MASTER

Optimization in the supply chain of high value reusable containers
a distributor perspective

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Univar Ltd.
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Abstract

The Safe-tainer is an expensive reusable container for chlorinated solvents. This project was a research into the supply chain of these containers, aimed at finding opportunities to reduce logistics costs. The main cost trade-off appears to be between the fixed costs of the Safe-tainer pool and the costs of transport. The result of this project is a quantitative model that describes the relationship between pool costs and transport costs. Augmented with a simple Optimization heuristic, the model can be used to determine the optimal pool size and also to determine the optimal allocation of Safe-tainers that are available to the distributor to its sites.

Executive Summary

Univar Ltd is a large distributor of chemicals in the UK. Univar is a reseller. That is, the company buys chemicals from suppliers, possibly repacks them, and sells them to customers. Univar's distribution network consists of 11 sites. There are more than 11 sites but those sites operate independently in another business segment. The network is set up as in a hub & spoke configuration. That is, stock for each product is centralized at one site called the hub. From this site the product is replenished to all other sites that are called spokes when required. Each site serves all products to all customers in its region.

Safe-tainers

Univar operating margins are under pressure and therefore, the company needs to cut its costs of operations. The group of product that is the subject of this research was identified as an important contributor to the operating costs. These products are chlorinated solvents, and more specifically chlorinated solvents in a special type of containers: Safe-tainers.

Safe-tainers are expensive reusable containers for chlorinated solvents. The Safe-tainer is basically a regular drum in a galvanized steel body. The drums are fitted with a pump system that allows solvent to be pumped straight from the Safe-tainer into the user's machine. Because they are double walled and solvent can be pumped out of the drum (instead of having to be poured into the machine), they are safer to handle and during transport than regular drums. This is important because chlorinated solvents are an environmental and health hazard.

All Safe-tainers are property of a subsidiary of Dow Chemicals: Safechem. In the UK, Safechem only sells chlorinated solvents in Safe-tainers to two distributors: Univar and Caldic. Only the solvent is sold. Also no deposit or rent is charged by Safechem for the use of a Safe-tainer.

Assignment

Univar has asked the student to conduct a research into the supply chain of Safe-tainers to identify and implement opportunities to reduce the logistics costs. The project is divided into four phases. In the orientation phase information about the company and the main issues related to the project is collected. This leads to an assignment and to potential improvement opportunities that are investigated in the analysis phase. One of the improvement opportunities is worked out in detail in the design phase. Finally, the implementation issues are dealt with in the implementation phase.

Orientation ──► Analysis ──► Design ──► Implementation

At the end of the orientation phase, the assignment is formulated as follows:

Make an efficient design for the supply chain of chlorinated solvents which comprises both short term 'quick gains' and long term objectives. The short term design will be implemented as soon as possible. The long term design is a feasibility study into a number of supply chain concepts to be defined at a later stage. The design considers inventories, transport, ordering policies, and allocation of operational activities.

In this assignment, short term 'quick gains' refers to two improvement opportunities that were initially proposed by Univar:

1) Transfer the existing process from Grimsby to Middlesbrough, where Middlesbrough is to deliver Safe-tainers via the existing network and Regional Distribution Centres.
2) Negotiate with Dow Chemicals an agreement whereby Univar will store and fill Safe-tainers at Middlesbrough.

These two proposals are very important to Univar and if the would turn out to be profitable, they had to be implemented as soon as possible. We found that the first opportunity would be profitable but suggested a different site to function as the hub: South Kirkby, mainly because expected savings are almost double the expected savings if Middlesbrough is used. Filling of Safe-tainers was found to be not economically viable unless other business can be found to utilize the extra capacity of a filling station.

Issues Identified

The main part of logistic costs for Safe-tainers at Univar is caused by transport. Currently, vehicles of which Safe-tainers are transported are not used efficiently for the following reasons:

1) Safe-tainers are not distributed over the spokes,
2) Special detours need to be made for Safe-tainers,
3) Vehicles need to return to the hub for Safe-tainers only,
4) Vehicles used for trips to and from the filler are poorly utilized.

Essentially, the first three issues mentioned here come down to the same result as issue 4: vehicles are underutilized. The first three issues are solved if the first of the abovementioned proposals is implemented. However, there is one major barrier: the availability of Safe-tainers.

The Safe-tainer is expensive. A lot of capital is tied up in the UK Safe-tainer pool. Safechem therefore limits the size of the Safe-tainer pool. As a result, the number of Safe-tainers that are available to the distributor is also limited and depends on the number of Safe-tainers that are in use by the customer. This sometimes leads to a Safe-tainer shortage at the filler and distributor. Shortages are dealt with by making extra trips on poorly utilized vehicles. An example will clarify this. Suppose 2 Safe-tainers need to be delivered to a customer before the end of the week. Univar is out of stock. Although Univar has placed an order with the Safechem, nothing has been delivered yet because there are only 3 Safe-tainers on stock at the filler (and Univar ordered a batch of say 30 Safe-tainers). Because Univar wants to deliver Safe-tainers to the customer on time, it sends a vehicle to the filler with capacity for at least 40 Safe-tainers to collect the 3 available Safe-tainers. Later in the week, the rest of the Safe-tainers will be collected.

If Safe-tainers are distributed through the spokes, Univar needs to keep a Safe-tainer stock at each spoke in order to meet the delivery lead times. This would increase the amount of stock required at the distributor. In other words, higher availability of Safe-tainers is needed. If the availability is not increased, more frequent trips on poorly utilized vehicles are needed to move Safe-tainers.

Another barrier to the transition to hub & spoke for Safe-tainers is that Safe-tainers are individually tracked. Each Safe-tainer has a uniquely identifying code and with this code, every movement of a Safe-tainer in the supply chain is logged.

Improvement Opportunities

Improvement options other than the first proposal that was mentioned earlier are the following:

3. Supply of bulk solvent by road tankers directly from the production plant in Germany, eliminating current inventories at the Vopak terminal in Teesside
4. Reducing replenishment lead times and perform cross docking at spokes in order to eliminate all inventories at the spokes
5. Differentiated supply chain with two customer lead times aimed at keeping a minimum amount of Safe-tainers at the spokes only to serve customers with the most stringent lead time demands, whereas other customers customer orders are satisfied (over the spokes) from hub stock
6. Determination of the optimal Safe-tainer pool size and optimal allocation of available Safe-tainer to the distributor sites
7. Determination of economic batch sizes
    a. on trips to/from filler
    b. for return of waste Safe-tainers from spokes to hub
    c. on trips to the customer
8. Increasing customer utilization, thereby reducing the number of Safe-tainers at customers and increasing the availability at the distributor
9. Vendor managed inventory (VMI): Univar manages customer inventories
10. An alternative Safe-tainer concept where the outer hull is separated from the drum and the cycle of outer hull is reduced to the spoke and customer

Based on the following criteria, one of these options was selected to be worked out in detail:

- Expected supply chain profits. These also include profits that are incurred by Safechem.
- The risk of failure. This is the product of required investment and the probability that the improvement does not lead to profits.
- Location of profits and investments. The prerequisite is that improvements must yield savings for Univar.
- Added value of the student in working out the improvement option.

A qualitative judgement was made of each option based on these criteria supported by rough quantitative analysis if possible. Option 6 was selected.

The model

A model was developed that has two functions:

- At the tactical level, the model can be used to determine the optimal pool size. The independent control variable is the pool size. The dependent variables are the fixed costs of the Safe-tainer pool and the logistic costs at Univar. The optimum is reached where the marginal increase of these costs are equal.
- At the execution level, the model is used to determine the optimal distribution of available Safe-tainers among the Univar sites. Optimal spoke inventory levels are not fixed but depend on the availability of Safe-tainers. The model determines the cost optimal inventory level for each site given a certain availability.

The model is based on two major assumptions:

- Univar has its own Safe-tainer pool that has a fixed size. In reality the Safe-tainer pool is shared with the another distributor in the UK. Safechem has no policy on the allocation of Safe-tainers in case there are shortages.
- The total logistic costs increase linearly with the average expected system backlog at Univar. The average expected system backlog is the average amount of Safe-tainers backlogs if no special action is taken to avoid a shortage at one of the sites.

The model uses the following input parameters:

- Pool size
- Number of Safe-tainers in use by Univar customers (average and standard deviation)
- Nominal supply lead time, and replenishment lead times
- Parameters of the demand process at each spoke:
  - Average number of orders per week
  - Average size of an order
- The amount of available Safe-tainers at each site

The model output is the expected average backlog. This amount can be translated to expected logistic costs. A simple heuristic is proposed that can be used with the model to determine the allocation of available Safe-tainers to sites that minimizes the system backlog.

The reliability of the model is tested by comparing its results to the results of a discrete simulation. 5 scenarios are based on recent data about 5 products that Univar sells in Safe-tainers. It is shown that the model is reasonably accurate. Average backlog given by the model differs from the simulation by approximately 0.1. There is no bias is the results.

The model is a powerful tool to relate the Safe-tainer pool size costs for the supplier to logistic costs for Univar. Substantial savings can be achieved both at the distributor and at the supplier by choosing the right pool size for each product. The model also provides decision support for stock control of Safe-tainers. This is important because the common DRP approach of fixed target stock levels lead to non-optimality.

If the model is used, availability barriers to further supply chain improvements like the proposed improvements 1 and 7 are reduced.

Preface

Industrial Engineering and Management Science is an MSc. program at the Eindhoven University of technology. This five year program is concluded with the graduation project. During this project that usually takes the form of a placement with a company, the student has to show that (s)he can put the knowledge and skills obtained from the program into practice. A graduation project in this program is always design oriented. An initial problem or assignment is investigated. Using a systematic and scientific approach a solution is developed. Finally, this solution is implemented or a plan for implementation is developed. The project is described and the project results are presented in a final thesis.

This document is the final thesis for the graduation project that I did with Univar Ltd. in the United Kingdom. It is structured chronologically. First, the reader is introduced to the company and the problem. Second, information about the problem that was collected during the orientation phase is presented. Third, alternative solutions are analysed and discussed. Fourth, one option is selected and worked out in detail. Fifth, implementation issues are discussed. The thesis ends with the conclusion and recommendations for the follow-up of the project.

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