Inventory Planning in the Engineer-to-Order (ETO) Steel Industry

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Topic Areas: Inventory Planning, Manufacturing, ETO

Summary: This capstone studied the raw materials inventory planning of an ETO steel infrastructure manufacturer. The company aims to improve its inventory management system by replacing the traditional methods with scientific-based ones. Two inventory planning models (s,Q model and R,S model) were studied. The main contribution of the model is to suggest optimal safety stock level, review period, and order quantity to the company. Results show that the (R,S) model is better for the case company: it will help the case company optimize its inventory spending on an annual basis.

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KEY INSIGHTS

1. **The ETO steel industry is searching for ways to correlate demand, uncertain lead time, and safety stock.**
2. **The company seeks scientific approaches to replace its current inventory planning system.**
3. **Two inventory models were studied and tested. The better model was recommended to optimize the annual inventory total cost.**

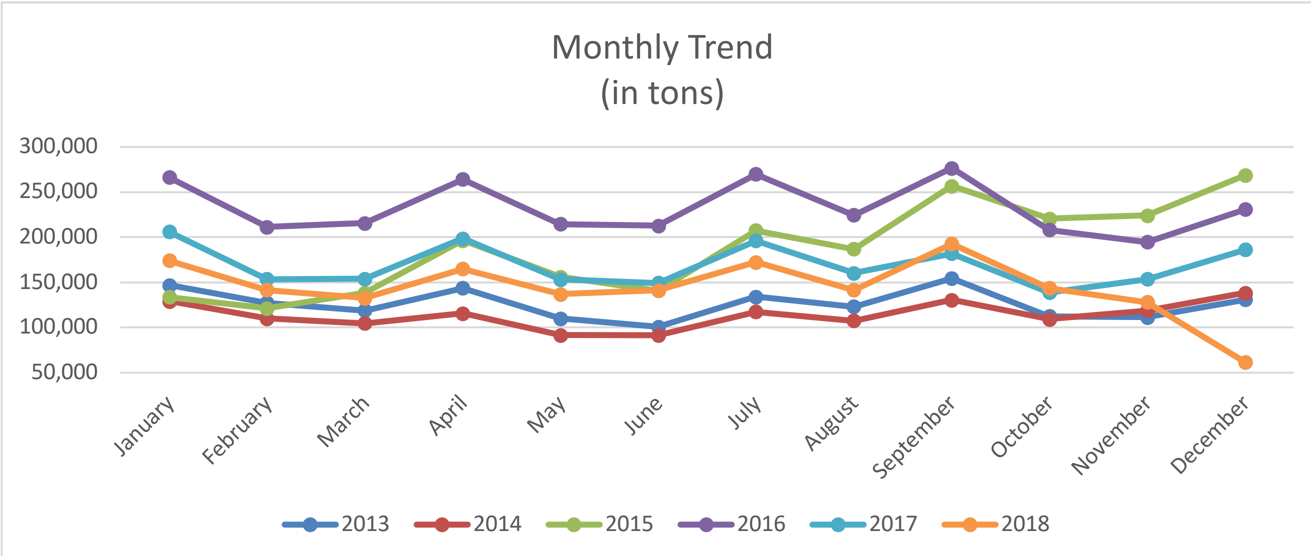
Introduction

Inventory planning plays an important role in the success of a business. In 2008, firms operating in the United States spent hundreds of billions of dollars to maintain inventories. Businesses always pursue the right amount of inventory at the right time within the right time frame. The effective use of inventory, both strategically and tactically, is crucial for success in this global and volatile world. Although just-in-time inventory is the ultimate goal of every inventory planning process, it is not realistic, especially in the ETO business, where the decoupling point starts from the design stage. The ETO supply chain involves design, engineering, and manufacturing based on each new customer order, and normally includes modifications and customizations. In addition, demand uncertainty and long lead time make the inventory planning for ETO complex.

This study identifies several challenges that affect the inventory planning process of the case company: safety stock, lead time, and ETO project-based order pattern. This study focuses on the regular business process, which does not consider unexpected demand surges, and which assumes winning the returning project. The data used in this capstone was provided by a leading agriculture and infrastructure manufacturing company. The goal of this study was to suggest optimal safety stock level, review period, and order quantity. The new findings and solutions will provide guidelines to the company for potential inventory planning.

Interviews with the department managers of the company made it clear that an inventory model had to be simple and easy for the decision makers to understand and apply to the daily work. This capstone

Figure 1. Monthly Trend



suggests two inventory models -- the (s,Q) model and the (R,S) model -- that can be applied to improve the company's inventory management.

The (s,Q) model and the (R,S) model were constructed. Both models were run on the aggregated dataset and the (R,S) was shown to be better. Then the (R,S) model was applied to each of the company's five important manufacturing sites.

Analysis

Case Company

This capstone targets the utility segment of the business, which is an ETO project-based business. and focuses on utility products that consume steel as raw material. This capstone recommends the optimal inventory policy for the centralized inventory planning team. The team is responsible for ordering raw material for all manufacturing sites. The data including sales and raw material inventory planning was gathered and analyzed.

Demand and Inventory

Basic statistical analysis shows that the sales in each of the past three years followed similar patterns. The high demand points in a year are February, June, August, and September, and historical low demand points are April and July. This finding interestingly suggests that even for the ETO business, demand does show a certain pattern year after year. Another conclusion that can be drawn from the analysis is that the late summer months tend to have higher demands.

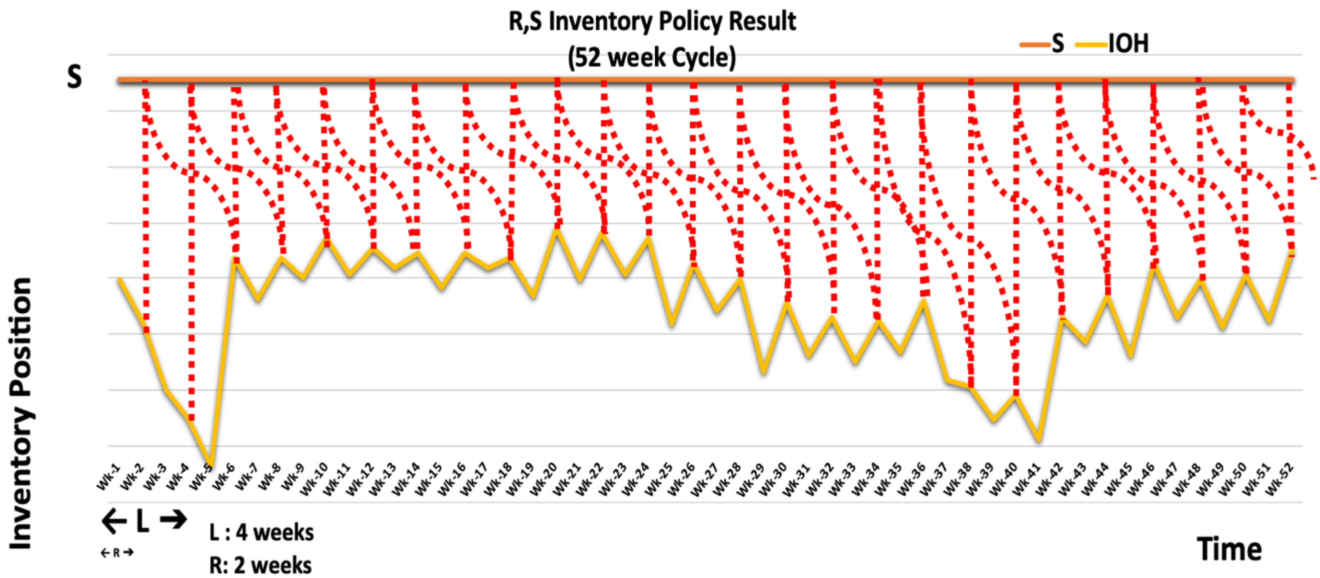
There is not a good inventory policy across the supply chain. However, there is a historical seasonality pattern for the company's raw material. Figure 1 shows that normally in April, July, September, and December, inventory level tends to be higher than other months.

Methodology

Two inventory models were identified as appropriate for the inventory policy. For continuous replenishment cycles, an event-based base stock policy (s,Q) model is a good choice; for periodic replenishment cycles, a time-based periodic review (R,S) models is a good choice. This capstone uses the total cost formula to provide the optimal solutions for the company to determine the proper inventory policy.

The better model is the (R,S) model. Figure 2 shows the inventory policy result of the (R,S) model. Under the (R,S) policy, total annual relevant cost is much lower than under the (s,Q) policy with the same service level. The resultant saving is about $4.6 million dollars. The ordering cost under the (R,S) policy is much higher than under the (s,Q) policy mainly because of the smaller order quantity but higher order frequency. The holding cost under the (s,Q) policy is higher, due to huge on-hand inventory costs (cycle stock), longer order intervals and larger order size in each order interval.

Figure 2. (R,S) Inventory Policy Model Result



Sensitivity Analysis

Sensitivity analysis was done to test how different values of the input variables affect the total annual relevant cost. The sensitivity analysis shows that a 2-week review period and a CSL of 95% is the optimal solution for the company.

Scenarios Analysis

The (R,S) policy is applied to the company's five major manufacturing sites. The results provide the optimal review period and order quantity for each of the five manufacture sites. For four out of five sites the ideal review period is 2 weeks; for one site the optimal review period is 3 weeks.

Conclusion

This capstone project studied the raw materials inventory planning of an ETO utility infrastructures manufacturer. The study compared two inventory models, the continuous (s,Q) inventory model and periodic (R,S) inventory model, for the ETO steel company.

To limit the scope, this capstone built on long-term and returning customers, who order from the company on a regular basis. This eliminated uncertain bid win/loss situations.

The better model, the (R,S) inventory model, was suggested based on running a 52-week total annual relevant cost simulation. The (R,S) model suggests the optimal review period is 2 weeks. The model provides safety stock level and more detailed order quantity in each review period.

According to the sensitivity analysis, shown in Figure 3, a 2-week review period is confirmed as the optimal solution. However, the managers decided that a service level of 90% is not the optimal solution for the company. The model suggests a service level of 95% is optimal. The management team should re-evaluate their decisions regarding service level.

Figure 3. (R,S) I Review Period and Service Level Sensitivity Chart