Design a Supply Management System in Dynamic Demand Environment

Department of Industrial and Systems Engineering | IE300R System Design Project AY 2014/2015

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I. Problem Description

IBM Ireland Product Distribution Limited launched a new project to manufacture high-end servers. The dynamic demand caused a potential shortage of server packaging materials, putting potential risk to the punctual delivery of server orders.

IBM: unexpected high demand towards quarter and year end

Supplier: potential shortage of packaging material stock to cover demand

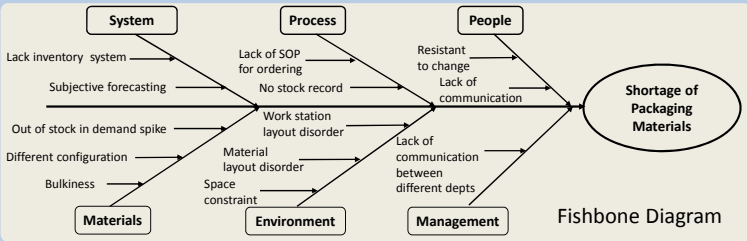
II. Project Objective

The system design project has two objectives:

To analyse existing forecast and historical demand data to come up with a prediction of lead time demand

To design a systematic packaging materials replenishment system to facilitate inventory management

III. Methodology



Fishbone Diagram

Existing System Analysis

- Data collection
- Production on-site visit
- Production manager interview
- Supplier interview

Preliminary Models and Solutions

- Brainstorm solutions
- Discuss different model feasibility with professors
- Select recommendations for integration into model

Final Model and Solution

- Integrate advices into model
- Validate and verify model
- Incorporate feedback from operations team

IV. Preliminary Solutions

Problem Identification

REGEN Forecast
- Hard to predict demand spikes
- Sometimes in shortage or in excess
- No forecast within the month

No Inventory Record
- No system to track inventory
- Possible double counting
- Asymmetric information sharing

No Ordering System
- No query report to reflect shortage material
- Possible risk of insufficient order buffer

Space Constraint
- Server will take up spaces for packaging material stock area during year end high demand period
- No record of actual packaging material inventory location

Challenges Faced

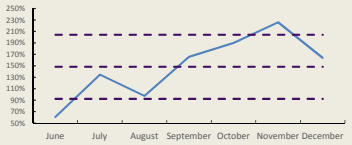
Previous Proposed Methods	Method Description	Reason of Failure	Challenges identified
Forecast for Intermittent demand	Frequent intervals with no demand Large variation in demand levels Creston's method based on exponential smoothing	Intervals between order are not random	Strong seasonality influence
Multiple method	Past data of similar models with complete life cycle to get the trend factor for new forecast	Historical data of similar products are not available.	Immature Product
REGEN forecast regression	Make use of their most recent subjective forecast from sales team	Only monthly forecast from May to December is available, and no strong correlation can be observed	Human-driven performance
Deseasonalized forecast	Time series forecast with multiplicative seasonality factors Remove patterns due to seasonality and analyze underlying trend	Model fit is extremely low due to random data	Non-stationary demand

V. Finalized Solutions

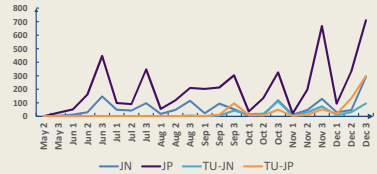
Supplementary Forecasting System

Step 1: Observe Sales Forecast and Actual Ratio

- Divide the existing sales forecast and the actual shipment number to get the ratio of forecast/actual
- Use the ratio to calculate the range of next month's forecast

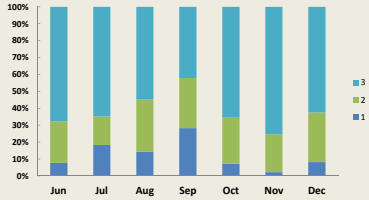


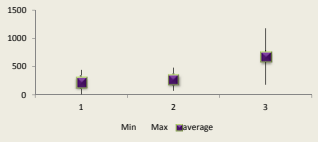
Step 2: Identify Cyclical Pattern



- Server demand is highly cyclical due to its product life cycle.
- Best cyclical pattern is observed by grouping data into 10-day period
- The highest demand always happens at month end, quarter end and year end

Step 3: Determine Mean and Range

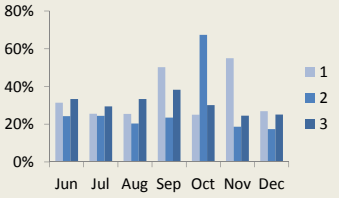




The minimum, maximum and mean of the study period are used to form the range of period forecast in next month

Inventory Replenishment System

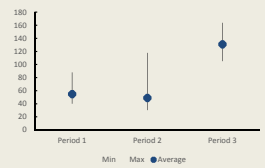
Step 1: Calculate Daily Demand Ratio



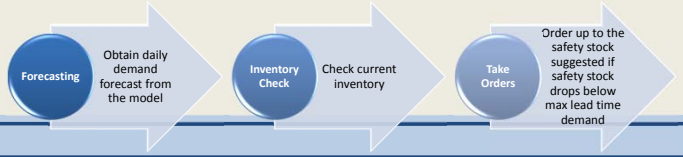
- Use the maximum 1-day demand to divide period demand to get demand ratio
- Use the ratio across the same period of different month to get the range of daily demand ratio

Step 2: Obtain Daily Demand Range

- Use the the minimum, maximum and mean of the study period to form the range of daily demand forecast
- Use the ratio with period forecast to get the range of daily demand



Step 3: Safety Stock Planning



VI. Recommendations and Conclusion

Systematic Inventory Replenishment

1. Reduce risk of insufficient stock buffer by placing order based on model output. Reduce training costs for new staff by establishing standard operating procedures.
2. The solution requires minor change on current process, and avoids asymmetric information sharing or double counting problem.
3. Model tool developed is easy to understand and use, thus requires minimum training for operation staffs.

Project Improvements

1. Current result is based on data of 4 newly launched servers and can be potentially extended to use for other servers sold by IBM.
2. Due to relatively short life cycle of servers, demand prediction input has limited accuracy, thus a conservative approach for safety stock planning was used. More historical data is likely to improve the model performance.