Journal of Natural Gas Science and Engineering 39 (2017) 44–53

Contents lists available at ScienceDirect

Journal of Natural Gas Science and Engineering

journal homepage: www.elsevier.com/locate/jngse

Development of industry performance metrics for offshore oil and gas project

Zhenhua Rui [a, *], Chaochun Li [b], Fei Peng [c], Kegang Ling [d], Gang Chen [a], Xiyu Zhou [a], Hanwen Chang [e]

[a] University of Alaska Fairbanks, USA
[b] Southwest Petroleum University, China
[c] China University of Petroleum, Beijing, China
[d] University of North Dakoda, USA
[e] Nexen, USA

ARTICLE INFO

Article history:
Received 30 October 2016
Received in revised form
25 January 2017
Accepted 28 January 2017
Available online 1 February 2017

Keywords:
Oil and gas project
Offshore project
Performance evaluation
Performance metric
Project management

ABSTRACT

Historical records on the performances of global offshore oil and gas (O&G) projects show that most did not meet industry expectations; therefore, there is a significant need to provide an effective evaluation system for offshore O&G projects to identify project deficiencies and improve project performance. Considering their unique characteristics, a set of two-dimensional industry metrics were developed to evaluate offshore O&G projects across five categories: cost, schedule, safety, production, and quantity. The project data and the results of a survey taken by industry experts were used to validate the credibility of the metrics. In addition, the drivers of each metric are discussed or verified with first principle and were confirmed by industry experts. Finally, the practice for using these metrics is recommended. In other words, with the characteristics of offshore O&G projects taken into account, these metrics will be verified so they are perceived as an efficient tool to evaluate project competitiveness and identify gaps for project performance improvement.

1. Introduction

Offshore hydrocarbon production is a major source for meeting the global energy demand. Offshore hydrocarbon projects have produced about 30% of the world's oil production and 27% of world gas production since 2000 (Maribus, 2014). Numerous hydrocarbon offshore projects have been developed in the Gulf of Mexico, North Sea, West Africa, Western Australia, etc., but the average water depth of these offshore projects has increased from 650 ft to 13,000 ft since the 1950s (Maribus, 2014). In addition, the offshore projects are moving farther away from the land. For example, the Libra offshore project in Brazil is 125 miles away from Rio de Janeiro. The capital investment for individual O&G projects has, therefore, increased significantly to develop more and more challenging oil fields. The largest completed offshore project, the Gorgon project in Australia, cost more than $57 billion, which more than doubled the estimated cost (Meyers, 2014). However, these global offshore projects have not performed well. More than 60% of the projects experienced a cost overrun of 33% or more, schedule delays of 30% or longer, and lower than expected hydrocarbon production (Merrow, 2012). As the data show, improving offshore O&G capital project efficiency is critically needed. The project performance metric is a tool for senior management or project teams to measure project outcomes and identify gaps for future improvement. Compared to capital projects in other industries, offshore O&G projects have many different and unique characteristics, such as a larger project size, higher number of scopes, higher complexity, etc. In general, offshore O&G projects tend to be significant in terms of their capital size. So called “multi-billion dollar offshore O&G megaprojects” are common in Industry today. Typical offshore projects also usually have a larger number of subscopes, such as well, subsea system, production system, transportation system, etc. These individual project subscopes are also quite large with costs in the hundreds of millions of dollars. As such, these individual project subscopes are usually implemented or managed by multiple contractors. To develop offshore O&G projects, a large project team is formed that is comprised of various functional

* Corresponding author.
E-mail address: zhenhuarui@gmail.com (Z. Rui).

http://dx.doi.org/10.1016/j.jngse.2017.01.022
1875-5100/

groups, including geology, geophysics, reservoir engineering, drilling, completion, subsea engineering, production engineering, pipeline, procurement, construction, plug and abandon, etc. In addition to the large number of scopes and functional groups, a significant amount of new technologies are employed to overcome the technical challenges from the nature of the O&G resources, such as the deep water field, high pressure and high temperature reservoir, etc. Furthermore, regulatory requirements and/or the political climate can significantly influence the performance of O&G projects. All of these factors combined affect offshore O&G projects and lead to higher project complexity and significant interfaces compared to projects in other industries. Many general metrics or evaluation systems have been developed or proposed to evaluate typical projects, but they are not well fitted for measuring the performance of O&G offshore projects due to their unique characteristics. Thus, developing a distinct metric system to better evaluate the performance of O&G offshore projects is highly recommended.

2. Background

Performance metrics are an important element of a project evaluation system, which is often used to benchmark project performance from different perspectives. Many researchers have recognized the importance of performance metrics and conducted studies or developed metrics for measuring project performance. Cox et al. (2003) developed six key metrics for evaluating project performance: quality, cost, schedule, unit cost, hourly rate, and safety. Yeung et al. (2007) created a weighted composite indicator with seven key metrics that considered the cost, schedule, management, communication, and technology performance. Ling et al. (2009) found that management practices affect project performance significantly, so it developed seven major performance indicators. Luu et al. (2008) found that execution cost, execution schedule, safety, customer response, product quality, project team, and management turnover are the key metrics for evaluating the performance of large contractors. Rankin et al. (2008) proposed metrics based on capacity in addition to the typical cost, schedule, safety, and quality metrics. Almahmoud et al., (2012) tested six key metrics across a number of cases for identifying project performance weaknesses. These authors developed a wide range of general metrics, including cost, schedule, quality, safety, customer satisfaction, productivity, profitability, sustainability, communication, innovation, unit cost, staff, functions, etc. Some authors have developed metrics that consider the project phases. Shohet (2006) proposed 11 performance metrics for the operations and maintenance phase, including asset development, organization, and maintenance efficiency metrics. Haponava and Al-Jibouri (2009) designed metrics for the planning phase, including objective alignment, client engagement, a development plan, and scope changes. Yun et al. (2016) developed performance metrics for five project phases, from front-end planning to startup/commissioning, including capacity based on efficiency metrics, relative growth metrics, FTE-based staffing metrics, procurement metrics, and safety metrics. Wegelius-Lehtonen (2001) examined key indicators for the procurement phase, including activity metrics based on improvement measurement and cost and quantity metrics based on monitoring measurement. In addition to metrics for the different project phases, very few researchers have also developed specific metrics for certain industries or projects to account for their unique process. Osborne (1996) and Bender (1996) identified some development cost metrics for pharmaceutical facilities, but these were based on a limited sample size. Hwang et al. (2010) developed hierarchical structural metrics for evaluating pharmaceutical projects. The 50 metrics designed were grouped into cost, schedule, and dimension and used to collect 40 pharmaceutical projects, and then validated by industry experts from major companies. The Construction Owners Association of Alberta (COAA) and Construction Industry Institute (CII) worked together to develop a benchmarking system for Canadian oil sands projects that covered cost, schedule, changes, rework, safety, and productivity, and then identified 12 Best Practices for improving oil sands project performance (COAA, 2009). Chanmeka et al., (2012) employed oil sands metrics to identify relationships between metrics and project characteristics. A total of 37 Alberta oil and gas sand projects were analyzed to quantify the effect of the project characteristics. Ikpe et al., (2014) developed an additional 52 new metrics for benchmarking steam-assisted gravity drainage (SAGD) oil sands projects, 9 of which are specific to SAGD oil sands projects (e.g., steam oil ratio, water reuse, and well pairs/well pad). In addition to the tradition metric approach, many researchers conducted simulations to evaluate oil and gas production performance from a perspective of geology, geophysics, and petroleum engineering (Li et al., 2005; He et al., 2016; Sun et al., 2016; Zhao et al., 2016; Ren et al., 2016; Wang et al., 2017). Recently, some researchers have developed quantitative indices to evaluate shale gas production performance (Ou et al., 2016; Zhao et al., 2015a, 2015b; He et al., 2016; Hu et al., 2016; Hu et al., 2017). Some of these metrics were used or tested for project evaluation and have brought value into project performance improvement. Considering the special characteristics of O&G projects, a customized set of metrics or indictors is highly recommended for oil and gas project evaluation. However, there is a lack of offshore O&G project evaluation metrics in the public domain. Based on the historical poor performance of offshore O&G projects, a more significant research effort is needed to improve O&G offshore project performance and the development of performance metrics is critically needed. In this study, we attempt to design industry standardized metrics that consider the hierarchical structure of offshore O&G projects, the project phases, and the project characteristics. All of these metrics were examined and validated by project data collected and industry experts with tremendous experience in offshore O&G project development. The objective of this study is to identify key factors affecting O&G offshore project performance and an effective design performance metric frame for benchmarking offshore O&G projects.

3. Research method

The existing knowledge of offshore O&G project metrics is very limited. After an exhaustive search, this appears to be the first research around developing performance metrics for offshore projects in the public domain. In the first stages, we gathered as much project performance information possible with the goal of understanding offshore O&G projects. For example, there are a good amount of engineering papers supporting the fact that well measure depth is a key factor in determining the well cost and duration (Cochener, 2010). We reviewed many technical and project management research papers and reports to identify factors affecting offshore O&G project and project subscope performance, such as water depth, capacity, weight, pipeline length, pipeline diameter, measured drill depth, etc. The objective of the first stage is to understand offshore O&G projects and identify the drivers of project performance using public literature and provide material for the second stage of work involving interviews with industry experts.

The second stage involves interviewing industry experts. Based on the first stage, the exploratory research and literature review, we designed an interview form to create a foundation for collecting information on evaluating offshore O&G projects. This interview questionnaire includes a series of questions regarding the