3 MODELS FOR INVENTORY CONTROL

Stocking the right parts:
Using inventory management in a car part distribution network
(This extension material accompanies the text on p. 593.)

A wholesale car parts company supplies car parts to independent garages and service centres. The company has a central warehouse but also a network of 63 branches nationwide. Garages need to work on cars brought in that day so they expect to be able to phone for parts in the morning and receive immediate delivery. However, the warehouse holds 56,000 *different* parts. The warehouse delivers to the branches every night but makes additional daytime deliveries for urgent orders, although this is expensive. The branches deliver to the garages but each branch only sells some of the 56,000 parts in any year. Parts for popular vehicles will be stocked at every branch but about 50% of the parts only sell 11 or fewer units a year across the whole company.

The Company needs to control which parts should be stocked at which branch and how many of each. They want to reduce the cost of holding stock and special deliveries whilst maintaining service to garages.

Which parts should be stocked at each branch?

To approach this problem the business analysts looked at demand for parts at a typical branch. In particular, they considered the number of movements per year. Here, a movement was a unit or a set of units if a part was sold in a set. The 6400 fastest selling parts moved 3 or more times a year. A further 9500 moved twice or once. These were still important to that branch because they accounted for 16% of sales revenue, although they represented 45% of investment in stock. The remaining 40,000 parts weren't sold from that branch that year.

The analysts wanted a simple rule, which would be acceptable to the branch managers, for whether a part should be stocked at a branch or not. They considered rules on the lines of, ' Only stock parts that move at least twice a year' or, 'Only stock parts that move at least 3 times a year'. To find the 'boundary' to stock or not stock, they considered the effect of increasing it by one unit at a time. For instance, suppose the rule was to stock parts that moved at least twice a year. Was it worth increasing the stock/don't stock boundary and saying that only parts that moved three times a year should be stocked? To answer this they needed to consider any savings in *not* stocking the parts that moved exactly twice a year. At a typical branch 2555 parts moved exactly twice a year, and these had value £74,789. . If these parts were *not* stocked the stock value would reduce by £74,789, but 2555 x 2 = 5110 extra movements would have to be made by special delivery a year. The reduction in value of stock per special delivery would therefore be £14.63. Taking into account holding costs and delivery costs it was decided that a reduction in stock value of £12 or more per special delivery was cost effective. (A special delivery can carry lots of movements.) So it wasn't cost effective to stock units with a demand of two a year and *was* worth increasing the stock/don't stock boundary to 'Only stock parts that move at least three times a year'.

They then looked at the next possible increment in the stock/don't stock boundary. Should the rule become, 'Only stock parts with a demand of four or more a year'? The cost saving in *not* stocking the 1261 parts, worth £31,021, that moved exactly three times a year was calculated. If these parts weren't held in stock the value of stock would be reduced by £31,021. But every time one of these parts was requested it would have to come on a special delivery – three times a year i.e. 1261 x 3 = 3783 times. So the stock 'saving' per special delivery was £8.20. As this saving was below the threshold of 12, they decided it *was* cost effective to stock parts that moved three times a year. Parts that moved four, five etc. times a year were fewer, hence of of less value but require more frequent special deliveries if not stocked, so the stock saving per special delivery was very small.

The 'rule' therefore became to stock at a branch all parts that moved 3 or more times a year. The rule was applied with some flexibility for new branches or product ranges. Its advantage was that it was simple for branch managers to apply and to review monthly.

How many of each part should be stocked at each branch?

According to the rule above at least one unit or set of each part with 3 or more movements a year must be stocked at a branch. But how many more? The analysts found, at least for 'slow movers' *(*say fewer than 50 movements a year) that the number of movements in any month followed a Poisson probability distribution (see Probability 4, section 2). If you don't know about probability distributions this just means that for known average demand per month, they could make a reasonable estimate of the proportion of months that had zero demand, the proportion that had demand of 1 and so on.

Suppose one unit is stored at a branch if demand is three or more times a year. If this is used it can be replenished from the warehouse within a particular lead time. To see whether it was worth stocking a second unit at a branch the analysts calculated the probability of a second part being needed within the lead time. This is bigger when demand per year, N is bigger. They then multiplied this probability by N to obtain a formula, with N in, for how many times a year this second unit would be needed. The reasoning described above, that it is only worth stocking a part that moves at least 3 times a year, applies equally to this second unit. They then worked out that values of N of 18 or less in the formula gave demand for the second unit of less than three times a year. Hence it was not worth stocking that second unit. A similar process (using the probability that 2 or more parts are needed during the lead time) was followed to establishe whether it was worth stocking a third unit. This process produced the following rule for the quantity of each part held at a branch:

If annual demand $N < 3$ do not stock the part
Annual demand N from 3 to 18 units, stock one unit
Annual demand from 19 to 43, stock two units.

For higher demand the Poisson assumption didn't work well so for faster movers a different process was used.   Also, if the part was sold in variable quantities (about 10% of parts) the mean and variance of these was used to set a minimum stock level such that 90% of individual orders were below it.

After these rules were implemented sales rose by 28%, but stock levels increased by only 2% in value. However, stock 'turn' that is the number of times a year an item is sold and replaced in stock increased by 29%. An alternative way of viewing this is that the average time an item of stock is held decreased by 29/129, about 22%.

For full details of this study take a look at

Breadth of range and depth of stock: forecasting and inventory management at Euro Car Parts Ltd. FR Johnston, EA Shale, S Kapoor, R True, A Sheth. J. *Operational Research Society* 2011, 62, 433-441.