



Aligning downstream Retail Service Level with company Finished Goods Inventory holding for maximizing Freshness

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ABSTRACT

Traditionally, the inventory across Value chain has been linked to Customer Service Level (CSL), the service level provided by a FMCG company to its distributors. In order to get closer to the consumer, we need to relook at the traditional approach. There is a need to align the Retail Service Level (RSL), the service level provided by the distributor to the retailer, with company finished goods inventory (FGI) holding.

This can be realized by designing a scientific model to calculate the correct, differential, distributor Norms. Norms is defined as the maximum inventory level a distributor can maintain at any point of time, and has three components - Safety Stock, Cycle Stock and Pipeline Stock. The establishment of correct norms would require the estimation of distributor wise, SKU wise, Redistribution Planning Accuracy, which is the planning accuracy at the distributor level, Customer Service Level and Retail Service Level. Once the norms are designed, the model can be linked with finished goods inventory to determine the total inventory across Value Chain.

The second part of the research deals with designing a relationship model which correlates various Key Performance Indicators (KPIs) across value chain. This model acts as a decision support tool for redesigning the value chain, to link it with a companies' freshness proposition to end consumer. Company level targets for key performance indicators and finished goods inventory can be decided by a holistic view of entire value chain. An effort has also been made to shatter the myth that a service level of less than 100% means loss of sales, by carrying out a Customer Service Level – Distributor stock out simulation.

LITERATURE REVIEW

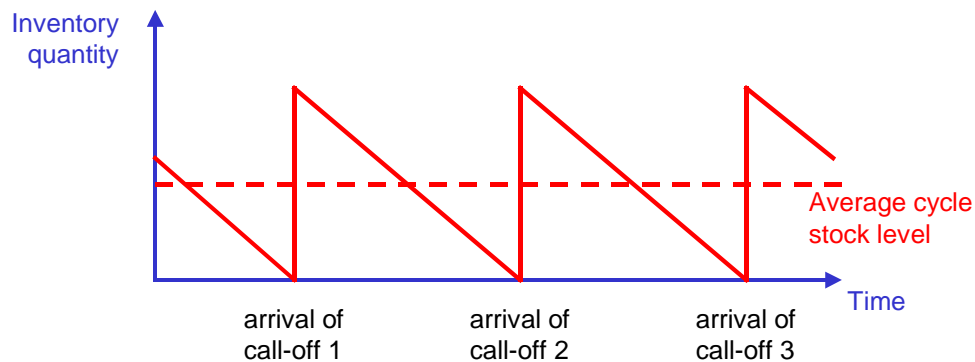
There are different stock components required to fulfill the operational needs (making up the components for the objective stock). Understanding these components ensures that

the right inputs are taken to establish stock objectives and also used as a basis for continuous improvement actions.

For Finished Goods, 3 main types of stocks can be distinguished:

1. CYCLE STOCK:

The cycle stock depends on the call-off quantity. In average, half of the call-off quantity is carried in the inventory:



The economic optimization of the Call-Off quantities requires finding an optimum between inventory carrying costs, production downtime costs and order costs. At the same time, constraints as shelf-life, production batch sizes and risks of obsolescence need to be assessed.

The main drivers influencing cycle stock and thus the Inventory Norms are:

- **Receipt Gap or Receipt Frequency** – it is the gap between two orders.

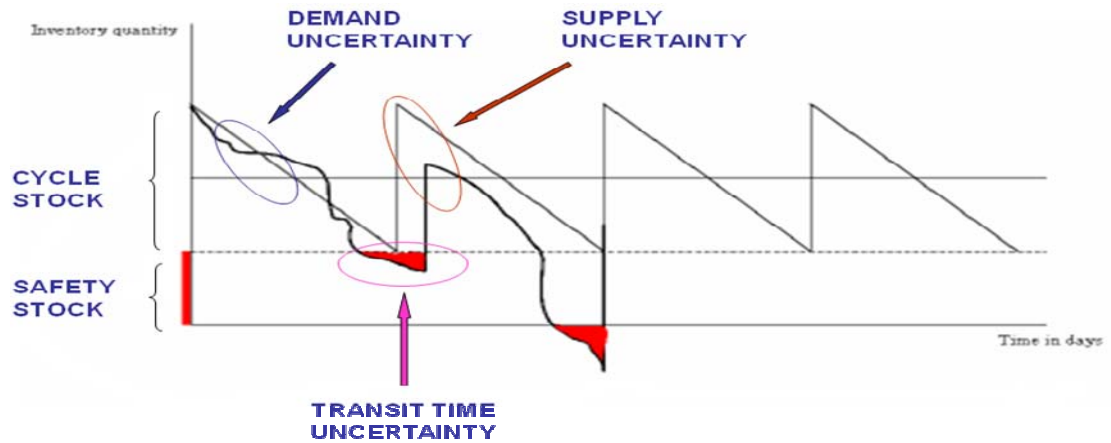
2. PIPELINE STOCK:

Pipeline Stock is the stock in transit. The main drivers influencing cycle stock and thus the inventory norms are:

- **Transit time** – it is the time taken in transporting the material from the warehouse to the distributor.
- **Order processing Time** – time taken to prepare the OBD (Out bound delivery)

3. SAFETY STOCK:

The safety stock ensures the capability to handle uncertainty in demand, supply and transit time, whilst guaranteeing a defined availability of finished goods at the distributor.



The safety stock depends on:

- **CSP (Customer Service Plan)** – It is the frequency with which the distributor is serviced
- **CSL (Customer Service level)** – It is the service level provided by warehouse to the distributor
- **RSL (Retail Service Level)** – It is the service level provided by the distributor to the retailer
- **RDPA (Redistribution Planning Accuracy)** – It is the planning accuracy at the distributor level
- **OPT (Order processing Time)** – It is the time taken to prepare the out bound delivery
- **TT (Transit time)** – Time taken to transport the goods from warehouse to distributor

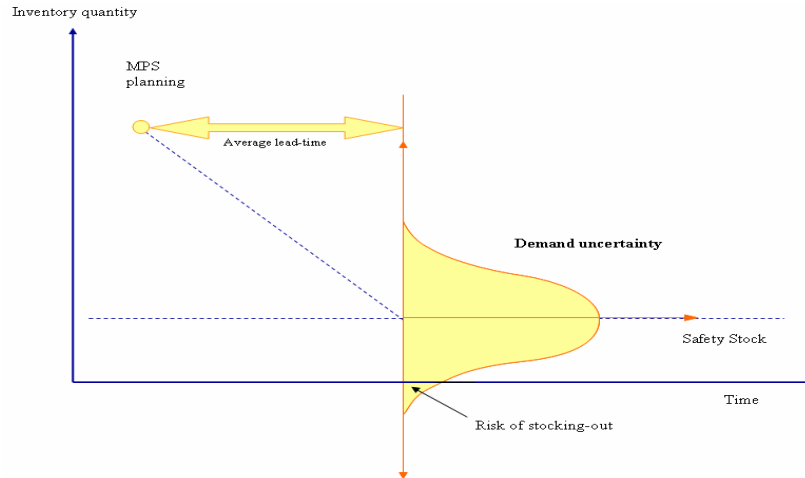
DEMAND UNCERTAINTY

To calculate the probability of the demand uncertainty, Demand Plan Accuracy plays an important role. The mathematical concept considers a normal distributed probability of the demand uncertainty (Normal Distribution). As shown in the graph below, the assumption is that the possibility to over- or under forecast happens with the same probability when the forecast is unbiased. The probability to over- or under forecast varies around the mean deviation, which is described as the safety stock quantity. The probability for the normal random variable is given by the area under the curve.

It is possible to transform the DPA into a standard deviation of the demand σ_{dm} on a weekly horizon.

$$\text{Demand Uncertainty } (\sigma_{dm}) = 1.253 * (1 - \text{RDPA}) * \text{Demand} * \text{Planning Horizon}$$

When choosing a DPA on a monthly horizon it is necessary to convert the average weekly demand into month. Therefore the average weekly demand is multiplied by 4.3 weeks (52weeks/12 months= 4.3 weeks/month). In addition it is assumed that:



$$\text{Demand (monthly)} = 4.3 * \text{Demand (weekly)}$$

Thus, $\sigma_{dm} \text{ (month)} = \text{SQRT}(4.3) * \sigma_{dm} \text{ (week)}$ based on the mathematical concept of “succession of independent random variables”. Thus,

$$1.253 * (1 - \text{RDPA month}) * \text{Demand (month)} = \text{SQRT}(4.3) * 1.253 * (1 - \text{RDPA week}) * \text{Demand (week)}$$

This gives us the relation: $\text{RDPA (week)} = 1 - (1 - \text{RDPA month}) * \text{SQRT}(4.3)$

Based on the variance of the demand uncertainty, it is now possible to derive the demand uncertainty during the lead time/ planning horizon. When a defined reorder point is reached an order is placed. This order needs a certain time (average lead time) to arrive in the distribution centre (wholesaler). During this period it is possible to over or under forecast the demand. The demand uncertainty during the average lead time is based on the normal distribution.

$$\text{Planning Horizon} = \text{Max}(\text{CSP}, \text{OPT} + \text{Avg. TT})$$

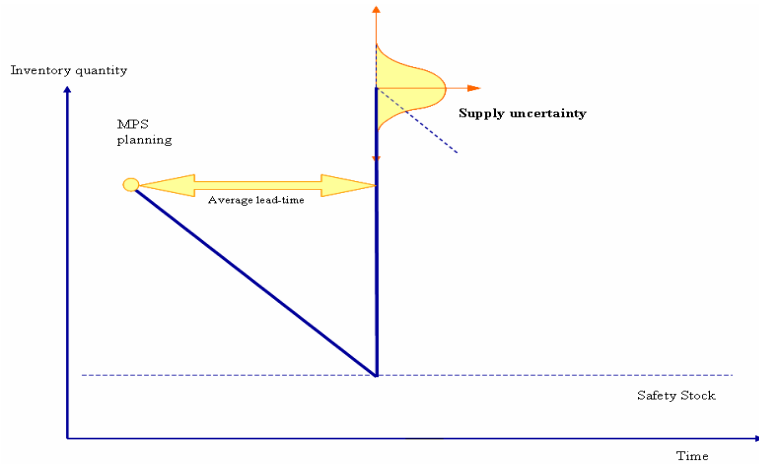
The demand uncertainty during planning horizon is given as:

$$\sigma_{dm} = 1.253 * (1 - \text{RDPA}) * \text{Demand} * \text{SQRT}(\text{Max}(\text{CSP}, \text{OPT} + \text{Avg. TT}))$$

The demand uncertainty during the average lead time will be the first parameter to be used in the determination of the safety stock.

SUPPLY UNCERTAINTY

The mathematical concept considers a normal distributed probability of the supply uncertainty. As shown in the graph below the probability to be under or over supplied varies around the mean deviation, which is the cycle stock. The probability for the normal random variable is given by the area under the curve. The total area under the curve is 1.

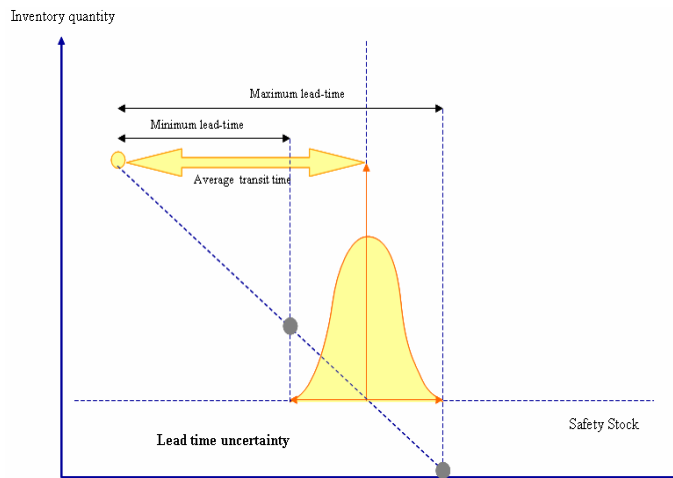


Taken this mathematical concept, it is now possible to transform the CSL into a standard deviation of the supply

$$\sigma_{sp} = 1.253 * (1 - CSL) * CSP$$

TRANSIT TIME UNCERTAINTY

When choosing the normal distribution, the probability of an early or late arrival varies around the mean deviation which is described as the average transit time of receiving the goods at the wholesaler. The probability random variable is area under the curve. The total area under the curve is 1.



$$\sigma_{tt} = (\text{Max. TT} - \text{Min. TT}) / 6$$

After the computation of all three uncertainties individually, it is now possible to merge them in order to compute the standard deviation of the quantity due to all sources of uncertainties during the planning horizon. Thus,

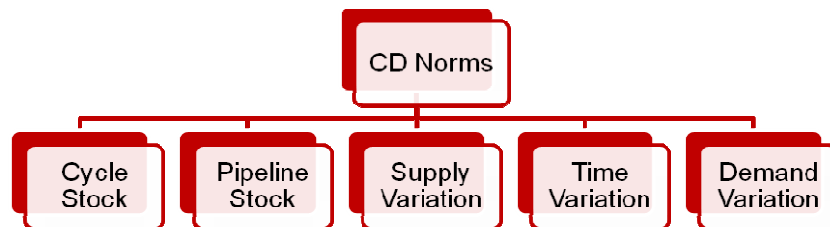
$$\text{TOTAL UNCERTAINTY} = \text{SQRT} (\sigma_{dm}^2 + \sigma_{sp}^2 + \sigma_{tt}^2)$$

During the planning horizon, it is possible not to deliver all ordered SKUs. This is caused by the service level intended to give to the customers. The customer service target should never be equal to 100% as the cost to generate this service with any RDPA lower than 100% would be too high. The markets are free to set the service level (Case Fill Rate Target). The Safety Stock is calculated as:

$$\text{SS} = \text{Z factor} * \text{Total Uncertainty}$$

Z factor is calculated using the statistics table corresponding to the RSL value. Once the Safety Stock has been calculated, we can determine the CD NORMS.

$$\text{CD NORMS} = \text{Safety Stock} + \text{Cycle Stock} + \text{Pipeline Stock}$$



This method gives us a scientific method of calculating Distributor Inventory Norms. The biggest advantage of this model is that it gives differential norms i.e. different distributors can have different inventory levels as their Norms.

VARIATION OF CD NORMS WITH CSL, RSL and RDPA

The variation of Norms with CSL, RSL and RDPA, for a distributor being replenished once a week has been shown in the matrix below.

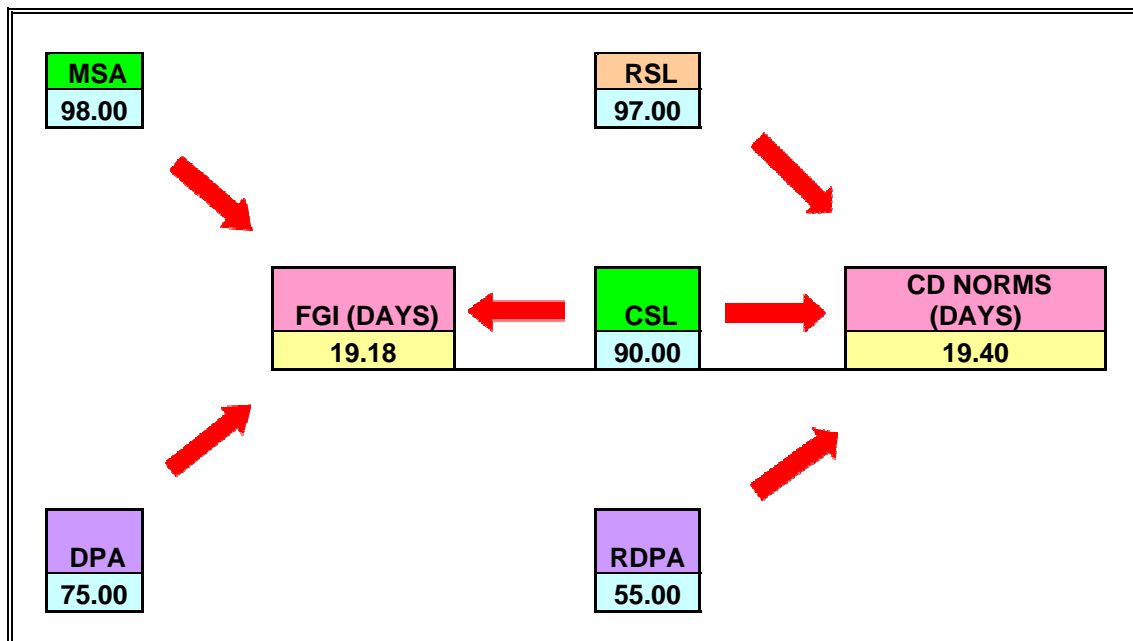
CSP	7	Days
Max. TT	2	Days
Min. TT	1	Days
OPT	2	Days

CD NORMS (Weeks)									
CSL (%)	99	6.4	5.76	5.13	4.5	3.89	3.28	99	RSL (%)
	97	5.68	5.09	4.52	3.95	3.4	2.87	97	
	95	5.23	4.68	4.14	3.62	3.11	2.63	95	
	93	4.91	4.38	3.87	3.38	2.92	2.48	93	
	91	4.65	4.15	3.67	3.21	2.77	2.36	91	
	89	4.44	3.97	3.51	3.07	2.66	2.28	89	
		15	25	35	45	55	65		
RDPA (%)									

The model to calculate the CD Inventory Norms is replicated at the DC i.e. warehouse level to calculate the optimum inventory levels to be maintained there. The inventory there would be a function of MSA (Master Schedule Attainment), DPA (Demand Planning Accuracy) and CSL (Customer Service Level).

KPI CORRELATION MATRIX

Once the correct CD Norms have been estimated, the RSL can easily be linked with the Finished Goods Inventory. A KPI (Key Performance Indicator) correlation matrix across the value chain is designed. Basis the various KPI's, the inventory across value chain can be determined. An example has been demonstrated in the figure below.



The total inventory across value chain is the sum of Finished Goods Inventory (FGI) and Inventory being maintained at the Distributor.

The Freshness of a product till the time it reaches the Retailer is calculated as:

$$\text{FRESHNESS} = \frac{\text{Shelf Life of product} - \text{Inventory across Value Chain}}{\text{Shelf Life of product}}$$

This model acts as a decision support tool for redesigning of the value chain to link it with companies' Freshness proposition to end consumer. Optimal levels of CSL which ensure no CD Stock out can substantially reduce company FGI and increase Freshness – thereby providing competitive edge in market.

CSL – CD STOCKOUT SIMULATION

Once the model has been established, it is important to unravel the myth as to whether a CSL < 100% means Loss of Sales. An example has been taken to understand the approach.

Weekly Demand = 100 Cases
 Safety Stock = 2 weeks = 200 Cases
 CSL = 85%

Situation after (Days)	Demand	Sales	SS Consumed	Remaining Safety Stock	Remaining SS (Days)
7	100	85	15	185	13
14	115	98	2	183	13
21	117	99	1	182	13
28	118	100	0	182	13
35	118	100	0	182	13

This table shows that rather than the CD getting stocked out, the Safety Stock readjusts itself to a level lower than the previous value. Thus, a company can operate at a lower service level to its distributors/ wholesalers provided the Safety Stock is used in an optimum way.

CONCLUSION

The KPI correlation model acts as a decision support tool for redesigning the value chain to link it with companies' Freshness proposition to end consumer. This model relates all KPI's across Value Chain and estimates the Total Inventory throughout and the Freshness of the product. Optimal levels of CSL which ensure no CD stock out can substantially reduce company Finished Goods Inventory and maximize Freshness – thereby providing competitive edge in market.

REFERENCES

“A guide to Effective and Efficient Supply Chain Management”, Nestle 1997
“Improving Supply Chain management at Nestle”, 2nd release, January 2003
“Customer Service - Increasing product freshness on the shelf”, November 2008
“SC Development, Raw and Packaging Material Stock Management”, May 2008
“Demand & Supply Planning - “Unbundling” Annual Targets for Finished Goods Stock Cover, Supply Chain Best Practices”, March 2006

Annexure 1 (Glossary)

CSL – Customer Service Level

RSL – Retail Service Level

FGI – Finished Goods Inventory

SKU – Stock Keeping Unit

DC – Distribution Centre (Warehouse)]

CD – Cash Distributor (Nestles' distributor)

KPI – Key Performance Indicator

RDPA – Redistribution Planning Accuracy

TT – Transit Time

OPT – Order Processing Time

CSP – Customer Service Plan (Replenishment frequency)

MSA – Master Schedule Attainment

DPA – Distribution Planning Accuracy