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Continuous Inventory Level Monitoring Replenishment Model for Modern Trade

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Abstract:
Stock Replenishment process is a major area of concern for modern retail in India. The paper explores various problems associated with the supply chain design to improve the stock replenishment process by reducing the information gap in the supply chain. Author has proposed Continuous Inventory level Monitoring (CILM) framework to make the information flow more efficient. The framework provides a way to track the status of inventory at various nodes in supply chain. This will help to tackle various problems in supply chain like – sudden demand spikes, stock-outs at retail store, Raw material and Packaging material procurement, information flow delays etc. It also provides for calibrating the forecasting so as to have better predictions. In the end paper briefs about how the logistics cost can be reduced using this framework. The limitations of the application of the framework are the degree to which the stakeholders agree to share information among them. In ideal scenario all the entities will be sharing the information as required by the model.

Keywords*: Modern Retail, Replenishment Model, Fill rate, Inventory Management, Distribution Network*

1. Introduction

Indian retail landscape is changing with modern trade expanding at the speed of 13.2%. This high growth has attracted a lot of big players to this industry. With such a high competition, supply chain is one of the differentiating areas that most of the companies are looking at. High demand variability accompanied by competition to win the shelf space makes it necessary for FMCG players to maintain a high fill rate which can be achieved through improving the information flow in the entire supply chain. The paper discusses about how information flow can be improved leading to better stock replenishment process in modern retail.

1.1. Literature Review

There is a lot of research available for stock replenishment in general trade retail format but very less research has been done for modern trade. This is the area where still very traditional methods are used for stock replenishment. Most of stock replenishment is MBQ (Minimum Base Quantity) based where stocks will be sent to the retail stores from the company DC once the stock available at the store crosses the MBQ level. In case the stock out happens before the reorder quantity, the shelf will remain empty or else the competitor's product will be placed at the empty space.

Research is available on the importance of collaboration in supply chain for stock replenishment. Juhwen Hwang, Su-Hwa Wu(2013) in their paper summarizes the benefit of collaboration in improving the supply chain performance. This is one of the fundamental idea on which the model tries to improve the supply chain performance. Increased collaboration will lead to increased information flow which in turn improves the forecasting accuracy and thus the replenishment process.

Some existing Literature also explores various demand forecasting models for stock replenishment like heuristic, neural networks, Bayesian networks etc. These algorithms are not sufficient to improve the overall performance until continuous POS (Point of Sale) data is fed to them. This is the area where the CILM framework will improve the system.

2. Current Model

The basic replenishment model in modern retail has following processes involved:

- Continuous replenishment from manufacturing unit to company warehouse or Hub
- Continuous replenishment from company warehouse to company distribution center(DC)

- PO based replenishment from company warehouse to key account DC (retailer's warehouse)
- Then MBQ based replenishment from key account DC to retail outlet

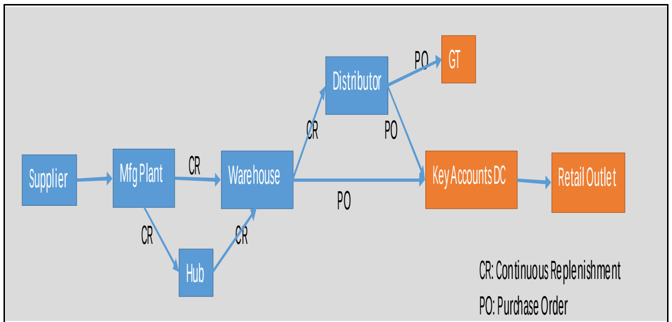

Figure 1: As- Is Model, Current Distribution Network

Figure 1

This model has various problems associated

- Handling of sudden spikes becomes difficult and fill rates are not met in such a case
- The spikes lead to shortage/ stock-out or excess inventory.
- Raw Material and Production Material (RM / PM) are not able to meet drastic changes in the demand at short notice
- Sudden spikes leads to disturbance in the production process and leads to wastages
- There is a delay when it comes to actual PO generation then the delivery of items
- Truck loads are not optimized as per the sudden spiked requirement
- Estimates / forecasting are not calibrated with current status thus it leads huge difference in forecasting and actual requirement
- Sudden fulfillment is done by smaller size trucks therefore the MTBS (Mean Time between Shipments) increases

3. Proposed Model

The products of a particular supplier should be classified in a 2X2 matrix based on the parameters given below:

- Mass seller
- Premium
- Slow Moving
- Fast Moving

	Slow Moving	Fast Moving
Mass Seller	Least Priority	Revenue Earner
Premium	Niche	Top Priority for MT
Strategy Matrix		

Table 1

Mass Seller goods are those for which margins may be low but volumes are high. Thus profits are made by increasing the sale volume. For premium products the volumes may be low but the margins are high. So maintaining their premium nature is the most important factor. Fast moving goods are the goods for which frequency of selling is high and they need more frequent replacement. For slow moving goods this is comparatively slower.

Since the premium products are majorly sold through modern trade outlets, Premium fast moving products should be replenished with the top most priority. As far as fast moving mass sellers are concerned, these are the highest revenue earners and hence system should allow continuous monitoring. These products are sold more in General Trade (GT), thus these outlets need to be monitored through distributor network. A mobile application for updating for the GT outlets would help us gauge the exact requirement at the distributors end before time, in order that the GT outlets never run out of stock fast moving mass sellers. Slow moving mass sellers should be replenished based only on PO for the GT outlets. If the demand cannot be fulfilled totally be Warehouse or distributor independently then there should be flexibility to fulfil orders via distributors and Warehouse to the key accounts. The key accounts are the warehouses of the modern retailers.

4. Proposed Network

The model proposes that the replenishment between company warehouse and key account DC should be continuous. Thus in this case instead of DC sending PO to the supplier Company for stock replenishment, a continuous replenishment, by the producer company, shall be established so as to fulfil the stock requirement of the retail stores.

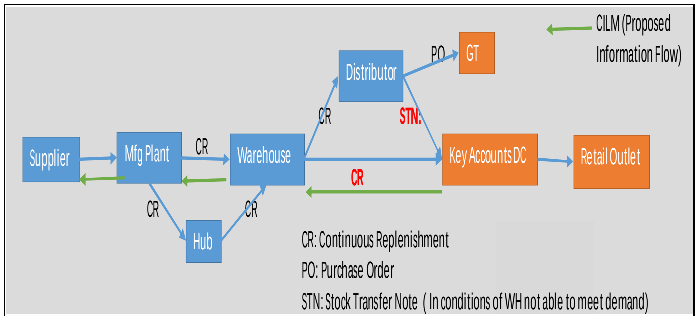

Figure 2: Proposed Distribution Network

Figure 2

For this model to work there is a necessity of continuous information flow upstream. This will enable on time accurate procurement of Packaging Material (PM) / Raw Material (RM). Also manufacturing plant through put can be maintained to address the sudden surges in demand that manifest as spikes in the forecast.

4.1. Proposed model for continuous monitoring of Inventory data for Key Accounts:

The information of stock at various parts of supply chain is important for demand planning. The proposed model defines five inventory levels for checking the health of inventory and for calculating reorder point. The real time information needs to be gathered at all parts of the supply chain including dealer's warehouse on continuous basis. The current replenishment being dependent on MBQ at the MT outlets, which are filled by their own DC on setting of trigger which makes demand discontinuous**.** With the provision of levels the unit just before the demand spike will get a prior intimation.

Green	100 to 80%	Plenty
Yellow	80 to 75%	Demand may increase
Blue	75 to 50%	Fullfillment required
Red	50 to 10%	Fulfillment by Priority
Black	Below 10%	Top Priority

Table 2: Continuous Inventory Level Monitor(CILM)

In the proposed model, inventory data will be captured continuously for key accounts DC through an online terminal in probably a suitable excel format.

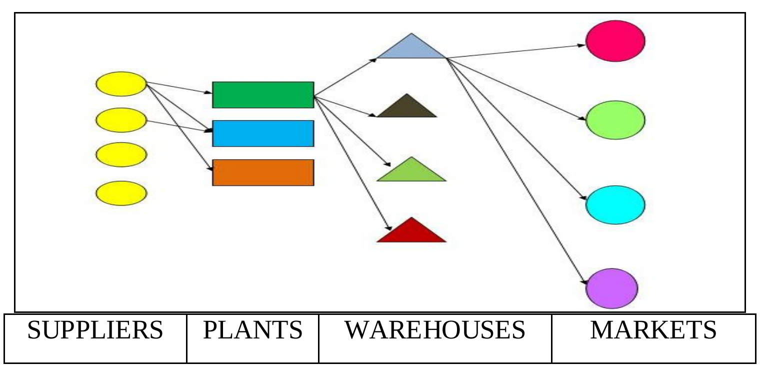

Figure 3: Display of status at various levels

We consider a supply chain model wherein the supplier sends RM to plants and plants send finished products to warehouses that in turn supply to the MT distribution centers. Multiple warehouses may be used to satisfy the market and multiple plants may be used to replenish the warehouses.

5. Logistics Planning

In order to make logistics responsive more aligned to the new proposed model following is proposed to as to develop the logistics plan. The model requires following inputs [3]

- **m**= number of demand points or MT distribution centers
- **n**= number of potential factory locations
- **l**= number of suppliers
- **t**= number of potential warehouse locations
- $\mathbf{D_j}$= annual demand from customer j
- $\mathbf{K_i}$= potential capacity of factory at site i

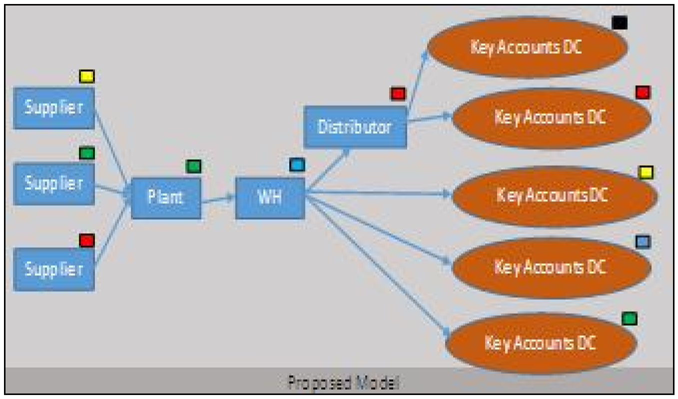

Figure 4

- $\mathbf{S_h}$= supply capacity at supplier h
- $\mathbf{W_e}$= potential warehouse capacity at site e
- $\mathbf{F_i}$= fixed cost of locating a plant at site i
- $\mathbf{f_e}$= fixed cost of locating a warehouse at site e
- $\mathbf{c_{hi}}$= cost of shipping 1 unit from supply source h to factory i
- $\mathbf{c_{ie}}$= cost of producing and shipping one unit from factory i to warehouse e
- $\mathbf{c_{ej}}$= cost of shipping one unit from warehouse e to customer j

The objective is to identify the plant, warehouse locations and the quantities required to be shipped between various points in order to minimize total fixed and variable cost.

Following are the decision variables:

- $\mathbf{Y_i}$=1 if factory is located at site i, 0 otherwise
- $\mathbf{Y_e}$=1 if factory is located at site e, 0 otherwise
- $\mathbf{X_{ej}}$= quantity shipped from warehouse e to market j
- $\mathbf{X_{ie=}}$ quantity shipped from factory at site i to warehouse at e
- $\mathbf{X_{hi}}$= quantity shipped from supplier h to factory at site i

The problem is formulated as the following linear integer program:

$$Min \sum_{i=1}^{n} F_i Y_i + \sum_{e=1}^{j} f_e Y_e + \sum_{h=1}^{l}\sum_{i=1}^{n} c_{hi} X_{hi} + \sum_{i=1}^{n}\sum_{e=1}^{l} c_{ie} X_{ie} + \sum_{e=1}^{t}\sum_{j=1}^{m} c_{ej} X_{ej}$$

The above mentioned objective function minimizes the total fixed and variable cost of the supply chain network subject to the following constraint

I. $\sum_{i=1}^{n} X_{hi} \leq S_h \;\; for\; h = 1, \dots\dots, l$

Total amount shipped from supplier cannot exceed supplier's capacity

II. $\sum_{h=1}^{l} X_{hi} - \sum_{e=1}^{t} X_{ie} \geq 0 \;\; for\; i = 1, \dots\dots\dots, n$

Amount shipped out of factory cannot exceed the amount of raw material received

III. $\sum_{e=1}^{t} X_{ie} \leq K_i Y_i \; for\; i = 1, \dots\dots, n$

Amount produced in factory cannot exceed its capacity

IV. $\sum_{i=1}^{n} X_{ie} - \sum_{j=1}^{m} X_{ej} \geq 0 \; for\; e = 1, \dots.., t$

Amount shipped from warehouse cannot exceed quantity received from factories

V. $\sum_{j=1}^{m} X_{ej} \leq W_e Y_e \;\; for\; e = 1, \dots\dots\dots, t$

Amount shipped from warehouse cannot exceed its capacity

VI. $\sum_{e=1}^{t} X_{ej} = D_j \; for\; j = 1, \dots\dots, m$

Amount shipped to customer must cover the demand

VII. $Y_i, Y_e \in \{0,1\}, X_{ej}, X_{ie}, X_{hi} \geq 0$

Each factory or warehouse is either open or close

5.1. The below mentioned model can be used for supply chain network establishment.

The distribution cost can be further minimized by employing ETSP model. The replenishment gets triggered by the color code at each MT distribution center. ETSP is used for the routing of the vehicle for delivery of replenishment using a milk run approach. Travelling salesman model (TSP) optimizes the logistics cost by setting up a shortest circuit trip to be followed by the delivery vehicle.

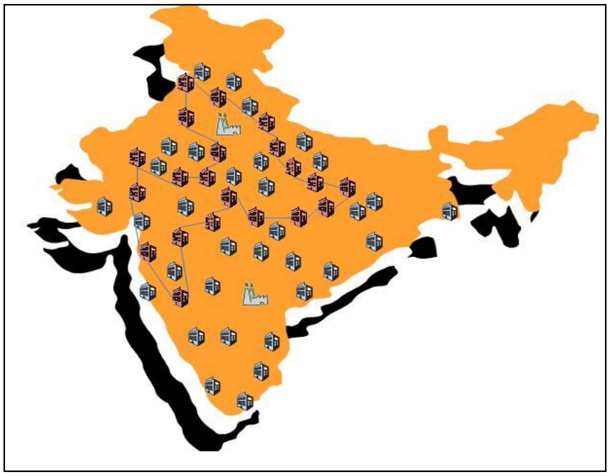

Figure 5

In the given figure the red color indicates the nodes to be replenished, The TSP program connects them in a circuit trip thereby defining the path of the delivery van. The number of nodes to be replenished in one trip should be selected based on the capacity of the carrier employed.

Mixed integer linear programming problem formulation of TSP:

$$\min z = \sum_{i=1}^{n}\sum_{j=1}^{n} c_{ij} x_{ij}$$

$$s.t. \quad \sum_{i=1}^{n} x_{ij} = 1, \quad j = 1,2,n$$

$$\sum_{j=1}^{n} x_{ij} = 1, \quad i = 1,2,n$$

$$u_i - u_j + n x_{ij} \leq n - 1, \quad 2 \leq i \neq j \leq n$$

$$x_{ij} = 0,1, \quad i, j = 1,2,n$$

$$u_i \geq 0, \quad i = 2,3,n$$

Both these models can be modelled in excel for 6-7 nodes exceeding which the program should be solved using LINGO, LINDO or CPLEX.

6. Benefits of Proposed Model

- Spikes generation due to discontinuous order from POs reduced by removing PO based fulfillment
- As inventory is continuously monitored and is fulfilled on the need basis the stock outs / extra stock cases are reduced.
- RM/ PM can be better planned as the spikes can now be predicted from its origin
- Truck loads can now be better planned and have a cushion as well due to continuous monitoring.
- The TSP model also helps optimize the route
- Calibration and synchronization of forecasting and actual status is better established.

7. Problems While Deploying New Model

There are few problems that may come while deploying the new model. They are as follows:

- Management issues in information sharing between the retailer point of contact and the FMCG supplier
- Discrepancy in the Format of the information sharing
- Issue with the software systems used at different retail points

- Delay/ Error in the information flow to the FMCG supplier

7.1. Solution

- The benefit of information sharing should be clearly presented to the management so that proper agreement can be made for information sharing
- Predefined format needs to be prepared by the company and that should be strictly followed for each retailer
- If there is no direct link between the Key accounts and manufacturers then the data sharing could be done in excel through internet in a desirable format
- The company Brand managers at the stores should be made responsible for checking the validity of data for any error

8. Conclusion

The proposed model tries to eliminate the information lag that happens in modern retail causing the inefficiency in meeting the demand. CILM framework will provide a simple way to track the inventory level and thus the required replenish accordingly. The model will also help in reducing the overall logistics cost by using the inventory level information and will also help sending push based inventory to the retailers in case of under-utilized truck load. The model has scope for further enhancement with IT systems capable of capturing and processing real time inventory data. This system will help in integrating the data from the POS at the retailer's end to the procurement at the supplier end.

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