Reverse Redistribution Management

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***Abstract*-The purpose of this paper is to prove methods of redistribution management on the model of unsold goods. A research was carried out with data sourced from the aftermarket sector. The research was used to explore basic questions of what are the benefits of unsold goods redistribution and how it should effectively contribute to inventory management.**

The existing information models have focused on forward distribution flows – from suppliers to consumers. The current information systems are generally in-depth specialized in forecasting methods of future consumption while they do not deal with returnable asset control. The paper provides a comprehensive description of the redistribution principles tested on the compiled model. The basic prerequisite that needs to be fulfilled in order to reach results, is sharing information between suppliers and consumers. For application of this method a shared information platform within the supply chain is required.

The expected outcomes of the proposed model are reduced inventory levels and improved structure of the portfolio resulting in higher profits. The redistribution was conducted with the aim of accelerating inventory turnover and minimizing redundant purchasing. Furthermore, a correlation between unsold goods redistribution and higher load vehicle factor was identified.

Keywords: redistribution, inventory management, cost reduction

I. INTRODUCTION

Every production, replenishment and shipment between manufacturers (distribution centres) and every retailer (store) require a particular material flow in the whole supply chain. Current supply chain management demands accurate forecasting of future sales in order to ensure effective logistics system. An accurate demand forecasting and its distribution resource planning (DRP) have several business benefits. The main benefits include lower inventory level and reduced number of stock-outs. Besides the main benefits, there are the so-called hidden reserves, which could be drawn from Flowcasting. Collaborative Flowcasting is based on the inventory planning principles of DRP systems enhanced by:

- Actual store level item demand
- Data refreshment based on actual store results daily
- System handling with huge volume of data at the store level integrated in central ordering system
- Reverse redistribution system from stores

The hidden reserves consist of redundant purchases and enhanced level of distribution costs. Well-functioning and sophisticated ordering system with integrated redistribution model saves not just only hidden reserves, but also reduces risk of stock-outs and on the top of that it saves operating and investment costs. The research objectives were to determine the practices of redistribution management used in Flowcasting.

II. METHODS AND PROCEDURE

Redistribution method was tested in distribution network of an aftermarket distributor. This network constitutes of one central warehouse and 25 stores located in the Czech Republic. Stores act as unique warehouses and keep their individual inventory levels. Distribution between warehouse and stores was established on daily basis. A method was designed to minimize supplies from central warehouse to stores. The aim was to use inventory which is held on other store and is unlikely to be consumed, rather than ordering new inventory batch from supplier to central warehouse. This approach will decrease inventory levels in distribution network, amount of capital locked-up in inventory; will reduce ordering cost and supplier distribution cost.

Basic prerequisites for redistribution:

- Base stock and forecast for each SKU (Stock keeping unit) on each location must be known.
- Base stock can be calculated by using advanced mathematical methods for

demand forecasting (theory of time series) for SKU´s with smooth demand or by probability approach such as bootstrapping (Smart-Willemain 2003) for SKU's with intermittent demand. Data analysis and evaluation were obtained from Planning Wizard – the system for forecasting and demand planning.

- Limit price value of order must be set in order to avoid inefficient reverse distributions. Limit price value of order include costs for packing and administration workload. Distribution cost is not included, because of using currently established regular transport. All orders valued less than proposed price limit will not be selected for redistribution.

Compiled model covers 25 stores and one central warehouse. At first method used for SKU's with smooth (constant or normal) demand is presented:

Let:

- D_{ai} be demand for SKU *a* on store *i*,
- I_{ai} be inventory of SKU *a* on store *i*,
- F_{aij} forecast of SKU *a* consumption on store *i* for next *j* days
- LT_{ai} the lead time for SKU *a*
- BS_{ai} the base stock for SKU *a* on location *i*
- P_a the price of SKU *a*

At first an excessive inventory at stores must be found. Excessive inventory is determined by base stock calculation. Different approach is used for SKUs with intermittent demand and with smooth demand. Intermittent demand appears randomly with many periods that have no demand. Typical examples of intermittent demand are spare parts or aftermarket. Majority of items have smooth demand which are forecasted by traditional statistical methods such as exponential smoothing and moving averages.

For smooth demand excessive inventory EI_{ai} at store is calculated:

$$EI_{ai} = I_{ai} - BS_{ai} - 2*F_{aiLTai}$$

Expected consumption for two lead time period is necessary to secure that item will not be redistributed from one store location to another and that excessive inventory is not likely to be consumed, thus creating demand for order from supplier.

For intermittent demand, the excessive inventory is calculated by means of Smart-Willemain method. The Smart-Willemain method is based on bootstrapping (taking random samples from time series). For defined period, days are randomly selected from time-series many times.

Then these experiments are used to build statistical robust picture of the lead time distribution. These random consumptions are then summarized in histogram, which forms distribution function. For given service level and lead time inventory base-stock level is calculated, by randomly selecting demand for lead time period (for 10 days lead time, chose randomly 10 days) many times.

To find out what inventory is unnecessary to be held at location in next lead time period, double lead time period must be held for Smart-Willemain method. Double lead time is used to secure that algorithm will not suggest frequent movements of inventory from store to store, which will occur if inventory for more than one lead time period is considered excessive.

Let $BS_{aidouble}$ be base stock for doubled lead time period. Than Excessive inventory is calculated:

$$EI_{ai} = I_{ai} - BS_{aidouble}$$

Next, excessive inventory on stores is ordered descending by excessive inventory and demand is fulfilled in this order.

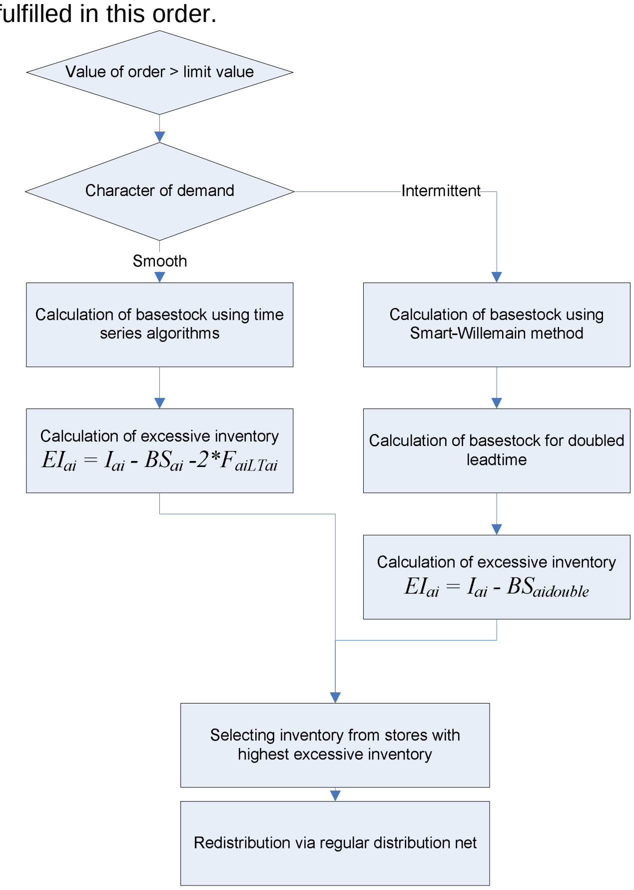

Fig. 1: Redistribution procedure

III. RESULTS AND DISCUSSION

Based on the methodology described above, an analyzed portfolio was about 100,000 unique items from the aftermarket sector. Inventory management in the aftermarket deals with intermittent demand, which is the reason for redistribution implementation.

This item portfolio is used in one central warehouse and 25 stores located in the Czech Republic. Stores act as warehouses and keep their unique inventory level. Entire portfolio was tested in two intervals with a difference of three months, a period that corresponds to the longest lead time (delivery time) for supply from China.

The entire portfolio is from the perspective of inventory management divided into three main groups – distribution centre (central warehouse), new items, and stores.

Model prerequisites: new items are those with sales history not longer than two months. These items need to be eliminated for further steps due to the significant errors in forecasting. New products represented the amount of approximately 9 thousands of unique items (2%) in the value of 0.14 M € (4%). According to the procedure above, 2 stages were simulated. In the first stage the redistribution functionality is not used; in the second stage redistribution is applied. The obtained results are shown in the tables below.

TABLE I
MODEL WITHOUT REDISTRIBUTION FUNCTION: PORTFOLIO VALUE IN € AND IN NUMBER OF PIECES (QUANTITY)

Portfolio classification according to inventory allocation	value of inventory		number of pieces (quantity)	
	€	%	number of pieces	%
Distribution centre	2.503 M €	67%	0.255 M	60%
Stores	1.086 M €	29%	0.159 M	38%
Total	**3.589 M €**	**96%**	**0.414 M**	**98%**

TABLE III
MODEL WITH REDISTRIBUTION FUNCTION: PORTFOLIO VALUE IN € AND IN NUMBER OF PIECES (QUANTITY)

Portfolio classification according to inventory allocation	value of inventory		number of pieces (quantity)	
	€	%	number of pieces	%
Distribution centre	2.517 M €	69%	0.257 M	62%
Stores	0.984 M €	27%	0.147 M	36%
Total	**3.501 M €**	**96%**	**0.404 M**	**98%**

The presented tables compare value of inventory without redistribution function (table I) and with redistribution function (table II). As shown in the tables, **the difference of 0.088 M € in the inventory value and 10,000 difference in quantity (number of pieces) per month was achieved as a result of redistribution function**.

IV. CONCLUSION

Nowadays, redistribution is an important issue for each business management dealing with its own distribution network providing transport of goods to stores. Effective redistribution management within its own distribution network is a source of savings in inventory (capital) and minimizing redundant purchasing. Other benefit is the flexibility of customer service within self-served network rather than staying dependent on external suppliers. Redistribution means serving customers in a sustainable way.

Based on the presented research, a reduction of inventory value by 0.088 M € per month was achieved due to effective redistribution management. Redistribution management system implies the use of forward-direction distribution network, thus does not produce extra transportation cost.

In addition to financial savings, it is necessary to mention the contributions in a global system of sustainable development. Due to efficient inventory consumption the liquidation of unused (technologically obsolete and unsalable) inventory is minimized. The future issue will be to manage redistribution not just within own distribution network, but in the whole supply chain.

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