Supply Chain Integration to Support Technical Innovation in Oil Well Drilling Industry

تكامل سلاسل التوريد لدعم الإبداع الفني في صناعة حفر آبال النفط

By

Golnaz Fathi Khosrowshahi

Dissertation submitted in partial fulfilment of
MSe in Project Managment

Dissertaion Supervisor
Dr. Mohammed Dulaimi

September 2011

DISSERTATION RELEASE FORM

Student Name	Student ID	Programme	Date
Golnaz Fathi	90064	Project Management	May 2012

Dissertation Title :

Supply Chain Integration to Support Technical Innovation in Oil Well Drilling Industry

I warrant that the content of this dissertation is the direct result of my own work and that any use made in it of published or unpublished copyright material falls within the limits permitted by international copyright conventions.

I understand that one copy of my dissertation will be deposited in the University Library for permanent retention.

I hereby agree that the material mentioned above for which I am author and copyright holder may be copied and distributed by The British University in Dubai for the purposes of research, private study or education and that The British University in Dubai may recover from purchasers the costs incurred in such copying and distribution, where appropriate.

I understand that The British University in Dubai may make that copy available in digital format if appropriate.

I understand that I may apply to the University to retain the right to withhold or to restrict access to my dissertation for a period which shall not normally exceed four calendar years from the congregation at which the degree is conferred, the length of the period to be specified in the application, together with the precise reasons for making that application.

Signature

Executive Summary

Studying innovation within the context of supply chain is associated with the establishments of co-operative ties between firm and its supply chain partners in order to create new processes, products and services.

Organizations are more and more obliged to get together and work as part of broader network with other firms to develop or absorb new technology, new product, or merely to maintain their contact with the advance technological developments. These networks are formed upon the collaborative efforts of firms each specialized in specific intermediate component and service complementary to the broader system. Successful innovation is the result of cooperation and how firms' objectives are aligned with each other that motivate the firms to commit their utmost effort for the overall success of the system

This study is aimed to get a deeper understanding of innovation development within the context of oil production supply chain and also to reveal the relations between the impediments in this process and their underlying causes.

The study of current oil industry supply chain revealed range of major factors impacting effective innovation within the area of supply chain management such factors are: collaborative relationships, communication, knowledge, capability and motivation. Motivated by these results, the subsequent part of this paper identifies and studies these factors and their impact on innovation in channel of supply chain.

The ultimate goal of this dissertation is highlights number of lessons for the organisations of relevant business to this study to improve the integration of supply chain in order to facilitate

innovation. The suggestions are based upon the findings of the case study, and the literature review conducted earlier in this study.

الخلاصة التنفيذية

ترتبط دراسة الإبداع في سياق سلسلة التوريد ببناء علاقات التعاون بين المؤسسة وشركائها في سلسلة التوريد بهدف خلق عمليات ومنتجات وخدمات جديدة.

وقد باتت المؤسسات ملزمة بشكل متزايد بالتعاون فيما بينها والعمل كجزء من شبكة أوسع نطاقا مع مؤسسات أخرى لتطوير أو استيعاب التكنولوجيا الحديثة والمنتجات الجديدة أو مجرد الحفاظ على التواصل مع التطورات التكنولوجيا المتقدمة. وتقوم تلك الشبكات على الجهود الجماعية للمؤسسات التي يتخصص كل منها في عنصر وخدمة محددة وسيطة تكمل المنظومة الأوسع نطاقا. ويعد الإبداع الناجح نتاجا للتعاون ولتوافق أهداف المؤسسات مع بعضها على نحو يحفز المؤسسات على الالتزام ببذل أقصى جهد لإنجاح المنظومة ككل.

وتهدف هذه الدراسة إلى بناء فهم أعمق لعملية تطوير الإبداع في سياق سلاسل التوريد في مجال إنتاج النفط فضلا عن كشف العلاقات بين المعوقات التي تنطوي عليها هذه العملية والأسباب الكامنة وراءها.

وقد كشفت دراسة سلسلة التوريد لصناعة النفط الحالية عن طائفة من العوامل الرئيسية التي تؤثر على الإبداع الفعال في مجال إدارة سلسلة التوريد وهي: العلاقات التعاونية والتواصل والمعرفة والقدرة والدافعية. وبناء على هذه النتائج يتولى الجزء التالي من الدراسة تحديد ودراسة هذه العوامل وأثرها على الإبداع في قنوات سلسلة التوريد.

ويعد الهدف النهائي من هذه الأطروحة تسليط الضوء على مجموعة من الدروس التي تستهدف المؤسسات التي تمارس أعمالا ذات صلة بموضوع هذه الدراسة بهدف تحسين عملية تكامل سلسلة التوريد بما ييسر الإبداع. وتقوم المقترحات على نتائج دراسة الحالة ومراجعة أدبيات هذا الموضوع والتي تم عرضها في الجزء الأول من الدراسة.

Table of Contents

List of Figures

1. Introduction

Oil is a finite and scarce natural resource which modern society heavily depends on it as a major source of energy. Oil industry is closely integrated to the world economy and oil products have major part in people's life by fuelling their homes, work places, manufacturing plants, industrial units and transportation system. In addition, they comprise of raw materials for many industries such as plastics, chemicals, medicine, and artificial fibres.

Petroleum, generally referred to as oil, is a fuel formed during the millions years process of tremendous heat and pressure from the decomposition of plants and animals buried in the ground. Oil and gas exploration, development, and extraction are the primary functions of oil and gas upstream industry. Oil fields and reservoirs are commonly placed in sensitive geographical locations such as offshore, forest, and extremely cold areas. The oil and gas extraction and production is associated with huge cost for its processes. Therefore, oil industries are constantly in the need for new techniques and new product technologies to improve the efficiency, safety and ultimately reduce the cost of their functions Rocha et al. (1996).

However, innovation within the field of oil and gas cannot be easily achieved due to the involvement of large, complex supply chain. The petroleum industry is usually divided between the upstream and the downstream activities. Exploration, production and transportation of crude oil and gas to the point of transformation into final products, constitute the upstream activities. The downstream encompasses functions dealing with processing of crude oil in refineries and ultimately the distribution and marketing activities of the oil products. The upstream sector is

comprised of several exploration and production companies as well large number of associated sectors such as seismic and drilling contractors, service rig operators, engineering firms and different technical, technological, service and supply companies that each of these firm's operation involve several activities and utilize many equipments. Ashesh et al (2011) in such complex, and inter- dependable processes, innovation cannot be achieved by single company in isolation but is the outcome of collaboration and integration of entire key players within the petroleum supply chain.

1.1 Aims of the thesis:

The oil well drilling system is comprised of many parts and sub systems which are supplied and manufactured by different manufacturing firms and suppliers. Innovation within oil industry specifically oil well drilling is a multifaceted and complex process that cannot solely be developed in isolation.

Therefore, the aim of this paper is to tackle the challenges of oil production system through project management lenses, and study the importance of effective supply chain integration on achieving technical innovation in oil well drilling industry that will be essential to open up and facilitate the efficient development of oil and gas reserves. Moreover, this paper seeks to develop an improved and deeper understanding of the process of joint design and development activities, the influence of the involved parties, and the impediments and their causes affecting the innovation within the oil well production supply chain .

1.2 Objectives:

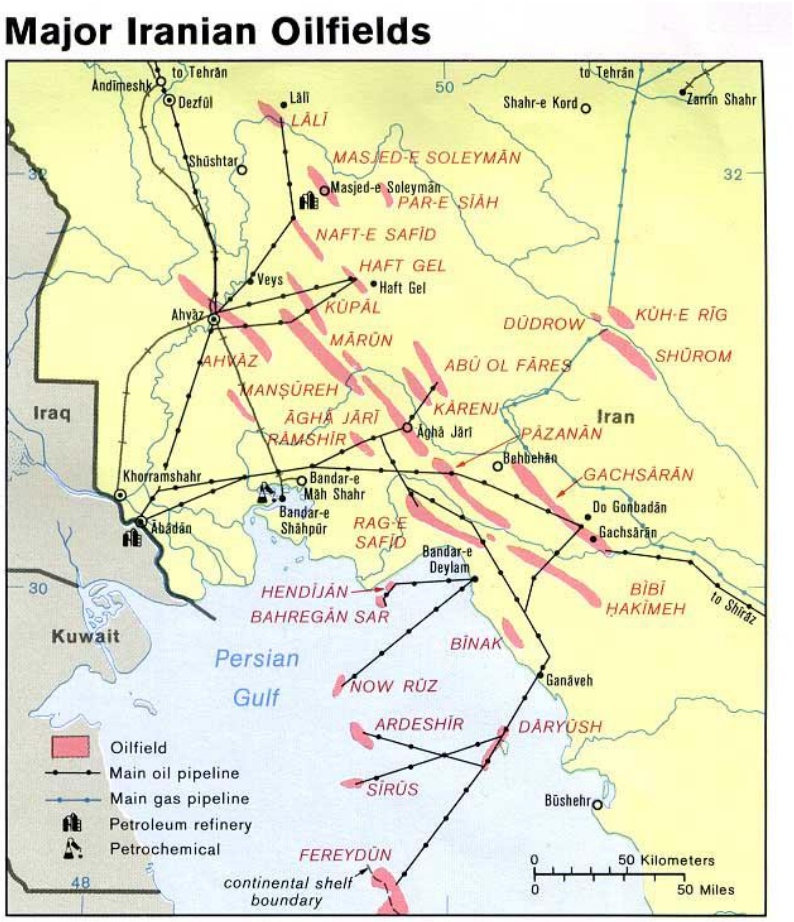
In order to achieve the intended aims, the research will:

- Investigate the impediments of managing successful technological innovation within a complex supply chain.
- Investigate the role of innovation in driving improvements in oil well production.
- Examine the challenges facing project management in integrating supply chain parties to support technical innovation in oil well drilling and production.
- Examine current regional focused practices in supply chain management in oil sector and their impact on the success of technological innovation in oil well drilling.

1.3 Scope of the dissertation and Boundary limits

Due to the extensive size of oil and gas industry, it would not be possible to cover the entire petroleum supply chain in this research. Therefore, this dissertation only focus on the upstream sector of supply chain and merely present general review on the overall system. This research will provide deeper study on the oil well drilling sector and relevant approaches to technical innovation. In order to achieve above, the case study approach has been chosen to provide focus and in depth information on the selected research topic.

2. Geographical Focus



This paper starts with brief description of the geographical focus of the study to reveal the importance of this study for the oil sector of Iran as the selected region of this study. The Gulf Basin hydrocarbon resources are among the world's largest basins. Konyuhov & Maleki (2006), based on number of estimates, the Gulf basin holds 55-68% of recoverable oil reservoir and more than 40% of gas reserves. Iran in particular contains the world's third richest known oil reserves of 132.5 billion oil barrels and the world's second largest natural gas reserve of 971

trillion cubic feet. However, Iran oil industry has not been able to fully utilize its resources for two major reasons.

First of all, the current technology deployed for the oil fields under production is not suitable for efficient production. Iran Oil (2008), current technology only enables to access only 20% to 25% of the overall hydrocarbon of an oil reservoir from Iran's fractured carbonate basins, 10% less than the world average. It is estimated that 400,000-700,000 bbl/d of crude production is lost yearly because of the declines and lack of advance techniques to maintain efficient production in the mature oil fields.

Second, there is a lack of effective technology that makes the production of oilfields efficient, and economically viable. World Oil (2008), there are still various oil fields in the Gulf region that are not been explored or considered for the production. The reported remaining oil basins for the Gulf countries of Iran, Iraq, Kuwait, Qatar, Saudi Arabia, United Arab Emirates are about 585 billion barrels of undeveloped, or non-producing oil reservoirs. According to National Iranian Oil company (2006), Iran's recoverable liquid hydrocarbon reserves was 138,4 billion barrels.

The above information reveals the importance of the selected region in terms of oil reserves and the vitality of technological innovation for improvement of current oil production system and also to activate the idle reservoirs that previously were technically impossible or was economically unwise.

3. Quick review on the technical process of oil production:

Exploration

The input, oil, is located in the ocean. Geologic team as the subsidiary sector of the oil company conduct the seismically survey on tract of land that is of interest under the sea. Using a variety of techniques, team of specialized geologists search for geologic formations that are likely to contain oil. Employing sophisticated equipment and techniques, The seismic ship drags equipment behind it that sets off explosions and the acoustic equipment listens to the returns to determine whether the surface of the sea contains oil reservoir. The oil company then study the reports, and if the reports approve the possibility of oil reservoir, the oil company will lease that tract of land from the government. Soon after, the oil company will hand over the land to the main service company to set up its oil production facilities and start the production.

Production

After the geologic findings determined the likelihood presence of oil, the service company identifies the suitable well sites. Soon after, the service company accepts bids from different suppliers and manufacturers for their drilling equipments . One major sub contractors is the rig company (tower-like steel structure to support the drilling equipment). After winning the bid through tendering process, the rig and other equipments are transported to the desired drilling area and set up for production. The production rig is usually owned and operated by the rig company. The drilling process is usually directed by the company man, the project manager from

the service company, and the rig manager does what the company man ask him to do. One major supplier to the service company is the bit manufacturer. Drilling bit is an equipment of the drilling system that comes in many sizes and shapes based on the section and formation of the ground to be drilled. The bit is attached to the end of drilling string (collection of the well pipes that is being raised and lowered by the rig to facilitate the drilling of the well) and breaks apart the rock being drilled until it reaches the oil reservoir. when oil is found, the drill pipe and bit are raised from the well, and metal pipe referred as casing is sent down into the drilled hole and cemented in place. The casings upper end is attached to a system of pipes and valves called a wellhead, or Christmas Tree, through which natural pressure forces and directs the oil into separation and storage tanks. The entry point of oil from the reservoir into the well is called wellbore. If the natural pressure is not strong enough , pumps are used to force the oil to the surface.

Transportation

Ultimately the output of production referred as crude oil is transported to refineries by different ways such as pipeline, ship, truck, and railroad. Transportation is usually done by separate companies that are funded by the oil company.

4. Literature review

4.1 Preview

This chapter aims to address the objectives of this dissertation by identifying and discussing the theoretical aspect and scholar's view on the concept of innovation within the context of supply chain management of the oil industry. In the first section, general study of oil industry supply chain is presented to bring insight on how the oil industry operates. Afterwards, more specific focus is given to upstream oil sector by presenting major sectors of the upstream oil industry supply chain, their functions and their correlation.

The second section of literature review focuses on the concept of the innovation within oil industry. It presents brief description of some of the major recent technological innovations are reviewed and their impact on oil industry is discussed. Later, sources of innovations from earlier to present time is investigated.

In the third section, the approach to supply chain integration and challenges of collaboration is discussed. The traditional techniques of supply chain management and the current approach to integration in upstream oil industry and more specifically on oil well drilling supply chain is discussed to present the evolution of the system.

The study of current oil industry supply chain revealed range of coordination and collaboration factors hindering effective innovation in this industry. Motivated by these new challenges, the

final part of the literature review is aimed to bring insight on scholar's view on the strong correlation of supply chain integration and innovation. Therefore , the factors impacting the effective innovation in channel integration in supply chain is investigated:

Collaborative relationship:

- Inter- organizational relationship (firm level, corporate level)
- Customer-supplier relationship
- Supplier-supplier relationship

Communication:

- Information sharing strategies
- Types and level of communication links within supply chain

Knowledge & capability:

- Knowledge Network
- Capabilities
- Resource Sharing
- Training and knowledge sharing

Motivation:

- Business Vision & alignment of incentives
- Trust
- Competition

Finally, the third part of the literature review starts by studying the general framework of supply chain management, the traditional application of supply chain and evolution of supply chain concept. And later it proceeds by explaining the following factors affecting the supply chain integration:

4.2 Supply chain in oil industry

4.2.1 Macro Focus: How the Industry Operates

Exploration → Production → Refining → Marketing → Consumer

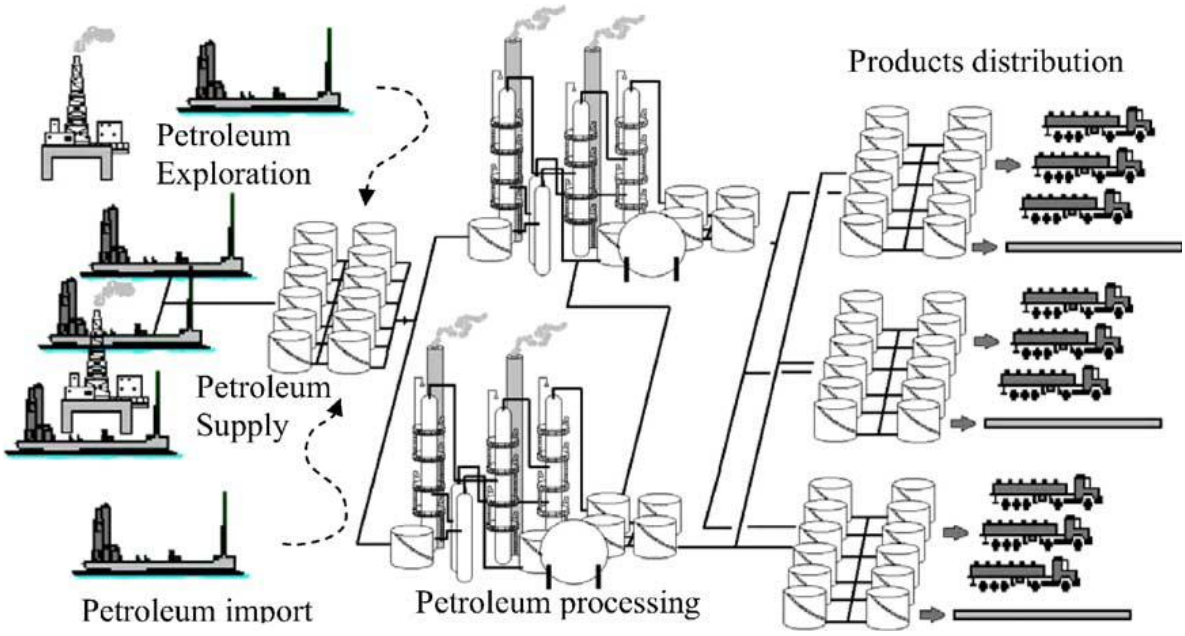


Fig. 1. General petroleum supply chain (PSC).

Oil industry can be broadly grouped in to exploration, production , refining, marketing, and consumer sectors. Exploration is considered as the initial process in the chain that the outcomes of this sector forms a basis for proceeding processes. The exploration process involves number of subsystems including seismic, geophysical and geological operations. The outcome of exploration are information about the oil field formation and its properties. Later on, the findings of exploration are used as the primary source of information in production phase. Production phase involves oil well drilling and production operations. The outcome of production phase is the crude oil that is refined during a complex operation . Like manner, marketing is the customer of refining. Marketing involves the retail sale of gasoline, engine oil and other refined products. The final phase is transportation of the oil products such as gasoline to the ultimate consumer as the end user of this supply chain.

The petroleum industry is divided into the upstream and the downstream activities. Exploration, production and transportation of crude oil and gas to the point of transformation into final products, constitute the upstream activities. While the downstream activities deal with processing of crude oil in refineries and finally the distribution and marketing activities of the oil products obtained. According to Forrest and Oettli (2003), oil industry still manage its activities such as planning, central engineering, upstream operations, refining, and supply and transportation by complete separate entities. Each phase of the link is a separate firm or a unit of an integrated organization.

4.2.2 Micro Focus: upstream oil sector:

Forrest and Oettli (2003), Finding, developing, and extracting oil and gas are the primary functions of the upstream oil industry. The upstream oil supply chain consists of operators (oil companies), main service companies , subcontractors and suppliers. Oil companies are positioned on highest level of chain and they manage the subsystems. Oil companies have interface with governmental entities worldwide and some are directly related to the governments themselves. The upstream supply chain activities are managed by large oil companies. As a subsidiary to oil company, main service company manage the oil well drilling and production. Main service companies are often traditional engineering and contractor companies that have been expanded under years of development strategies.

The service company collaborates and sub contracts the tasks to sub sectors such as manufacturer and suppliers. The majority of procurement is structured as project execution tasks. Each project is unique and different in size. In spite of the large number of suppliers involved in the process, much of the supply chain management is based on the hierarchical model meaning that the service company is the main decision maker and collaborator of the links.

The main goal of supply-chain management in oil industry is to provide greatest customer service at the least possible cost. Therefore, economics plays an important role and the main issue along the links of upstream supply chain is evaluating the benefits versus costs along the chain.

4.3 Impact of technological innovation on oil industry

New advance technologies are transforming the face of oil well drilling industry. Snyder (2004), drilling technology has evolved from 71 feet to many miles beneath the earth surface in different directions. The drilling system can now hold up under extreme geographical conditions of the offshore environment which was not possible just a decade ago. In the same manner, drilling bits technology has advanced in a way that can coax more oil resources from the extremely hard formation of the rocks where just until recently was not even considered.

Schempf (2007), Oil well drilling has greatly progressed from basic geology activities to highly advanced computer based calculations. Precise identification of even small oil reservoir is now possible by advance technology without drilling the ground and eliminates the traditional process of test drilling hoping to spot the reservoir.

Snyder (2004), The 21st century oil well drilling industry is supercharged by technological innovation. Innovation in oil well drilling system has significantly changed the process in which oil reservoirs are discovered, developed, and produced. Technological advancement in oil industry has minimised the risks associated with exploration activities and also reduced the time required to drill an oil well. Also, some new technologies have lowered the production cost by reducing the number of project participants and improved safety. Last but not least, Technological advances have also developed better environmental protection and management of natural resources.

4.4 Source of technological innovation in oil industry

Eva & Martin (2011), Oil well drilling technologies have originated from different sources, such as oil companies, main service companies, government funded research and development centres, universities laboratories, and small firms within the industry. However, the sources of new technology have faced changes over years. Traditionally oil companies developed the new technology to the point of feasibility acceptance and then contract it out to its subdivisions and manufactures to build upon it and produce it. During 1980's, major oil companies reduced their level of research and development on oil well drilling as part of the business strategy to buy new technology products versus in house development.

At the present time, both oil companies and suppliers collaborate to develop new technology, but for the most part, the oil companies are more concentrated on exploration and production activities. Consequently, oil company mostly focus on exploratory investigation and early-stage development to shape and direct the new technology processes. Therefore, the oil company can be defined as a system integrator that pull together various technological elements in its highly multifaceted production system.

Service companies have increased their research and development activities which leaded them to differentiation from competitors and growth in order to be among the major technology drivers in the oil industry. The present technology development model in oil well drilling places large amount of the responsibilities with the service companies. The large integrated service companies join together with smaller contractors and suppliers are often the major source of many innovation in the industry.

Eva & Martin(2011), “A key feature of innovation in the oil industry is that it is both distributed across supply chin and often undertaken in formal collaboration arrangements among them typically involving oil companies, service companies ,suppliers.”

4.5 Integration in oil well drilling supply chain

Oil well drilling system is comprised of complex supply chain that incorporates diverse range of technologies in its system. The literature review highlights the crucial role of planning activities ,Stank et al.(2001). Cross-functional collaborations among the supply chain, Lambert et al.(1999), coordination of the supply chain, Umanath (2005), supply chain alignment of business vision, Peck & Juttner (2000), and communication strategy of supply chain, Lamming (1996). Beamon (1998) defines such cooperation among the supply chain members as an integrated process in which suppliers, manufacturers and other sectors along the chain work jointly in an attempt to acquire and convert the raw materials into products and ultimately deliver them to the end user. Therefore there is no doubt about the important role of suppliers involvement and collaboration in integration of the entire supply chain.

Adams (1985), based on the traditional approach, oil well drilling is a process ordered in a chain of different phases. Some of the processes have linear relationship meaning that on phase should be carried out before the other process could be developed. Vertical integration can be defined as an interaction of one firm with another firm in order to sell an output or buy an input. Vertical integration can be easily applied to oil industry supply chain where the output of one firm in the supply chain link is the input for the other. As mentioned above, the output of exploration is the input to production. The output of production is the input to the refinery, like manner, the output

of the refinery is the input to marketing. Therefore, the oil and gas industry provides a possibility for vertical integration. Moreover, vertical integration is associated with the question of what processes to be performed internally by the firm and what processes to be sub contracted. On the other hand, vertical disintegration is focused on co-development and co-operation with and among supply chain members for new product development. However, new approach to the oil well drilling process has different perspective.

Lasschuit and Thijssen (2003) suggest that there is a great appeal for the oil well drilling supply chain to be integrated horizontally across different subdivisions. The horizontal integration of the supply chain promotes the joint coordination and cross relationship of the layers of strategic, planning, and operation. This approach to the supply chain requires substantial amount of operational information and decision making processes that involves feedstock, production, integration across supply, distribution, terminals, and channel segmentation. The cooperation among different divisions in the petroleum supply chain has a dynamic nature. The decisions in manufacturing can be affected by operating efficiencies, transportation costs as well as production planning.

Mentzer et al. (2000), no single organization in the oil well drilling industry encompasses all the essential expertise, knowledge and capabilities to serve as a natural integrator of the skills needed for successful development of major technology. Corswant & Tuna (2002), firms need to understand that product development and collaboration of the supply chain is a complex process that involves many internal and external interactions. The inter-organizational new product development as well as their collaboration with other manufacturers and suppliers along the supply chain were considered to be crucial to successful new development and generation of new technology.

Neiro (2004), the need for collaboration has forced the companies within supply chain to overstep their organizational boundaries and to consider the surrounding business environment before planning their activities. In support of the latter, Yichen et al. (2010) highlights the need for firms to seek collaboration opportunities outside their firms with partners in order to improve the supply chain's efficiency, and performance. Uzzi (1997), Collaboration of organizations within the supply chain enables a firm to quickly take advantages of the market opportunities. Kalwani & Narayandas (1995), Collaboration among supply chain partners can be the source for innovation, problems are resolved faster and new products will be developed faster.

4.6 Challenges of oil well drilling supply chain collaboration

Eva & Martin (2011), the challenges facing oil industry supply chain has been changed along with the changes in oil production technologies. The challenges have become more complex and diverse hindering what firms could develop internally. Oil well drilling operations require collaboration of the entire suppliers for effective customization of the technology that cope with particular environmental challenges of the operation such as the diversity of geological formation, marine (within offshore operations), hydrocarbon, and weather conditions.

Ashesh et al. (2011), upstream oil industry supply chain is complex due to its global nature and large number of processes and organizations involved in the system. The oil production requires great specialization that would not be possible to acquire all the skills and capabilities in one place. As the supply chain extends the geographical boarders, the integration becomes more complex as the number of variables to manage increase along with the coordination difficulty between the large number of scattered players. Dispersed geographical footprints cause

challenges for collaboration of the supply chain. Therefore, globalization of the supply chain has increased the need for effective supply chain management within the global context.

Moreover, Rao & Rodriguez, (2005) argues that knowledge differences of the suppliers and service companies is the reason for slow progression of new technology development within upstream oil industry. The differences on level of knowledge is sometimes referred as " information asymmetry" . Lack of efficient knowledge of service company is the impediment for effective and rapid new technology development. In the same way, the lack of detailed expertise in new technology development hinders the service company's ability to evaluate the new technology. Fast and frequent development of the new product is related to the firms absorptive capacity that can be developed through joint organizational network of learning, knowledge sharing , and problem solving between supply chain partners.

At the heart of this collaboration cycle is the communication strategy. The frequency, quality, flow and ease of communication that support all the participants in this cycle will have a great impact on the speed of idea-discovery and innovation. Traditional business processes and communication methods need to be changed to support the new integrated view on supply chain. Innovation within supply chain integration involves application of advance information system and IT upgrading to facilitate and increase collaboration of extended supply chain Andez et al. (2005), Morooka et al.,(2001).

4.7 Frame work of supply chain management

Keah Choon Tan (2000) describes supply chain management as the evolvement of traditional purchasing and logistics functions in to a strategic management of the resources and their distribution. Supply chain management involves the collection of business units that facilitate the collection and conversion of raw materials to products and deliver them to the end user by means of distribution system. Moreover, Chen & Paulraj (2004) defines supply chain management as a chain encompassing of several entities of manufacturing and supply that each entity is connected to another in the process of developing and delivery of products to the end user.

Harland (1996), effective supply chain management involves coordination of business activities and relationships within an organization, between the customer and suppliers, among the suppliers and within the entire supply chain. The primary concept of supply chain was implemented during 1980s and is been continued to be used in the current time as an effective method in the area of inter-organizational management of operations, system integration, and information exchange Ashesh et al. (2011) .

Traditionally, supply chain literature studied procurement, and value adding activities without clearly specifying new product development as part of this process. The literature findings often focused on the output excluding the actual dynamics and factors affecting the process of supply chain that led to the new product development, McIvor et al. (2006); Brown & Eisenhardt(1995); Kamath & Liker (1994).

Zairi (1999), today supply chain management focuses on value adding activities, efficient and better use of all resources, materials, people, technology and information for the sake collaborative new developments. Farley(1997), Supply chain integration focuses on how firms employ their suppliers knowledge, capability and technology to improve their competitiveness.

4.8 Supply chain integration

The literature is filled with headword related to supply chain management such as : supplier integration, buyer supplier joint venture, suppliers partnerships, strategic supplier alliances, to address new concept of supply chain management, Tan et al.(1998); New (1997); Londe & Masters (1994).

Tan (2000), supply chain integration can be defined as the coordination of flows of materials and data sharing among suppliers, manufacturers, and the customers. However, an effective integration of supply chain exceeds that and requires formation of co-operative relationship where supply chain partners work jointly towards the achievement of common goal Sheu et al. (2006); Manthou et al. (2004); Stank et al. (2001). Mei & Zhang (2011) state " A supply chain is composed of a sequence or network of interdependent relationships fostered through strategic alliances and collaboration ."

In the support of the above point, Kim (2009) suggests that for linking supply chain management practices and competitive capability to improve the firms performance and technology development, supply chain management practices are not sufficient. while a firm utilizes efficient supply chain management practices, and posses competitive capabilities, it still requires integration of supply chain through strategic alignment of business vision and collaboration with its supply chain. Integrated supply chain addresses the organizations within the supply chain as a unified entity. Such a virtual organization encompasses of number of independent entities with

the common goal of effective management of its functions including the integration of purchasing, demand, production planning, governance and new product development.

Zairi (1999), the integration of supply chain can facilitate the close and smooth interface with new product development. The supply chain integration can be achieved through well-organized linkage among supply chain activities and that can be possible by effective formation and application of supply chain techniques for integrated system. This indicates that a firm seeking effective application of supply chain management practices shall focus on supply chain integration.

4.9 Innovation within supply chain

According to Photis et al. (2009), " Innovation can be defined as any incremental or radical change embodied in product and process and includes change in value activities such as service and administration." Nooteboom (2000), The innovations is owing it novelty to the difference between the component elements, or to the new way that these elements are recombined and therefore regenerated.

Within the context of supply chain, innovation is characterized as an interactive, cumulative and cooperative phenomenon taking place among different entities of a system Zaheer & Bell (2005).Sher & Yang (2005) believe that innovation is associated with the level of co-operation between firm and its supply chain partners in generating new processes, products and services. In fact, firm is a dynamic entity comprising of different subsystems that join together to collaborate and attempt for survival of the firm like a living thing.

Innovativeness has frequently associated to the higher firm performance (Calantone et al., 2002; Christopher et al.,2009;Deshpande and Farley, 2004) since it provides the firm with the ability to generate valuable, unique and differentiated products, Barney (1991). Tan (2000), Performance is improved across the supply chain when all the major supply chain organizations join together and act as a unified entity. Kaufman et al.(2000), firms improve their ability in product innovation by carefully managing their relationships with suppliers and customers

In support of the same point, Zairi(1999), collaboration of technological innovation within supply chain is associated with integrative innovation. The successful innovation management is the result of the interface between the creative and the productive part of the supply chain. Therefore , it is not possible to ignore the area of supply chain when talking about innovation management.

4.10 Elements of innovation in channel integration in supply chain

Number of prior literatures have identified a broad range of factors crucial to successful product innovation. This part of literature review will provide a summary of the key variables within the area of supply chain management, such factors are: collaborative relationships, communication, knowledge, capability and motivation.

4.10.1 Collaborative relationship

Innovation should be analyzed both at the focal organization level, as well as the network level where the goals of the focal firm and those of the collaborating companies are jointly studied. There are number of studies that have looked at the impact of collaborative networks on product

innovation performance. In this section, the aim is to present and discuss the prior literature on different types and level of collaboration within supply chain and its impact on new product development. Level of collaboration is categorized as:

4.10.1.1 Inter- organizational relationship

Firm level:

It is necessary to examine how inter-organization factor plays a crucial role in acquiring, assessing and integrating the external knowledge. Internal network of the organization plays an important part in the way firms attempt to improve the effectiveness of external knowledge Hansen & Nohria (2004).

Inter- organizational networks:

In this context, innovation is no longer examined at the level of single firm. This approach is concerned by the firm's management and integration technique with its partners.

Michel et al. (2008) describes partnership as the collaboration through establishment of specific type of inter-organizational networks that each firm's type of assets and level of competencies to be joined together to create joint capability. The partners in the network are evaluated and determined based on their assets, resources, capabilities and knowledge that are needed for the functioning of the constellation. Technological complexity is one reason that firms collaborate in network since one company is not capable to autonomously develop a new product.

Jap (1999) explains that suppliers partnership can lead to innovation through the combination of ideas from different sources. Likewise, Malhotra et al. (2005),Supply chain partners improve understanding of and reaction time to the market by collaboration and working together.

In order for the firms to engage in partnership activities, they should be evaluated on following factors:

- Knowledge Network : Availability of efficient level of knowledge to participate in innovation activities.
- Skills & Capabilities: Availability of technology and expertise to involve in production activities.
- Cultural Factors & Relationships: Utilization of close and trustworthy partner relationship to engage in the process new developments.
- Resource sharing: availability and willingness to share resources to engage in the activities

4.10.1.2 Customer-supplier relationship

Zairi,(1999), today, supply chain is led by the demand rather than supply, in fact it is frequently referred as " demand chain management". This concept revolves around the customer-focus point of view in which innovation development is mainly based on the customer's specific requirements. The reason is that the supply chain management has shifted its focus from purchasing, converting, and distributing of products to a focus on specific customer demand.

Number of scholars have studied the role of customers in generating innovations Narver & Slater (1994) ; Christensen & Bower (1996).

Based on the earlier view of Michel et al.(2008), Yichen et al (2010) argues that operand resources (such as skills, knowledge, resource, core competence, technology and relationships) instil value during the manufacturing process. value co- creation is a significant driver of innovation with in the area of supply chain. This view suggests that firm's level of knowledge, resources, technology and relationships with other organizations in the supply chain instil value during the new product development process.

The concept can be addressed by advocating a customer-oriented, relational view in which innovation development focuses on a specific customer need, and values the customer's co-creation. Customer-focus view point encourage the following activities to encourage innovation in the system:

- Customer involvement in the new development process
- Organizational culture and strategy of customer-centric services
- Multi-method approach to capture customer knowledge
- Integration of customer solution with the inter-organization's experience

4.10.1.3 Supplier-supplier relationship

In support of this approach to supplier collaboration is the Japanese model of effective supplier partnership Dyer & Ouchi (1993). The Japanese model indicates that suppliers relationship is

significant in new product development and communication has a critical role at all level of interactions.

Dyer and Ouchi (1993) studied the success factor of Japanese manufacturing supply chain. The findings revealed that Japanese method of collaboration is based on long term relationships; mutual goal and focus on new developments; willingness to share strategic information; investment in assets such as plants; R &D facilities, skilled human recourses; effective communication strategy for frequent and intensive information sharing; and trust building practices.

Dyer & Ouchi (1993) stated the part of the Japanese Ministry of International Trade and Industry speech in 1987 that highlighted the significant and influential role of suppliers collaboration "The Japanese manufacturing industry owes its competitive advantage and strength to its subcontracting structure. Essentially the nature of customer-supplier relationships in Japan is based on the fact that the common drive is on maximizing the efficiency of the entire business process of the supply chain."

4.10.2 Communication

The process of collaboration among supply chain members is studied based on frequency, direction flow, and means of communication. Open, regular, two-way, and multilevel communication suggests close relationships among the supply chain, Goffin et al.(2006); Tuten & Urban (2001).

Likewise, Mohr and Nevin (1990) examined the pattern of communication and suggested the concept of ‘‘collaborative communication strategy,” which refers to key communication features including frequency, extent of bi-directional flows, informal modes, and indirect content. Chen & Paulraj (2004) “Communication is the glue that holds supply chain partners together through balanced, two way, multilevel contacts and message services.”

Effect of customer- supplier communication on the new product development has been explored by number of scholars, Katz & Tushman (1979) ; Hauptmann (1986). Based on series of multinational corporation case studies, Wynstra et al. (2000) suggests that the common communication problems of supply chain during new product development are : poor guidelines for suppliers participation; incorrect implementation of the new product within customer’s system; outdated information hinder new development efforts. Mei & Zhang. (2011), miscommunication cause many collaboration to fail by causing conflicts and misinterpretation among supply chain members.

Liker et al. (1998), case study identified technical communication as an area of communication that cause problems during new product development. The findings indicated that in most of the cases the client’s team were not well educated in the supplier’s components yet had full decision power over the development of the component. In this regard, Yichen et al.(2010) emphasizes the role of effective communication in avoiding such coordination and collaboration problems and facilitating integration of supply chain and development of new product.

Collaboration among supply chain organizations is not only pure interactions, but leverages data sharing and creates market knowledge for sustainable competitive advantage, Malhotra et

al.(2005); Tuten & Urban (2001). Lee and Whang (2001) defines information sharing as the deliberate intention to make strategic data available to supply chain.

Min et al. (2005) described information sharing as the heart of supply chain collaboration. Information sharing is defined as the extent and frequency of firm's sharing of related, precise, comprehensive and confidential information frequency Sheu et al. (2006), Cagliano et al. (2003).

4.10.3 Knowledge & capability

Integrative innovation cannot be generated autonomously, hence collaborative partners combine and exchange knowledge and capabilities via information exchange processes, resource sharing mechanism , and effective governance system, Dyer& Singh (1998); Lavie (2006). Liker et al. (1998), argued that level of firm's knowledge and capability network is associated with factors causing technological innovation. The issue of technological incapability and Lack of knowledge caused the need to explore supply chain knowledge and capability networks as critical factors influencing the effective development of new technology or product.

4.10.3.1 Knowledge Network

Bhatt and Grover(2005), knowledge creation activities are mainly concerned with knowledge exploration and acquire of new and relevant knowledge; however, they can extend further to

assimilation and application of relevant knowledge among the supply chain partners which is referred as “knowledge exploitation” .

Harland et al. (2004), acquirement , exchange, and integration of knowledge between the supply chain key operands facilitate innovation and new technology development within the entire system of supply chain. Christopher et al.(2009) There is a strong link between innovation and knowledge. According to Peng et al. (2008), “ The essence of innovation has been characterized as pursuit of new knowledge for discovery.’’ Similarly, Grant (1996), new technology can be developed and lead to competitive advantages through alignment of the knowledge and the strategies of new development.

Fawcett & Magnan (2004) defines knowledge networks as strategic assets that allows to access sources of capabilities located outside the firm’s boundary that could not be achieved internally by in-house research and development activities. Lejeune & Yakova (2005) Firms attempt to attain effective supply chain integration to efficiently utilize the resources and knowledge of their suppliers.

Christopher et al, (2009), knowledge networks of a firm enables the firm to achieve higher level of capability. The combination of knowledge from partners with internal knowledge creates a unique base of knowledge to be utilized in new technological activities that could not be possible otherwise. The process requires managerial support and commitment to dedicate huge resources to gain knowledge about scale, directions, timing and the balance between internal and collaborative efforts. Managers set deliberate intentions of improving corporate learning and establishing with supplier companies in the pursue of knowledge and capability network development.

However, firm's current level of knowledge and capability affects it ability to collaborate with other organizations in the chain for new product development. Cohen & Levinthal (1990) emphasize the impact of prior related knowledge on the ability of firms to absorb external knowledge. Cohen & Levinthal (1990) " the ability to evaluate and utilize outside knowledge is largely a function of the level of prior related knowledge." Eva & Martin(2011). Likewise, Mowery (1983) in his study of the relationship between in-house and contract R&D. He emphasized the importance of internal firm's R&D efforts as a basis for engaging in externally contracted R&D: "the client firm requires substantial in house expertise simply to pose a feasible research problem, or to evaluate and utilize the results".

Eva & Martin (2011) conducted a case study on the evolution of knowledge network and capability of a major Brazilian oil company, within its supply chain integration that transformed it to one of the world leading technological leader in oil production.

The findings revealed that there are many levels to knowledge developments. The first level of evolution is characterized as a new form of network described as " active learning network" was established between the firm and its partners to achieve greater knowledge and capability. The network encouraged two way flow of knowledge, participation in knowledge production, learning from complex technological activities among the partners. These networks were concerned with learning through joint development activities and involve two way flow of knowledge among the partners.

Eva & Martin (2011) described the establishment of more advance network " innovation networks". The innovation networks are pursued by the firms with deliberate intention of undertaking innovation and involves joint research and development activities with partners. The innovation network involves bidirectional flow of design, engineering, and technical knowledge and can be characterized as the source for balance and equally joint knowledge production.

Eva & Martin (2011), describes the most influential knowledge network as "Strategic Innovation Networks". This type of networks do not only involve joint research and development activities and collaboration with other supply chain members, but also technology and knowledge exchange with major oil companies and innovator in the industry. In the support of same point, Freeman & Hagedoorn (1994) revealed that an advance level of capabilities close to the global technological innovator is needed in order to participate in the international technology collaboration.

Parallel to the findings of Eva & Martin (2011), Eva Dantas and Martin Bell (2011) emphasize on the correlation between the development of firm's internal capabilities with the development of their knowledge network. Bell & Pavitt (1995) stated that knowledge exchange among the supply chain members act a link that connect their internal capabilities. However, they later emphasize that knowledge interactions cannot be effective unless sufficient level of capabilities already exist in both of the firms. Hence, firms level of capability affects the type of knowledge network that can be developed.

4.10.3.2 Capabilities

The capabilities of key supply chain operands were identified as another component elements of new technological development and innovation Figueiredo (2010); Lall (1987). Kim (1997)

Number of capability dimensions were identified such as the nature of technological developments; the kind of knowledge base originating those developments; the modes and objectives of learning pursued by firms, and the available R& D facilities and resources to carry out innovation.

Eva & Martin(2011), The findings of the study revealed that similar to knowledge system, there are three model of capability development within the supply chain:

Assimilative capabilities can be described as no formalized mode of innovation development, and limited research and development capability of the firm that only focus on the learning and application of external technology.

While adaptive capability of the firm can be described as a formalized and deliberate mode of learning through training and engaging expertise in the system, as well as the creation of R&D facilities, and hiring of experienced personnel and technical teams to carry out design activities, engineering and relevant technical knowledge.

Generative Capabilities is defined as the most influential mode of capabilities to develop innovation. It is mainly based on independent research and development activities; broader engineering and technical knowledge related to the mode of technology or product development. Generative capability involves formal engineering and scientific activities; hiring people with relevant expertise, educating and training of the personnel, and experimenting and developing novel product or technology.

4.10.3.3 Resource Sharing

As part of the efficient utilization of the capabilities, resource sharing activities such as sharing of manufacturing equipment, facility, and technology are carried out among the supply chain partners Mei & Qingyu (2011); Mei & Qingyu (2011). Dyer & Singh (1998) suggest that firms that combine resources in a unique way achieve competitive advantages over other firms who cannot create the same mode of network because of its unique, valuable, non-substitutable, and difficult-to-imitate nature (Barney, 1991).

In the support of latter, Lavie (2006) also suggest that integrated organizations in dyadic cooperation combine and align operant resources with in-house resources to attain competitive advantage for the organization in focus. Vargo & Lusch (2004) referred to this strategy as an integrator and transformer of micro-specialized competence into multifaceted services that have competitive market advantages.

4.10.3.4 Training and knowledge sharing

Rao and Rodriguez (2005), lack of service company's familiarity with the new technological developments hinder effective technology application in the system. McIvor et al. (2006) revealed the need for training to permit those most affected by new developments to acquire skills and knowledge to utilize the new technology and implement it in the system. moreover, training activities develop better collaboration among the project team, problem solving, and conflict management.

Dantas & Bell (2011) the firms attempt to strengthen their human resources and rebuilt their technical knowledge by investing in training programs, hiring personnel with expertise, attending conferences, and experimenting the new developments.

4.10.4 Motivation

DTI (1994) the real challenge in supply chain is to motivate the suppliers to utilize their maximum effort to make extraordinary contributions to the system. The solution requires change in traditional approach to supply chain and build relationships based on trustworthy collaboration and the expectation that the benefits of collaboration will be shared among the player. In this section motivation dimension is examined within three major themes relevant to the concept of innovation within the area of supply chain.

4.10.4.1 Business Vision & alignment of incentives

Anantaram & Joseph (2004), argue that collaboration and coordination among supply chain organizations generates new challenges and complexities due to the possibility of conflicting business incentives among different supply chain players.

Therefore, collaborative relationship in supply chain should be based on the similarity of intentions, common goal, and sharing of benefits Wong (1999), Tuten & Urban (2001). Supply chain partners can increase their benefits and achievements by collaborating toward common business vision and mutual goals Sheu et al. (2006), Manthou et al. (2004).

4.10.4.2 Trust

Concept of trust has been studied by many scholars as a mean to identify the factors influencing performance and development in supply chain and business relationships of different industries chain. Trust is identified as the willingness of a firm to depend on an exchange with its partner in whom it has confidence Moorman et al. (1993), Currall & Inkpen (2002). Moreover, trust significantly encourage good relationship building and positive interaction among the operands. The role of trust in the area of supply chain relationships is identified and demonstrated by the scholar's studies Seppanen et al. (2007), Moorman et al. (1993).

Gilbert Aryee (2006) stated that trust is necessary for successful supply chain collaboration which is concerned with dynamic relationship for innovation development. Photis et al. (2009) believed that trustworthy collaboration among the supply chain firms disclose the full benefits of a supply chain integration. The reason is that the parties in supply chain can have a better understanding of each other's function and therefore can help each other in improving the supply chain processes Li et al. (2007), Eng (2006).

Trustworthy relationship and effective supplier joint venture may take many years to be develop gradual learning, change in corporate culture, sharing of strategic information Carr & Pearson (1999), Ireland & Webb (2007).

4.10.4.3 Competition

Fiol (1996), technology is an integral part of the oil industry specifically within the oil well drilling field and has a major role in achieving success in global economy. Firms in oil industry

are facing increased global competition to develop frequent technological improvements in order to remain in the market. Firms face the urge to invest large amounts in research and development activities in order to decrease product development times , improve quality and reduce costs so they can remain competitive. However, McIvor et al. (2006) suggest that technological innovation is a result of collaborative relationships in which the focus is on shared interdependence and decentralize power and responsibility and distribute it within the system. According to this concept, competition among firms is replaced by competition among supply chain networks.

5. Methodology

This chapter aims to present the research method used in this study. First, qualitative research method is presented, and then qualitative data collection is discussed including, participants, data collection process, and major criteria themes.

5.1 Introduction

Considering the number of suppliers and amount of resources needed to develop a new design for the section of oil well drilling system and the little research available of the subject as such, it's appropriate to increase knowledge about this matter. The oil well drilling company recently decided to improve its production rate for a major oilfield project and in this regard requested drilling bit manufacturer as its subsidiary company to develop new bit design according to the project requirements. The project yielded many knowledge and experience that will be discussed in this study and later will be aligned against literature theory to attain an understanding of critical factors affecting the successful development of new product design within oil well drilling supply chain.

5.2 Research questions

As part of this study the following research questions are considered:

1. What are the impediments and their underlying causes to effective integration of supply chain that effect innovation?

2. What are the lessons from the research for the organisation to improve the integration of supply chain in order to facilitate innovation ?

5.3 Research alignment

One influential author in method literature, Yin (2003), argues that academic research can have the three main purposes:

Exploratory studies:

Exploratory studies are useful if the researcher aims to increase the reader's understanding of an issue. The main purpose is to investigate situations where the intervention being performed has no clear set of results. (Yin, 2003) "What is happening; to seek new insight; to ask questions and to assess phenomena in a new light". The aim of exploratory research is to form hypothesis based on the research question. In this type of studies, the information is gathered prior to generation of any theories or research questions.

Descriptive:

Descriptive studies are more comprehensive and attempt to describe the characteristics of the situation, but do not provide substance and understanding to the causes of the phenomenon. (Lekvall & Wahlbin, 2001) " A descriptive study is useful when you want to display a case, a process, a situation or an event and the real-life context in which it occurred." (Yin, 2003) "This

study is also appropriate when the problem is structured, but the intention is not to analyze the connection between causes and symptoms."

Explanatory:

Explanatory studies are suitable when the researcher seek to establish and explore answers to relations between causes and symptoms. (Yin, 2003) "In contrary to descriptive studies, explanatory studies provide substance and understanding to its underlying cause." The goal is to study the issue to reveal the relations between causes and symptoms. (Kalbasi, 2007) "Theory is used in order to understand and explain the exact, rather than to produce generalizations".

In order to understand such practices, this case study draw parallel to prior literature and therefore, can be classified as an explanatory case study.

5.4 Research approach

Qualitative :

There are many literatures study the inter-organizational processes with respect to new product development; however, there are less available information associated with an effective integration process of external suppliers in to new product development. In this regard several researchers have highlighted the need for more study in this area, Brown & Eisenhardt (1995); Hartley et al. (1997). Therefore, qualitative method was selected for this case study to achieve deeper analysis of this issue by focusing on specific project. (Berg, 2001) "The qualitative

methods will take a greater extent intended to capture the meaning and experience, that can't be quantified or measured."

The case study approach was used to get deeper understanding of the project in focus that would not be possible with other methods.

5.5 Research Participants

Purposive sampling was conducted as part of the qualitative research approach of this study. Individuals were selected based on their position, their role in the project, and their level of knowledge about the project. Participants of this study included project members from different organizational level, background, level of involvement and area of responsibility in order to study the project from different perspectives.

The overall supply chain had been drawn to indicate the key organizations and their relationship network (Figure 1). As it is shown, the supply chain is divided in to intra- organizational supply chain and inter-organizational supply chain.

Ultimate customer, National Iranian Drilling Company (NIDC):

Within the external network structure, National Iranian Drilling Company (NIDC) is positioned on the highest level of hierarchy as the ultimate customer. The project was initially set off by NIDC. The NIDC's department of engineering and geology studied the oil field and conducted the initial drilling

Main service company, Petro Pars:

Petro Pars service company is a subsidiary of National Iranian Drilling Company (NIDC). When the initial field study was completed, NIDC awarded the oil field production project to Petro Pars. In this study, Petro Pars service company is regarded as the customer to the oil well drilling supply chain. The company has different subsystems such as sub contractors, manufacturers and suppliers that collaborate and provided parts and resources for the oil well drilling project.

Local supplier, Pars Mateh:

Pars Mateh is a local oil well drilling bit manufacturer that is a subsidiary to Petro Pars service company. The company is among the oil well drilling supply chain that provides drilling subsystem to the service company. Drilling bits are among the major parts to be used on oil drilling project.

Pars Mateh partner, Varrel Europe:

Varrel Europe is bit manufacturer company based in France and is in partnership with the local bit manufacturer (Pars Mateh) and work jointly to manufacturer oil well drilling bits.

The head office, plant, and R&D centre is located in France. In each region they have their team of technical support such as engineers, geo science analyst , technician which report to the head office in France. In addition they should also report to the regional manager since they are responsible to set the targets and ensure the budget to be done.

Supplier's supplier:

The bit company has its own chain of suppliers and collaborate with them closely to improve its bit design. These suppliers have close relationship with the bit company at local level bit these suppliers are not considered to be as a single sourced arrangement.

Interview Participants:

The participants involved in this study were the actual key personal that carried through the project and best understood the process of the project. The interview participants included followings:

- Pars Mateh manager
- Bit site engineer
- Bit technician
- Local bit production manager
- Varrel's regional manage in Dubai
- varrel's (bit manufacturer's joint venture) production manager
- varrel's (bit manufacturer's joint venture) head of Research & development centre

5.6 Research Setting

As it was mentioned, the case study project was the outcome of the collaboration between the large number of geographical scattered players. In order to get a deeper understanding of the processes involved in this project and acquire more comprehensive data, I travelled to Iran, Dubai and France in order to directly meet and discuss with the parties involved in this project. Moreover, I visited the manufacturing sites and research & development centre in order to deeper understand the process of new product development.

5.7 Data collection

According to Yin (2009), a good case study use several sources for data gathering. In order to gain information from different sources, direct observation and interview should be used as main measure instruments

Interview/ semi conducted:

The most important source of information in this case study were acquired by According to Yin (2003)s. According to Yin (2003), interviews are the main source for the case study research method and are used to interpret the meaning of major themes through the applicant's interpretation of the phenomenon. Deep knowledge of the situation is obtained and conveyed in common language.

In this study, list of predefined questions based on the literature review were prepared and supplementary questions were asked during the interview to gain more adequate understanding. The interviews were taped with the participants consent. Based on the questions, the interviews have been conducted as a conversation, where I encouraged interviewees to talk freely around the areas I was interested in. During the sessions, I emphasized that each interviewee may express his/her personal opinions and views without any restraint.

- The semi-constructed interview questions are listed in the appendix
- Written documents

In addition to semi structured interviews, written documents relevant to this paper were studied as another type of measure instruments. This included collection of documents related to the

project provided by the bit company and the offshore drilling company. The goal was to complete the findings from the interviews from the qualitative study. The documents related to the project acted as secondary data in this research. However, due to the confidentiality and strategic nature of the project information, the company did not allow me to disclose the documents in this paper.

5.8 Qualitative Data Analysis

The data analysis was conducted by breaking down raw data from interviews and categorize them into relevant and understandable pieces of information. This process helped to interpret the data and draw out the major themes data in accordance with the purpose of this research study. However, It should be said that the data analysis was a continuous process and new findings were added to the research body.

Primary data :

Primary data was first collected in the latter period of the study from the interviews.

Secondary data:

Secondary data was available from start to end from the already collected documents.

6. Empirical findings & Discussion

In this chapter I will present the empirical findings from the qualitative data.

6.1 Introduction

The new bit design project was initiated by the oil service company as part of its production improvement strategy for its upcoming major oilfield production. The goal was to introduce a better design configuration tailored to the requirement of the oil well drilling project.

Since the huge project such as oil well drilling involves the large number of processes ,parties, and chain of supplies , it would not be possible to cover the whole matter in this paper. Therefore, one specific company within this complex supply chain has been selected as the focus of this research to give an insight on the successes factors and impediments of new design development with in such an interconnected and complex supply chain.

Pars Mateh, the bit manufacturer company, has been selected as part of the oil well drilling supply chain and as the main responsible party to develop the new bit design for the major oilfield project. Although the bit company was in direct contact with the service company to develop the new design, the effect of other parties in the supply chain on the process of new bit design has revealed to be of major importance. Therefore, the aim of this research paper is to find the important factors of successful supply chain collaboration that consequently effect the new design development.

6.2 Project characteristics

Complex:

One of the characteristics of this project was its complexity and large number of its processes. The project of new bit design requires vast area of knowledge in terms of technology, materials, and new advances and capabilities in terms of R&D and design facilities.

Geographically dispersed:

Since the project requires high level of capabilities and technological knowledge, it was not possible to find all the required skills and facilities locally in one place. Therefore, the organization (bit manufacturer) had to expand its geographical boundaries and collaborate with peers and suppliers in global context. As a result, the supply chain consist of large number of members located in different part of the world.

Customization:

The technical processes and requirements of one oil well drilling project can't be applied to the other project due to the geography and nature of the oil reserve. Therefore, the new bit design required great customization based on the customer specification and given information about the characteristics of the oil field formation to be drilled.

The oil well drilling operation in focus was an offshore operation and therefore, required greater customization of the technologies to deal with the diversity of geological, marine, hydrocarbon, and weather conditions, particularly with the advance into challenging environments of such as deep waters requiring collaboration with suppliers to deal with such customized demands.

Critical to oil well drilling project:

Oil well drilling can be ranked as one of the world's most risky and expensive projects costing between 400,000 $ -1,000,000 $ per day. The staggering daily cost of oil production demands

no break during the project of off-shore drilling. The project schedule of 24 hours a day , seven-day-a-week often require workers to live on oil rigs for weeks at a time. Within such a pressurized project schedule, careful planning of all the parts and processes are crucial. In this regard, drilling bit as one of the critical instruments to the project plays an important part. Any fault in the bit design or technical aspect can cause major down time of the project resulting in the loss of thousands of dollars.

Expensive :

As it was mentioned earlier, the new bit design project is a complex process requiring vast area of knowledge in terms of technology, materials, and new advances and capabilities in terms of R&D and design facilities. Therefore, having several of human resources with expertise in the subject from around world and provide them with the required facilities and resources is expensive. Moreover, the developed design solution has to be tested many times throughout the project. The process of design- trial of the new product is very expensive and time consuming.

6.3 Qualitative themes & Dimensions

Study and analysis of the data obtained from the interviewee's answers, revealed findings within the area of the research questions and literature review. The data were grouped based on their relevancy to the research question. The categorization of the data helped to extract major themes of the study, these themes were narrowed to five major themes that were more important than others. However, some themes are entangled together and some of the responses from the

interview's participant cross number of themes at the same time. The themes collaborative relationship, communication, capabilities & knowledge, and motivation stood out from the rest.

The study of these themes within the project boundary helps to identify the weakness and strength factors of the project as such and overall supply chain system. By describing and analysing the success and failure experiences during the project, and provide a room for improvement.

Research Strategy & Major Themes associated with innovation within supply chain integration

Major Themes	Criteria analysed using case study data collection method
Collaborative Relationship	• Customer-supplier relationship • Supplier-supplier relationship • Inter- organizational relationship (Collaboration among different partners)
Communication	• Types of communication links between the company in focus and the supply chain • Level of cross-functional communication between the Company in focus and the supply chain

Capabilities & Knowledge	• Capability & knowledge differences between the company and its customer • Capability & knowledge sharing strategies(joint venture & partnership) • Training and knowledge sharing
Motivation	• Business Vision & alignment of incentives • Degree of competition between suppliers • Impact of tendering and contract management

6.3.1 Collaborative relationship

An analysis of data from the interviews and collected documents highlighted the importance of good relationship between different parties of supply chain in this project. The project as such

requires an interactive and cooperative relationship between inter-organizational members as well as external parties(Li & Vanhaverbeke, 2009) .The relationships can be broadly classified to two categories of inter-organizational interaction between the member of the same company as well as intra-organizational interaction with other member of supply chain. The interaction between different level of supply chain is discussed as customer- supplier relationships which discuss the role of customer in innovation. The interaction between the same level of supply chain is discussed as supplier- supplier relationships which examines the effect of other suppliers on innovation of another supplier.

6.3.1.1 Customer-supplier relationship

The customer-supplier relationship in this project was mainly based on the customer focus perspective. The project was initiated by the customer and the project planning and criteria for new bit design development were set according to exact requirement of the customer. The findings of this study give insight on how the interaction network between the service company and the bit manufacturer affect the process of the new bit design project.

6.3.1.2 Supplier-supplier relationship

The findings of this study reveals that the relationship between the suppliers of the same customer is another relationship network that had a major impact on the outcome of this project. however, suppliers relationship network had some constraints . Main service company, Petro Pars, was the centre point of all interactions meaning that if the bit manufacturer wanted to discuss an issue that effect the work of other suppliers, it could not pick up the telephone to solve the issue but had to contact the main service company. Therefore, any type of interactions had to pass through the customer's check point. Main service company was responsible to manage any

issues and coordinate with other suppliers and if necessary would arrange the meeting involving all the responsible suppliers to discuss the issue.

6.3.1.3 Internal supply chain: Collaboration among different partners

In addition to the external relationship of the bit company with its supply chain, Internal supply chain of the bit company is also focused to study the collaborative relationship of the local company with its internal supply chain. In this regard, the relationship of the bit company with its international partner is studied in order to understand how such a collaboration and integration of western European technologies with local insights will affect the project outcome and ultimately the innovation.

6.3.2 Communication

Communication and its head words such as information exchange, and data sharing were mentioned many times by the interviewees. Data findings revealed that from the beginning phase of the project to the end, different type of communication strategy were used between the project stakeholders

6.3.2.1 Types of communication links between the company in focus and the supply chain

Meetings :

Internal meetings: in this case between the local bit company and its joint venture in France. Engineer and site supervisor from the local company prepare a presentation regarding the

performance of the bit and give their findings and suggestions for design improvement to their R&D team in France. Problems of the bit is discussed among them and the decision to make changes to the design is made at the end of the meeting and new requirements are sent to R&D to be studied and developed.

External meetings: among the local bit company as a face of his joint venture and the client (service company) and other sub service companies involved in the project ex mud company, cement, mud logging, rig manager, geologist, BHA company

In this meeting the client point out the weakness of the project, it is very important as a sub contractor to avoid pointing out the problem of the other sub contractors directly it should be said only as a light suggestion, cause it might cause relationship problem in other projects. It is the responsibility of the project manager to point out the problems and require each sub companies to explain the reasons and suggest solutions.

Post run meetings: the main service company project manager explains to all the involved parties what needs to be done in the project

Daily meetings: review of daily report of each party involved in the project on the day, and discuss any problems occurred during the day

Performance review meeting: review the project expectation and check if the project expectations are achieved and the requirements are met. What were the problems encountered during the projects and what needs to be improved.

Project meetings: project team and all the other external and internal relations to be up to speed on what was going on in the project. The frequency of project meeting also made it possible to

issue tasks and overcome issues in plenum. It was appreciated that the project management took advices, in relation to hinder and obstacles, from the rest of the project members into consideration.

Online, interactive Database:

Data revealed that internal communication within Bit manufacturer company was good, and that issues were quickly brought up on the agenda. Bit Company used an interactive online database listing all the company's products and its applications and can be accessed by their people anywhere, anytime.

Database software was accessible to all the internal company team to register and access all the information they need about all the bits, for example, Laurent as a regional manager can select the appropriate drill bit and discuss with the production manager ex he has a customer that wants a type of bit and not sure which bit is more appropriate so he can discuss it with the product manager and compare to select the best one for the customer.

Inspection sheet

That has all the characteristics of the bit with its part specification mentioning each part has done by which technician so in the case of any fault, they can tract the responsible person and fix the problem

6.3.2.2 Level of cross-functional communication between the Company in focus and the supply chain

In order to understand the level of cross-functional communication in this project, communication system is studied among the inter-organizational project team and with outsiders

including customer, and other suppliers in terms of flow, pace and quality of information exchanged

In addition, major project's communication problems were pointed out by the interviewees such as complex communication system, poor guidelines for supplier involvement; information asymmetry; and outdated information which are discussed further during the case study of each phase.

6.3.3 Capabilities & knowledge

6.3.3.1 Capability & knowledge differences :

The project as such, it was very important to have dedicated and experienced people from all involved parties, including bit company, service company and other suppliers. The review of interview data did however emphasize that the level of capabilities and knowledge of the service company in regards to technical aspect of major parts had room for improvements.

It was pointed out that the company man (service company project manager) needed more extensive knowledge about the technical aspect of the sub system such as bit design in order to use it properly for its oil well drilling project.

6.3.3.2 Capability & knowledge sharing strategies(joint venture & partnership):

In terms of inter-organizational knowledge & capability, there was satisfactory comments about the level of knowledge and company's capability to develop new product design. Thanks to the joint venture with French bit manufacturer, Pars Mateh (bit company) increased its internal capability and knowledge. The company got access to new knowledge and advanced facilities and recombine them into pioneering capability to design and manufacture drilling bits. The joint venture increased the Pars Mateh's (local bit company) technological capability and agility to the market and enabled it to produce high quality bits at the right time. As it was revealed in the literature, various sources of knowledge enables the firm to create new combination of knowledge, (Kuen-Hung, 2009). In this case study, the collaboration with different partners allowed the local bit company to establish a unique knowledge network that could not be replicated by the competitors and also increased the chance of achieving the successful design development of new bit due to the diverse and broad sources of the knowledge and capabilities to be shared.

6.3.4 Motivation:

Headwords related to motivation such as incentives, commitment, competition was brought up many times by interviewees. The case study showed that innovation plan can only be successfully implemented if sufficient amount of commitment and effort is put in to action.

In this case study, two type of motivation is emphasized and discussed.

6.3.4.1 Business Vision & Alignment of incentives

While there was a strong motivation for the internal organisation members to create an improved bit design, the overall business strategy of the customer was not effective enough in

alignment of suppliers incentives. The overall business vision of the project is defined by the main stakeholder which in this project is the main service company. The customers as a responsible party that manage the whole project, should create motivation by establishing effective business vision that aligns the business incentives of all the key players and promotes high expected project outcomes, level of commitment and team work among the project key players. However, the comments from the case study showed that there were conflicting incentives between the suppliers that hindered the honest and effective team work among them.

6.3.4.2 Degree of competition between suppliers

Competition was a motivation driver that improved the internal collaboration of the bit company specially with its international partner to meet and exceed the customer's requirement in order to beat the competitors and sell its product to the customer. However, the study identified number of external factors such as political policies and managerial decisions that affected the number of competitors and degree of competitions.

6.3.4.3 Impact of tendering and contract management

The case study findings showed that the type of tendering effected the supplier's motivation in developing new design. Volume tendering was conducted for the selection of the suppliers. The volume tendering ensures the purchase of large quantity of product from the supplier. In this case, the oil company buys the parts in large quantity and the orders are usually in volume. therefore, the focus will be more on providing customer with large quantity of products or parts in a short time with good price and reasonable performance. While for a successful product

design, the motivation nature should be on optimum performance. The case study will later study how the tendering strategy affects the nature of the suppliers motivation to produce new product design.

6.4 Project phases

Phase One: Initial Analysis & Specification

The project was set off by the ultimate customer, National Iranian drilling company (NIDC). Initially, NIDC's engineers and geologist studied the oil field and did the initial drilling before handing the project over to service company (customer). When the initial field study was completed, NIDC awarded the oil field production project to Petro Pars as one of its subsidiary and provided them with the main planning and its requirement.

By the time the project was awarded to Petro Pars service company, pre production planning (well planning) was carried out by the service company team of engineers and geologists based on the specific requirement of the oil company. The project review was conducted assessing the technical and operational scope. Later the project plan was conducted and the subcontractors and suppliers were selected to participate in the tendering process.

Selection of Suppliers / Tender Process:

Number of suppliers and sub contractors were invited to participate in the tendering process. Petro Pars service company provided them with all the detailed technical information of the project (well program) on the number and type of the wells, type of the formation , time and

procedure of each section and requirements . The tender proposal were both technical and commercial giving the service company the chance to compare them based on both criteria.

Types of tender: volume tender

Volume tendering was conducted for the selection of the suppliers. The volume tendering ensures the purchase of large quantity of product from the supplier. In this case, the oil company buys the parts in large quantity and the orders are usually in volume. therefore, the focus will be more on providing customer with large quantity of products or parts in a short time with good price and reasonable performance.

Awarding the tender:

The client (main service company) was responsible to provide all the necessary information such as well property and characteristics of the formation to its selected sub contractors and suppliers. In this project, the client advised the bit company to focus its design development on different type of bit than previous projects(using roller cone bits instead of PDC bits) because the formation of the well scratch and damage the PDC bits. In this situation the drilling should be done by roller cone bits and the final section of the well should be drilled by PDC bits. This requires the bit to be pulled up and changed which can be time consuming and very costly. In the drilling project that has the daily cost of 300, 000 dollars , time plays a critical role. Because of this special situation, the client required a new solution that must be less time consuming and more cost effective.

Phase Two: Design & Solution Development

As it was revealed in the first phase, the new bit design was primarily based on customer requirements, characteristics of the new project as well as evaluation of bit performance in the previous projects with number of common characteristics.

The client's requirements as well as the special conditions of the project was initially received by Pars Mateh as the local bit manufacturer and later through discussion and meetings with its joint venture partner in France, the information were analyzed in order to proceed with new bit design. The local company site technician and engineer communicated with R& D headquarter in France. Through the two way communication, the new PDC bit was designed that was scratch resistance and could be run through different section of the well and therefore, there was no need to waste production time by pull up and change the bit type.

The scientific analysis was done involving both local and international members such as engineers, technicians, geologist team on the following factors:

- Section of the well the bit will be used
- Well profile: vertical / directional, if horizontal what motor is going to use to give the directional angle
- Type of the formation: requires different design and material of the bit
- Well architecture: casing

Some of the technical support was done by their local joint venture company and some by sending resource from France to Iran. Most of the job is done by them since they receive all the information from the costumer and analysis and finally send the product design request. Based on the design request, the order is manufactured in plant.

Phase Three: Performance Testing & Evaluation

For an appraisal project, drilling bits were provided to the service company to be tested in an appraisal well.

Initially the service engineer from the bit manufacturer had to be presented on the appraisal project to find the optimum drilling parameters for the new bit; since, the best of the bit design cannot give the best performance if not given the right parameters.However, no one from the bit company was present during the project and also service company did not update the bit provider during the process of the appraisal project. when the new scratch resistance bit was run in an appraisal project, the performance rate was still low.

When the evaluation finished, bit company were told that their bit performance rate was low. Post project meeting was held between the internal parties (in this case the local bit company engineer, and site supervisor as well as a designer and engineer part of the joint venture team in France) to evaluate the performance of the new bit design.

After number of meetings between the service company and the bit company, it was revealed that there were many factors affected the performance of the bit.

- The bit was not run properly, the bit type was not appropriate for section of the well which it was used
- The parameters applied on the bit was not correct.
- The design alteration on the bit has affected the performance of BHA which is another tool that is provided by another company.

During the post meeting, it was pointed out that the company man (service company project manager) needed more extensive knowledge about the technical aspect of the bit in order to use it properly for its oil well drilling project. For example, during this project, special technical

procedure had to be done on specific part of the bit to make it ready for the project, however the company man ignored the bit company request and called it unnecessary. The situation caused disruption in the project until the company man reviewed the manual of the part and realized he was wrong. The problem occurred because of the lack of knowledge of the project manager on technical procedure.

In order for the new bit design to work properly, the service company project manager felt the urge to coordinate meetings between the bit company and BHA company to resolve their design issues. Finally, The cooperation through the main service company was done between the bit company and the BHA company to resolve the problem and make changes accordingly. It should be emphasised that only by changing the bit design, the performance rate of the drilling cannot be improved. Performance rate depends on all the parts involved in the drilling and one part performance is related on the performance of another part.

As a result of this situation, the appraisal project had to be repeated however, this time a technician from the bit company was present during the project and monitored the bit performance and made sure the bit technical requirements were met by the service company people.

Yet, the service company hesitated to inform the bit company about the exact time of the next appraisal project and notified them just days before starting the project. While on the other hand, the bit company had to be informed long time in advance to make the arrangement with its joint venture in France in order to send the technician for this project. Therefore, the bit company could not make the arrangement for the technician trip to Iran in such a short notice and eventually had to make a compromise and send a local technician on site.

During the project, company man (project manager from service company) was the number one responsible person to coordinate the resources, procedures, and had the full authority over the subsidiary service companies and suppliers. However, the company man's involvement in job of its subsidiaries caused critical problems and down time of the project. For example, in this project, special technical procedure had to be done on specific part of the bit to make it ready for the project, however the company man ignored the bit company request and called it unnecessary. The situation caused disruption in the project until the company man reviewed the manual of the part and realized he was wrong. The problem occurred because of the lack of trust of the project manager in subsidiary company, and also the lack of knowledge on technical procedure.

During the final post project meeting, the drilling bit supervisor who monitored the drilling bit at the site, presented the group with his site report and findings about the bit performance. Later in the meeting, suggestions were given from key parties to make changes to the bit design.

Phase Four: Production Acceptance/ Redesign

Based on the post project meeting with customer and other suppliers involved in the appraisal project, the design changes were applied to the bit. The bit was redesigned and the new proposal was given to the customer (main service company). The new presentation was provided to the client specifying the advantage of the revised design, and once approved the new design was sent to the production and scheduled to be tested in the next appraisal project.

This time, the service engineer from the Varrel (international partner of the local bit company) had to be presented during the project to find the optimum drilling parameters for the new bit and educate the customer on the new design application.

The process of design development was a circular process and continued until the bit was approved in the appraisal project. Meeting were held among the service company and all of the sub system company such as bit company that were involved in the appraisal oil drilling project.

The focus group provided feedback and suggestions for improvement so that the cycle could be improved further. The information design cycle was repeated several times, based on the feedbacks and review obtained from the focus group, until it met the customer's requirements of the project. Finally, when approved the bit prototype was sent for production in larger quantity and later was used in the service company's major oilfield production project.

Despite the fact that the new bit design for the project ended with the approval of the product however, due to the nature of the field, the customer always asks for the better, more durable bit. Therefore the design process is in the circular progress to keep up with the competition and is in constant change to meet the requirement of upcoming projects.

6.5 Qualitative themes by each phase

6.5.1 Phase One: Initial Analysis & Specification

Collaborative Relationship

The customer- supplier relationship in the initial phase of the project was mainly one way flow from the customer to the supplier. The service company (customer) had the pre-eminent decision-making power in this phase, allocating the tasks and providing the bit company as part

of its subsystem with what exactly needed from the new bit design. The service company is positioned on top of the supply chain hierarchy meaning that all the collaboration between the subsystem had to go through the service company.

Communication

Customer-supplier communication was emphasized by all the interviewees as a major factor influencing the project. The initial phase was the most critical time to assess the overall situation, analysing the customer's need, project customization, and the project characteristics. In this situation, the key to success was to gather as much information about the project as possible. Therefore, the need for information gathering was the reason why communication is the most important factor in the first phase.

There was a moderately complete and clear communication between the supplier and the customer in the first phase of the project. Project specification was completely understood and agreed by both parties to avoid any problem later in the project.

communication is the neural system" of the project and without it; no involved parties would work properly.''

Complex communication system

Some of the comments were that more accessible and uncomplicated system of communication between the supplier and customer should be adopted that improve the communication pace. Complex coding system for documentation and communication that comes with a manual that explains each code: even for sending a short email to the service company, complex coding system should be followed. Which is very time consuming and can cause mistakes and headache

for the subsidiary service companies and suppliers to communicate with the main service company.

Capabilities & Knowledge

Capabilities and knowledge in first phase of the project was mainly focused on the service company's (customer) ability to provide the sufficient information about the project to its supplier. As it was mentioned by bit design engineer " Because of the challenging oilfield characteristic, the customer could not give the complete information about the formation and characteristics of the field to be drilled and it makes it very hard for us to design the bit with incomplete information"

The quote revealed that the service company's capabilities and knowledge directly effects the supplier's design abilities. In this project, lack of advance technology in geologic tools had affected the bit company's design capability.

While on the other hand, the supplier good level of capabilities and knowledge was vital to digest the project specification and the information given by the client and to develop it into marketable product.

Motivation

The type of formal collaboration between the service company and its sub system was a reason that limited the influence of suppliers autonomy to come up with total innovation. As it was mentioned earlier, the service company (customer) had the full decision-making power allocating the tasks and providing the bit company with what exactly needed from the new bit design leaving little room for the bit company to make great changes. Therefore, low level of

autonomy was another factor that weakened the motivation to come up with an entire new bit design.

Moreover, the type of tendering ‘‘ Volume tender’’ used in the first phase changed the nature of the motivation. In this case, the motivation for the new bit is price based rather than performance. Therefore, the manufacturer is not motivated to make major changes to its existing design rather focus on the financial benefit of the project since he is ensured that he has the order.

6.5.2 Phase two: Design & Solution Development

Collaborative relationship

The collaboration in this phase turned out to be very important since it required very close interactions between internal members of local and international partners to work as a team and combine the local partner knowledge of the local industry with western advance knowledge to develop a distinctive bit design. The internal collaboration between the local bit company and its partner was cross functional meaning that the project members from both companies of different departments were in direct contact to discuss and resolve any imminent issues.

Communication

In the design and solution development phase, communication was mentioned by the all the interviewees. A substantial part of the work done in this phase, was conducted in France, where all the design facilities and major part of production plant were situated. It was mentioned that the regular and two way communication between the internal members was the main tool to control the resources within geographical dispersed location of the members and to ensure that

they progressed according to project plans. Good internal communication system such as online interactive database, video conferences, sending expert human resources from France to Iran, were used on regular bases between partners in Iran and France.

Capabilities & Knowledge

The internal knowledge and capability of the supplier during the design and solution phase revealed to be important to meet the needs of the customer, and enable them to react on time to any sudden changes during the project. With insufficient technological capability, firms may not be able to meet the needs of customers, and will experience delayed reactions to the issue even if they discover latent customer needs.

According to the bit company's bit company's regional manager in Iran " sometimes the customer make changes to some parts of the project for example they in this project they changed the mud type and did not inform us about the changes. Fortunately, we had the similar experience before and could react quickly and adjust to the new parameters however"

while there was the difference between the capability of the local bit manufacturer on what it could do locally, and what to be done outside the local market. knowledge differences between the local company and the international partner was minimized by the regular training of the local technicians and engineers by the international partner. During this project, number of engineers flew from France to Iran to train the local technicians on the features of the new bit design and new processes involved for the final production processes.

Motivation

The inter- organizational motivation factor definitely existed during the design and solution phase. As one of the interviewees mentioned, the aim of the project was customer focus and to come up with a new design that satisfy the customer's need.

The company was motivated to win the competition from other bit manufactures by producing higher quality bits faster than their competitors, which could help the bit company could earn higher economic returns. According to the local bit company manager "competition is high, and we should be at the edge up technology to compete"

6.5.3 Phase three: Performance Testing & Evaluation

Collaborative relationship

The main objective of this phase was reliable testing of the established design solution. The project management role of the company man revealed to be crucial to the success of this phase. The company man was the executive force and responsible for coordinating the tasks that needed to be conducted to reach the project objective. However too much involvement of the company man revealed to have adverse affect in this case study. As it was described in the phase three, the company man attempted to govern every small procedures concerning the bit. Therefore, every small action had to be overseen by the company man, although it can ensure the accuracy of the task but can be very time consuming and requires vast area of technical knowledge about each subsystem which cannot be possible in a oil drilling project that contains huge number of subsystem and parts. The situation called for the importance of the good relationship and trust between the customer and supplier that allow the sub system to make decisions that facilitate the project result and accelerate the processes.

Good relationship and trust between the suppliers were also highlighted. As it was given an example earlier in the phase three of the project, the performance rate of the drilling bit was directly related to other subsystems. As it was explained by the bit site supervisor, the parameters given by the rig manager (another supplier involved in the appraisal project) is the major factor that influence the bit performance. Therefore, there should be not only a effective communication among suppliers such as rig manager and bit company but also a good working relationship. The reason is that the bit engineer was not always at the site to monitor the bit performance, and if not in the good relation, the rig supervisor can cause low performance rate for the bit by applying wrong parameter on it. This example reemphasis the importance of trust and good relationship among the suppliers.

Communication

Comments were made that although there were good amount of communication prior to the project commencement, better communication during the project should have been implanted by the company man (project manager). Pre-project meetings were held among the project manager (company man) and all the subsidiary service companies involved in the project to make sure that each party was aware of its responsibility and the project requirement. However, lack of effective communication between the suppliers about the unanticipated issues during the project was as the reason that the supplied bits for the appraisal project were misused leading to low project performance rate.

Capabilities & Knowledge

Internal capability and knowledge of the bit manufacturer was critical factor in design and solution development phase. While during the evaluation phase, the comments were more about

the current level of the service company's capability and knowledge .The case study revealed that the service company's ability to use its own prior related knowledge to understand and use its subsystem knowledge directly affected the design and implementation of the new bit. The company man (service company's project manager) had relatively good experience in the field and knowledge about its subsystem products. However in this phase the problem was not the knowledge level of the service company but the service company's capabilities in terms of available tools and parts for its oil drilling system.

Due to the international political policies on Iran oil production industry, some of the drilling tools and parts are sanctioned. For example, there was a problem for providing spare parts from original rig manufacturer company. Therefore, spare parts had to be provided from less desired sources, these parts had relatively shorter life time and had to be replaced more often causing down time and unreliability in the project. The rig is the main piece of oil drilling equipment that provide the bit with necessary parameters to perform. the problem with rig parts directly affected the evaluation of the new bit design.

Motivation

There was lack of mutual incentives that discouraged teamwork among the subcontractors and suppliers. Every subcontractor's performance was evaluated merely on their responsibilities and not on the overall project performance. While on the project as such, each subcontractors part is integrated and compliments other subcontractors part. For example In order for the oil drilling project to be done successfully, all the service companies had to do their part correctly without any compromise in their performance, however, this was not the case. The case study revealed that in this project, there was the case of conflicting incentives, the rig owner company was not

honest about the capability of its rig (said that the maximum amount of torque it can give to the bit is 5000 while it could reach to 10000). The rig owner was getting his daily rent and was not motivated by the better performance of the drilling and rather compromise in its performance to not ware out its parts. While on the other hand the bit company needed better amount of torque given by the rig in order to increase its performance.

In this case, the comments emphasized on the responsibility of the company man as the project manager to clear all the required parameters ahead of the project and reach agreement among the group of subsidiary service companies to avoid any argument during the project. And also to make sure that no party compromises in their parts.

6.5.4 Phase four: Production Acceptance/ Redesign

Collaborative Relationship

The main goal in phase four was to reach an agreement with the customer about the final design of the bit. Therefore, a large amount of communication was running back and forth between the customer and the supplier. However similar to the initial phase of the project, the interactions between the bit company and other suppliers were entirely managed by the service company and the main objective of the collaboration was to finalize the design based on the customers suggestions.

Communication

The communication process in the phase four of the project was similar to phase two in which the information in regards to design evaluation and redesign suggestions were obtained from the customer and transferred to the internal organizational team. Through the constant two way

communication with internal partners, the feedback from the appraisal project and customer suggestions were implemented in to the new design. The good communication was vital for the company to shorten the redesign process and ensure the redesigned bit model ultimately met the customer's requirement. Answers from the interviewees underlined that the communication between the internal and external key players boosted the quality of the final product.

Capabilities & Knowledge

The appraisal project in phase three revealed some problematic incidents that occurred because of the clients lack of knowledge about the new bit design as well as its lack of capability to apply the needed parameters to the bit in order for it perform in its best way. This description of the problematic incident during the appraisal project disclosed the need to educate the customer about the new design so that the same problem would not happen during the real project. several interview participant emphasized the value of sharing the knowledge and educating the customer about the new product system and its properties. The proper knowledge of the customer about its subsystem parts ensure the rate of successful use of the new bit design during its major oil production project.

Motivation

Learning during the bit design project was mentioned as the motivational experience. The project team appreciated the chance to work on a novel project, learn new skills and apply them in new field. As it was said by the head of R& D centre of bit company

"We enjoy a particular challenge faced by the new project, it gives a sense of control in being able to cope with that challenge. Learning new skills boost people's self-confidence in their capabilities and lead to better results"

7. Final Discussion & Conclusion

This study tried to give a more comprehensive insight about the process of new product design process of one company that is part of an integrated supply chain such as upstream oil production. The case study of a single project was conducted in order to deeper understand the situation. Based on qualitative data collection method, key themes that had major effect on the project's outcome were identified and discussed based on the different issues occurred within different phases of the project.

This chapter presents the answers to the research questions mentioned earlier in this paper:

- What are the causes of the impediments to effective integration of supply chain that discourage innovation?
- What are the lessons from the research for the organisation to improve the integration of supply chain in order to encourage innovation ?

The main reason behind the project initiation was the customer's demand for a more advanced technical solution for the drilling bit that can meet the distinctive requirement of the oil field formation to be drilled.

Study of the narrative data from the interviews yielded five important themes which influenced the project outcome significantly. While the themes are common within the project management territory, but nevertheless revealed some unique insights on how these factors can lead the project destiny. The project was a joint cooperation between the external and internal resources. I

believe that the inter-organizational collaboration between the local bit company and its international partner was very good in promoting new bit design. Most of the problematic incidents occurred externally mainly between the customer and the supplier, and in some cases among the members of the supply chain.

Analysis of the themes based on each distinctive phase of the project helped not only to identify the impediments but also to dig deeper and reveal the source and cause of these barriers.

Collaborative relationships

The practical value of this case study lies in a better understanding of how the configuration of a collaborative network affects its own performance. The impediments to the effective collaborative relationship should be searched in the overall supply chain power structure. The supply chain in this case study had a hierarchy based structure meaning any inter- subsystem issue had to be referred upwards to the service company. Suppliers had no autonomous interaction with other vendors during the design development but with the service company's engineers and personnel. Vertically integrated supply chain was the reason that the Petro Pars team had preeminent decision-making power, and the subsystem company's' decisions were constrained to innovation activities. In this situation, each subsystem team was linked to others by passing through the service company gate, therefore, it was not be possible to consult with other supplier directly about the design of the new bit and how that change would affect their part as well. Although the customer transferred the information to other supplier but the quality of the collaboration would not be the same as it could be if they could be directly in contact and were not limited to the formal meetings conducted by the customer every now and then. Moreover, this type of structure put a heavy responsibility on the customer to manage every

aspect of the project had weakened any chance for the suppliers of same level to build a good working relationship. Furthermore, the findings of the case study showed that, too much involvement of the customer was not helpful to innovation but was problematic for the supplier to perform its tasks properly. The case study showed that having the customer as the centre of any interaction could hinder direct decision-making and intervened to resolve conflict

In addition to the external structure of the supply chain, this study showed that different types of collaborative networks such as joint venture and partnership can help the companies to achieve the desired innovation. This can have important implications for managers to be aware of the importance of suitable partnership as it is an important factor for better alliances in product innovation performance. Companies should view collaboration with different partners and suppliers as a mean to acquire external knowledge to improve their internal capabilities.

Communication:

Communication was acknowledged by all the interview participants as being crucial to effective integration of the overall supply chain. The case study indicated that the project team recognised the criticality of the communication but commented that it was also one of the main challenges to integrate suppliers functioning. The findings however, also revealed that the drilling teams would benefit from consistent level of communication throughout the project. while, it was indicated that there was a good amount of communication prior to project commencement such as pre-task briefing and pre-project meetings, there was less findings that the same level of communication was maintained during and after the project. There appeared that lack of effective communication between the suppliers about the unanticipated issues during the project was as

the reason that the supplied bits for the appraisal project were misused leading to low project performance rate.

Knowledge & capability

Findings provided important implication for knowledge and capability that affected innovation. Level of knowledge and capability of the firms showed to be an important factor that enabled the project team to come up with novel product design. In order to have a good level of knowledge and capability, firms need to search for various resources outside of the organizational boundary. The Firms explore the latest new knowledge across industry boundaries and geographic locations. The case study showed that one way to achieve this goal is through suitable partnership and joint venture activities. Moreover, the study showed that the organization on its would not be able to undertake novel innovation internally if it did not collaborate with its partner. Therefore, external knowledge was needed to recombine with internal knowledge for innovation. In addition to inter-organizational knowledge network, further findings indicated that the client's level of knowledge and capability to understand and use its subsystem knowledge was comparably an important factor to the design and implementation of the new product. These findings show that, sufficient amount of knowledge and capability should be existed within all the key members of the supply chain. Both customer and the suppliers should be able to transfer their knowledge and also be able to absorb the external knowledge.

Motivation:

The findings of this paper highlighted the role of motivation on the level of trust, commitment to task, and competition within the supply chain. The comments showed good motivation existed

among the internal members; For the reason that there was a clear customer focus strategy and strong goal from the management to win the design project. Also, members of the bit company were all motivated by the new challenge and learning opportunity that the design project provided them. Moreover, Competition was a another motivation driver that improved the internal collaboration of the bit company specially with its international partner to meet and exceed the customer's requirement in order to beat the competitors and sell its product to the customer. However, the study identified number of external factors such as political policies and managerial decisions that affected the number of competitors and degree of competitions which also affected the motivation.

While the inter-organizational motivation definitely existed , the further findings showed that the external motivation among the supply chain system was less effective. The comments from the interviews pointed out to the lack of aligned incentives as the main issue that hindered strong motivation. Further study of the findings revealed that the customer's overall business vision and management of the subsystems was not effective enough to generate a common goal and teamwork among the subsystems.

Therefore, it can be said that having an effective business vision that evaluates the subsystems based on the effective teamwork with other suppliers can be beneficial to encouraging motivation. Also, correct management of the subsystems through adequate co- ordination and co-operation of the suppliers promote good relationship and motivation for effective teamwork resulting in better new product development.

8. Recommendations

Based on the literature review and the findings of the research, the following recommendations are presented to improve the success chances of future similar cases:

There is a need for improvement in the customer- supplier relationship: as it was revealed from the findings, many of the problematic incidents occurred externally mainly between the customer and the supplier. One issue with the customer supplier relationship is about the technical communication. It was revealed that the customer's technical knowledge about some detailed part of the subsystem components were not sufficient, therefore, it is the responsibility of the supplier to provide comprehensive information and instruction of the component to the customer prior to the project commencement to avoid any misunderstanding and delay in the project.

On the other hand, in order to establish a close relationship, the customer should be more open, honest and direct about what is needed to be achieved and its requirement from the supplier. The customer should establish a strong business vision by declaring its intention on the outcome of the project and share in detail what is required from the suppliers to make sure the success of the project is achieved. This can be done not only during procurement but should be continued during the process. The supplier should be constantly updated about any changes on the project requirement to avoid any problem afterwards.

There is also a need to improve the relationship among suppliers in the chain: the major issue was the lack of interaction that hindered effective communication and relationship building among them. The study revealed that supplier relationship is not autonomous and is based on the customer's decision. Open communication, and direct channel of communication must exists among the suppliers of the chain . It should be easy to get in touch with other parties if there is

any related question or issues to discuss. The direct communication will encourage suppliers of the same system to exchange constructive feedbacks that will improve the overall system of supply chain.

In regards to communication, there is a need for better information sharing system to link the external supply chain members and facilitate co-operation. The current complex coding system for documentation and communication is very time consuming and can cause mistakes and headache for the suppliers in the chain to communicate with the customer. Therefore more IT advance system such as interactive online system is necessary that can make interaction and information exchange accessible, and instant to all the parties furthermore, it will ensure more consistent level of communication throughout the projects.

Although the findings revealed the good level of internal knowledge and capability of the bit company, the main issue was the lack of others suppliers' level of capability that affected the bit company new development, hence, effective strategy should be employed to fill this gap. Firm in the chain should constantly improve their level of knowledge and capability via regular training, conference attending and education of its human resources . Also, the firm should search for various resources not only in local market but also across different geographical locations. This can be achieved through formal collaboration such as partnership and joint venture.

Although the findings revealed the good level of motivation within the inter-organizational level, however, there should be stronger level of motivation to encourage the collaboration among suppliers. In this regard, the customer is the responsible party to establish effective motivation drivers in the system of supply chain. This can be achieved during contracting and procurement

by establishing team-based financial and other incentives that provides the opportunity to evaluate the suppliers by their contribution to the overall outcome of the project and not only their autonomous responsibilities.

Limitations & Future Research

It should be pointed out that the research area of this study is narrow. I have chosen case study method therefore, the findings are very unique and cannot simply be compared to other cases. This study did not attempt to generalize; in order to generalize, the researcher requires various set of tests, which this case doesn't present. According to Yin (2009) " case studies are in fact can be generalized to theoretical propositions, but not to populations or universes." However comprehensive literature review was conducted to form a theoretical proposition stand that has been examined against the project in focus.

In terms of future research, This study identified five major themes that highly impacted the case study project. However, these findings left room for further research and improvement in this area. Perhaps, quantitative study can be used to increase the sample size in order to generalize the theory.

In addition, future research should comprise of quantitative surveys to be sent to other organizations within oil supply chain. As it was revealed in this paper, the new product development is not merely technical matters and is also about people relationships , therefore, future research should also attempt to attain the various stakeholders' perspective of such project. Moreover, the researcher should take an unbiased view of matter and preferably come from external source.

References

A

1. Anantaram, B., Joseph, G., 2004. Collaboration and coordination in supply chain management and E-commerce. Production and Operations Management Society 13 (1), 1–2.
2. Angeles, R., Nath, R., 2001. Partner congruence in electronic data interchange (EDI) enabled relationships. Journal of Business Logistics 22 (2), 109–127.
3. Armistead, C.G., Mapes, J., 1993. The impact of supply chain integration on operating performance. Logistics Information Management 6 (4), 9–14.

B

4. Barney, J., 1991. Firm resources and sustained competitive advantage. Journal of Management 17, 99–120.
5. Bello, D.C., Lohtia, R., Sangtani, V., 2004. An institutional analysis of supply chain innovations in global marketing channels. Industrial Marketing Management 33, 57–64.
6. Bhatt, G.D., Grover, V., 2005. Types of information technology capabilities and their role in competitive advantage: an empirical study. Journal of Management Information Systems 22 (2), 253–277.

7. Boddy, D., Macbeth, D., Wagner, B., 2000. Implementing collaboration between organizations: an empirical study of supply chain partnering. Journal of Management Studies 37 (7), 1003–1019.
8. Bowersox, D.J., Closs, D.J., Stank, T.P., 2003. How to master cross-enterprise collaboration. Supply Chain Management Review 7 (4), 18–27.
9. Braganza, A., 2002. Enterprise integration: creating competitive cap- abilities. Integrated Manufacturing Systems 13 (8), 562–572.

C

10. Cagliano, R., Caniato, F., Spina, G., 2006. The linkage between supply chain integration and manufacturing improvement programs. Inter- national Journal of Operations & Production Management 26 (3), 282–299.
11. Calantone, R.J., Cavusgil, S.T., Zhao, Y., 2002. Learning orientation, firm innovation capability, and firm performance. Industrial Marketing Management 31, 515–524.
12. Carr, A.S., Pearson, J.N., 1999. Strategically managed buyer–supplier relationships and performance outcomes. Journal of Operations Management 17, 497–519.
13. Christopher, M. (1990) Developing customer service strategies. In Gower Handbook of Logistics and Distribution Management, J. Gattorna, ed., Gower.
14. Christensen, C.M., Bower, J.L., 1996. Customer power, strategic investment, and the failure of leading firms. Strategic Management Journal 17, 197–218.
15. Currall, S.C., Inkpen, A.C., 2002. A multilevel approach to trust in joint ventures. Journal of International Business Studies 33 (3), 479–495.

D

16. Deshpande, R., Farley, J.U., 2004. Organizational culture, market orienta- tion, innovativeness, and firm performance: an international re- search odyssey. International Journal of Research in Marketing 21, 3–22.
17. DTI (1994), Building Competitive Advantage with your Suppliers. Improving Relationships - Why It's Important and How to Do It. Supply Chain Management Group, Department of Trade and Industry.
18. Dyer, J. H. and Ouchi, W. G. (1993) Japanese-style partnerships: giving companies a competitive edge. Sloan Management Review, Fall, 5 1-63.
19. Dyer, J.H., Singh, H., 1998. The relational view: cooperative strategy and sources ofInter organizational competitive advantage. Academy of Management Review 23 (4), 660–679.

E

20. Eng, T-Y., 2006. An investigation into the mediating role of cross- functional coordination on the linkage between organizational norms and SCM performance. Industrial Marketing Management 35, 762–773.
21. Eva Dantas and Martin Bell (2011). The Co-Evolution of Firm-Centered Knowledge Networks and Capabilities in Late Industrializing Countries: The Case of Petrobras in the Offshore Oil Innovation System in Brazil. SPRU – Science and Technology Policy Research, University of Sussex, Brighton, UK

F

22. Fawcett, S.E., Magnan, G.M., 2004. Ten guiding principles for high-impact SCM. Business Horizon 47 (5), 67–74.
23. Figueiredo, P. N. (2003). Learning, capability accumulation and firms differences: Evidence from latecomer steel. Industrial and Corporate Change, 12(3), 607–643.
24. Figueiredo, P. N. (2008). Industrial policy changes and firm-level technological capability development: Evidence from Northern Brazil. World Development, 36(1), 55–88.
25. Figueiredo, P. N. (2010). Discontinuous innovation capability accumulation in latecomer natural resource-processing firms. Technological Forecasting and Social Change, 77(7), 1090–1108.
26. Freeman, C., & Hagedoorn, J. (1994). Catching up or falling behind: Patterns in international interfirm technology partnering. World Development, 22, 771–780.
27. Frohlich, M.T., 2002. e-Integration in the supply chain: barriers and performance. Decision Sciences 33 (4), 537–556.
28. Fuente, M.V., Rosa, L., Cardos, M., 2008. Integrating forward and reverse supply chains: application to a metal-mechanic company. International Journal of Production Economics 111 (2), 782–792.

G

29. Ganesan, K., Saumen, B., 2005. Corporate turnaround through effective supply chain management: the case of a leading jewellery manufacturer in India. Supply Chain Management 10 (5), 340–348.

30. Grant, R.M., 1996. Toward a knowledge-based theory of the firm. Strategic Management Journal 17, 109–122 (Winter Special Issue).
31. Gilbert Aryee.(2006). The Cultural and Trust Aspects of Collaborative Supply Chains. Innovative Manufacturing Research Centre, Cardiff University, Cardiff Wales, U.K
32. Goffin, K., Lemke, F., Szwejczewski, M., 2006. An exploratory study of close supplier manufacturer relationships. Journal of Operations Management 24 (2), 189–209.
33. Golicic, S.L., Foggin, J.H., Mentzer, J.T., 2003. Relationship magnitude and its role in inter-organizational relationship structure. Journal of Business Logistics 24 (1), 57–75.

H

34. Handfield, R.B., Pannesi, R.T., 1995. Antecedents of leadtime competitiveness in make-to-order manufacturing firms. International Journal of Production Research 33 (2), 511–537.
35. Hansen, Morten T. And Nitin Nohria (2004), how to build collaborative advantage", Sloan management review, fall, 22-30
36. Harland, C.M., Zheng, J., Johnsen, T.E., Lamming, R.C., 2004. A conceptual model for researching the creation and operation of supply networks. British Journal of Management 15 (1), 1–21.

I

37. Iran Oil". Country Analysis Briefs. US Energy Information Administration. 2007. http://www.eia.doe.gov/emeu/cabs/Iran/Oil.html. Retrieved 2008-04-27.

38. Ireland, R.D.,Webb, J.W., 2007. A multi-theoretic perspective on trust and power in strategic supply chains. Journal of Operations Management 25, 482–497.

J

39. Jap, S.D., 1999. Pie-expansion efforts: collaboration processes in buyer-supplier relationships. Journal of Marketing Research 36 (4), 461–476.

K

40. Kalwani, M.U., Narayandas, N., 1995. Long-term manufacturer–supplier relationships: do they pay? Journal of Marketing 59 (1), 1–15.
41. Kannan, V.R., Tan, K.C., 2006. Buyer–supplier relationships: the impact of supplier selection and buyer–supplier engagement on relationship and firm performance. International Journal of Physical Distribution & Logistics Management 36 (10), 755–775.b
42. Kaufman, A., Wood, C.H., Theyel, G., 2000. Collaboration and technology linkages: a strategic supplier typology. Strategic Management Journal 21 (6), 649–663.b
43. Kessler, E., Chakrabarti, A., 1996. Innovation speed: a conceptual model of context, antecedents, and outcomes. The Academy of Management Review 21 (4), 1143–1191.b
44. Khazanchi, S., Lewis, M.W., Boyer, K.K., 2007. Innovation-supportive culture: the impact of organizational values on process innovation.Journal of Operations Management 25 (4), 871–884.
45. Kim, K, Umanath, N., 2005. Information transfer in B2B procurement: an empirical analysis and measurement. Information and Management 42 (6), 813–828.b

46. Kim, L. (1997). Imitation to innovation: The dynamics of Korea's technological learning. Boston: Harvard Business School Press.

47. Kim, D., Cavusgil, S.T., Calantone, R.J., 2006. Information system innovations and supply chain management: channel relationships and firm performance. Journal of the Academy of Marketing Science 34 (1), 40–54.

L

48. Lall, S. (1987). Learning to industrialise: The acquisition of technological capability by India. London: Macmillan.

49. Lall, S. (1992). Technological capabilities and industrialization. World Development, 20(2), 165–186.

50. Lambert, D.M., Emmelhainz, M.A., Gardner, J.T., 1999. Building successful logistics partnerships. Journal of Business Logistics 20 (1), 118–165.

51. Lamming, R.C., 1996. Squaring lean supply with supply chain management. International Journal of Operations and Production Management 10 (2), 183–196.b

52. Lavie, D., 2006. The competitive advantage of interconnected firms: an extension of the resource-based view. Academy of Management Review 31 (3), 638–658.b

53. Lee, H.L., Whang, S., 2001. E-business and supply chain integration. Stanford Global Supply Chain Management Forum, SGSCMF-W2-2001.

54. Lejeune, N., Yakova, N., 2005. On characterizing the 4 C's in supply china management. Journal of Operations Management 23 (1), 81–100.

55. Levinthal, D.A., March, J.G., 1993. The myopia of learning. Strategic Management Journal 14 (8), 95–112.

56. Li, W., Humphreys, P.K., Yeung, A.C.L., Cheng, T.C.E., 2007. The impact of specific supplier development efforts on buyer competitive advan- tage: an empirical model. International Journal of Production Economics 106, 230–247.

M

57. Manthou, V., Vlachopoulou, M., Folinas, D., 2004. Virtual e-Chain (VeC) model for supply chain collaboration. International Journal of Production Economics 87 (3), 241–250.b

58. Mentzer, J.T., DeWitt, W., Keebler, J.S., Min, S., Nix, N.W., Smith, C.D., Zacharia, Z.G., 2001. Defining supply chain management. Journal of Business Logistics 22 (2), 1–25.b

59. Malhotra, A., Gasain, S., El Sawy, O.A., 2005. Absorptive capacity configurations in supply chains: gearing for partner-enabled market knowledge creation. MIS Quarterly 29 (1), 145–187.b

60. McGrath, R.G., 2001. Exploratory learning, innovative capacity, and managerial oversight. Academy of Management Journal 44 (1), 118–131.b

61. Mei Caoa, Qingyu Zhang. (2011). Supply chain collaboration: Impact on collaborative advantage and firm Performance. Journal of Operations Management 29 (2011) 163–180

62. Mentzer, J.T., Foggin, J.H., Golicic, S.L., 2000. Collaboration: the enablers, impediments, and benefits. Supply Chain Management Review 5 (6), 52–58.

63. Michel, S., Brown, S.W., Gallan, A.S., 2008. An expanded and strategic view of discontinuous innovations: applying a service-dominant logic. Journal of the Academy of Marketing Science 36, 54–66 forthcoming.

64. Mohamed Zairi,(1999). Total supply chain for innovation. Best Practice, Pages 235-282
65. Mohr, J., Nevin, J.R., 1990. Communication strategies in marketing channels: a theoretical perspective. Journal of Marketing 54 (4), 36–51.b
66. Mone, M.A., McKinley, W., Barker, V.L., 1998. Organisational decline and innovation: a contingency framework. Academy of Management Review 23, 115–132.b
67. Moorman, C., Deshpande, R., Zaltman, Z., 1993. Factors affecting trust in marketing research relationships. Journal of Marketing Research 57, 81–101.b
68. Morash, E.A., Lynch, D.F., 2002. Public policy and global supply chain capabilities and performance: a resource-based view. Journal of International Marketing 10 (1), 25–51.
69. Morooka, C. K., Guilherme, I. R., & Mendes, J. R. P. (2001). Development of intelligent systems for well drilling and petroleum production. Journal of Petroleum Science and Engineering, 32, 191–199.

N

70. Narasimhan, R., 1997. Strategic supply management: a total quality management imperative. Advances in the Management of Organiza- tional Quality 2, 39–86.
71. Narver, J.C., Slater, S.F., 1994. Does competitive environment moderate the market orientation performance relationship?. Journal of Marketing 58, 46–55.
72. Nooteboom, B., 2000. In: Learning and Innovation in Organizations and Economies. Oxford University Press, Oxford.
73. Nurmilaakso, J.M., 2008. Adoption of e-business functions and migration from EDI-based to XML-based e-business frameworks in supply chain integration. International Journal of Production Economics 113 (12), 721–733.

P

74. Peck, H., Juttner, U., 2000. Strategy and relationships: defining the interface in supply chain contexts. International Journal of Logistics Management 11 (2), 33–44.b
75. Peng, D.X., Schroeder, R.G., Shah, R., 2008. Linking routines to operations capabilities: a new perspective. Journal of Operations Management 26 (6), 730–748.b
76. PhotisM.Panayides a, Y.H.VenusLun.(2009). The impact of trust on innovativeness and supply chain performance. Int. J. Production Economics,122, 35–46

R

77. Roy, S., Sivakumar, K., Wilkinson, I.F., 2004. Innovation generation in supply chain relationships: a conceptual model and research propositions. Journal of the Academy of Marketing Science 32 (1), 61–79.
78. Rungtusanatham, M., Salvador, F., Forza, C., Choi, T.Y., 2003. Supply-chain linkages and operational performance: a resource-based perspective. International Journal of Operations and Production Management 23, 1084–1099.

S

79. Schempf, J. (2007). Untested technologies encourage industry to invest in the future. Offshore, p. 100-102.

80. Seppanen, R.,Blomqvist,K.,Sundqvist,S.,2007.Measuring inter-organizational trust a critical review of the empirical research,.IndustrialMarketingManagement,36,249–265.
81. Sher, P.J., Yang, P.Y., 2005. The effects of innovative capabilities and R&D clustering on firm performance: the evidence of Taiwan's semiconductor industry. Technovation 25, 33–43.
82. Sheu, C., Yen, H.R., Chae, D., 2006. Determinants of supplier-retailer collaboration: evidence from an international study. International Journal of Operations and Production Management 26 (1), 24–49.
83. Snyder, R.E. (2004). Record water-dept drilling. World Oil. Retrieved September 18, 2007 from Michigan State University Libraries.
84. Soo Wook Kim (2009). An investigation on the direct and indirect effect of supply chain integration on firm performance. Int. J. Production Economics 119 ,328–346
85. Swink, M., Narasimhan, R., Wang, C., 2007. Managing beyond the factory walls: effects of four types of strategic integration on manufacturing plant performance. Journal of Operations Management 25 (1), 148–164.

T

86. Tuten, T.L., Urban, D.J., 2001. An Expanded model of business-to-business partnership foundation and success. Industrial Marketing Management 30 (2), 149–164.

U

87. Uzzi, B., 1997. Social structure and competition in interfirm networks: the paradox of embeddedness. Administrative Science Quarterly 42 (1), 35–67.

V

88. Van der Vaart, T., Van Donk, D.P., 2008. A critical review of survey-based research in supply chain integration. International Journal of Production Economics 111 (31), 42–55.
89. V. Barrag´an-Hern´andez a, R. V´azquez-Rom´an a, L. Rosales-Marines a, F. Garc´ıa-S´anchez. (2005). A strategy for simulation and optimization of gas and oil production. Computers and Chemical Engineering, 30, 215–227
90. Vickery, S.K., Jayaram, J., Droge, C., Calantone, R., 2003. The effects of an integrative supply chain strategy on customer service and financial performance: an analysis of direct versus indirect relationships. Journal of Operations Management 21, 523–539.

Y

91. Yichen Lin , YichuanWang,ChiahuiYu, 2010, Investigating the drivers of the innovation in channel integration and supply chain performance: A strategy orientated perspective, Int. J. Production Economics 127, 320–332

Z

92. Zaheer, A., Bell, G.G., 2005. Benefiting from network position: firm capabilities, structural holes, and performance. Strategic Management Journal 26, 809–825.

Appendix

Dear Participant

Introduction:

As part of my Master of Project Management at British University in Dubai, I have sought to investigate the concept of innovation within the context of oil well drilling system. As main empirical sources of data I have decided to use the recent new bit development project that Pars Mateh bit manufacturing company conducted, in partnership with Varrel company and collaboration of Petro Pars as the main service company of oil well drilling project.

The main goal is to identify the major factors in the mentioned project that was critical to the project.

Method:

In order to gather this information I will conduct semi-structured interviews, and review existing documents that relates to this project.

INTERVIEW QUESTIONS

Name:

Company:

Location:

Project start date:

Project end date:

Title:

Department:

Role in the project:

- How long have you been with the company?
- Did you encounter any technical problem during a drilling project of a special condition? If so, what was the cause of it?
- Did the problem in the project affected other parties in supply chain?
- who is the responsible party in supply chain (project manager) during difficulties?
- Did the solution require the coordination of all the key supply chain parties?
- How did you communicate the problem within the supply chain? What techniques were used?
- Did communication among the supply chain helped to exploit a new idea to solve the problem?
- Could you list key factors influencing the success of new bit development project?
- Could you provide a comment about the reason for each of these factors?

In this study, based on the prior literature I have adopted the new product development model consisting of four phases:

Phase One: Initial Analysis & Specification

Phase two: Design & Solution Development

Phase three: Performance Testing & Evaluation

Phase four: Production Acceptance/ Redesign

- I have also identified factors that may affect the project as such. Do you agree with them? If not, why?

Major factors	Criteria analysed
Collaborative Relationship	• Customer-supplier relationship • Supplier-supplier relationship • Inter- organizational relationship (Collaboration among different partners)
Communication	• Types of communication links between the company in focus and the supply chain • Level of cross-functional communication between the Company in focus and the supply chain

Capabilities & Knowledge

- Capability & knowledge differences between the company and its customer
- Capability & knowledge sharing strategies(joint venture & partnership)
- Training and knowledge sharing

Motivation

- Business Vision & alignment of incentives
- Degree of competition between suppliers
- Impact of tendering and contract management

- Could you explain the importance of each factors in each phase?

In addition to the above, the following questions were pointed at the managers since they were involved in the procurement phase of the project and management of the project internally.

- During the period of bidding and contract, has the oil company, as the customer, enforced a policy that requires the contractors and sub contractors to be more competitive?
- During the time of bidding, has the oil company enforced the technology transfer clauses in the contracts?
- In terms of internal development, what is your strategy to be at the edge of advance technology and stay competitive in the market? Tell us about your joint venture with other companies ?

Figure 1: Structure of Oil Well Drilling Supply Chain