MIT SCALE RESEARCH REPORT

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Research Report: ZLC-2016-2
Improving Supply Chain Performance Using Analytics
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Improving Supply Chain Performance Using Analytics

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Summary:

This thesis tackles the research question of finding the root cause of service disruptions in supply chain of surgical medical devices affecting supply chain performance and reliability. The key performance indicator of supply chain performance can be observed in terms of customer service level. A backorder is occurring when the company cannot fulfill a customer order. A qualitative analysis was performed in several factors responsible for service disruption or backorders in the supply chain network. A detailed quantitative analysis is done to understand the relation and impact of forecast, raw material availability and production process on backorders.

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KEY INSIGHTS

1. Root Cause Analysis: Using the root cause analysis, we identify the key factors relevant for that affects customer service level.

2. Forecast accuracy, production process, supplier performance and raw material availability matrices are the related to the service disruptions in terms of backorders.

3. Several characteristics of the production process like batch size, production scheduling, capacity utilization and prioritization were found to be directly impacting the customer service level.

Introduction

Supply chains are complex global networks, having the challenge of customer satisfaction that is providing the right product to customers in the right quantity to the right place and time. The medical device industry is facing growing pressure of price reduction from insurers and hospitals, creating demand for products that are good enough and competitively priced. Thus, serving the customers best and keeping them plays a critical role for the company analyzed in this thesis. Our sponsor company, one of the largest medical device companies in the world, has been working on developing a reliable supply chain in all the countries in which it operates. The reliability of the medical device supply chain is especially important, since a stock out of the surgical product can reduce the effectiveness of the treatment on patients, putting their lives at risk.

The purpose of this thesis was to identify the key factors causing a disruption in customer service (by creating backorders) and finding the relationship of possible factors by quantitative analysis.

Methodology

Based on our literature review and several interviews with stakeholders, we identified the factors responsible for customer service disruption or backorders.
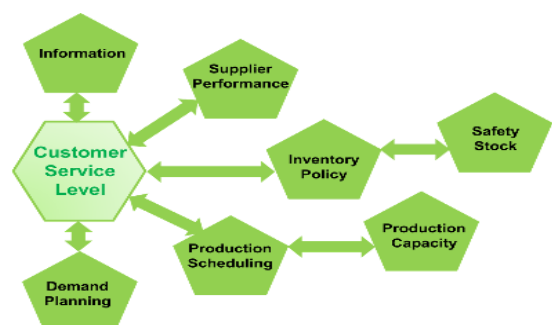
We defined our scope, product segmentation, and then we apprehended the supply chain network for the product analyzed. To do the detailed analysis of factors affecting backorders, we did data collection and integration and used the following methodology for the data analysis:

We used statistical regression and simulation approach in analysis. In the end we provided recommendations on how the company could improve the service level by reducing backorders and suggested some directions for future research.

Analysis of Factors affecting Backorders

Based on initial analysis, the SKUs with high demand have higher backorders (BO) than SKUs with low demand, therefore for accurate analysis we defined the matrices in terms of ratios as BO ratio, forecast accuracy ratio, available to schedule (ATS).

$$\text{Backorder ratio} = \frac{\text{Backorder quantity per week}}{\text{Demand per week}} \% \qquad ATS = \frac{\text{Actual quantity started}}{\text{Suggested quanity required}} \%$$

$$\text{Forecast accuracy ratio} = \frac{\text{Demand per week}}{\text{Forecast per week}} \%$$

From our analysis, it is found that SKUs with higher demand variability have higher backorder ratio. This directly points out to the accuracy of the forecasting method. In regression analysis, hypothesis of forecast accuracy and backorder relationship was proved to be significant with a very good coefficient of determination. Based on the different discussions with stakeholders managing this process, we realized that different forecasting methods are in place, which means that after comparing different methods company is failing to pick up the most accurate value of forecast.

Theoretically, higher lead time causes the backorders, but we could not prove this due to data unavailability. Our study demonstrates that a higher production lot size tends to a higher backorder level. The company produces high mix of products, from a production scheduling standpoint, high lot size could represent a big impact of outcome in terms of product mix, scheduling products with high lot size could delay other products with lower lot size.

We could only perform the qualitative analysis for inventory policy and found that it is considering all the possible factors of variability (demand variability, supplier variability and lead time variability) and keeping additional buffers to achieve the target service level. But the execution of the defined inventory policy was questionable due to backorders in the system, which is directly dependent on the production process.

The advance planning system (APS) first of all allocates the capacity to SKUs as per net requirement and then checks for raw material availability during production scheduling. The ATS matric is considering both the capacity and raw material availability. We found that in 92% of the cases the total raw material availability and capacity availability is less than required. The delay caused by this allocation will also increase the lead time. To explain further, we found that the two production lines (014 and 023) are contributing with the 60% of the total backorders, pointing out that capacity of these lines might be constrained due to higher number of allocated SKUs. Also, the performance of some of the suppliers is as low as 20%. Doing regression analysis, we found significant results for impact of ATS on backorders.

We created a generic simulation model in Arena for inventory policy and ran the model for several SKUs by changing the percentage of raw material availability. We found that improving raw material availability by 20% can reduce BO on average by 18% and by 40% can reduce BO on average by 28%.

Conclusion

We started with the question of finding the root causes of backorders leading to lower customer service level and hence affecting supply chain performance. The forecast accuracy is one of the factors company should focus to improve the customer service level. The company should investigate on relative error analysis of different forecasting methods to choose the best forecast values and use the most accurate one for forecast. Though the inventory policy is considering the lead time variability for safety stock, but the delay in capacity and raw material allocation is further increasing the total lead time. The capacity allocation and raw material availability metrics are impacting service level. So the company should investigate more into the supplier performance to improve raw material availability, capacity allocation and production flexibility. As we determine that production scheduling is a vital part for this supply network, we suggest that an additional research should be done in this area to understand the impact on service level through simulation, similar to our inventory model in Arena. Once a service disruption has happened or a backorder is created, till the time this order is fulfilled it stays in the system. On one side, delay in order fulfilment impacts on customer satisfaction and on the other side, it adds the complexity to future planning execution. Though the company prioritize to fulfill BO first, but it should be analyzed by a metric such as ratio of BO age and defined lead time to check the system performance.