Core Problem

To maintain the company's vision of maintaining a high level of customer satisfaction and order fulfillment, KM has adopted an Order Up-to-Level (OULT) approach for its inventory management. However, as the company continues to expand its businesses, the OULT approach poses great problems and burdens to its multi-echelon distribution system.

In times of declining demand in some branches for consecutive months:

1. Unresponsive to changes
2. Unnecessary inventory costs
3. Inventory Obsolescence
4. New orders continuously being made from some branches due to lack of communication

Lower profits
Lower efficiency

Project Scope

- Focus on service parts and consumables.
- Available data from Thailand and Malaysia.

1. Project Description

Konica Minolta Business Solutions Asia Pte Ltd (KM) is part of Konica Minolta Incorporated, a Japanese technology company which specializes in advanced document management technologies and print solutions. The company adopts a multi-echelon distribution system for its supply chain management.

What is a Multi-Echelon Distribution System?

- Manages the entire supply network as a "pool," rather than as a group of independent locations.
- New inventory shipments are first stored at a central/ regional distribution center (RDC) which are the internal suppliers to the forward distribution centers (DCs) which in turn supply goods to individual branches.
- Forecasts are usually made in the lowest echelon and the echelons above benefit from that.

2. Project Objectives & Key Skillsets

Objectives

1. Reduce inventory obsolescence while maintaining high customer satisfaction.
2. To improve inventory management at branch level.
3. Develop a tool that assists forward planning of inventory levels in a systematic way.
4. Incorporate great usability, flexibility and portability in the tool so that KM can adapt to suit future needs.

Key Skillsets

- Project Management: breakdowns the complex problem into subproblems for ease of analysis.
- Data Visualization: Understanding of data and identification of assumptions and limitations.
- Supply Chain Management: Demand Forecasting, Cross validation and Accuracy Prediction.
- Operations Research: Linear Programming and Optimisation of distribution of SKUs.

3. Root-Cause Analysis

Core Problem

Minolta

Skus

Solutions

4. Data Visualisation

Insights:

- Demand data exhibits highly varying characteristics (stable, fluctuating, rare occurrences) for different branches over recorded time period.
- Data are highly aggregated, lack of specific characteristics (e.g. demand types – walk in, repair, regular)
- Limited data available (only around 1 year of data) – complexed algorithms may not work well

5. Methodology

Create an inventory re-planning desktop application that will forecast SKU demand at each branch and redistribute excess SKUs among branches. Data will also be stored in database server for a centralised control and management which helps to facilitate sharing of information among branches.

Architecture Diagram

(Software)

- Visual Studio (app development)
- R Programming (forecast)
- Visual Basic (backend processing)
- Microsoft SQL Server (database)

6. Logic Flowchart of Model

1. Input Modeling: Upload historical demand and inventory data excel files into database and specify planning time period.
2. Data Cleaning: Extract, sort and mapped relevant data into desired formats for manipulations.
3. Demand Forecasting: Fit appropriate time series forecast model. Cross validate to obtain accuracy/error value.
4. SKUs Reshuffling: Optimise and redistribute excess SKUs among branches.
5. Model Verification: Validate model with historical data.
6. Output Modeling: Display the results of the reshuffling and other relevant details in a clear and intuitive manner.

Assumptions & Limitations

- Demand for SKUs is stochastic.
- Constant lead time
- Costs of transportation between branches are negligible in comparison to the savings from reshelving.

7. Detailed Approaches/Procedures

Demand Forecasting

- Algorithms used are auto.arima, ets and prophet.
- Ability to decompose data into trend, seasonal and residuals components.
- Do not require substantial assumption of params.
- Cross validated to obtain Mean Absolute Error (MAE).

SKUs Reshuffling

- Linear optimization model
- Redistribute excess SKUs among branches after factoring fulfilment of indiv’s demand for next two months.
- Min new order → Min inventory obsoletes.

Database Management

- Centralised server created on MSSQL
- Ability to use Entity Framework
- Object Relational Mapping for structured organization of data
- Facilitates storage and transfer of data, enhances coordination between branch levels.

8. Result Analysis

- Details the no. of units to be taken in or shuffled out from each branch for the different SKUs.
- Anomaly data highlighted to provide greater managerial insights.
- Accuracy of model is validated using historic data from Malaysia and Indonesia, results points to at least 70% accuracy and 15% reduction in new orders to be placed.

9. Future Directions

1. Incorporate better, more robust forecasting method/algorithms when more complete data are available.
2. Scale to include to other regions such as the Philippines, Indonesia or out of Asia etc.