A Joint Inventory and Sourcing Strategy to Balance Efficiency versus Risk

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Summary: This research seeks the right strategy to mitigate the risk of supplier disruption while maintaining supply chain efficiency for a company in the medical device industry. By comparing the impact on the ROA ratios, the authors prove that in this industry holding additional inventory is generally a better strategy than establishing a second source to reduce the possible risk of supplier disruption. In addition, this research also identifies the key factors which influence the strategy selection for each SKU category by sensitivity analysis.

KEY INSIGHTS

1. Establishing a second source is rarely a better solution to reduce the risk of supplier disruption due to the high one-time cost of personnel and tooling/non-recurring engineering.
2. For fast movers, cost, monthly demand, and the demand variability are key drivers for the strategy selection. For slow movers, only cost has a significant impact on the optimal strategy.
3. Strengthening the qualification process of supplier selection is the fundamental solution to lowering the potential risk, while reducing the required investment amount.

Introduction

Medtech, a global leader in the medical device industry, is exposed to great risk of supplier disruption because of its single source practice. This research focuses on how to mitigate the risk of supplier disruption through supply chain strategies. To deal with the impact of supplier disruption Medtech has three approaches: to hold additional inventory to cover the demand over the time-to-recovery, to establish a second source to reduce the risk, and to do nothing and tolerate the risk. The main objective of this research is to identify the right strategy for different SKU categories.

This research is centered on 320 instrument SKUs of the orthopedic business, which are externally sourced and provided to customers for free as required tools to support implant products.

SKU Classification—by Demand and Importance

In order to manage SKUs with various demands and demand variability, Medtech classifies SKUs based on two characteristics—demand and importance. Medtech defines an SKU whose average monthly demand is less than six as a “Slow Movers,” while those exceeding six are “Fast Movers.” SKUs with higher importance are defined as “Core” SKUs, while SKUs with lower impact are defined as “Non-Core” SKUs. Therefore, under these two standards, 320 SKUs can be grouped into four categories: Core—Fast Movers, Core—Slow Movers, Non-Core—Fast Movers, and Non-Core—Slow Movers.

Time-to-Recovery Evaluation
To gain information about Medtech’s time-to-recovery, we conducted several semi-structured interviews with representatives from different functions. As a result, the time-to-recovery for 136 Core SKUs varied from 17 to 23 weeks (4.25 to 5.75 months), and the time-to-recovery for 184 Non-Core SKUs was assumed to be 52 weeks (13 months). We assumed that an SKU with high cost infers that it has higher product complexity. Hence, we assigned the possible time-to-recovery to each SKU based on its complexity (measured by cost) by linear scaling. The time-to-recovery range for 72.8% of core SKUs was from 4.25 to 5 months.

**Additional Inventory for Risk Management**

The additional inventory covers the demand over the time-to-recovery after supplier disruption. The additional inventory is made up of two parts—cycle stock and safety stock.

For the fast movers, we used the safety stock equation to calculate the safety stock which is used to deal with the variability over time-to-recovery. The formula is below:

\[
\text{Additional Inventory for Fast Mover} = \text{Monthly Demand} \times \text{Time-to-recovery in Month} + k \times \sigma_{\text{Lead Time}} \times \sqrt{\frac{\text{Time-to-Recovery in Month}}{\text{Lead Time in Month}}}
\]

The total value of additional inventory needed for these 162 fast movers was around $5.22 million (58% was for the regular demand over the time-to-recovery and 42% was for the safety stock during the time-to-recovery.)

For slow movers, the logic to calculate additional inventory is similar to that for fast movers. The cycle safety stock formula for slow movers is same as that for fast movers, but the safety stock is determined by Poisson distribution. The formula is below:

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\text{Additional inventory for Slow Mover} = \text{Monthly Demand} \times \text{Time-to-Recovery in Month} + \text{Safety Stock}
\]

The total value of the additional inventory needed for these 158 slow movers was around $1.94 million (40% for the cycle stock over the time-to-recovery and 60% for the safety stock during the time-to-recovery.)

**Second Source against Supplier Disruption**

In order to evaluate if establishing a second source is a competitive and efficient strategy to mitigate the risk of supplier disruption, it is necessary to estimate both the one-time costs related to the implementation of a new supplier, and the ongoing costs to maintain the relationship.

The required one-time costs differ from SKU to SKU according to its product complexity. The range of the cost for finding and establishing a second source was from $15,000 to $75,000, given by the Procurement function. We followed the same logic as time-to-recovery calculation to identify one-time cost to each SKU depending on its complexity level (measured by its cost).

As for the ongoing cost of supplier maintenance, we collected the average number of annual supply chain costs and also the life cycle for each SKU from the Procurement team to obtain the total cost of maintaining a second source. The average tooling and non-recurring engineering cost was $30,000. The annual cost for extra effort needed to maintain a second source of supply for each instrument was $655, but the life cycle for each SKU varied from one to 10 years. Therefore, the total extra effort cost of only two SKUs is $655, while the total extra effort cost for the other 357 SKUs was $6,550.

The total cost for a second source ranged from $45,879 to $111,550. Fifty-two percent cost of the maintaining second source was tooling and non-recurring engineering costs, while the extra effort only cost 12% of total cost.

**Risk Measurement—Expected Lost Revenue**

Not taking any action and tolerating the risk is Medtech’s third option. This risk of not taking any action is measured by the expected lost revenue for each SKU, which equals probability of an SKU disruption multiplied by potential lost revenue over time-to-recovery.

The potential lost revenue over time-to-recovery is calculated based on the total revenue of the implants from 2008 to 2014 divided by the total number of the instrument sets from 2008 to 2014 times the utilization ratio. The average revenue from implants related to each instrument is equal to $866,160. The utilization ratio for all 136 core SKUs was 100%, while this number for 184 Non-Core SKUs ranged from 0% to 78%. Thus, with a time-to-recovery range of 4.25 to 13 months, the range of potential lost revenue over time-to-recovery was from $9,723.73 to $743,141.66, with a mean of $201,075.52.

We assumed that the probability of an SKU disruption equals highest probability of a supplier disruption times relevant risk level for a supplier. The relevant risk level is...
the percentage of a supplier’s D&B Supplier Evaluation Risk Rating over its full range. Their D&B SER Rating scores ranged from 1 to 7, with a mean of 3.54. Accordingly, the relevant risk level for each supplier ranged from 11.11% to 77.78%. Then, we calculated the probability of an SKU disruption under different highest probability of supplier disruption. The highest probability of supplier disruption influences the expected lost revenue for each SKU dramatically (Figure 1).

### ROA Comparison

For each SKU, we compared the three numbers, including the investment of holding additional inventory, the cost of establishing a second source, and the expected lost revenue over time-to-recovery. We incorporated the concept of the return on assets (ROA) from the DuPont model to compare these three different strategies.

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\text{Return on Assets (ROA)} = \frac{\text{Net Income}}{\text{Sales}} * \frac{\text{Profit Margin}}{\text{Asset Turnover}} = \frac{\text{Net Income}}{\text{Total Assets}}
\]

The value of the total assets for this particular business sector in 2013 was around $44.59 billion and the net income was about $4.43 million. Based on these two numbers, we conducted the sensitivity analysis of ROAs in the very first year by changing the total asset value or the annual expenses respectively for each SKU and then selected the approach with the highest ROA ratio as the solution. In this research, we did not take tax into consideration, assuming the tax rate is 0% for the following calculation.

The base value of ROA ratio was calculated as 9.94281%. After these three ROA ratios are calculated, the strategy which has the highest ROA ratios represents the most cost-effective way to proceed.

In addition, since the actual supplier risk level was hard to predict in practice, we conducted the sensitivity analysis on different overall risk levels by setting different maximum probabilities of supplier disruption as 1%, 2%, 5%, 10%, 15%, 20%, 25%, 30%, and 50% respectively. The details of sensitivity analysis on strategy selection are presented in Figure 2 below. The ROA ratios of holding additional inventory were higher than the ROAs of establishing a second source. Only one SKU had a slightly higher ROA ratio from establishing a second source.

### Recommendations

Based on the result of the ROA comparison, if the company is unable to dramatically reduce the one-time cost of establishing a second source, using a second source of supply is rarely a good idea. As the probability of a supplier failure rises from zero to the maximum, the desired risk mitigation alternative shifts from “taking no action” to “holding additional inventory.” It also indicates that the actual amount which the company needs to invest depends on the total risk level of supplier disruption. Thus, the company should strengthen its qualification process of supplier selection to reduce the overall risk exposure and hold additional inventory for the SKUs which have comparatively high risk.