Universitat Pompeu Fabra Barcelona

Case 1: Beanie Limited

Vicent Roselló
Arnau González
Álvaro Romo

May 6th, 2022

Dear Elisa,

We have carefully analyzed the past year's performance from Caserta's plant, and we are ready to share with you the insights and results from our study.

1. Overall performance in 2021.

Performance in 2021 for Caserta's plant had two main issues: there was a high percentage of days with insufficient stock to satisfy customer's orders (24%) , and there were also periods where stock was too high. The most important metrics are presented in the next table.

Demand quantity mean	50,149.19
Demand quantity standard deviation	14,201.27
Sourcing amount mean	335,581.70
Sourcing amount standard deviation	65,918.09
Stock quantity mean	35,9941.21
Lead time mean	7.31 days
Lead time standard deviation	1.83 days
Days between sourcing mean	6.01 days
Days between sourcing standard deviation	4.87 days

Demand was roughly around 50,000 kgs and had a relatively small standard deviation throughout the year, but request orders to the warehouse were more inconsistent than demand. We believe that both of the main issues that Caserta suffered throughout the year were mainly influenced by the irregularity of the orders made to Diemen.

On one hand, the mean sourcing amount is insufficient to cover a 7-day period needed for another order to arrive. It also presents a higher variability than what demand presents; this means that orders made to Diemen tend to be very inconsistent.

On the other hand, the days between sourcing orders present a very high variability. There have been orders placed with just 1 day of difference, and orders placed with as long as 24 days of difference. This causes a very high variation in the sourcing events, and may lead to much higher or much lower stock levels than usual.

2. Policy proposal with no minimum order restrictions

By analyzing thoroughly the previous year's demand, current stock, and purchasing orders, we were able to simulate different ordering policies and evaluate their performance.

We started by asking ourselves what would be an optimal initial starting stock for the year, and what is the critical stock amount in which we make a new order, commonly known as the reorder point.

Our methodology has been as follows. We calculate a reorder point[1] in order to have a benchmark. As the initial stock of the warehouse affects the performance of the policy, we thought that finding a feasible initial stock which does not affect the simulation, then would allow us to find an optimal reorder point and the amount to order.

We decided to carry out the iteration with an initial stock between 350,000 kgs and 450,000 kgs. This range comes from the fact that the average stock of previous year was 360,000 kgs, thus we find it reasonable to start the year with an amount in this range.

Once we determine this range we iterate through the reorder point amount as well as the amount to order. After we determined these numbers, we tried different ordering amounts with the goal of having no more than 5% of days with stockout. The results showed that the optimal quantity to order each time would be the 85% quantile of the distribution of previous year demand multiplied by the average lead time[2].

By going through a number of different combinations of starting stock, and reorder points we found that it would be optimal to start the year with 360,000 kgs of stock and a reorder point of 355,000 kgs. These numbers go in line with what the daily average demand is, and what the average lead time is.

Simply put, the policy is as follows:

- Start the year with 360,000 kgs of stock (if it is plausible).
- If on a given day the current stock is less than 355,000 kgs and there is no current order ongoing, order 442,323 kgs.

By implementing such a policy, we estimate that the probability of stock out is 5.8%, and the mean stock would be 221,293 kgs. This way, we reduce the average stock by around 40%.

An optimal policy without uncertainty would be having a stock mean of zero as well as the stock out rate. However, as we deal with uncertainty, this situation is not feasible if we want to reduce costs. Therefore, we have minimized as much as possible the amount of stock

[1] ROP = (Average daily demand*Average lead time) +Z*Sdlt.

[2] Average Lead Time = 7 days

stored at Caserta. Thus, we reduce storage and warehouse costs while the stockout rate has decreased from 25% to roughly 5%.

3. Policy proposal with minimum order restriction

As you have mentioned, we have a minimum order restriction that will affect the previous policy, since the amount we order is bigger than the optimal one.

Now, we decide to always order the same quantity, 500,000 kgs. But to reduce the mean stock we need to decrease the reorder point. Following the same methodology as before, we iterate for each reorder point with a fixed order quantity.

Simply put, the policy is as follows:

- Start the year with 360,000 kgs of stock (if it is plausible).
- If on a given day the current stock is less than 345,000 kgs and there is no current order ongoing, order 500,000 kgs.

As a result of such policy, we estimate that the probability of stock out is 5.84%, and the mean stock would be 242,534 kgs. As we thought, the restriction of the minimum order affects the results negatively. In particular, the stock mean grows up by around 10% compared with no restriction, this implies an increase of storage costs. Nevertheless, we still outperform the year 2021.

4. Policy proposal with fixed lead time

With the new restrictions we face a completely different scenario, as the lead time is exactly 15 days. This change has a trade-off decision. On one hand, that change should benefit your decision policy as the uncertainty is reduced. On the other hand, the lead time is doubled, so the amount of stock in the warehouse must increase and so storage costs.

Thus, we follow the same strategy as before, we calculate the new reorder point[3] with those features and then we iterate in a range of values to find the optimal order quantity, which is 800,000 kgs. As the lead time is the double of the previous lead times, we find reasonable that the initial stock to be doubled in order to maintain the equilibrium.

Simply put, the policy is as follows:

- Start the year with 720,000 kgs of stock (if it is plausible).
- If on a given day the current stock is less than 725,000 kgs and there is no current order ongoing, order 800,000 kgs.

[3] ROP = (Average daily demand*lead time) + Z*Sdlt.

Due to such a policy, we evaluate a strategy with 5.7% of stock out and a stock mean of 363,551 kgs. Those results fit with our intuition, we deal with a higher stock mean, due to the increment of the lead time, and so a higher warehouse costs. This scenario is worse than the others we have analyzed. Nevertheless, compared with the base case, we reduce the stockout level to our objective maintaining roughly the same amount of stock.

We hope the analysis helps you to improve the performance of your business. If you have any questions, do not hesitate to ask us.