Inventory Control Theory For Hospitals

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Why Inventory Control Theory Is Relevant To The Hospital

- There are many costs associated with controlling inventory
- Understanding these costs can help us minimize them
- Note that we are not talking about the purchase cost of the inventory (except when discounts are involved)

Typical Inventory Control Related Costs

- **Inventory control costs come from the cost of:**
  - **Processing orders**
  - **Holding inventory**

- **Note that we are again not talking about costs that are related to our total consumption**

Internal Inventory Control Costs From Processing Orders

- Placing the order
- Approving the order
- Checking the order (in the purchasing department)
- Faxing the order
- Checking the packing slip against unfilled order database
- Checking the invoice against contract database
- Paying the invoice
- Banking fees, auditing fees, . . .

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Internal Inventory Control Costs From Processing Orders

- Note that many of these costs go away (partially or totally):
  - When using EDI
  - When using RFID
- Note also that we can reduce these costs by reducing the frequency at which we order

External Inventory Control Costs From Processing Orders

- Picking
- Packaging
- Shipping

External Inventory Control Costs From Processing Orders

- Note that many of these costs are passed on by the supplier in the form of higher costs
- Note also that some of these costs can be reduced by reducing the frequency of orders
- We are interested in these costs

Inventory Control Costs Due To "Holding" Inventory

- Cost of space (if space is at a premium)
- Cost of capital
- Expired Items
- Items no longer being used

Inventory Control Costs Due To “Holding” Inventory

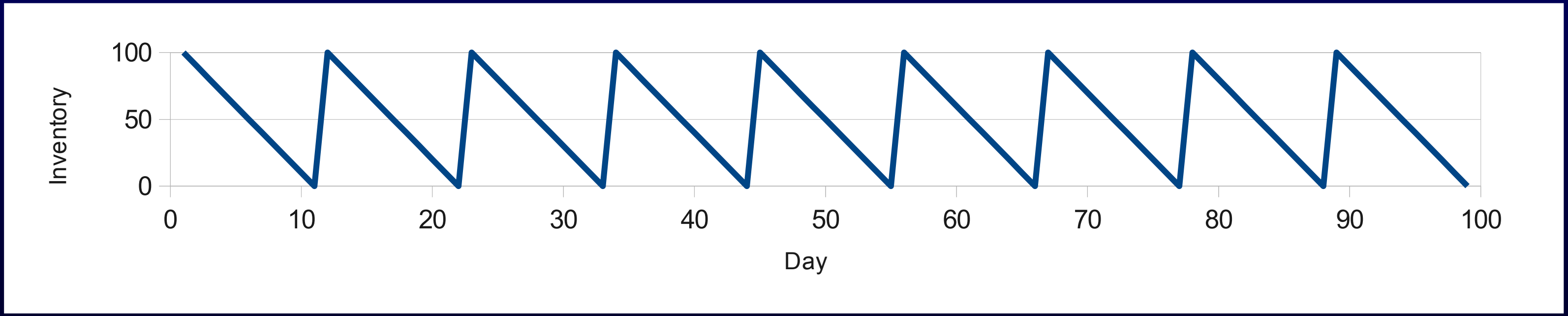
- Many of these costs can be reduced by holding less inventory
- Some of these costs can be reduced by managing inventory (to make sure older items are used first)
- Some of these costs can be reduced by better planning

Simple Inventory Control Theory Problem

- (D) Demand (units per period of time) for a product is constant over time and has no variability
- (LT) Lead time for delivery of an order from the time it is placed is constant over time and has no variability
- (C_O) The cost of placing an order is constant over time and has no variability
- (H) The holding cost per unit of held inventory per unit of time (e.g. a year) is constant over time and has no variability
- Stockouts are not allowed

Simple Inventory Control Theory Problem

- In this simple problem, provided we arrange for new orders (of size Q) to be placed at the right time we do not need any safety stock
- Inventory versus time will look like



where the maximum level is our order size Q

Simple Inventory Control Theory Problem

- From the graph we can deduce that:
  - Average inventory level is half of the maximum (because the area of a triangle is half that of the corresponding rectangle)
  - The number of orders we place per period of time = D / Q
    (e.g. if annual demand is 3650 and we order 100 units at a time we will place 36.50 orders per year)
  - Our Total inventory control Cost will equal
    $TC = (D/Q) * C_o + H * Q / 2$
  - The optimal order quantity (can be determined by setting the derivative with respect to Q to 0) will equal
    $Q^* = (2 * D * C_o / H)^{1/2}$

Simple Inventory Control Theory Problem

- **Important results:**
  - **The optimal order quantity $Q^* = (2 * D * C_O / H)^{1/2}$**
  - **The optimal number of orders per period of time equals $D^{1/2} / (2 * C / H)^{1/2}$**

Just In Time Inventory Control

- For Just In Time to be the optimal inventory control policy, it needs to make economic sense
- In Just In Time, the order frequency is high
- For this to make sense, $D^{1/2} / (2 * C / H)^{1/2}$ should be large
- Looking at C and H, this will occur when:
  - C is small
  - H is large

Just In Time - Internal Ordering Costs At The Hospital

- Internal Ordering costs at the hospital include:
  - Checking the order
  - Faxing the order
  - Checking the packing slip against unfilled order database
  - Checking the invoice against contract database
  - Paying the invoice

- These are all manual processes at the hospital

Just In Time - External Ordering Costs At The Hospital

- External inventory control costs at the hospital from processing orders come from:
  - Picking
  - Packaging
  - Shipping
- My sense is that at least some of these costs are per order costs regardless of order quantity

Just In Time - Holding Costs At The Hospital

- Cost of space if space is at a premium - this should be much less of an issue when construction is finished given the space dedicated for stores
- Cost of capital - currently interest rates are low
- Expired Items – if inventory is managed properly this should not be an issue
- Items no longer being used – if product selection is planned well this should be a minimal issue

Just In Time - Reorder Frequency

- The optimal number of orders per period of time equals $D^{1/2} / (2 * C / H)^{1/2}$

- When construction is finished
  - H should be relatively low
  - C will become lower if we go to RFID and EDI

To Stores Or Not To Stores

- When items are packaged directly to go to individual units:
  - Vendors have to add on their extra costs
  - There are many, many more orders
- If items are ordered from the vendors by stores:
  - The number of external orders will go down very significantly
  - The hospital will need to do more cross-docking; with additional space this can be done much more efficiently
  - The hospital will need to store more and pick from stores more; appropriate automation would reduce these costs

Safety Stock

- There is a lot of variability in demand particularly in units
- To address variability we need safety stock to ensure we meet actual demand during lead time (which may or may not also have variability), assuming a normal distribution (for reference purposes only):
  - 90.00% => 1.28 * standard deviation of demand
  - 99.00% => 2.33 * standard deviation of demand
  - 99.90% => 3.09 * standard deviation of demand
  - 99.99% => 3.72 * standard deviation of demand

Safety Stock

- **If we use stores and pool safety stock from many units with approximately the same demand distributions, the standard deviation of the pooled demand is inversely proportional to the square root of the number of units in the pool**
- **For 25 units, this means 1/5 of the needed safety stock**

Double Bin

- ?

What's One To Do

- **Use real cost data and real analysis**
- **Don't use gimmicky rules**
- **If it's optimal to use Just In Time, the analysis will demonstrate that**

More Information

- http://webspace.ship.edu/mtmars/MIS_530/inventory/Inventory_notes.html

Questions?

Inventory Control Humor

- How many supply chain planners does it take to change a bulb?
- None, the light bulbs are late.

- What’s the difference between big foot and an accurate forecast?
- Big foot has been sighted.

- What's the easiest way to find missing inventory?
- Place a new PO.

Inventory Control Humor

- Demand forecasters are like Slinkies.
- Not really good for anything, but you still can't help but smile when you see one tumble down the stairs.

- Employer: "For this buyer's job, we need someone who is responsible."
- Applicant: "I'm the one you want. In my last procurement job, every time there was a problem, they said I was responsible."

(http://blog.kinaxis.com/2009/04/top-10-supply-chain-jokes/)

Thank You!