Study complexity factors in oil and gas projects management and finding new methods to improve projects performance using complexity theory concepts.

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Introduction

More than 80% projects are failed due to production rate, schedule, or cost. On a $5 billion project, the average overrun cost is $1.7 billion, which is around 33% of the overall coast. Similarly, the production impairment and schedule cost can be equivalent to that amount. As a result, companies have to bear the loss of billions of dollars. The reasons for this loss and its frequent occurrence are many; however, the major one is that that oil and gas industry has become more complex and the management is incapable of managing these complexities of oil and gas industry related projects (Gate, 2016).

There are four stages of complexity: (1) simple, (2) complicated, (3) complex, and (4) chaotic and between simple and chaotic complexity is situated. A simple system consists of few independent parts; hence, failure of one part does not necessarily affect the other part or parts. The complicated project has many parts. Nevertheless, the independence of the part still exists largely and within a subsystem, failure can occur. However, in complex projects, there are several interconnected parts. Thence, the failure of one part affects other parts. Moreover, this failure occurs in unpredictable manners and no project manager can foresee this occurrence before time (Gate, 2016).

Figure 1 below shows the Y axis that is the measure of ROI while the X axis is showing reservoir size. According to Gate (2016), it means when an oil and gas company explores for oil it has the assumption for finding large reservoirs because it is related to this company's money making. Though this is an honest approach, yet there is a point that is touched by the ROI and then it declines, so this is complexity and its scientific understanding. Hence, the management of oil and gas can cope with complexity. The scientific study of complexity networks are based on nodes and connections, figure 2 demonstrates these nodes and connection.

Figure 1. Complexity: Source (Offshore, 2017)

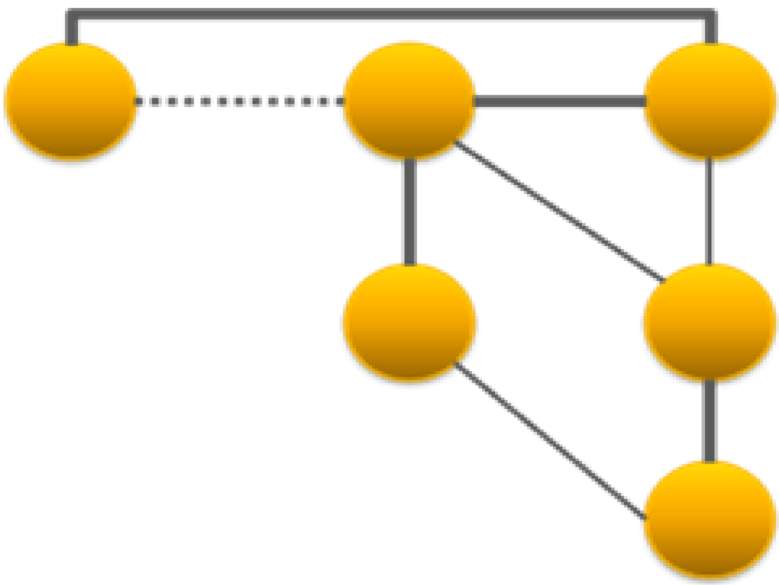

Figure 2. Nodes and Connection between them: Source (Melanie, 2009)

This network, Wang and Chen (2003) found that in accordance with several parameters, varies. For instance, the number of nodes can be varied; the nodes' adaptability or intelligence varies. Similarly, a node may have binary characteristics. Due to the density of interconnectivity, complex systems can vary with each other. Likewise, the nodes' interconnection may vary in bandwidth or strength. The simple nodes are the most interesting feature of the simplest network; they are populated sparsely and have connections with different bandwidth. Though this type of network seems very simple and without any interesting properties, yet they are comprised of many interesting properties. For instance, our brain is a network it is comprised of on/off switches or neurons along with synapses. In bandwidth, the connections are varied and sparse. Similarly, Yu et al (2011) stated that an ant colony is a good example of a network. If ants are in large number then they build a culture, find food, divide work, build and defend their nests; however, a lone ant with very few skills may wander and die. Conclusively, this leads the article towards teamwork. Logically, the culture of ant belongs to the system. The system does not belong to individual nodes; hence, the emergence of culture is the property of the system. Thus, the parts are less important than the sum.

According to the claim of Yu et al (2011), the ants or nodes are not very intelligent. Each ant has a very simple responsibility inscribed in its brain and it does its duty without change of behaviour and thinking. This network is called CPS (Complex Physical System). However, the network of human teams is a network of intelligent nodes and it is known as CAS (Complex Adaptive System). The huge power of CAS is because of the intelligence of nodes. Notwithstanding, this power requires the fuel of motivation and coordination. For instance, Li et al (2008) mentioned that by doubling the number of ants for constructing a mound will increase the construction work. On the contrary, by doubling the number of engineers on a project will not increase the speed of the project though work potential will increase because the size of the team and work potential has the linear relation. Moreover, like ants, the humans do not know about the parameters of their work responsibilities.

With team size, losses of motivation and coordination increase non-linearity. It demonstrates that a less efficient team would be created after increasing its size. Hence, the output of the work decreases with increasing staff. This has been demonstrated in Figure 3.

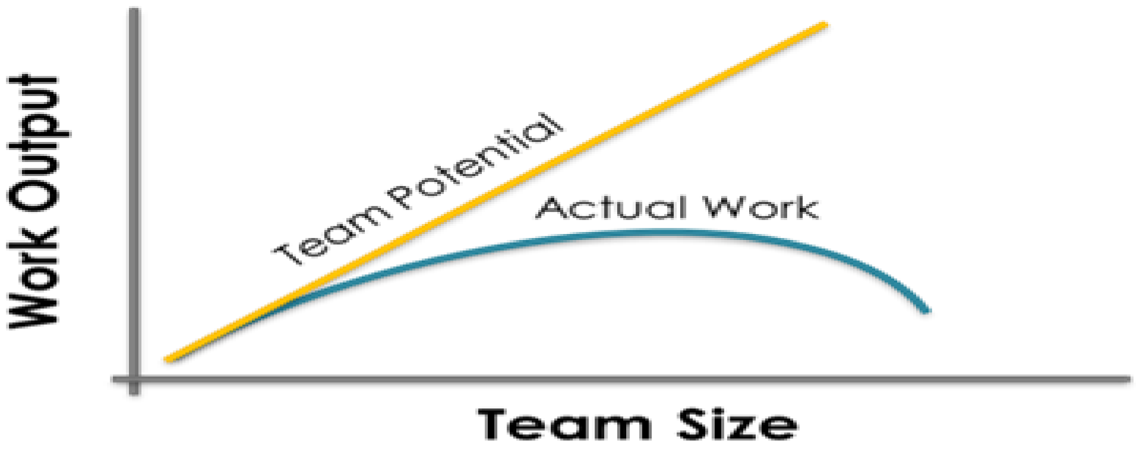

Figure 3. Work Output vs. Size of Team: Source (Gate, 2016)

Sources of Complexity

The current study shows that CPS and CAS are an integral part of every project. The interaction of these two complex systems creates some emergence. Moreover, the following sources of complexity are important (Figure 4).

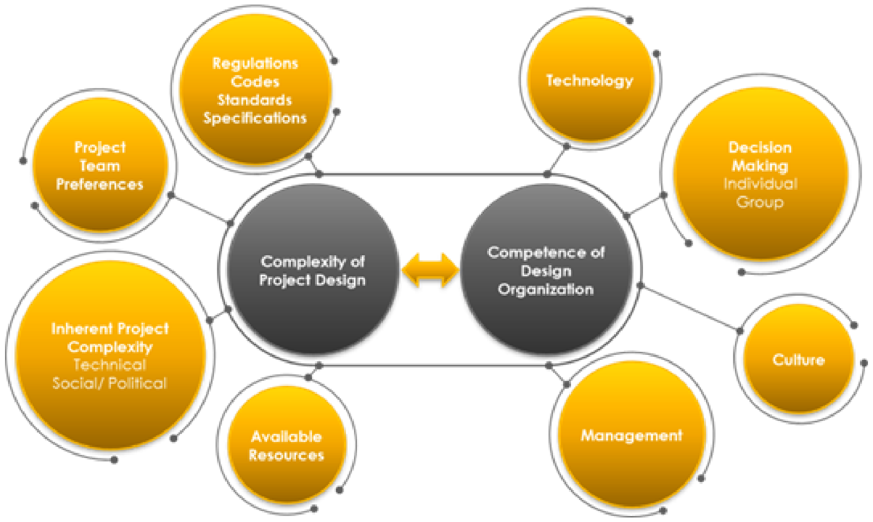

Figure 4. External Sources of Complexity: Source (Gate, 2016)

The Significance of Complexity

Kaye (2011) and Ed (2011) found in their study that time to time increase in oil prices is because of project complexity. These projects are huge multi-billion dollars projects. They want the return on their investment. Definitely, if oil and gas companies were losing billions of dollars due to project complexity they would try to cover it by increasing oil prices. Hence, the future is uncertain if the project management of oil and gas industry would be unable to find an appropriate solution to meet the challenges of the complexity of project management.

Inherent Project Complexity

Kaye (2011) commented that inherent project complexity is inclusive of social-political complexity or technical and non-technical complexity. However, a structural approach is essential for understanding all the dimensions. Technical complexity can be the brown/green field, local infrastructure, logistics, supply chain, weather or seasonal issues, surface geography, subsea geography, fluid properties and reservoir properties. However, inherent social-political complexity can be cost or schedule pressure, contractors or vendors, local resources, organisational, commercial, the engagement of NGOs, partner alignment, community engagement, regulatory regime and the political and legal environment.

The inherent complexity of a project is highly painful, specifically, when it is non-technical complexity. It is very essential, for the identification of the source of inherent complexity, to use a structured process and share all the findings with the project team. However, the identification and assessment of the inherent project complexity are not easy; therefore, frequently, the project team is highly inclined and optimistic regarding the inherent complexity of the project and it generally underestimates the likely threats to the project.

The Design of Project Complexity

According to Clift and Vandenbosch (1999), a simple design of inherent project complexity may not resolve the issues; however, it should not be highly complex. Initially, the design can be complex; nonetheless, the trimming process should be used for cutting out needless project complexity. Therefore, Howard (2011) claimed that the prerequisite is the design objectives' comprehensive identification including the removal of processes and kit that are not helpful for obtaining desired outcomes. For instance, the trimming of drill centers or entire platforms is very significant if possible at the time concept selection. Similarly, at the time of feed, the project team should try to trim systems. Likewise, at the time of detailed design, it ought to try to minimise components and during operations, it must focus to remove needless processes.

Design Organisation and Its Competency

Van et al (2008) observed that the most critical factor of design organisation is its competency. If a firm used a highly experienced team then the execution of work can be flawless. However, an easy engineering task can become highly difficult if the assigned team is less qualified and inexperienced. Notwithstanding, the requirements of organisational competency are higher than the appropriate technical skills. Moreover, it demands effective learning from previous projects, relevant experience, subject matter experts, narrowly-focused effective coordination and defined procedures and processes, Therefore, a gap analysis is essential for the entire designing organisation. For the effective identification of the gaps, the understanding of the task execution must be developed along with the plan for execution, executing plan parties and distribution of responsibilities between them. Obviously, at different project stages, there will be the requirement of different parties with different sets of skills. Moreover, before each stage, a gap analysis must be performed.

Technology

Karl and Kathlene (2007) emphasised that the increasing complexity is the consequence of deeper wells, higher temperatures and pressures, harsher environments and the requirements of large projects according to economies of scale. Therefore, Tatikonda and Rosenthal (2000) stated that in the case of inherent complexity, a high-tech solution is needed sometimes but the other times it is not required. The frequent employment of existing technology on a large scale projects has become common. The execution of complex projects comprising of large project organisation that are distributed around the world is possible because of modern communication technology. However, this develops the optimistic approach that is highly illusive that organisations can coordinate efficiently and effectively between their widely scattered complex design teams by just employing modern technology.

Case Studies

The management unit of Partex Oil and Gas Group is Partex Services Portugal. The main purpose Partex Service Portugal is to facilitate the Group with managerial, technical and organisational support for Group’s oil and gas related operations. The Partex Group is involved different mega projects and these projects are inclusive of facilities integrity and efficiency, production operations, field developing planning, reservoir management, reservoir simulation and characterisation, hydrocarbon recovery optimisation and seismic interpretation and geosciences (Zarina, 2013)

In oil and gas projects, according to Zarina (2013), Partex applied to risk management tools to effectively managing the challenges of project complexity. However, the risk management tools have not been applied in project complexity management. According to Sholarin (2007), in oil and gas industry and its studies there is not much evidence about the implementation of standards and frameworks; hence, this industry has been unaware of using standards and frameworks in project management techniques. In oil and gas industry, risk management implies for the prevention of hazards such as workforce injuries, oil spills, fatal accidents, etc.

Guddu Thermal Power Plant

In 1950, a huge reservoir of natural gas was discovered in Guddu, Sindh. The discovery led to the development of a complex project providing 2,400MW and supporting 700,000 homes annually. In this regard, for the project work, ENGRO Fertiliser selected GE Oil & Gas. The GE Oil & Gas had to deliver installation, commission, pre-commission, and startup along with performance test in just 6 weeks (GE Oil & Gas, 2017).

However, due to the tight deadline, harsh conditions and location, the project was highly challenging. Though ENGRO had great confidence in GE Oil & Gas, yet it was the most difficult project comprising of many complications and short deadline.

For the GE project team, the most difficult challenge was because of the tight project deadline was staggering the equipment components' shipment. At the site, the first two items arrived were compressor cylinders and compressor skid. However, almost at the end of the schedule, the team received suction scrubbers and pulsation bottles. Now, they were in great difficulty because of the execution of the huge task of assembling the units on site and making sure that during the startup, no problem occurred related to assembly. Surprisingly, the project team did the job within the schedule (GE Oil & Gas, 2017).

How the team did this

The team, prior to starting the activities on site, collected history of the project phase and studied all requirements of the project. As the team had observed the harsh environment, it created a safe environment on the site for every project team member and in this regard to obtained help from customer's logistic support. The second priority was to resolve the presence of many tactical decisions vs tight schedule. In this regard, the team used, for facilitating the communication between several involved parties, extensively on-site management tools (GE Oil & Gas, 2017).

The establishment of a rigid work activities protocol was performed inclusive of daily updates, management prioritisation, engineering support, alternating field coverage schedules and 24/7 onsite support. Everybody was involved because of the utilisation of the Red Flag Review Process and it was kept until the issues were catered including the management crew of customer by taking instant actions for fulfilling the requirements of the customers (GE Oil & Gas, 2017).

GE Oil & Gas and Statoil

The last case study is also related to the excellent project management performance of GE Oil & Gas but this time it was working with Statoil for managing project complexity.

During the start of 2017, GE and Stat faced a challenge to resolve a critical issue of improving the efficiency of proppants; they are used in unconventional operations for reducing the impact of trucking. According to the experience of GE and Stat, sand, in shale development, is the best proppants and it plays a pivotal role in the process of hydraulic fracturing and improving the productivity of oil and gas well. By way of water, sand was transported for prop opening or stimulating the small fractures and then to enable the flow of oil and gas freely.

Hundreds of trucks of sand are required, at the time of stimulation of a well. However, GE and Stat accepted the challenge. However, surprisingly they did not use sand; instead, they used replacement for the sand. They found five replacement for sand: (1) lightweight expandable polymer proppant, (2) coiled biopolymer fluid additive, (3) alumina ceramic proppant in X shape, (4) locally-sourced ceramic proppant, and (5) lightweight polymer proppant manufacture by semplastics.

Conclusion

Conclusively, the project management complexity is a lengthy and wider subject. Similarly, its study is very important for project managers, contractors, subcontractors, stakeholders and owners of projects. Though the Simple project is only related to small scale or home building projects, yet it provides an initial and learning basic of the project management and this is the path leads to Complex programmes, Full-Scale projects and Focused projects. Nevertheless, the understanding of Focused projects and Full-Scale projects is significantly important for their implementation and combination of Complex programmes because every Complex programme requires support and help from Full-Scale and Focused projects. Furthermore, an experienced project manager or leader clearly understands the relationships of all types of project and he or she has the potential to amalgamate all of them expertly and to organise everything from different processes to scheduling and completion of the finished job.

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