Inventory Management and Transportation Mode Selection for Chemical Supplies in Oilfield Services Industry

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Summary: Inventory management is a complex aspect of supply chain management that is frequently discussed and debated due to the fact that it has a high impact on customer satisfaction as well as financial performance. This thesis addresses the challenges in developing an inventory management policy for the supplies of chemicals in the highly technical oilfield services industry, and provides statistical guidance for inventory levels. Furthermore, the project evaluates various scenarios to assess the key factors affecting the inventory costs and evaluates the integration of an alternate mode of transportation in the current system.

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KEY INSIGHTS

1. Apply statistical inventory policies in a continuous review system in place of the present system for substantial inventory cost savings.

2. Segment the SKU base to take advantage of the analytical models for inventory management.

3. Integration of air transportation as an alternate mode of transportation for high value items with high demand fluctuations, and high lead-times can lead to substantial cost savings.

Oilfield Services Industry Background

Oil exploration and production is a complex process where each step of the oil supply chain involves specialized technology. Oil reservoirs are identified through geological fieldwork, geological modeling, seismic imaging, and exploratory drilling. Oil is then extracted with production equipment and transported in tankers and pipelines. Oil refineries refine crude oil into various marketable end products including gasoline, diesel fuel, jet fuel, marine fuel, petrochemical feedstock, and other chemicals. Most oil companies, even vertically integrated giants do not build the equipment needed to complete all of these difficult and costly tasks, given the high level of technical expertise and the associated equipment required for the same. Instead, oil companies turn to the engineering and industrial firms that build and operate the oilrigs, tankers, and pipelines that are the backbone of the industry. These oilfield service companies provide the infrastructure, equipment, intellectual property, and services needed by the international oil and gas industry to explore for, extract, and transport crude oil and natural gas from the earth to the refinery, and eventually to the consumer.

Industry Competition in Asia Region

The world's top oilfield services companies including Schlumberger, Halliburton, Transocean, Saipem, Baker Hughes, Petrofac, China Oilfield Services Ltd., Fluor, BJ Services Company and Weatherford International have their operations in Asia. The top companies are highly competitive in their services and offerings, enabling a highly competitive business environment in the region. Furthermore, there are several other comparatively smaller companies such as Alpha Geo (India) Ltd., Duke Offshore Ltd., Exxotech Corporation Ltd., Interlink Petroleum Ltd., Omnitech Petroleum Ltd. etc. operating in the region. The smaller companies are able to offer the services at a lower price to gain more customers, threatening the larger companies. Consequently, the switching cost for the customer in the oilfield service industry is low and this enables a fierce competition in the oilfield services industry in the Asia region. In such an environment, it is critical for each company in the oilfield services to perform with high efficiency to keep their costs competitive and provide superior services in the industry to gain new customers and sustain the current ones.

Company Introduction

The company in this project (hereafter called the "XYZ" company) is a leading oilfield services provider, with operations in more than 85 countries. XYZ's expertise lies in providing highly technical, specialized and customized services that serves as a backbone of operations in oil and gas industry. Their customers operate at a very high rate (dollars of revenue per hour) and suffer significant financial setbacks if the operations go offline. In the presence of high competition in the industry, XYZ does not want to lose its customers (usually oil giants) to the other players. Because of this sensitivity, ABC is looking to operate at a high service level to meet the customer's needs and avoid stock outs at all opportunities while still being sensitive to cost.

Challenges Faced by XYZ

As a leader in the oilfield services industry, XYZ faces many unique business challenges. Some of these challenges include (but not limited to): intense competition, dynamic business environment, intense capital requirements for field equipment, remote work locations and communication difficulties, depleting oil and gas resources, oil price fluctuations, developing the ability to respond to rapid growth opportunities, upsurge of alternative oil and gas resources, and economic reliance on few, very large customers. For XYZ to sustain in such a dynamic and demanding environment, it was clearly evident that the targeted inventory management policy for XYZ needs to deliver the operational efficiency, and provide the required responsiveness.

Project Motivation

Company XYZ deals with a large range of services ranging from seismic, drilling, subsea, characterization, production to well intervention projects. For successful execution of each oilfield service project, XYZ requires a number of facilitator goods such as chemicals, mechanical collars, heavy engineering equipment, electronic chips, cement, steel etc. Most of these goods are highly specialized and customized as per the demography and the specific requirements of a particular project, and so are characterized by high lead-times for procurement. This thesis focused on investigating the characteristics of one of the facilitator goods, that is the chemicals and developing statistical inventory strategies for its storage in the central hub for distribution in Asia.

XYZ currently does not employ a definite forecasting tool to gain certainty of demand for the chemicals supplies in Asia. While uncertain about demand, XYZ has simultaneously experienced significant fluctuations in lead-time for procurement. For some of the chemical SKUs, the lead-time is as high as 22 weeks. On the other hand, the average lead-time for the start of a project is 4 weeks. These fluctuations in replenishment, coupled with an unknown demand, have led to increased transportation costs in the form of last minute product transfers or high costs in storing large stocks of particular SKUs in the central hub. Most of the chemicals SKUs for this range of projects are ordered in low volumes and XYZ currently employs a decentralized ordering process for the supplies, adding to the difficulty in forecasting the demand. Furthermore, due to the involvement of third party logistics service provider and the above-mentioned factors, currently there is no definite inventory management policy that is in order at the central storage location. The large number of SKUs needed for the services, the variability of demand, high lead time and the required immediate availability is posing a challenge to XYZ in terms of determining the inventory levels at the central hub for distribution in Asia. Taking into consideration the above-mentioned challenges, criticality of each project undertaken, and the expected service level, this project employed analytical tools to develop strategic inventory levels for chemicals storage at the central hub and also investigated the integration of air transport as an alternate mode of transportation for transferring the chemicals from the origin hub to the central location. Additionally, the thesis evaluates the characteristics of particular facilitator good SKUs that make integration of air transportation as a favorable option in the oilfield services industry.

Asia Chemical Supply Network

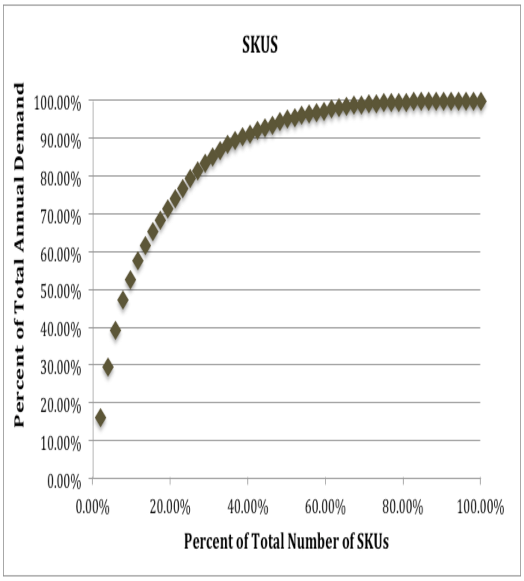
The hub for the storage and distribution of chemicals in Asia for XYZ is located in Singapore. The origin hubs for the chemicals for XYZ are located in: United States, Europe, United Arab Emirates and Japan. The chemicals are transported via ships to Singapore. A third party logistics service provider handles the storage and distribution of chemicals at the central hub. Singapore hub is the central location for distribution to various regions within Asia, such as Bangladesh, Cambodia, China, Indonesia, Japan, Myanmar, Malaysia, Papua New Guinea, Thailand, and Vietnam.

SKU Segmentation

Though inventory-holding calculations are made at the SKU level, the sheer size of a SKU base often makes this an impractical and tedious effort. To better cope with a large SKU base, companies often create groups and determine an inventory strategy for that group. Individual SKUs are then assigned to one of the groups and are subject to that group's inventory policy. In a commonly used model, inventory items typically follow an A-B-C classification where A items are the most prioritized items, and so deserve the most managerial attention and review.

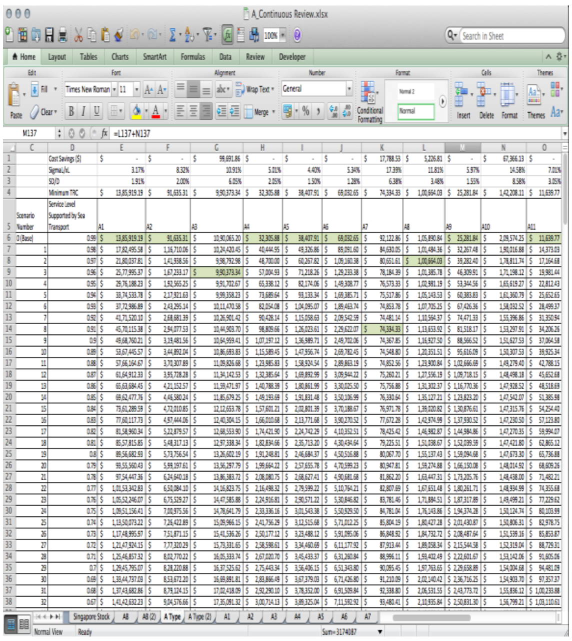
This project advocates SKU segmentation as a necessary prerequisite for the optimal implementation of an inventory strategy. The SKU segmentation should follow the company's product strategy and corporate priorities to account for factors (including but not limited to) lead time, physical size, the criticality of product availability, consumption and cost. In this project, the segmentation of the SKUs was restricted to A-B-C classification due to the limitation of available data. Using a distribution by value graph, class A items were identified as the items accounting for 80 percent of the total demand value. 25 percent of the SKUs were identified as the class A items.

Following a similar approach, next 25 percent of the SKUs accounting for 15 percent of the total demand value were identified as class B items. And the rest of the items (50 percent of total SKUs) were identified as class C items accounting 5 percent of the total demand values.



Inventory Policies

Models were developed under the assumptions of continuous review system and periodic review system for each class of items. The figure shows the snapshot of the model developed for A class items under continuous review system assumptions.



Simulations were carried out to evaluate the inventory levels and associated costs to fulfill 99% service level by storing chemicals at the central hub location, as per the rules as shown in the table below. These rules were chosen according to the key insights gained from implementation of inventory policies in different industries. The applicability of the individual policies as per the class of item and the review system was evaluated in this project for chemical SKUs in the oilfield service industry.

Class of Item	Continuous Review	Periodic Review
A	(s, S)	(R, s, S)
B	(s, Q)	(R, S)
C	(s, Q)	(R, S)

For each class of items, it was observed that the continuous review system leads to more inventory cost savings than the periodic review system. Continuous inventory review permits real-time updates of inventory counts, which can make it easier to know when to reorder items to replenish inventory, and thus enable the company to avoid keeping high levels of stock. This method of inventory review also facilitates accurate accounting, since the inventory system can generate real-time costs of goods sold. Additionally, continuous review system enables more flexibility and responsiveness in the inventory system than the periodic system, which is a pre-requisite in the dynamic oilfield services industry. On the other hand, periodic review system can make it difficult to ascertain when reordering items are necessary. It also can make accounting less accurate, but has the advantage of lower cost of implementation.

Inventory policies, with details of the replenishment quantity, reorder point, order up-to level, review system, etc. were developed for each class of items, and the corresponding inventory cost savings were calculated. It was found that for A class chemical SKUs, more than 10% cost savings could be achieved on the inventory carrying costs for XYZ by adapting the policy as suggested by the project. Similarly, for B class chemical SKUs, more than 15% cost savings could be achieved on the inventory carrying costs. For C class chemical SKUs, the projected cost savings were substantial, more than 50% on the carrying costs. Such extensive cost savings in case of C items reflect on the large amount of inventory stock being maintained by XYZ in the current system, and clearly points towards the huge cost savings that can be achieved by adapting a formal inventory management policy.

Key Variables

Simulations were carried out in the model to evaluate the various levers that can be adjusted to modify inventory levels and associated costs. The following table illustrates the key variables determined from the model that affect the inventory costs, and also shows its corresponding effect on inventory levels and costs.

Variable	Effect on Inventory
Customer Service Level	↑
Ordering Cost and Holding Cost	↕
Lead Time	↑
Lead Time Variability	↑
Demand Variability	↑

Alternate Mode of Transportation

A set of scenarios was analyzed to evaluate the optimal inventory management and transportation mode policy for each SKU for Class A items in a continuous review system. Emphasis was laid only on Class A items due to their criticality and the applicability of air transport for high value items only. Continuous review system was shown to have better-cost savings and provide more responsiveness than periodic review system as discussed before, and so the concentration was laid only on continuous review system. It was observed that the use of air transportation as an alternate mode could lead to substantial cost savings for high valued items that were characterized by high demand variability and high lead times. It was detected that cost savings of more than 30% could be achieved by integrating air transportation as an alternate mode for a particular SKU that had high value for XYZ, high demand variability (about 15%) and high lead-times for procurement (18 weeks). Similarly, different SKUs were identified for which integration of air transportation led to substantial cost savings. Running a number of simulations reinforced the observation by reducing the demand variability by up to 30%, and discerning its affect on the inventory costs.

Conclusion

This work investigates the challenges of managing the facilitator goods in oilfield service industry and presents a recommendation for developing inventory strategies for the same. The critical understanding of the factors influencing the high costs of inventory can help companies to re-define the policies for optimal output. A detailed segmentation of the SKU base is the first step towards developing an efficient inventory policy, and can lead to development of alternate strategies (such as integration of air transportation) for a particular set of SKUs for further cost savings. For facilitator goods in oilfield services industry, it was observed that integration of air transportation could lead to substantial cost savings for SKUs with high demand variation, high lead-times for procurement and high value for the company. It was concluded that for XYZ to achieve inventory cost savings along with the required responsiveness, it was a necessity to execute detailed segmentation of the SKU and accordingly implement statistical inventory management policies as developed in this project. Furthermore, it was identified that integration of air transportation in the current system for specific SKUs had high potential for XYZ to improve efficiency and flexibility in the system. Additionally, it was recommended that it was vital for XYZ to maintain strong data integrity and ensure a strict review system to improve the efficiency of the system. Lastly, it was recognized that centralization of ordering process at XYZ could lead to decrease in variability in demand forecasting, and would consequently lead to better inventory cost savings. The analysis of effects of centralization of ordering process on other operations at XYZ needs to be further assessed.