartiles. Source: COAA (2008)

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The COAA established a benchmarking database of capital projects that has been in operation since 2006, allowing COAA members to assess the performance of their projects against projects in their industry. COAA members input cost, schedule and safety data and engineering and construction information into the benchmarking system at two specific times in the project life cycle, namely sanction (budget) and completion (actual). The system utilizes this data to calculate metrics that can be further analysed to assess project performance and engineering and construction productivity.

COAA-SPECIFIC METRICS

The benchmarking system includes additional COAA-specific metrics to quantify Alberta project performance and productivity. Many of these additional metrics relate to indirect and direct construction costs, mechanical and equipment costs, scaffolding work hours, the use of offsite modules, as well as various workforce metrics. The additional metrics were developed to evaluate suspected major causes of cost overruns and schedule delays common to large projects (Flyvberg et al, 2003; COAA 2008). Despite the introduction of these metrics to improve performance on sites, limitations still exist. The limitations are reflected in its application to assess SAGD project performance These limitations prompted the initiation of key report and data miner that were undertaken by COAA/CII (Construction Industry Institute) aimed at understanding the causes of cost and schedule overruns.

It is suggested that a proper understanding of these metrics is critical to the development of appropriate methods to compare SAGD projects performance that will reduce the causes and consequently cost and schedule overruns. AlthoughCII have tried to develop metrics for Alberta construction industry and how these can improve project performance,there is a need to develop additional metrics for SAGD project performance. The rate of projects performance through the data collected from the COAA database provide a compelling justification to search for improved methods of SAGD projects by developing new metrics specially tailor to Alberta oil and gas projects.

Despite the fact that Alberta companies involved in SAGD projects have a benchmarking system, there is insufficient data contained in the current benchmarking database. According to Aminah (2006) collecting historical data is not sufficient and suggested that future project performance measurement should be based upon the sound benchmarking system.Using benchmarking system for improving project performance can reduce the cost overruns for the successful execution of oil & gas projects with a focus on benchmarking SAGD projects.

RESEARCH METHODOLOGY

There are three principal research approaches that can be employed, namely qualitative, quantitative and mixed methods (Creswell, 2003). The qualitative methodology was employed and is considered to be the most appropriate strategy in the context of this study for collecting data. Lincoln and Guba (1985) described the qualitative research approach as an enquiry process of comprehending a social or human problem phenomenon based on building a complex holistic picture formed with words, reporting detailed views of informants and conducted in a natural setting. Walker (1997) and Creswell (2003)

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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 metrics 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 metrics to benchmark SAGD projects.

DEVELOPMENT OF QUESTIONNAIRE

The questionnaire was designed primarily to elicit information from participants in Alberta oil and gas industries on benchmarking SAGD projects so that metrics can be identified for a better performance. Some of these personnel chosen are shown in figure 4 below and have average of 24 years experience in the oil and gas industry. They are mostly responsible for project performance in their respective organizations and also are knowledgeable on issues concerning COAA systems.Semi-structured interviews were conducted to assess the effectiveness and use of existing system. Interviews were conducted with these personnel from 17 construction and oil and gas industries in Alberta. The interviewees were chosen from owner, engineering, procurement and construction (EPC) companies.

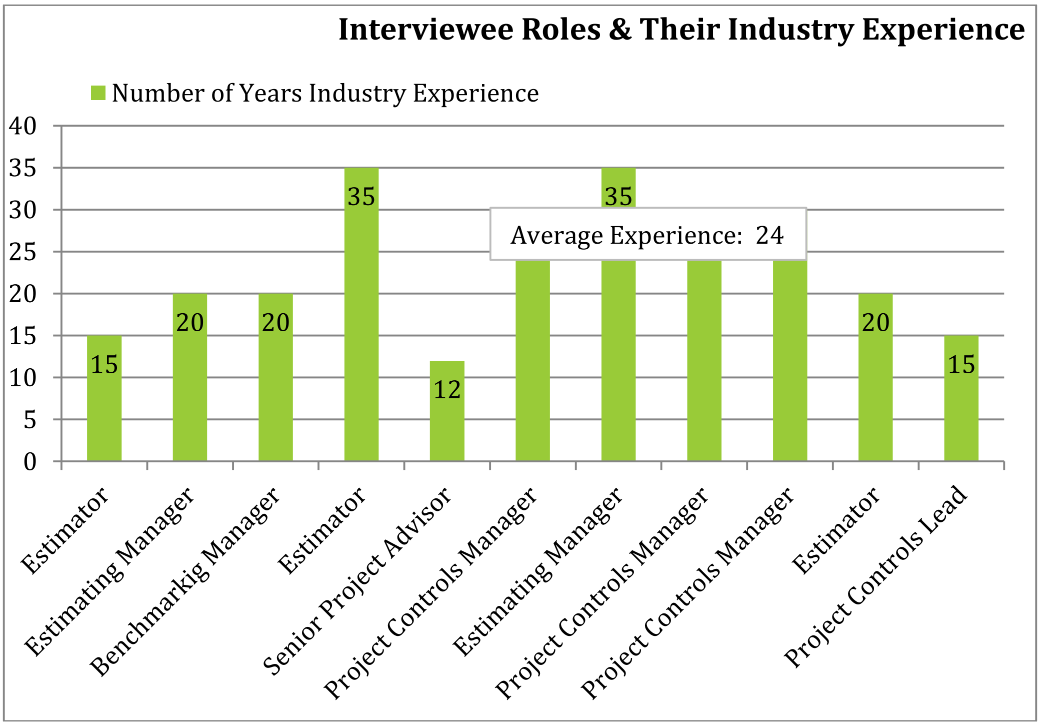

Figure 4: Experience related to SAGD projects

RESEARCH FINDINGS

As the result of the interviews, 52 metrics were identified and 9 are proposed to specifically benchmarking SAGD projects.

Research & Analysis Journals

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Listed below are the identified 52 metrics.

1. Designed SOR/Actual SOR (Steam Oil Ratio)
2. Well Pairs/Well Pad
3. Produced Water Reuse
4. FEL Phase Hours / Total Eng. Hours
5. Direct Hours/Indirect Hours
6. Average duration per Facility (facility means, CPF, Pipeline)
7. Cost of CPF/Barrel
8. Shop Fabrication Cost/Total Project Cost
9. Average Cost of Well Pair
10. Pipeline Cost/Km/Diameter-inch
11. Utilities Cost /barrel, required definition of utilities
12. Owner Cost for Project Management/Barrel
13. Total CPF Cost/Equipment Cost
14. Total Site Work Hours / Capacity of Plant (Barrels)
15. Engineering Cost/ Capacity of Plant (Barrels)
16. Project Cost/Capacity of Plant (Barrels)
17. Total Equipment Cost / Facility, Facility: (CPF, Well Pad, Gathering & Distribution lines Utilities)
18. Total Engineering Cost / Facility
19. Total Fabrication Cost / Facility
20. Total Construction Cost including Fabrication / Facility
21. Equipment Cost/ Mechanical Equipment Costs
22. Total Engineering Cost / Total Field Cost
23. Total Cost of Bulk Material / Total Equipment Material Cost
24. Total Direct Labor Cost / Total Direct Labor Hours
25. Total Indirect Labor Cost / Total Indirect Labor Hours
26. Total Direct and Indirect Labor Costs / Total Direct and Indirect Labor Hours
27. Percent of Modularization hours to Total Direct Field Hours
28. Engineering Cost per hour- FEL Phase
29. Engineering Cost per hour- Detail Engineering Phase
30. Temporary Construction Facilities Cost / Total DFL Hours & S/C Hours
31. Construction Management & Support Staff Cost / Total DFL Hours & S/C Hours
32. Total Indirect Cost / Total DFL & S/C Labor Cost
33. Cost of Safety/Project Cost
34. Total Field Rework Factor (Fabrication): Fabrication Rework / Fabrication Cost
35. Total Field Rework Factor (Construction): Construction Rework / Construction Cost

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36. Changes ($)/ Total Project Cost (For Construction Phase)
37. Changes ($)/ Total Project Cost (For Fabrication Phase)
38. Engineering Hours/Direct Field Hours
39. FTE Planned/FTE Actuals; Full time Equivalent
40. Percentage of Engineering Completion prior to Issuance of P.O for all Long Lead Items.
41. Percentage Quoted Equipment at the end of FEED Phase
42. Average pipe rack cost (Hrs/Ton, $/Module/Kg, Dia/Cost/Tonn)
43. Cost/Module for Equipment & Pipe racks
44. Fab Cost/Total Project Cost
45. Average pipe rack duration
46. Average fabrication cost for building (Not equipment)
47. Shipping Cost/Tone
48. No. of Fab Module Required/Total Modules Required
49. Modularization Cost/ (Modularization Cost + Direct Field Costs)
50. Modularization Cost per Hour
51. Peak Manpower/Average Manpower
52. Commission Cost/Construction Cost

In order to improve construction industry and specifically SAGD project performance, this study proposed 52 new metrics. From this 52 metrics, 9 metrics are specifically for SAGD projects while 43 are not SAGD specific but are general metrics for project performance. The 9 specific metrics for SAGD projects are Shop Fabrication Cost/Total Project Cost, Designed SOR/Actual SOR (Steam Oil Ratio), Well Pairs/Well Pad, Produced Water Reuse, Average duration per Facility (facility means, CPF, Pipeline), Cost of CPF/Barrel, Average Cost of Well Pair, Total CPF Cost/Equipment Cost and Total Equipment Cost/Capacity/Facility (CPF, Well Pad, gathering & Distribution lines utilities).

DISCUSSIONS

In order to improve SAGD project performance, this study identified 52 metrics and proposed 9 new metrics in addition to the COAA existing metrics. It is suggested that these proposed metrics can contribute to a decline in cost and schedule overruns in the Alberta oil and gas industry. Although, the analysis revealed that there are significant COAA existing metrics. The development of new metrics can be greater important to improve SAGD projects performance in addition to the existing metrics. This, therefore, makes a compelling case for encouraging Alberta oil and gas industry to take necessary steps in applying these metrics as these would lead to improvement of SAGD projects performance that they may not aware of. Implied in these results is a tacit recognition that if new metrics are developed to benchmark SAGD projects, there will be reduction in cost and schedule overruns.

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Given the importance of the project performance of Alberta oil and gas industry, this finding suggests the need to adopt the proposed metrics in addition to the existing COAA metrics to benchmark SAGD projects to improve project performance in the Alberta oil and gas industry. This will provide the desirable project performance to raise confidence in reducing costs and schedule overruns.It was revealed that the existing metrics are not sufficient to benchmark SAGD projects because of cost and schedule overruns in the industry. These results imply that further metrics on SAGD projects will improve project performance. They also imply that an additional metrics is associated with extra performance of Alberta oil and gas industry.

CONCLUSION

The paperdiscussedthe SAGD process, SAGD project, which consists of central processing facility (CPF), well pads, source and disposal water wells, offside pipelines and utilities. The metrics in the COAA benchmarking system that are visually displayed in quartiles in reports and graphs are also discussed.It presented the data analysis and made it possible to specify the kinds of metrics to which can be used to improve SAGD project performance. The results of the analysis showed that theidentified 52 metrics and proposed 9metrics considered that could contribute to decline in cost and schedule overruns in Alberta oil and gas industry. Similarly, analysis was employed to evaluate the unique contribution of metrics to SAGD projects. These analyses were aided by the use of data analysis computer programme, SPSS and Microsoft excel.

ACKNOWLEDGEMENT

The authors would like to thank Natural Sciences and Engineering Research Council of Canada (NSERC), Construction Owners Association of Alberta (COAA), Construction Industry Institute (CII) and COAA contributing members for providing financial support, data and guidance.

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||Volume||1||Issue||07||Pages-356-366||Sept-2015|| ISSN (e): 2395-7220
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