Improving Efficiency of Hydrocarbon Development and Production through Lean Concept

By

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Abstract
Population and economy are two key factors considered in global energy demand projections. With rapidly growing world population, energy security is a global concern. The 2011 World Energy Outlook projected that from the 2010 levels, global oil demand will grow by 14% while gas use will rise by more than 50% as well as account for over 25% of world energy demand by 2035[1]. With hydrocarbons no longer easily accessible, success in the future of oil and gas will require meeting various challenges. It is imperative to make the most use of resources and improve operational efficiency. Lean is a business improvement technique with a collection of tools to eliminate ‘waste’ in an operation and reduce cycle time. Originally developed by the Japanese automobile company, Toyota and widely employed in the manufacturing industry, more industries are adopting the Lean concept. This paper demonstrates application of Lean methodology in hydrocarbon development and production to eliminate wastes, improve operational efficiency and bring about a culture change.

Introduction
Globally, conventional oil reserves are shrinking and the cost of getting it out of the ground is rising. Due to lower production and higher costs, investments in the oil and gas business are not commanding same level of returns as they once did. Rising oil prices since 2002 have not created supply surplus to date. Although still profitable in absolute terms, the industry is changing. With hydrocarbons no longer easily accessible, success in the future of oil and gas will require meeting various challenges, including producing in economically and environmentally sound manner to offset field decline. Also, shareholders, non-government organizations and local communities are seeking for more value and demonstration of social responsibilities from the industry. Additionally, governments and policymakers are imposing stricter regulations that impact reserve maturation and production. One of the ways stakeholders’ expectations can be addressed is by making the most use of resources to lower costs and improve operational efficiency.

The Concept of Lean
Lean was originally developed by Toyota out of necessity in the post world war-II era, and heavily based on the teachings of W. Edwards Deming and others. Besides not being able to compete with the major automakers of the time, Toyota was in desperate need to reduce costs and improve quality while producing in a country with little space and few natural resources. Although Kiichiro Toyoda and many other people contributed to the development of lean (or the Toyota Production System as it is known), Taiichi Ohno is credited with pulling it all together as

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an approach to business. Lean methodology has helped Toyota become a competitive company that is known for quality.

Over time, Lean has become a methodology for continuous improvement that can be applied to just about any process in other industries. The core idea of Lean is to maximize **customer value** while **eliminating wastes** by using the **talents of the people** who do the work. Simply, Lean means creating more value for customers with fewer resources. It is not a tactic or a cost reduction program, but a way of thinking and acting for an entire organization towards continuous improvement. A lean organization understands customer value and focuses its key processes to continuously increase it.

Eliminating unnecessary steps or wastes in processes along entire value streams, instead of at isolated points, creates processes that need less human effort, less space, less capital, and less time to make products and services at less costs and with much fewer defects, compared with traditional business systems. Companies are able to respond to changing customer desires with high variety, high quality, low cost, and with very fast throughput times. Also, information management becomes much simpler and more accurate.

It is believed that in most processes, value added lead-time is 5-10% of total lead-time and is scattered throughout the process. Lean is about focusing efforts on what adds value to customer by focusing attention to eliminating what does not. Lean implementation targets the non value added activities (waste) in the system with a view to eliminating such (Figure 1).

![Figure 1: Lean focus areas in a value stream](image-url)
Principles of Lean implementation

There are five basic principles of implementing Lean (Figure 2). These are:
1. Identify and specify value from the standpoint of the end customer.
2. Identify all the steps in the value stream and eliminate whenever possible those steps that do not create value.
3. Make the value-creating steps occur in tight sequence so the product will flow smoothly toward the customer.
4. As flow is introduced, let customers pull value from the next upstream activity.
5. As value is specified, value streams are identified, wasted steps are removed, and flow and pull are introduced, seek perfection of the process through continuous improvement.

Lean Tools

There are many tools in the Lean toolbox to help in delivering optimum value to the customer and eliminate waste (Figure 3). What is important is selecting the right Lean tool to manage outcomes and customer expectations. Some Lean tools that have been applied to eliminate wastes and bring about sustainable process improvements in the oil and gas business include:
- **5S**: Strategy for creating a well organized workplace. Benefits of this technique include increased organizational efficiency, increased safety and improvements at an inexpensive cost.
- **Value Stream Map (VSM)**: Process map of the value stream, includes information and transformational processing particularly useful for identifying non value add processes and interface issues especially in multidisciplinary field development processes.

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3 Ibid
- Kaizen Event: Waste elimination process which examines the As-is process to identify waste, improve the process (To-Be), creates an implementation plan for implementing improvements, checks the effectiveness of the improvements and documents and standardize the improved process.

- Standard Operating Procedure (SOP): Written document of the way in which each step in a process should be performed – a means of communicating and codifying current best practices.

Figure 3: Some Lean Tools

Application of Lean in the Oil and Gas Business – Case Studies
Lean is about reducing wastes by taking out non value added activities and complexities in various processes to deliver value to the customer (Figure 4).

Figure 4: Schematic of Lean implementation in a typical process

This methodology is applicable in all processes across the hydrocarbon life cycle encompassing exploration, appraisal, development, production and abandonment as well as in support services.

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4 Case studies 1 and 2 were published by The Marshall-Teichert Group (http://www.mtgl.com/case-studies/upstream-oil-gas.htm).
such as Contracting and Procurement, Health Safety and Environment, Finance, Human Resources management. It has been applied in the oil and gas industry to improve performance and, ultimately, production as shown in the following case studies.

**Case study 1: Instructions on how to properly operate and maintain a certain type of wellhead compressor.**
In the USA, a large independent oil and gas company contracted an East Texas asset lease operators for certain maintenance procedures on well head gas compressors. The contract specified that the vendor was to maintain 95 percent availability, otherwise a rebate or credit was due. The manufacturer of the compressor had prepared the usual, written instructions for start-up, routine maintenance, and shutdown of the machines. However, the instructions were difficult to understand. In addition, different lease operators approached compressor maintenance differently, depending on their background and training, resulting in compressor downtime.

After clarifying responsibilities and accountabilities for compressor downtime, both planned and unplanned, Availability Tracking Sheet was designed and placed in the compressor control panel door. The lease operator was only required to record 24-hour run time on a daily basis and to explain any downtime. These sheets were used to calculate percent availability on a monthly basis and to claim rebates from the vendor. A Lean tool, Standardized Work, was applied to create a set of Visual Maintenance Instructions. Each step in the process was clearly illustrated with digital photographs and a concise written description of the procedure.

Utilization of the Availability Tracking Sheet and Visual Maintenance Instructions resulted in a marked increase in compressor uptime, better unplanned maintenance response time by the vendor, and the creation of common, easy-to-follow procedures for the lease operators.

**Case study 2: Reduction in time required for drilling rig moves**
In a particular drilling operations in the Washakie Basin of Wyoming, rig move times were highly variable, ranging anywhere from four days to more than 10. Lack of planning, communication, and coordination with the trucking company that transported the rig parts contributed to the lengthy moves. A field observation of existing rig moves to understand the timing of key process steps and the sequence of events was conducted. From this, a rig-move procedure with a clear description of process steps, including the target times in each step’s critical path was developed. A variance report was used to record rig move issues, perform a root cause analysis, and develop action plans for continuous improvement.

Applying a Lean tool, SMED (Single-Minute Exchange of Dies) techniques to rig moves produced positive results: Of the 14 tracked rig moves, 79 percent showed an improvement from their base of 6.5 days. Overall, rig moves were shortened by an average of 0.82 days per move.

**Case study 3: Lean implementation in Hydrocarbon Development and Production in Shell Nigeria**
Some great examples of Lean applications in Hydrocarbon Development and Production in Shell Nigeria have also been recorded.
A Kaizen event applied on hydrocarbon maturation process in Shell Nigeria resulted in reduction in maturation cycle time of projects from four to two years for high complexity fields, improvement in the volume flux and savings in manpower cost from reduced work cycles. Similarly, a cross functional Kaizen workshop reduced the change out of gas lift valves from one year to less than a month, resulting in gains of about 7kbopd. A Lean process that employed the Standard Operating Procedure (SOP) tool was also employed to address the heart and minds issues for production personnel and change work cultures. Standardized work flow process was developed and blogs introduced to share best work practices across assets. The business impacts from these are optimum production for assets, proactive problem solving culture and increased safety in facilities.

Even for non-core oil and gas business areas like travels and logistics management, application of Lean concept and tools yielded significant business impact. For the travel contracting and management process, a Lean workout exercise delivered significant cost savings and freed up over 12,000 man hours per annum for more value adding work.

Creating a mindset of continuous improvement and making people think and work together to solve problems that save time and achieve sustainable cost reduction is at the heart of Lean implementation in Shell Nigeria. This has yielded other soft benefits including:

- Enhanced Integration within /among all disciplines
- Transparent & Standardized workflow process
- Prompt & Quality Decision making

**Securing the future of the Nigerian oil and gas industry**

As the Nigeria population is set to grow rapidly like elsewhere, the pressure to improve quality of life and reduce poverty would necessitate provision of cleaner energy to light homes at night and to cook food so that ill-health associated with stoves fuelled by coal, wood or cow dung can be reduced. The Nigerian government aspiration for Nigeria to be one of the 20 largest economies in the world by 2020 would further require sustaining revenue generated from the oil and gas export market while meeting significant growth in domestic demand for electricity supply and energy security to Nigerian households.\(^5\) The need to take more efficiency actions to minimize risks to energy supply and secure the future of oil and gas industry therefore becomes inevitable. Lean is the way that many organizations win in today’s hyper-competitive world economy.

A study by Wood Mackenzie\(^6\) in 2005 reported that field development times for deepwater projects in Nigeria is significantly longer compared to Angola. This is attributable in part to the slow approval of projects in Nigeria. The International Finance Corporation and the World Bank, through indicators benchmarking business regulations in 183 economies reported that doing business remains easiest in OECD high income economies and entrepreneurs have it hardest in

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Sub Saharan Africa. Nigeria ranked 137 out of 183 countries surveyed in the report. It makes sense for policy makers to help businesses grow by improving the regulatory environment especially with local content drive and entrance of marginal field operators into the Nigerian oil and gas industry. Several processes such as contracting and procurements, permits application, budgeting and performance reporting, commercial issues resolution and regulatory activities in the Nigerian Oil and Gas business could benefit immensely from reduction in cycle time and cost of delay in decision making. Adopting lean methodology will enhance faster decision making and efficiency in producing revenues leading to value maximization and profitability.

**Conclusion**

Lean implementation methodology isn’t just focused on improving operational processes, but geared towards becoming a part of an organization’s ways of working. Organizations can realize short-term gains by spending money on training and new equipment, but without building a lean culture, sustainable, long-term gains are unlikely. Much of the wastes in organizations are locked up in cultural and organizational barriers that cannot be removed without a fundamental change in the business philosophy and culture. Lean culture is crucial in generating long-term results - continuous improvement is more than a technique, it is a way of life. A steady stream of small gains, multiplied across the many processes in the oil and gas business would translate to acceleration in hydrocarbon maturation leading to more flux volumes per time, reduction in costs, efficiency in operations and overall optimization of oil and gas processes and contribute to securing the future of the industry.

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**Other References**


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