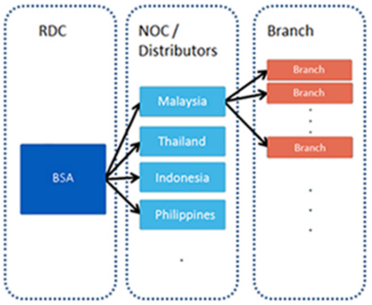
IE3100R SYSTEMS DESIGN PROJECT | DEPARTMENT OF INDUSTRIAL SYSTEMS ENGINEERING & MANAGEMENT

Improving the Inventory Management for Service Parts in a Multi-echelon Distribution System

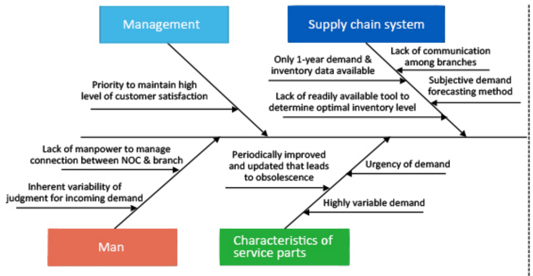
Team members: Hu Yizhi, Liu Dongdong, Sun Yiqi, Wang Bowen, Yuan Meng
NUS supervisors: Prof Andrew Lim, Dr He Shuangchi **KM supervisors:** Chan Wei Jie, Ian Wang Jie Yan

PROBLEM DESCRIPTION



With the target of maintaining a high level of customer satisfaction, KM adopts an order-up-to-level (OUTL) policy that leads to high inventory cost and obsolescence. Due to a lack of communication, branches with insufficient inventory keep ordering from RDC while others are overstocked. Therefore, the supply planning and inventory management have to be improved.

Root Cause Analysis



High inventory cost and obsolescence

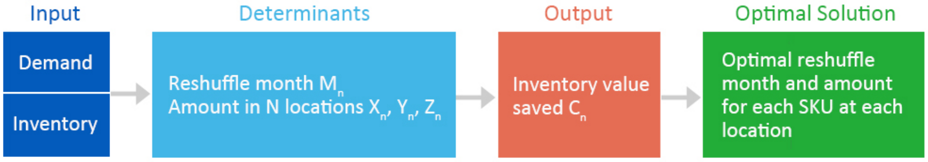
PROJECT OBJECTIVE

1. To improve inventory management at branch level for service parts
2. To develop a tool that assists planning and fulfilment of orders

METHODOLOGY

An inventory reshuffle system will be implemented to mobilize SKUs among branches, that is, the excess would be transferred to branches with shortage and the leftover, after reshuffling, will be be reverse purchased by RDC. A simulation model is built to determine the best reshuffling policy. COUNTRY OF STUDY: Malaysia with 30 branches due to problem with availability of data in other regions.

Model Design


Input
Determinants
Output
Optimal Solution

Demand
Inventory

Reshuffle month M_n
Amount in N locations X_n, Y_n, Z_n

Inventory value saved C_n

Optimal reshuffle month and amount for each SKU at each location

INPUT

Out of over 5,000 service parts SKUs, we filter out those that contribute to 80% of the total revenue (by Pareto Rule), giving us 157 SKUs as main objects of study. Naive forecasting using the monthly demand and inventory data from Sep 2015 to Aug 2016 is employed.

DETERMINANTS

1. Reshuffle Month
   - Reshuffle frequency (once a year)
   - Reshuffle month (determined after running the model)
2. Reshuffle Amount
   - New OUTL = Demand * (Lead time + Review period) + k * $\sigma * \sqrt{\text{Lead time + Review period}}$
     Reshuffle Amount = Inventory - New OUTL
   - Reshuffle Amount > 0 : inventory in surplus
     Reshuffle Amount < 0: inventory in shortage
3. Reshuffle Rules
   - Total excess ≥ Total shortage
     Fulfil all the shortages at branches
     Leftovers are purchased by RDC
   - Total exess < Total shortage
     Fulfil the branches with shortages one by one
     Unfulfilled demands are purchased from RDC

OUTPUT

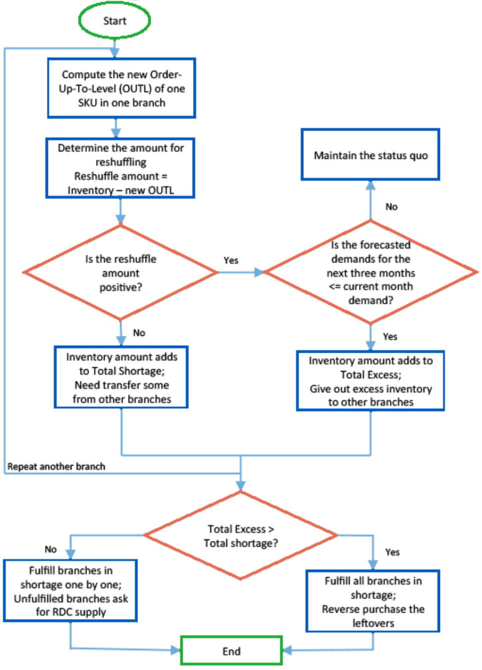
Using various sets of determinants, the cost saving is obtained from the simulation model.

- Inventory value = unit price x (reshuffle amount + repurchased amount)

OPTIMAL SOLUTION

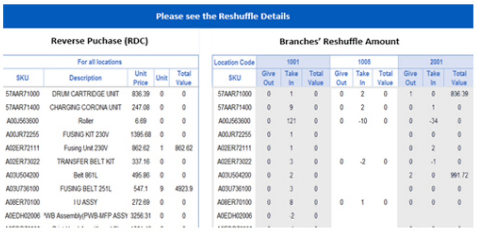
Among the various cost saving values obtained, we would select the optimal value which determines the final reshuffle policy, including reshuffle month and amount for each SKU.

Model Logic



RESULT ANALYSIS

After running the model, the result is displayed, showing number of units to be given out or taken in for each SKU in each location. When reshuffling is conducted in December, 4.2% of total inventory value is saved.

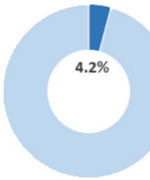

Please see the Reshuffle Details

Reverse Puchase (RDC)

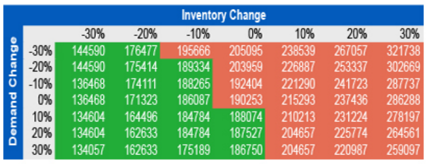
For all locations				
SKU	Description	Unit Price	Unit	Total Value
57AAR71000	DRUM CARTRIDGE UNIT	836.39	0	0
57AAR71400	CHARGING CORONA UNIT	247.08	0	0
A00J563600	Roller	6.69	0	0
A00JR72255	FUSING KIT 230V	1395.68	0	0
A02ER72111	Fusing Unit 230V	862.62	1	862.62
A02ER73022	TRANSFER BELT KIT	337.16	0	0
A03U504200	Belt 861L	495.86	0	0
A03U736100	FUSING BELT 251L	547.1	9	4923.9
A08ER70100	I U ASSY	272.69	0	0
A0EDH02006	'WB Assembly(PWB-MFP ASSY	3256.31	0	0

Branches' Reshuffle Amount

Location Code	1001			1005			2001		
SKU	Give Out	Take In	Total Value	Give Out	Take In	Total Value	Give Out	Take In	Total Value
57AAR71000	0	1	0	0	2	0	1	0	836.39
57AAR71400	0	9	0	0	2	0	0	1	0
A00J563600	0	121	0	0	-10	0	0	-34	0
A00JR72255	0	1	0				0	0	0
A02ER72111	0	1	0				0	2	0
A02ER73022	0	3	0	0	-2	0	0	-1	0
A03U504200	0	2	0				2	0	991.72
A03U736100	0	3	0				0	0	0
A08ER70100	0	8	0	0	1	0	0	0	0
A0EDH02006	0	-2	0						



4.2% of inventory value saved


Inventory Change

Demand Change	-30%	-20%	-10%	0%	10%	20%	30%
-30%	144590	176477	195666	205095	238539	267057	321738
-20%	144590	175414	189334	203959	226887	253337	302669
-10%	136468	174111	188265	192404	221290	241723	287737
0%	136468	171323	186087	190253	215293	237436	286288
10%	134604	164496	184784	188074	210213	231224	278197
20%	134604	162633	184784	187527	204657	225774	264561
30%	134057	162633	175189	186750	204657	220987	259097

The interactive effects of the changes of inventory and demand on the inventory value saved have also been studied using a two-way sensitivity analysis.

Variation of inventory level have greater impact on inventory value saved than that of demand.The outcome for the optimal reshuffle month is always December regardless of the values of variables of interest. Thus, it can be concluded that the model is relatively robust towards the changes.

Sensitivity Analysis of Lead Time, Demand & Inventory

As lead time increases, the inventory value saved from reshuffling would decrease. Within the studied range of lead time, the optimal month for reshuffling is consistently fixed at December.

FUTURE DIRECTION

1. Build a more robust demand forecasting model when more data becomes available in the next few years. Better forecasting results may be obtained using distribution and moving average methods.
2. Increase the reshuffle frequency per year
3. Apply the tool to other regions such as Philippines and Thailand, as well as higher echelons from distributors to RDC.