Shift to Cloud-Based (SaaS) Technology for Supply Chain in Oil & Gas Industry

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Abstract- **The oil and gas industry involved in a global supply-chain that includes movement and storage of raw materials includes domestic and international transportation of work in process inventory. Interconnected or interlinked, channels and node businesses combine in the provision of import/export facilitation technology required by end customers in a supply-chain. The purpose of this paper is to investigate role of cloud based solutions to their primary sourcing application. This research examines to improve supply-chain in oil & gas industry by executing supply-chain transaction, managing supplier relationships & controlling business processes associated with cloud based technology.**

Keywords- **Supply-Chain Management, Cloud Computing, Shift to Cloud Based Technology, Software-as –a-Service (SaaS), Oil and Gas Industry.**

I. INTRODUCTION

Supply-chain management can be defining as "design, planning, execution, control and monitoring of sequentially organized set of operations. The goal of supply-chain is to create net value, building a competitive infrastructure, leveraging worldwide logistics by synchronizing materials, information, capital, labor, technology, financial assets and other resources. The organization must weigh upstream and downstream value added flows by providing valuable services with lowest possible cost & maximizing benefits. It also consists of benefits versus costs of each decision. Supply-chain management is an extension of focus on customer service.

Cloud computing is an emerging IT-based paradigm that enable ubiquitous access to shared pools of configurable system resources and provides on demand computing services with reliability, scalability and availability in distributed environment (Xun, 2012). If used properly this third party clouds enable organizations to focus on their core businesses which develops inimitable resource that helps organizations to create & sustain their competitive advantages (Truong, 2010). Proponents also claims that cloud computing expanding day by day and being adopted in numerous business domains, it starts drawing attention of supply-chain practitioners. Though it is challenging to transition to cloud systems from traditional supply-chain management but it benefited by enabling wide range of capabilities in supply-chain management including: reducing costs, reducing lead time, increasing the supply-chain visibility, enhancing inter-firm collaboration by providing scalability, immediacy, efficiency. It also helps to reduce on boarding difficulties by optimizing different resources. (Shacklett, 2010; Schramm et al, 2011; Marston et al., 2011).

In recent times, there have been concerns regarding supply-chain sustainability in the oil and gas industry and supply-chain is highly concentrated business issue affecting organizations supply-chain logistic networks and it is frequently quantified by comparison with high-tech and low-tech operations and capital intensive operations. It is also a concern to manage by considering economic scale. Currently oil and gas industry entered an era of very scarce resources. But despite of the fact there isn't any worries of the resources; they are not the cause of supply constraints. In reality however, enormous potential still available including, developed and undeveloped reserves. There is always a possibility to increase scope of recovery from existing fields with new and advance available technology, further potential discoveries, and the new frontier of vast unconventional oil and gas reserves which includes oil sands, shale oil, coal bed methane (CBM), Gas hydrates that are in the money at today's prices.

II. LITERATURE REVIEW

Supply-chain management & asset have profound opportunities to improve core of their business technological advancement it essential in managing today's supply-chain. It is a metaphor of inter related web rather than liner chain where ERP software comes to the picture which focuses on relevant areas like supply-chain capabilities to adopt new changes making an ideal solutions for companies in these industries. Hybrid cloud solution, business and IT organizations can provides speed, flexibility, capacity and lower cost of a software-as-a-service (SaaS) cloud environment but it also preserves the necessary security and performance that core of supply-chain business requires. This section is divided into two parts. First, the emergence of supply-chain management of oil and gas commodities literature is described. Then, selected role of supply-chain management software as a hybrid solution using cloud environment to handle those commodities and major challenges & difficulties in cloud computing. Integrating cloud supply chain solutions to in-house systems and

applications can be challenging and requires strategic decisions (Truong, 2010).

A. Supply-Chain Link in the Oil and Gas Industry

Exploration → Production → Refining → Marketing → Consumer

The link shows above represent the interface between companies and materials in oil and gas industry that flow through the supply-chain. Oil and gas project management require advance and hybrid methodologies to handle large volume exploration operations like drilling, reservoir, production and facilities engineering in addition of refining operation. Refining is complex operation and its output is directly involve as an input to marketing where sales of gasoline, engine oil and other refined products. Each link is distributed separately manages by an individual service organization or else by an integrated firm. The common issue with a compliance obligation observed as the links in oil and gas industry supply-chain are likely as an economics where weighing benefits versus costs along the chain.

Oil and gas supply-chain holds the pivotal role in the solution, not only maximizing efficiencies by adhering different types of shipments made widely from gloves to pipes, valves, cranes, chemicals, cement, steel and drilling rigs, just to mention a few. In addition all oil and gas industry requires immense array of supplies to be moved daily or frequently in large quantities including the receiving / packing /warehousing / distribution, air and ocean transport, domestic transportation as well as customs clearance and delivery at some destinations for all of the supplies for the company's rigs on a global basis. Once after exploration companies entered into development phases where most of the exploration and production activities are repetitive. To recover all potential hydrocarbons present within reservoirs company drills a lot of oil and gas wells every year. All drilling contractors who are associated with oil and gas projects required as many as 45 or more different services sequentially and repeatedly to drill and complete each well and to recover entire volume of hydrocarbon which present within reservoir. It is basically humongous project which runs around more than 20+ years and which involves many activities all together and should be linked in a perfect sequential manner. Ghawar oil field in Saudi Arabia is one of kind example which proves that the how big this projects are. It is by far largest conventional oil field in the world and accounts more than half of the cumulative production of Saudi Arabia. (Source Saudi Aramco, the state run Saudi oil company).

The primary goal of every oil and gas company is to find all significant and important operations and planned them in advance. Thus, the whole process can be managed and tuned finely to find best way from reservoir to refinery to keep supply chain as smooth as visible. For this the company are looking for advanced logistical solution which would help to provide transparency to entire oil and gas projects as it has been observed that supply-chain linked to all operations sequentially and in likelihood manner where exploration operations create value through seismic analysis and identifying prospects. Production operations become the customers that use the output of exploration. In like manner, refining is the customer of production while marketing is the customer of refining and the consumer of refined products such as gasoline is the ultimate customer.

There is a need to bridge the gap between demand and supply and to reduce the uncertainties associated with oil and gas supply-chain industry by ensuring exact material needs of its customer, by protecting problems with suppliers and by maintaining buffers. International oil prices in dollars should be maintained throughout the entire supply-chain then only company's profit margin will get enhanced. The darkest part of supply-chain in oil and gas industry is numerous companies involved in various operations in different stages and each of them likely to act in its best interest to optimize its profit. Thus, the goal of satisfying the ultimate customer is easily lost and opportunities that could arise from some coordination of decisions across all the stages of supply-chain. If reliable supplier presents then there would be less need for inventories of raw materials, quality inspection work, rework and other non-value adding activities, resulting of lean production operations.

Oil & Gas supply-chain further divides in two different segments as an upstream sector & downstream sector. Where Tubes & tubular goods are among the important goods supplied in upstream side on daily basis and raw hydrocarbon to finish goods of refined products comes under downstream umbrella. These are very crucial and form part of supply-chain link. Supply-chain tubular goods further categorized as pipes, tubing and casing which ordered, manufactured, transported, stored, prepared and then delivered to the site for installation for constructing oil and gas well. Managing this part of supply-chain is a logistical and operational nightmare as delays in the arrival of all accessories can result in extensive rig downtime and consequently high operational costs. So do in downstream segment effective distribution of raw product from field to refineries and furthermore to market after segregating into by-products and that too keeping eye on current international crude oil prices is highly a difficult task.

In the sector of exploration and production of oil and gas industry, there is hardly any differentiation in finalized product as it is exactly the same for all competing firms: oil and gas with very thin line of changes. Consequently, many exploration and production companies can only differentiate themselves based on economically rather than introducing an exciting new product. Even though differentiating factors are limited; but it can be lie by adopting a sound supply-chain management program.

B.Management Decisions

As discussed earlier, supply-chain management involves configuration, coordination and improvement. There are some issues to be considered in each case.

1) Configuration involves the following questions

- what product-service companies should produce
- what portions of products should produce in house and what portion to purchase from others
- Total available facilities
- Available space
- Availability of technology
- Communication between supplier and customers
- standards expected of customers and suppliers

2) Coordination from the perspective of each company involves the following issues:

- Effectiveness of supplier in cost, timeliness and quality
- Setting appropriate targets for inventory, capacity, and lead time
- Monitoring demand and supply conditions
- Communicating market and performance results to customers and suppliers.

Operations researchers had used analytical approaches focusing on continuous evaluation because it has been suggested that amplification variability in supply-chain occurred and it's problematic in nature; but it can be reduce coherently by using advance information sharing system which is helpful for lead time reduction. The effect of such a system to brings effective configuration and/or approach to coordination to enhance the performance of overall chain. The choice as to which focus on simply to reduce costs along the chain and focuses on economic decision hinging on the approach provides maximum benefits at minimum cost. Since the goal of supply-chain management is to provide maximum customer service at the lowest possible cost, it has also been advocated that the supply-chain be managed as an integrated and coordinated system (Forrester: 1958, 1961). Furthermore it helps to reduce additional load by eliminating unnecessary uses or requirements which are on the chain. The effective integrating system reduces loads hence the costs.

C. Cloud Based Supply-Chain

Cloud based supply-chain management are reality today which represents a network of interlinked organizations which gives provision of products and services required by customers. Lindner et al. (2010) define a cloud supply chain as "two or more parties linked by the provision of cloud services, related information and funds". The supply-chain cloud is managing and partly coordinating bi-directional movements of products/materials, information and financials across all platforms in order to educate on the applications of

cloud based technology. It also helps to identifying solutions to improve on demand platforms, infrastructure services, and application services and monitoring and maintaining of these services. Figure 1 presents components of a cloud supply chain. In Figures 2 present examples of cloud supply chain in logistics sectors using Keyfort's cloud computing service (keyfort.net). Cloud based collaboration is key solution for shipping schedule, shipping notice, receiving notice and payment information stored and shared. It also improves the governance and compliance issue in particular around data residency, sovereignty & security.
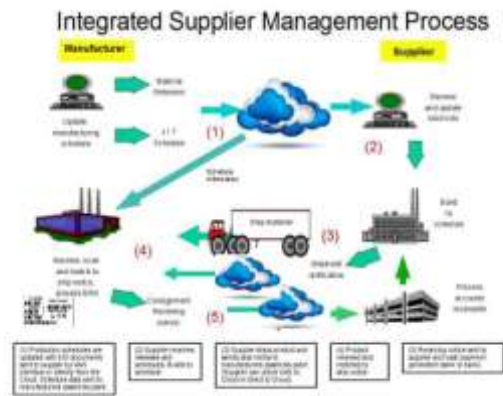

Figure 1: Cloud Supply Chain components

Figure 2: Cloud Supply Chain in Logistics Sector Using Keyfort's Cloud Computing Service (source: keyfort.net).

Among cloud chain solution, Software-as-a-Service (SaaS) is a hosting model for enterprise resource planning and many organizations are very receptive of this solution. SaaS based applications involves on firm's ERP applications on a vendor's servers. Cloud ERP is unique kind of enterprise resource planning that is hosted on cloud computing rather than on premise's within an enterprises own data center. The main aim of SaaS based software to reduce overall software cost by accessing through internet instead of purchasing it. Without installing and maintaining additional software this type of service offers a complete application functionality including customer relationship management or enterprise-resource management. (Examples:, Sales force Customer Relationships Management (CRM) system, SaaS Enterprise Resource Planning, Google Office Productivity application

and NetSuite). Some ERP modules also involve for finance and human capital management segments of a business. SaaS is licensed or owned by end user, but it use to increase accessibility via internet and it gives flexibility to users to share and transfer data across business departments as well as externally in real time. The most prominent part is that it comes with availability, backups and disaster recovery plans from providers to reduce interruption to the software. Figures 3 shows that deployment of ERP selection and further categorized by company size. It can be seen that more than 44% of companies have decided to use SaaS ERP compared to 56% that use traditional licensed ERP.
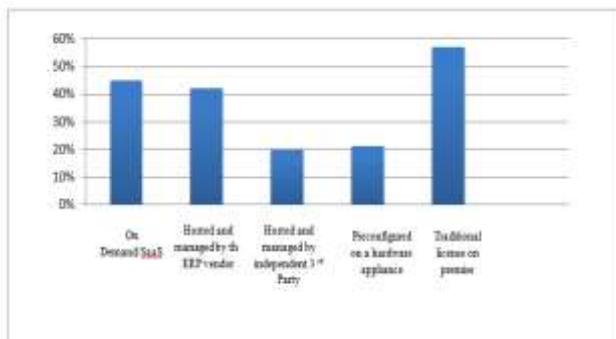

Figure 3: ERP Deployment Selection (source: data from mintjutras.com)

D. Advantages of Cloud Based Supply-Chain

While this study contributed to improve supply-chain visibility in oil and gas industry with the help of cloud based technology. Oil & Gas organizations has to set the goals as a virtualization of a supply-chain by virtue of digitization which only occurs when we choose hybrid ERP solutions like SaaS rather than to go for traditional ERP software's and it can be achievable with the following attributes.

- Complete lateral integration in which data from feedstock to product trading were integrated.
- Effective strategic fits through proper convergence in strategy, planning and scheduling.
- Optimizing speed with direct links to online plant processes.
- Real time monitoring of all the operations to calculate the delays, lead and process time.
- Simple as well as complex supply-chain operations efficiently achieved with good scalability
- Modularity gives that flexibility in implementation stages.

Cloud-based system have better control over supply-chain and access to customer feedback which is indirectly influential to improve the quality of upstream and downstream processes of oil and gas industries. The major Norwegian oil company, Statoil, considered outsourcing five processes: daily co-ordination of the flow of supplies, routing of supply vessels, problem solving and conflict of negotiation and influencing

and improving supply, evaluation of suppliers and logistics providers they used transactional cost analysis with the help of traditional ERP software where they have identified that only outsourcing the routing of supply vessels generate a substantial advantage. Although it is observe that the company stood to lose visibility of transaction-specific data as well as control over its supply-chain by concentrating only on core competencies of outsourcing.

Most of the national/multi-national oil and gas companies employ various software systems for managing their supply-chains. However they neglect that supply –chain visibility linked with the agility and competitiveness of companies. Lean processes give that agility but for that substantial efforts must be needed to integrate supply-chain management (SCM) and shift to cloud-based technological software's. Furthermore, only few SCM software packages can incorporate real-time vehicle routing and scheduling (VRS) capabilities. Oil and gas industries need to be achieving better integration between their software platforms to develop real-time end to end digital ecosystem.

As we have discussed earlier as how effective this cloud based ERP software's are in terms of their reliability over other IT-infrastructure as most of the platform providers have an agreement which guarantees 24/7/365 coverage's and 99.99% availability. These can be benefited to all oil and gas organization for massive pull of redundant IT resources as well as quick failover mechanisms. If one of the server fails hosted applications and services can easily transited to any of the available server. The most significant advantage of cloud based software is IT cost saving while keeping capital and operational expenses to minimum. With this benefit any oil and gas company can save substantial capital cost with zero in-house server storage and application requirements. Even the companies' can save big bucks on lack of on premises infrastructure cost in the form of power, air-conditioning and administrative cost which falls under associated administrative cost. One more advantageous thing is that these cloud based software's provides enhanced and simplified IT management and maintenance capabilities through some central administrative resources, vendor managed infrastructure and SLA backed agreements. Oil and gas companies need not worry about the infrastructure update and maintenance of software's as it is managed by SLA and it delivered and managed timely. Strategically it gives additional edge over competitors as it gives that simplicity to focus on business activities rather than focusing on advance technology.

E. Disadvantages of Cloud Based Supply-Chain

Downtime is a major drawback in this sector as many of service providers take care of number of clients each day; they can become overwhelmed and come against technical outages. This can harm your business processes by temporarily suspended. The most highlighted part is that if your internet

connection is offline; then you are unable to access any of your data, server or application from the cloud. Although this cloud based software's comes up with the best security options for your data; but at the same time it opens up risk by sharing data with external service providers. It gives access of your business data which you are sharing with your service provider. The ease in procuring and accessing cloud services can also give nefarious users the ability to scan, identify and exploit loopholes and vulnerabilities within a system. For instance take an example of multi-tenant cloud architecture where multiple users are hosted on same server a hacker might have tried to break data which hosted and stored by other users on same server. However such kinds of loopholes are not highlighted but the likelihood of compromises are not great. Another disadvantages is that it give minimal access to the customer as it is entirely owned, managed and monitored by service provider. They can only manage and control, applications, data and service operated and on top of that backend infrastructure. Key administrative task as shell access, updating and firmware management may not be transferable to end users.

Although issue with Vendor-Lock is a major concern in oil and gas industries as multiple service organization associated with single project as it is in upstream sector various organizations provides services like drilling which is a crux of a project requires all tubular goods like drill pipes, drill collars, heavy weight drill pipes, drilling bits altogether it is called as drilling string. Many organizations provides these goods same as in case of cementing operations and drilling fluid operation lots of additives required which service providers are supplying to drilling locations; apart from these activities; many more are there like well-logging, work-over, stimulation. But the problem faced during this activities are common in nature in terms of cloud based service provider they aren't provide flexibility for customers (different vendors) to use and integrate services. Switching cloud service is basically hasn't evolved yet and so many work needs to be done in this particular aspect. Plus the major drawback is that organization finds it difficult to migrate service from one vendor to another. The platform should be same as hosting and integrating on current platform may throw up interoperability and support issues. For instance, applications developed on Microsoft Development Framework (.Net) might not work properly on the Linux platform.

F. Gaps in Literature

As a decision making point of view there is little academic research exists and examines cloud supply-chain in oil and gas industry. There have been several industrial developments related to traditional ERP solutions as many of leading software providers like Accenture, IBM, and Oracle are using different platforms but none of them is having separate solution for O&G Industries. A review on existing research

on cloud supply-chain (Figure-3) reveals that literature is conceptual and descriptive but short on practical guidance from decision making prospective. In other words, these studies intend to provide firms with information needed to consider whether to adopt cloud supply-chain as they are mainly focused on pre-adoption stage. The common methods of studies are conceptual framework, case study or survey. Nevertheless it is just a beginning to adopt a new technology and get use to it; but more importantly how efficiently and effectively use it with minimal risks. Hence it is very important that scholars needs to focus on post-adoption stage. Organization who are adopting these cloud based supply-chain needs to understand the inefficiency of one organization should not affect the efficiency of other organization as most of the supply-chain operations are interlinked or interconnected. In order to fill these gaps we need to address these issues and provide solutions in decision science prospective that helps to resolve these issues.

G. Decision Science Approaches for Cloud Supply Chain Solutions

Decision science approaches have been widely used to support executives in making important strategic decisions in various business areas as a effective problem solving techniques and methods which are applied in pursuit of improved decision- making and efficiency. This research will give clear and step by step guidance for practitioners for taking important decision approaches for cloud based supply chain problems.

1) Data Development Analysis Method

It is crucial to evaluate of supply-chain system which uses cloud computing. Data Envelopment Analysis (DEA) is use to measure the efficiency of decision making units (DMU's) as compare to an estimated production efficiency frontier (El-Mashaleh et al., 2010; Ray, 2004). This model can identify inefficient DMU's and compute it to necessary improvements it is such as multi-factor productivity analysis model for measuring efficiency of homogeneous set of decision making units. DMU's should be organizing in supply-chain network (suppliers, manufacturers, distributors, wholesalers, retailers). The DEA model is very useful as it allows supply-chain decision makers to measure efficiency and compare it to make more efficient entire operation but for that output and input matrix of supply-chain system must be pre-determined.

2) Risk Assessment Method

As previously noted cloud computing is not without risks as it is delivered by external vendors through the only one internet medium. Many organization identified risks for example; Schramm et al. (2011) address three main risks: collaboration and the partner eco-system, competitive essence, and security along with that there are some technical as well as legal issues also associated with those risks. Organization must need to understand the types of risks and learn how to control it. To

implement this technology successfully the effective implementation of risk management model for cloud based solution is crucial. In other words this process includes risk identification, risk assessment and risk control. By prioritizing risk and by computing risk values companies can perform some popular risk methods as Monte Carlo Analysis, Tree Analysis, Scenario Planning, Fault Tree Analysis, Failure Mode and effects Analysis, Program Evaluation and review techniques. But they work on probabilistic approach and probability distribution of certain parameters which is only applicable on sufficient information and required data is available. In oil and gas industry this kind of data is difficult to obtain or may not even exists. Without reliable data this methods are unable to identify uncertainties and subjectivities associated with oil and gas cloud supply-chain operations.

3) Risk Optimization Approach

This research focuses on risk optimization by controlling failure probability and failure cost (Beck and Gomes, 2011). Every organization must have awareness of risk associated with program and they need to understand effective risk management approach. In oil and gas industry risk mitigation planning required special training and education as these activities require a long- term planning, top management commitment and involvement of all departments. This research focuses on oil and gas industries efforts to allocate resources appropriately to reduce the negative impacts of risks and thereby, minimize the expected costs of failure. The expected costs of failure can be determined as the product of failure costs by a failure probability (Beck and Gomes, 2011). Failure costs in terms of cost of solution unavailability, replacing solutions that are damaged, rebuilding of solutions, cost of repairing of cloud supply chain solutions. On the other hand, failure probability refers which is the probability that risks will occur in the cloud supply chain implementation process. The risk optimization model will consider cost of optimal safety investment. In order for safety oil and gas organization should allocate separate budget for cloud safety activities.

III. CONCLUSIONS

Based on cutting-edge capabilities we can say that cloud computing are an emerging concept which can change the way of oil industry to do business and collaborate with trading partners. Many organizations are adopting cloud as their major sourcing method as it is rapidly growing in supply-chain management. This research is focuses on pre and post adoption of cloud based supply-chain which can effectively execute with practical guidance in upstream and downstream supply-chain and how to asses and control risks associated with cloud-based solutions. This literature has several important contributions as after adopting cloud as their primary sourcing applications, oil and gas organizations face real challenge while implementing these solutions efficiently under

uncertainty. It mainly focuses on bridge the gap between existing literature which is mainly descriptive and conceptual in nature. This literature proposes three different approaches of risk management which have been proven to be effective problem solving techniques like decision science, risk management and risk optimization. Results of this study are important for practical implementation of cloud based software in oil industries. Supply chain decision makers, as cloud users, will benefit in several ways. First, they can use the efficiency model to identify inefficient organizations in cloud supply chain implementation and find solutions to improve the efficiency of these organizations which in turn will enhance the efficiency of the entire supply chain. Second supply-chain decision makers can use the risk assessment model to identify the size of risk and prioritize it. This will be a very helpful tool to help them determine risk likelihood, risk magnitude, and risk severity; thereby, forming appropriate strategies to reduce the probability of risk occurrence through discovering these risks in time. Third, the risk optimization model will enable decision makers to determine optimal safety investment to minimize expected costs of failures.

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