APPLICATION OF PRODUCTION MANAGEMENT IN INDUSTRIAL EPC AND MINING PROJECTS IN PERU

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ABSTRACT

Projects in the industrial EPC and mining sectors of the construction industry share common characteristics such as complexity and size, high levels of interdependency between multiple stakeholders, remote and disperse geographical locations, and in many cases, extreme weather conditions. The combination of these characteristics creates production environments in which variability abound hampering performance, causing delays, and reducing quality and safety levels. Ensuring the successful delivery of industrial and mining projects then requires new ways of working that support the identification and reduction of variability mainly from sources such as materials supply, engineering, and site operations. Traditional project management practices are not enough to identify, reduce, and buffer the remaining variability in support of performance improvement efforts.

This paper proposes how to adopt production management to complement existing project management practices for industrial EPC and mining projects in order to achieve better results in terms of schedule reduction and productivity improvement through variability management. The paper presents case studies on the application of production management techniques for this type of projects including results and lessons learned. This paper is a joined effort between Graña y Montero (GyM), the largest general contractor in Peru, and Strategic Project Solutions (SPS), leader in the development of solutions for the improved management of capital projects.

KEY WORDS

buffers, EPC, industrial, mining, planning, production management, variability

INTRODUCTION

Owner operators recognize capital projects as the means for achieving business objectives. In today's marketplace where increments in oil, gas and mineral prices are the rule rather than the exception, capital investments become critical and riskier undertakings needed to maintain competitive advantage in the market. In the oil and gas sector alone, the pressure to increase production levels has released an unprecedented wave of capital spending estimated to have exceeded $230 billion worldwide in 2006 (McKenna et al. 2006). While capital investments in mining and industrial projects are continuously increasing, these industries are witnessing many cases of project

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delays and cost overruns. Oil and gas owner operators are dissatisfied with project management performance (McKenna et al. 2006). The authors propose that one of the main root causes of this problem is the fact that planning and control (and optimization processes if they exist) do not consider input from those executing the work day in, day out - those directly involved in production. Therefore, traditional project management practices are insufficient to ensure project success in these working environments.

This paper proposes the deployment of production management solutions (customized strategies, effective processes, enabling tools, and capable people) as a complement to project management practices for industrial Engineering-Procurement-Construction (EPC) and mining projects in Peru. The authors believe that the ideas presented herein also apply for these types of projects in other regions around the world. Two short case studies are included to exemplify the application of production management in mining and industrial projects. Results indicate opportunities for time and cost savings.

INDUSTRIAL EPC AND MINING PROJECTS IN PERU

The execution of industrial EPC and mining projects in Peru share the following main challenges: 1) the complex nature of the work, 2) the magnitude of the projects, 3) high levels of interdependency between site activities and responsible trades (e.g., civil, electrical, mechanical, piping, structural, equipment, instrumentation, etc.), 4) large amounts of engineered-to-order (ETO) components with long lead times, 5) remote geographical locations such as the Andes and Amazon regions where weather conditions are extreme, and access routes are very limited, 6) detailed engineering and ETO procurement are typically performed by organizations located overseas, which increases the required levels of coordination and integration between design and site production teams, and 7) the need to establish social responsibility for local communities which see projects as sources of new jobs.

Under this working environment, variability abounds with a variety of sources from site operations to social aspects. The impact of variability on project performance is greater than projects executed in much more controllable environments such as building and housing construction. Using only traditional project management practices is insufficient to ensure successful project delivery.

APPLICATION OF PRODUCTION MANAGEMENT

Traditional project management practices focus primarily on project controls through the use of earned value analysis (EVA), scope and risk management, scheduling for progress reporting, contract management, to name a few. Although these practices are necessary, they do not take into account how work actually gets done and coordinated at the field level (the authors define this as production management). Diekmann et al. 2004 recognized this in a Construction Industry Institute Report stating that "the current project management model needed to be changed from a contract management model to a production management model, which would be oriented toward the way work is done". The authors propose that from a production point of view, project management focuses on understanding what happened (the past), trying to forecast what might happen (the future), however, does not necessarily manage how work is getting done now (the present). Moreover, project management does not formally recognize variability, and only addresses its impact through the allocation of time lags in project schedules, whereas production management addresses how to reduce variability and mitigate its impact through approach such as buffer management. To ensure project outcomes are achieved, project and production management practices must co-exist.

The proposed production management approach recognizes two phases: 1) macro planning, and 2) in-process planning. Macro planning focuses on performing a pro-active analysis on potential sources of variability and identifying buffering strategies to mitigate it. This phase also includes decisions related to the appropriate organizational structures needed to facilitate the management of production later on. The in-process planning phase uses collaborative lookahead scheduling, constraint analysis, and production control through a plan-do-check-act (pdca) cycle to continuously monitor and reduce variability levels. The idea here is that it is the coordination of work flows that reduces waste and also increases the ability to realize purposes (Ballard et al. 2001). The proposed in-process planning phase is based on elements of Last Planner (Ballard, 2000), however, incorporates additional coordination routines to ensure all identified constraints are removed on time aiming for continuous work flow. These routines focus on the generation of working plans for support teams or functions (e.g., purchasing, engineering, QA/QC, equipment maintenance, etc.) incorporating constraints in those plans. Figure 1 illustrates how these routines work using weekly production meetings as the forum for production and support teams to align priorities based on lookahead plans and constraint analysis. This is where production and support teams share potential challenges for the on-time removal of constraints to avoid disruptions in workflow. Basically, these routines are set up to manage interfaces between teams.

According to the authors' experience, production management implementations may not deliver stakeholders' expectations is there is no a formal solution (enabling tools, effective processes, and capable people) that makes the initiative sustainable over time. In complex projects such as industrial and mining, the level of coordination between production and support teams is so high that a working method or solution is absolutely required in order to obtain desired results. The continuity and sustainability of this approach has a major impact on production reliability, productivity, and consequently, efficient execution and completion of project schedules (refer to case study 2).

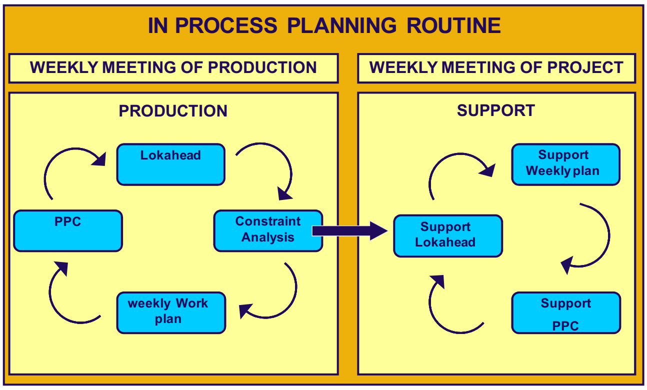

Figure 1: In-Process Planning Routine Model

Case Study 1 – Industrial EPC

In the 1980s, an estimated 11 trillion cubic feet of natural gas reservoir (including 600 million barrels of condensate) was discovered in the Camisea region of the Peruvian Amazonia. Since then, the Peruvian government, in cooperation with private organizations, has created a capital program that incorporates a series of projects from gas extraction, to industrial processing, to transportation for local use and commercialization in world markets. This case study focuses on the work performed during the installation of dry and liquid gas pipelines across the city of Lima for distribution to end users / customers (85 km. of underground steel pipeline, 20" diameter, ½" thickness).

Challenges and Strategy

The installation of the dry and liquid gas pipelines faced very specific challenges including: 1) not enough specialized welding labour and equipment for gas pipelines available in the local market, 2) many interferences found with existing water and sewer pipelines in the city of Lima requiring a large number of unplanned piping curves, which in fact required the use of the only curving machine available locally, 3) lack of reliable information related to interferences due to an irregular growth of the city, 4) welding quality standards were higher when working in the city involving 100% of ultrasound inspections, 5) the population living close to the pipelines had a negative perception of the gas project due to fears of potential explosions, creating opposition for its execution (district municipalities added additional requirements to issue construction permits for each street!), and finally, 6) in distant and poor areas of the city, there was an expectation from local people to work for the project, which caused many interruptions in production flow due to continuous protests.

The production management strategy included the following main components: 1) increase the reliability of information by creating crews for the identification of underground interferences, 2) creation of information buffers ahead of execution, 3) dynamic management of capacity buffers for identification crews as well as detailed engineering crews to respond to the expected construction speed, 4) use of inventory buffers for piping curves, 5) implement a small welding training facility to ensure ready-to-use labor capacity, 6) design and deploy campaigns to create awareness about the benefits of using gas, 7) map the process to obtain construction permits from all municipalities and government institutions involved, and 8) create inventories of work focusing on labor optimization.

Due to high levels of variability, a decision was made to maintain a 30-day buffer of work areas ready. This strategy was difficult to implement since the owner, its representatives, and some project team members wanted to start construction as soon as possible due to schedule constraints. Therefore, having a buffer of areas ready for work gave the impression of incurring in delays to start site work.

Once construction started, the in-process routine was deployed. The main focus was on actions related to the strategies described above to ensure enough executable work buffers to mitigate potential interruptions in production flows. Weekly production plans, weekly support activities plans, percent plan complete (PPC), and other performance indicators were systematically reviewed so decisions and actions were taken early enough.

Results

The main results were the reduction of production flow interruptions, which allowed project completion according to the original schedule. Also, labor productivity was improved in 15% compared to initial estimates. As stated by Koskela, 2000: "productivity and duration can be improved at the same time by improving reliability of work flow within the system". This case study provides the results that support this statement. On-time schedule completion was achieved despite of many factors such as initial delays with construction permits, opposition from local communities, procurement delays, to name a few. The owner was pleased not only with the final results, but also with the overall management process. This project provided an opportunity to establish an empiric relationship between production planning reliability and overall labor productivity. Figure 2 illustrates how high reliability levels (measured in percentage) correlate to high productivity levels (measured in man hours by lineal meter of pipeline).

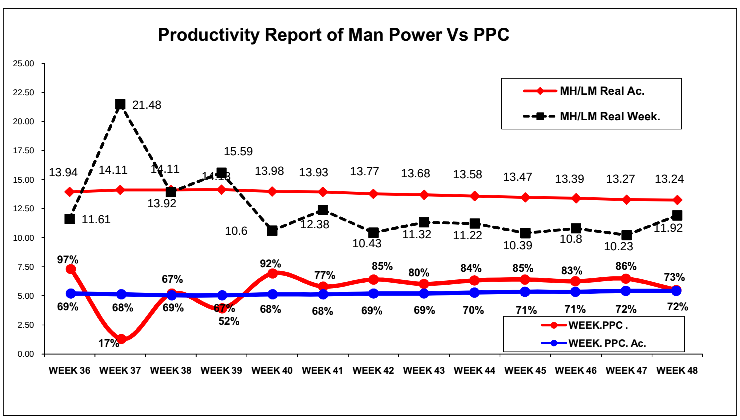

Figure 2: Correlation between Production Reliability and Labor Productivity

CASE STUDY 2

One of the biggest gold mines in the world is located in Cajamarca, Andean region of Peru. This mine uses a lixiviation process to extract gold particles from soil. This process implies constant changes in the landscape through massive earthworks opening and closing pits and and lixiviation pads across the mine. This case study focuses on a particular 483,000 m2 expansion project for a lixiviation pad. This project was scheduled to be completed in 12.5 months requiring 1,415,000 m3 of excavation and 1, 000,000 m3 of backfills. The scope of work included earthworks, and installation of geomembrane, piping and protective materials.

Challenges and Strategy

This project included the following main challenges: 1) the schedule included work during the rain season, 2) working in an archeological zone - in fact, pre-Incas remains were found during construction which caused delays for more than two months due to site inspections and removal of remains, 3) a large variety of different types of soils were found during excavation in irregular strata, having to dispose them in different locations (mines dispose excavation materials according to environmental impact), 4) a very complex and slow validation and measurement system for each material found underground causing many interruptions in workflow, 5) although there are typically high safety and environmental standards in mining, this project considered extremely high and complicated standards, which impacted the duration of equipment inspections, personnel recruitment processes, and work permits approval.

During the macro planning phase, the project team identified the following strategies to mitigate variability: 1) invest on additional soil studies to obtain sufficient information on material strata to increase the reliability of planning, and 2) create buffers of work by obtaining environmental and safety work permits in all pad areas. This required an investment in additional environmental protection materials (e.g., slit fences) to be used simultaneously as opposed to reuse them by moving them from one area to another. Similar to the previous case study, the in-process planning phase focused on identifying and removing constraints such as pre-requisite work for each new area of the pad that required validation of material excavation and related measurements to initiate work.

Results

The main result was the on-time project completion despite unexpected events such as the discovery of archeological remains and unusual rain levels. The owner confirmed this project became the first one to be commissioned on time in ten years. Labor productivity improved in 10% compared to previous experiences in similar mining projects. This generated cost savings 20 times greater than the additional investments made on soil studies and environmental protection materials used as strategies to mitigate variability. Finally, the contractor received an award for the best environmental performance, and outstanding safety results.

CONCLUSIONS

This paper has demonstrated through case studies that the deployment of production management in combination with project management practices delivers better results for industrial and mining projects than just isolated project management practices. In both case studies, on-time schedule completion and improvements in labor productivity were achieved despite the large number of challenges and high levels of variability. Formal analysis of variability sources during early planning stages enabled the project team to be proactive compared with traditional reactive approaches during project execution. The case studies demonstrated how the use of buffer management strategies delivers an important return on the original investment.

Ensuring success when deploying production management requires an attention to detail (the devil is in the detail, the money as well). Implementation challenges include a massive leadership effort to support behavioral changes, and continuous technical training (Arbulu and Zabelle, 2006). Without an effective implementation effort, no production management solution will deliver the expected benefits. The authors conclude that the integration of production and project management practices for mining and industrial projects is a must to ensure project objectives are achieved.

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