Weekly presentation SCM research

3nd presentation: Stock Control

Summary

I/Introduction

II/Models

1) *Description*
2) *Model 1 : Periodic review*
3) *Model 2 : Central stores*
4) *Model 3: Economic order quantity for constant demand and a stock-out cost*

III/Limits

I/ Introduction

- Stock need to be held
  - *Unexpected changes in customer demand*
  - *Compensate uncertainty*
  - *Delivery lead times*
  - *Economies of scale offered by transportation companies*
- Related costs may amount tp between 10% and 30% of the value of the stock
  - ➢ ***To keep stocks as low as possible***
- Conflicting interests solved scientifically with mathematical models
- **Main key figures**
  - The distribution of demand
  - Lead time

I/ Introduction

- Costs associated with stocks are split into 3 parts

  - ***Ordering costs****, function of the number of orders placed, differs according to the type of stock*

  - ***Holding costs****, proportionnal to the stock value, and depending as well on the material stored, rate of obsolescence…*

  - ***Stock-out costs****, function of the number of occasions and periods of time when the stock is not available*

I/ Introduction

- Two main methods of provisionning:

  - ***Two-Bin system(continious review),*** *order for a fixed quantity is made when stocks fall to a pre-set re-order level*

  - ***Cyclical review****, variavle quantity is ordered at fixed intervals*

- Stock held at different administrative levels

-> ***network planning***

II/ Models
1) Description

- Mathematical models can be adapted to problems which involve:
  - *Different type of stock*
  - *More than one location of a stock-holding point*
  - *Stock of one homogeneous item of stocks or hundreds of items*
  - *Small-scale or large-scale entreprise*
  - *Stocks other than ones of materials*
- Questions are:
  - ***When to order*** *(determine the re-order level of the interval of time between orders)*
  - ***How much to order*** *(re-order quantity or fixed maximum stock level)*

II/ Models

1) <u>Model 1</u>: Periodic review

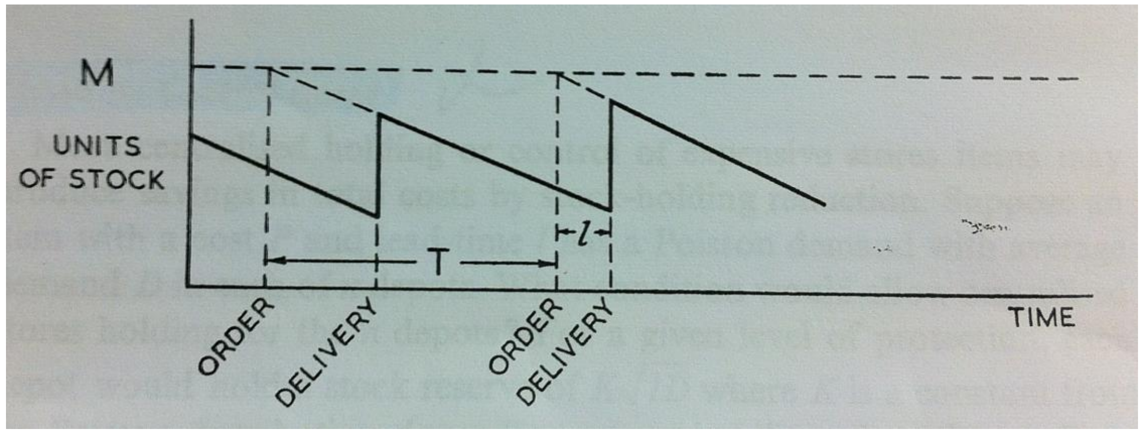
•Variable demand at an average rate D and constant lead time l, given probability of stock-out

•Key figures to determine:

- *At what **cyclical review intervals**, T, should stock be replenished*
- ***How much should be ordered** on each occasion (maximum level M)*

II/ Models

1) <u>Model 1</u>: Periodic review



- *C_1, yearly cost of **holding** per item*
- *C_2, cost for one **re-order***

- Yearly total cost

$$C = \left(M - lD - \frac{DT}{2}\right)C_1 + \frac{C_2}{T}$$

II/ Models

1) __Model 1__: Periodic review

- **Buffer stock** taken as some function $F(\overline{l+TD})$, which is the expected value of (M-lD-DT)
- **Total cost**

$$C = \frac{C_2}{T} + F(\overline{l+TD})C_1 + \frac{DTC_1}{2}$$

- **Minimise C**

$$T = \sqrt{\frac{2C_2}{DC_1}} \cdot \sqrt{\frac{D}{D+2F'}}$$

- **BUT** the value of T still includes a function containing T itself
  - ➢ *Approximation, depending on the distribution of demand*

II/ Models

1) *Model 1*: *Periodic review*

•Example

Demand follows a Poisson distribution, 1% probability of stock-out

Then the buffer stock is given by

$$F = 2{,}33\sqrt{(l+T)D}$$

$$F' = \frac{2{,}33\sqrt{D}}{2\sqrt{l+T}}$$

Finally T is given by the formula

$$T = \sqrt{\frac{2C_2}{DC_1}} \cdot \sqrt{\frac{\sqrt{(l+T)D}}{\sqrt{(l+T)D} + 2{,}33}}$$

II/ Models

2) <u>Model 2</u>: Central stores

- More centralised system can produce savings in total costs by stock-holding reduction
- What condition would allow centralised stores holding for the n depots, considering an item with a Poisson demand?

$K\sqrt{lD}$

$K\sqrt{lD}$

n

.....

$K\sqrt{lD}$

$K\sqrt{nlD}$

II/ Models

2) <u>Model 2</u>: Central stores

- Costs
    - *C_1, **stock-holding** cost per item*
    - *C_4, **transport cost** per item on average to move goods from the central store to each of the depots*
- *Money saving linked to stock-holding reduction*

$$C_1 * K\sqrt{nlD}(\sqrt{n}-1)$$

- *Extra transport cost*

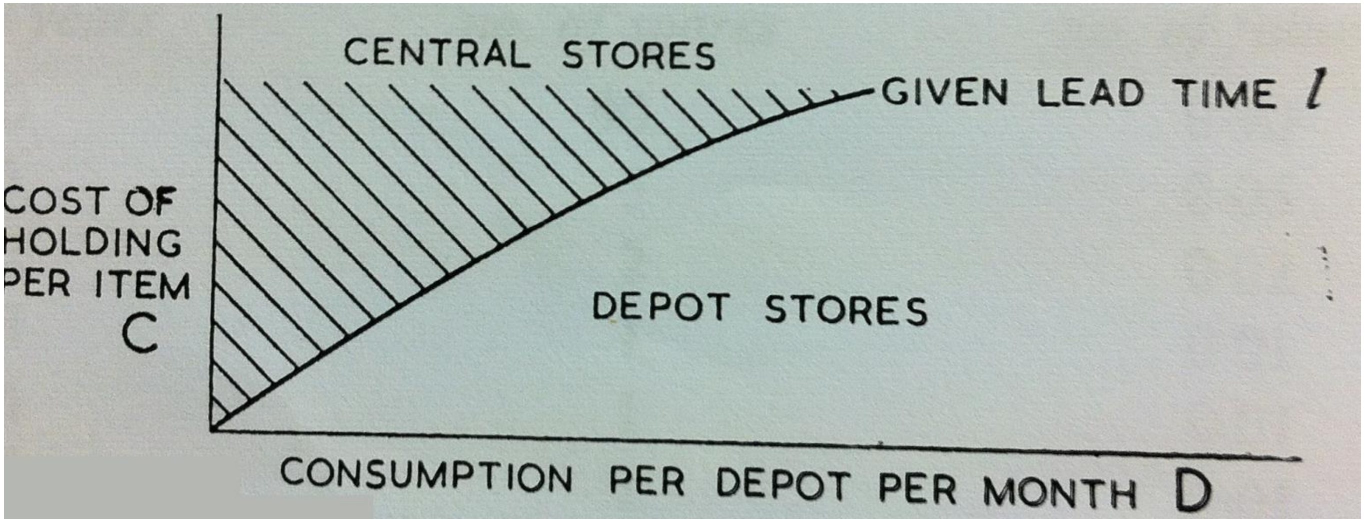
$$nC_4D$$

II/ Models

2) Model 2: Central stores

- ***Condition of rentability***

$$\frac{lC_1^2}{D} \geq \frac{nC_4^2}{K^2(\sqrt{n}-1)^2}$$



II/ Models

3) <u>Model 3</u>: *Continious review with stock-out cost*

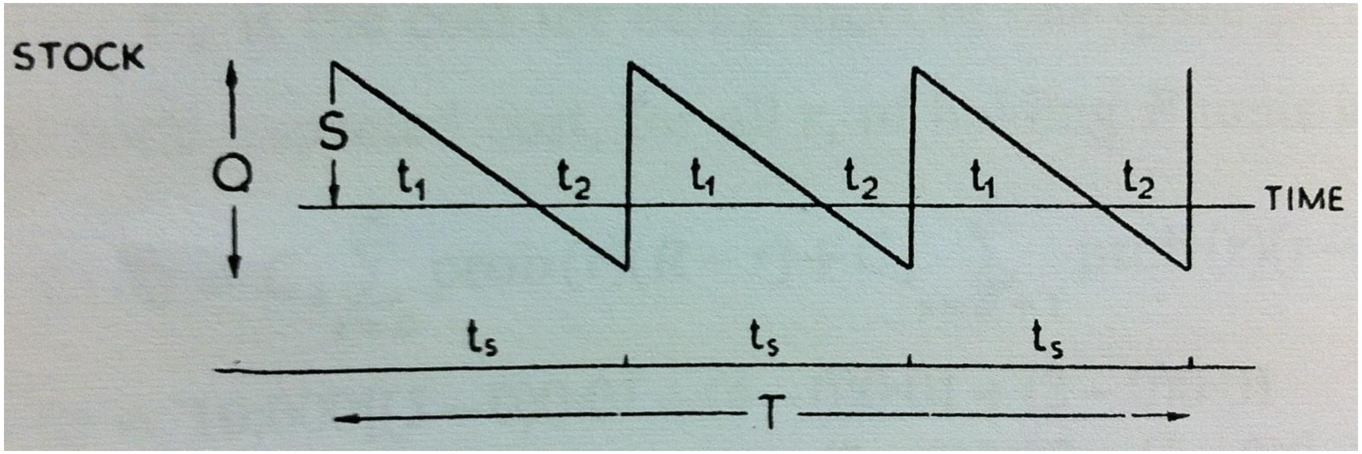
- Constant demand, stocks can be allowed to drop to zero(taken from the next batch)
- Consider a period T during which R units are supplied

- Variable costs
  - *C1, cost of **holding** one unit for aunit of time*
  - *C2**, set-up** cost per run*
  - *C3, cost of **stock-out** per unit of time per unit short (l=0)*

➢ ***What is the optimal size of batch Q which minimises the costs?***

II/ Models

3) <u>Model 3</u>: *Continious review with stock-out cost*



$$t_1 = St_s/Q = ST/R$$

$$t_2 = (Q - S)t_s/Q = (Q - S)T/R$$

Total cost(**holding** during t1, **stock-out** during t2, and **set-up** during T):

$$C = (SC_1 t_1/2 + C_3 t_2 (Q - S)/2 + C_2) R/Q$$

II/ Models

3) <u>Model 3</u>: *Continious review with stock-out cost*

Final equation

$$C = C_1 S^2 T/2Q + C_2 (Q - S)^2 T/2Q + C_2 R/Q$$

Solving by minimising C

$$Q_{min} = \sqrt{\frac{2C_2R}{TC_1}}\sqrt{\frac{C_1}{C_1 + C_3}} \qquad S = QC_3/(C_1 + C_3)$$

$$C_{min} = \sqrt{2RTC_1C_2}\sqrt{\frac{C_3}{C_1 + C_3}}$$

III/ Limits

- Distribution of demand is far more complexe (not always Poisson)
- Cost of stock-out is not known
- Costs are difficult to obtain and to split into parts (variances, dependent parts ...)

Thank you for your attention!