MAINTAINING A SEAMLESS SUPPLY CHAIN OF ESSENTIAL MEDICINES [A COMBINATION OF VARIOUS CONCEPTS CONVERGING INTO A NOVEL P^3 SYSTEM]

Dr Pradeep J. Jha [1]
LJ College of Engineering &
Technology, Ahmedabad
INDIA
pradeep.j.jha@gmail.com

Viranchi Shah [2]
Saga Laboratories
Ahmedabad
INDIA
viranchi@sagalabs.com

ABSTRACT

The prime objective of production system and inventory management system is to maintain optimum stock of raw material and finished goods or both which is a source of subsequent operations. The production process and inventory management system need to operate in coordination to provide an active collaboration between vendor, supply chain, and all buyers. In case of essential medicines, it is highly necessary to maintain the total integrity of the system. Widely accepted systems like KANBAN, VMI, and CPFR etc, have been mostly proved successful under a specific set of conditions only. Extracting salient features from different systems and carefully considering all practical aspects and business norms, we have designed a new system-- **P^3 system** (Planning, Production, and Procurement). The **P^3 system**, has inherited all the salient features of KANBAN, VMI, and Consignment inventory model. It takes care of major objectives of ECR in favor of buyers by tracking sales –record and establishing agencies, taking customers care and follow-up. This P^3 system, having special features, is likely to demonstrate better results in all segments under consideration.

Keywords: P^3 System, Safety Index, Emergency Index, Lightening stock, CPFR, VMI, ECR.

INTRODUCTION

We are a company engaged in production and exports of life saving essential medicines. Uncertainties exist in every production line, due to unpredicted events in production and supply chain and surge in demand. Again the demand and logistic operations are not fully within the control, and are influenced by several internal and external factors. Availability of essential medicines at the point of purchase is critical and a chain of actions are required to ensure the availability. The problems could be partially solved by a set of steps such as constant coordination with buyers, partially indirect market survey through customer care agencies and better co-ordination with the suppliers of raw materials. Buyers meeting shortages and demand for up gradation in the product as recommended by the customer-care agencies and fixing some parallel issues make it hard to sale and survive.

Upon practical study of various aspects, we structured a policy, which we refer as **P^3 system,** which has shown better results upon implementation. The objectives of this system are the still the same. These include maintaining seamless stock levels in the entire supply chain, profit maximization, cost minimization, purchase of raw material at competitive rates, uninterrupted production, sustaining buyers demand without any shortages or claims, analysis of the sales and forecasting the demand and beginning of the new production cycle.

---

1 Ph,D, M.S.(Mathematics, Gold Medalist), CAMET (U.K.) Research Guide in Mathematics.
2 (B.Pharm, MBA; Entrepreneur, Hon. Secretary- Indian Drugs Manufacturer's Association GSB, Joint Secretary- Indian Pharmaceutical Association- GSB & Member- Foreign Trade Committee, Gujarat Chamber of Commerce & Industry)

Here are certain dominant features of the P^3 system.

P^3 indicates **Planning, Production, and Procurement.** This very abbreviation (P^3) closely approximates pioneering concepts of CPFR. Planning for the production can be done only if forecast for the demand in the next production run is available. The forecast, probably, is a result of precise extrapolation of the current record and past records.

In addition, collaborative by nature, there is a planning for the buyers, suggesting them the
(1) Quantity to be supplied (This may be different then the quantity ordered)
(2) The amount of safety stock and discounted price and liberal payment terms.
(3) Informing the buyer to lift the 'Emergency Stock' from the appointed distributor

ASSUMPTIONS

(1)   That there is a reasonably fair coordination between the vendor and its buyers.
(2)   The first dispatch includes an safety stock and normalized demand.
(3)   A special discount and liberal payment terms are offered on the purchase price of safety stock; but all financial liabilities and pending, if any, are finalized before the vendor releases the first lot of the next production run.
(4)   The buyer informs the vendor and the distributor when existing stock is about to finish and the sale of the safety stock is being initiated.
(5)   Since that point of time, till the consumption period of lightening stock is the time for procurement of pre-ordered raw material in inventory, planning, production, packing , and forwarding to the buyers.
(6)   Considering various technical aspects, changes in the shape, size, and constitutional ingredients are not done and if at all necessary, are made just after the dispatch of the first lot and before the time the buyers are about to consume from their existing safety stock.

NOTATIONS

Following notations are used in this article.
1) d_{ij} = Demand of ith buyer in j^{th} month
2) d_i = Expected demand of ith buyer
3)   D = Harmonic mean of all expected demands
4) q_{jb} = Actual demand (order size) made by i th buyer
5) q_i = Normalized demand for i th buyer
6) K_1 = Safety index
7) K_2 = Emergency index
8) K_3 = Lightening index
9) P_1 = Production rate per day

In addition to these, we have introduced notations like ST_1, ST_2, and ST_3 which describe the current status of the amount to be produced and T_1, T_2, and T_3 show corresponding time to produce such lots.

OPERATIONS- PLANNING, OBSERVATIONS, AND DECISIONS

P^3 system is a complete system and it is carefully designed to operate efficiently assigning due priorities to each of its components. We have designed its stimulus structure that unites its different components each (vendor, buyers, and distributor) targeting at different objectives, to actively justify and follow the notion of CPFR. It is a loop of operations-- Planning, Production, and Procurement at buyer's end and at vendor's end are non-separable components of the cycle. It is an open-ended system and during the review period, new buyers who can meet with necessary entry level requirements can join and are entitled to enjoy all rights and reservations. Looking at the counter part, any buyer can depart from the system at a proper time without being the victim of any grievances. Again ,adhering to business ethics, a buyer once left reserves all the rights to rejoin and will, without any prejudice, enjoy all rights as he was used to previously.

(Such buyers in fact furnish a sound example of safety and soundness of business deals and the tenets of operators of P^3 system.)

To begin with, we highlight certain salient features of circulatory operations of the p^3 system.

(1)   Immediately on the first dispatch, the on-line system starts operating. The buyers are informed about the dispatch details of the first lot. This contains (1) Normalized stock (In proportion to the order placed) and (2) Safety Stock,

(2)   There is some percentage discount on the purchase price of the Safety Stock. In addition to this, the billed amount on the safety stock can be paid on any time but before the first lot of the production run is dispatched by the vendor.

(3)   The buyer is informed to replenish his inventory by directly approaching the distributor who has already availed necessary and planned stock for the respective buyers. This stock maintained by the distributor is the Emergency Stock.

(4)   After on-line verification about the buyer's inventory status, the distributor and the buyer, according to their mutual convenience, manage to shift the 'Emergency Stock' to the buyers' end.

(5)   As stated in the assumptions, starting from the point of time when the normalized stock at the buyer end is about to exhaust, and he is about to starts utilizing the units from the safety stock, till the time when the lightening stock is about to finish, this time period is important interval. This time is a signal for the vendor to start preparing for next production cycle. Following activities are targeting in this period.

a.   Procurement: -This would include floating raw materials indents, and identifying alternate sources of procurement of raw materials and evaluating them based on various decision parameters like cost, quality and lead time. Upon identifying the right source, the acquisition process is carried out.

b.   Planning: The planning department remains busy in collecting and analyzing the data. Identifying customer' level of satisfaction, new demands, suggestions related to the price, quality, and services that they may need or expect, market trend on possible inception of other competing companies. All these factors are critically studied and put into one basket; it helps production forecasts for the next cycle.

    c.   Production & Shipping: -The production operations are carried out and all other departments linked in this line efficiently handle the final process of dispatch of finished goods to the logistic department which is well informed in advance and it has already started its basic operations of fixing the shipping modes.

(6)   It is well known and distinctly obvious, that customer has a tendency to buy the best within their purchasing power. Buyer, in coordination with the vendor, tends to choose the best fit from all possible options. Customer satisfaction, their suggestions, professional business follow-ups and schemes for the patrons of the product etc, are extraneous but the most dominating factors, a professional vendor should attend to.

PART -1 NORMALIZED DEMAND AND CORRECTION FACTOR

At this stage, we introduce the role of VMI. Actual demand placed by the different buyers is a function of their recent demand, market trend, seasonal factor, financial capacity, buyers own intuitive ability of forecasting, and most important point is buyers inclination of ordering/ re-ordering the product.

These are the factors which dominantly influence buyers mind on determining the order size before placing the subsequent orders. This is the major driving force for the vendors to handle the situations of ordering pattern of buyers and **normalize** orders placed by different buyers. We do it by introducing a correction factor $\dfrac{D}{d_j}$ for each buyer j = 1 to N. Each d_j shows

Expected demand calculated on the basis of N observations of past records and D shows average of all expectations. We show the details as follows.

Buyers :	B_1	B_2	B_3	B_4	B_N
Order Size:	q_{1b}	q_{2b}	q_{3b}	q_{4b}	q_{nb}

A sales – record of last ' m ' weeks (preferably m > 5) is available with the buyer and hence as an on-line real system, the vendor and the distributor have an access to this data.

Sales Record per Week

BUYER MONTH	B_1	B_2	B_3	...	B_N
1		d_{11}	d_{21}	d_{31} ...	d_{N1}
2		d_{12}	d_{22}	d_{32} ...	d_{N2}
3		d_{13}	d_{23}	d_{33} ...	d_{N3}
4		d_{14}	d_{24}	d_{34} ...	d_{N4}
m		d_{1m}	d_{2m}	d_{3m} ...	d_{Nm}

Using the records, we can find frequency distribution of different demands against their relative frequency. Let p_{ij} denote the probability (relative frequency) that the i th buyer contributes d_{ij} units to the total sale.

As a result, Expected Demand of ith buyer = $d_i = \sum_{j=1}^{j=m} p_{ij}.d_{ij}$ for i = 1 to N

❶

As a result, we have

Buyers :	B_1	B_2	B_3	B_4 …….	B_N
Expected Demand:	d_1	d_2	d_3	d_4 ………	d_N

We find average of all these expected demands.

We denote this average as D $\therefore D = \dfrac{\sum_{j=1}^{j=n} d_j}{N}$

❷

Using this, we normalize the actual order quantity placed by buyers.

Buyers :	B_1	B_2	B_3	B_4 …….	B_N
Order Size:	q_{1b}	q_{2b}	q_{3b}	q_{4b} …….	q_{Nb}
Normalized Order –size:	q_1	q_2	q_3	q_4 ……..	q_N

where

Normalized demand = $q_j = q_{jb} .\left(\dfrac{D}{d_j}\right)$ for each j = 1 to N

❸

PART-2 SAFETY STOCK INDEX AND DISCOUNT:

As a part of P^3 system (triple tier system), we develop a scheme that parallels to "consignment Inventory Model'. This amount, now shall be known as Safety Stock, has the following characteristics.

(1)   It is calculated using the sum of absolute fluctuations between actual order size and normalized order size as a fraction of sum total of actual order size of all the buyers. We denote this factor as K_1.

Safety Index = $K_1 = \dfrac{\sum_{i=1}^{i=N} |q_i - q_{ib}|}{\sum_{i=1}^{i=N} q_{ib}}$

❹

We have $0 < K_1 < 1$

Using this safety index, we find corresponding safety stock for each buyer.
Based on this safety index;
Safety stock for the ith buyer is **$K_1.q_i$** for each buyer i= **1 to N**

❺

(2)   It is an amount or additional stock dispatched by the vendor to each buyer. It is proportional to the normalized order size determined for each buyer.

(3)   The buyer retains all sales rights on that stock.
(4)   All the buyers under the scheme will be entitled to receive a pre-fixed percentage discount and in addition to that payment towards its (purchase) cost/ amount may be done before during an interval of the receipt and the next lot sent by vendor.

As a result, each buyer, in alignment to the above conditions, receives a safety stock along with the normalized stock.

PART-3 TOTAL AMOUNT RECEIVED IN THE FIRST TRANSACTION

Two fundamental notions, VMI and Consignment Inventory Model, are clearly taken care of on implementing the notion of Normalized order size and Safety Stock.

This makes the next situation as follows.

Buyers:	B_1	B_2	B_3	B_4 …….	B_N
Order Size:	q_{1b}	q_{2b}	q_{3b}	q_{4b} …….	q_{Nb}
Normalized Order –size:	q_1	q_2	q_3	q_4 ……..	q_N
Safety Stock:	K_1q_1	K_1q_2	K_1q_3	K_1q_4…….	K_1q_N
Buyer Receives:	$q_1+ K_1q_1$	$q_2+ K_1q_2$	$q3+ K_1q_3$	$q_4+ K_1q_4$	$q_N+ K_1q_N$

PART -4 FIRST PRODUCTION RUN

The first lot to be produced is the total amount that the vendor is expected to supply to different buyers.
This amounts to a sum total $= ST_1 = N(1 + K_1) \sum q_i$

❻

Let the production capacity of the manufacturing unit be P_1 units in a unit time.
The total time, denoted as T_1, taken to produce the above lot is
$$T_1 = ST_1 / P_1 = [N(1 + K_1) \sum q_i] / P_1$$

❼

On completion of the above mentioned amount $(= ST_1)$ of production, the vendor has enough time to observe that whether
(1) The amount sent meet the necessary specifications.
(2) There is any discrepancy in the amount forwarded and actually received.
(3) The market trend closely follows the expected trend.

In addition to this, just on the onset of this period, the vendor can plan acquisition of the raw material for the second phase of the production run of the first cycle. If he has already acquisitioned enough lot for the complete production of the run then also he can schedule the purchase plan or purchase the raw material and make an inventory in anticipation. This is a review period and vendor, if necessary, can make minor changes in the set up of the machineries to achieve required norms and specifications.

PART-5 EMERGENCY STOCK AND LIGHTENING STOCK

In this phase, the P^3 system parallels its performance to the fundamentals of KANBAN system.

The buyers and the vendor share the pre- designed common operating system showing sales pattern and existing inventory on buyers end. The system signals before the first lot, including the safety stock, is about to finish. The vendor , as pre- planned and decided, passes instructions to the distributor and just before the stock –out is about to occur, the buyers receive adequate amount of stock that helps buyer uninterruptedly continue his business and maintain customers confidence ; this avoids stock-outs or shortages.

We call this amount as an Emergency Stock. This is the pre-planned and fixed stock for each buyer. It is stationed with the middle agency-the distributor. At this stage, as pre-decided, the vendor share with the buyer a fair fraction of the holding charges for this amount –' Emergency Stock'. The distributor simply acts as a middle agency working for and following to the instruction of the buyer.

In some cases the vendors establishes his own set-up or appoints some agency working for him. In most of the practical cases such agencies carry out such jobs for many private agencies paying them for the job. The amount such agencies are paid, in many cases, is proportional to the total lot moved to the different buyers in a year's period. The distributor is instructed to forward each buyer his amount on receiving instructions either from the vendor or the buyer. This is a pre –calculated and is a part of fundamental notion of **CPFR**. As, we know that it is a forecasted amount but we have, at this stage applied statistical measures in exploring the past records.

We derive index for calculating 'Emergency Index'. This is the mean absolute deviation derived using the expected demand and the average of expected demand. We denote this index by K_2.

Emergency Index $= K_2 = \dfrac{\sum |d_i - D|}{\sum d_i}$

❽

for each buyer i = 1 to N

This determines emergency stock $= k_2.q_i$ for each buyer i = 1 to N

This makes the next situation as follows.

Buyers:	B_1	B_2	B_3	B_4 …….	B_N
Order Size:	q_{1b}	q_{2b}	q_{3b}	q_{4b} …….	q_{Nb}
Normalized Order –size:	q_1	q_2	q_3	q_4 ……..	q_N
Safety Stock:	K_1q_1	K_1q_2	K_1q_3	K_1q_4…….	K_1q_N
Buyer Receives:	$q_1+ K_1q_1$	$q_2+ K_1q_2$	$q3+ K_1q_3$	$q_4+ K_1q_4$	$q_N+ K_1q_N$
Emergency Stock	$K_2 q_1$	K_2q_2	K_2q_3	K_2q_4…….	K_2q_N

On this, the vendor adds to his production amount $(ST_1 = N.(1 + K_1). \sum q_i)$ the sum total of emergency stock amount which equals $K_2. \sum q_i$

This new input makes a further addition to production amount denoted as ST_2.
   $ST_2 = (ST_1 = N.(1 + K_1). \sum q_i) + (ST_2 = K_2. \sum q_i)$

❾

The total time, denoted as T_2 taken to produce bo

$T_2 = (ST_1 + ST_2) / P_1 = [N(1 + K_1)(\sum q_i) + K_2 . \sum q_i] / P_1$

❿

PART -6 LIGHTENING STOCK

Now, it is a time to begin with the different segments of concluding session of the first cycle**.**

The following tasks require most attention to be paid:
.

(1)   Collection of latest sales records and existing stock.

(2)   Suggestions ,if any , from the buyers side

(3)   Demand from the new buyers expected to begin with the onset of the new cycle.

(4)   Finalization of purchase of raw material and Production Planning and coordination with the different units in line- Necessary set-up of machineries, labor force, and other concurrent departments like Packaging and forwarding, Quality control, and the most important is finance section liable to mount important decision making factors of financial out standings and responsibilities either pending or likely to be incurred.

(5)   Planning to dispatch the last stock, we call it 'Lightening Stock', to the buyers. The dominating feature of this stock is to maintain consistency of dispatch to the buyers and a close study for forecasting the likely demand. This is an important component of CPFR system. It gives the vendor enough breathing time to slightly modify his production and sales model and update the business strategies to make them more buyers oriented to satisfy their demands and requirements as and when suggested by the end users.

(6)   Coordination with account department and estimating the amount and expected period of cash inflow and outflow. In fact, this is the stock produced in the last phase of the production cycle. Study of the   past record, Customers response, and the difference between the expected and actual sales volume in the initial period on the arrival of the new stock are studied simultaneously.

As determined and explored by using the data of the past record the average of safety index K_1 and the emergency index K_2 lightening index , denoted as k_3 is determined.

Lightening Index = $K_3 = (K_1 + K_2)/2$

⓫

Lightening Stock received by i^{th} buyer = $K_3 . q_I$

⓬

(7)   At this stage, some minor changes as suggested and recommended by the efficient consumers are studied and if found not far away from the brand specifications and product values are accepted and if practically feasible, changes are made in the lightening production about to start. Customers who have already established a long standing trust in the quality and the product are the real ones who prove user-promoters are assets to the production department and hence to the vendor. Major changes in the physical specifications regarding the change in name or product logo, size, and minor changes in the nutritive values, though they may be more practical, beneficial and prove value / quality additive, may not be considered and

implemented. Such changes influence the brand values and impacts and may prove liable to distract the buyers or the end users. Such changes keep the buyers away from the purchase by creating doubts pertaining to originality and genuineness of the product and leave doubts about the quality of the product they are about to buy as compared to the one in their previous purchases. This is the principal doctrine of 'Efficient Consumers Response –ECR.'Customers satisfied with product, quality, durability, long expiration period, and after sales services, play dominant role in the contribution to the total sale. On the contrary, they become brand promoters of the product.

(8)   These units once produced are packed and kept ready for the immediate dispatch without making any delay. No regular routines except necessary formalities are out before pushing the amount to the logistic routine who attends to this request on priority basis.

(9)   Production time, packing time followed by forwarding time is comparatively less, carrying cost is negligible or applicable for a stipulated period.

(10)   In most of the cases, as soon as production of a given cycle is over, all the units involved in production process, start working on designing the next production run. It is an updating phase and all the activities involved in this phase are critical. In fact, a delay in any part may prove liable in disrupting dispatch in the first lot, comparatively high in volume.

This makes the final situation as follows.

Buyers:	B_1	B_2	B_3	B_4 …….	B_N
Order Size:	q_{1b}	q_{2b}	q_{3b}	q_{4b} ……..	q_{Nb}
Normalized Order –size:	q_1	q_2	q_3	q_4 ………	q_N
Safety Stock:	K_1q_1	K_1q_2	K_1q_3	K_1q_4…….	K_1q_N
Buyer Receives: (First Lot)	$q_1+ K_1q_1$	$q_2+ K_1q_2$	$q3+ K_1q_3$	$q_4+ K_1q_4$	$q_N+ K_1q_N$
Emergency Stock (from the Distributor)	$K_2 q_1$	K_2q_2	K_2q_3	K_2q_4…….	K_2q_N
Lightening Stock (From the Vendor)	$K_3 q_1$	$K_3 q_2$	K_3q_3	K_3q_4…….	K_3q_N

On this, the vendor adds to his production amount $(ST_2 = N.(1 + K_1). \sum q_i) + K_2. \sum q_i)$ the sum total of lightening stock amount which equals $K_3. \sum q_i$

This new input makes a further addition to production amount denoted as ST_3.

$$ST_3 = (N.(1 + K_1). \sum q_i)+ (K_2. \sum q_i) + K_3. \sum q_i$$

⓭

The total time, denoted as T_3 taken to produce all the three lots

$$T_3 = (ST_1 + ST_2 + ST_3) / P_1 = [N(1 + K_1)(\sum q_i) + K_2.(\sum q_i) + K_3. \sum q_i] / P_1$$

⓮

Where P_1 is the production and packing rate per unit time.

Let T_4 denote the average transition time of moving the first lot to the buyer, then this time, logically could be at the most

$(K_3.q_i) / D$ where $D = \dfrac{\sum\limits_{j=1}^{j=n} d_j}{N}$

⑮

PART -7 REVIEW OF TIME PERIODS OF DIFFERENT ACTIVITIES

Let D be the harmonic average of average sales figure for all the buyers calculated from the monthly sale of each buyer over a given period of time.

(1) T_{1j} = Consumption period of normalized stock of j th buyer = q_j / D for j = 1 to N (Buyers)

(2) T_{2j} = Consumption period of safety stock of j th buyer = $K_1.q_j / D$

(3) T_{3j} = Consumption period of emergency stock of j th buyer = $K_2.q_j / D$

(4) T_{4j} = Consumption period of lightening stock of j th buyer = $K_3.q_j / D$

(5) T_{5j} = Time for procurement, Review, Production, Logistic Activities = $T_{2j} + T_{3j} + T_{4j}$

This completes one production cycle and the vendor forms a team taking customer care and collection of data. He is free to begin with the production line of further commitment.

CONCLUSION

The design of this system – P^3 system, has strong foundation embedded in the fundamental notions of VMI system and KANBAN system. The vendor plays an important role in this system. In order to satisfy salient features of ECR- Efficient Consumer Response, the vendor designs:

(1) Procurement Policy of raw material

(2) Production Planning

(3) Procurement Policy for the buyers

Here, the VMI concept of vendor management of buyers' inventory is applied. In this system, the buyers' inventory level acts as a signal of starting next production cycle, which has its roots in KANBAN system. P^3 system also tries to incorporate the prime features of CPFR which is possibly feasible by taking due care of meeting with forecast and replenishment criteria on buyers demand on time that can be achieved by making probabilistic forecast based on study of market trend. It thus leads to a chain of activities that aim to maintain adequate and optimum stock at the point of purchase. A closed loop is achieved by linking inventory levels with production and procurement activities.

The need for continuous supply of products rests on buyer's need due to:

(1) Product Branding and long established market reputation owing to product quality and market acceptance
(2) After sale-services and Customer care and timely follow-up
(3) Customer satisfaction through interaction and feedback

Customers to an extent are compared with workers in the production line. 'What they want and when they want' are the important factors leading to the best production and sales volume.

The P^3 system designed above, in most of the cases, takes care of the major features which are of the extreme importance in a whole cycle right from beginning of pre-planned raw material through production, distribution to the buyers, and finally reaching customers through the market study.

The set of activities with the P^3 system are so planned that they work as a closed loop between the vendor and buyer and provides a self stimulating system for initiating of production and inventory movement in a way that a maintains continuous and seamless supply of products at the point of purchase. Being a self regulating system, it provides a scope for changes in trends over a period of time.

Thus P^3 system is a novel and extended system involving fundamentals of CPFR, VMI and KANBAN that can provide a new dimension to the vendor buyer relationship.

ILLUSTRATION

We have sales record of last six months of five buyers on list. We are given the order size oif subsequent order placed by each buyer. We are given the order size of the next month.

Sales Record of Last Six Months

	Buyer1	Buyer2	Buyer3	Buyer4	Buyer5	Total
Month1	200	180	270	190	180	
Month2	240	190	250	200	170	
Month3	180	200	270	190	140	
Month4	260	200	280	200	200	
Month5	200	220	300	210	210	
Month6	190	190	240	210	200	
Order –Size	210	210	250	200	180	1050
Sum Sales	1270	1180	1610	1200	1100	6360
Individual Average	212	197	268	200	183	1060

Harmonic Average = 208						
Deviation	3.25	11.75	59.92	8.42	25.08	108.42
Order –Size	210	210	250	200	180	1050
Normalized. Demand	207	223	194	208	205	1037
Absolute Difference	3.22	12.55	55.82	8.42	24.63	104.64
K_1 = safety Index						0.0997
K_2 = Emergency Index						0.1023
K_3 = Lightening Index						0.1010
Safety Stock =$K_1 qj$	20.61	22.18	19.35	20.77	20.39	103
Emergency Stock $K_2 qj$	21.15	22.76	19.86	21.32	20.93	106
Lightening stock $K_3.qj$	20.88	22.47	19.61	21.04	20.66	105
Total Production in a given month =						1351
Actual Supply	269	290	253	272	267	1351

CONCLUSION

(1) Amount of safety stock, Emergency Stock, and Lightening index received is nearly 10 % of the order size amount.

(2) The actual amount received depends on safety index, emergency index, and Lightening index discounted by Normalized order Size.

GRAPH

In the following graph, X-scale shows different buyers (1, 2,3….) while on Y- axis Normalized demand and the total amount received by each buyer within the span of a cycle is shown.
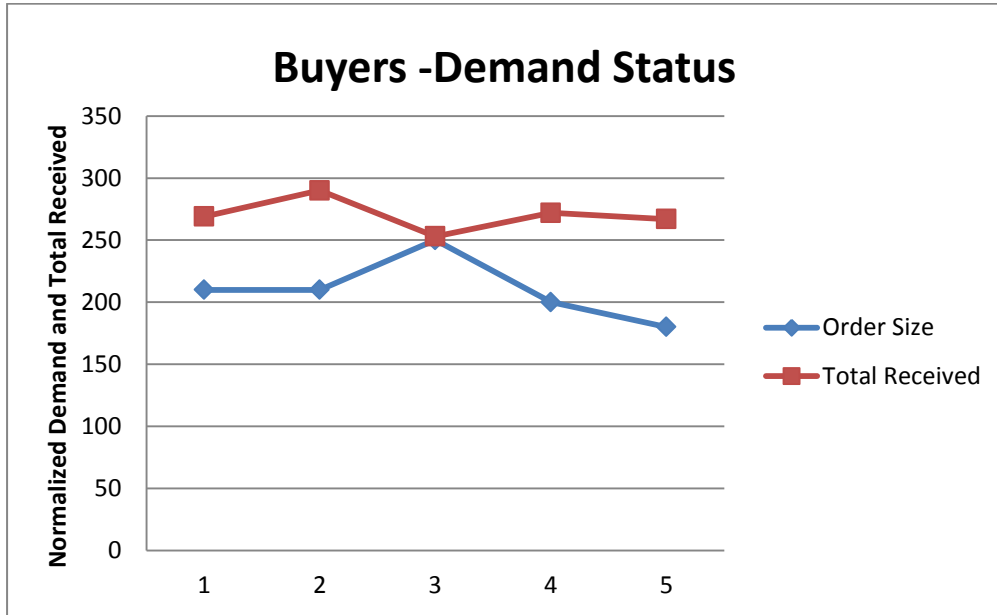

Figure 1

The next graph is the one which shows the stock in units and period available to the vendor to execute planning, production and procurement and making it available to the point of purchase.
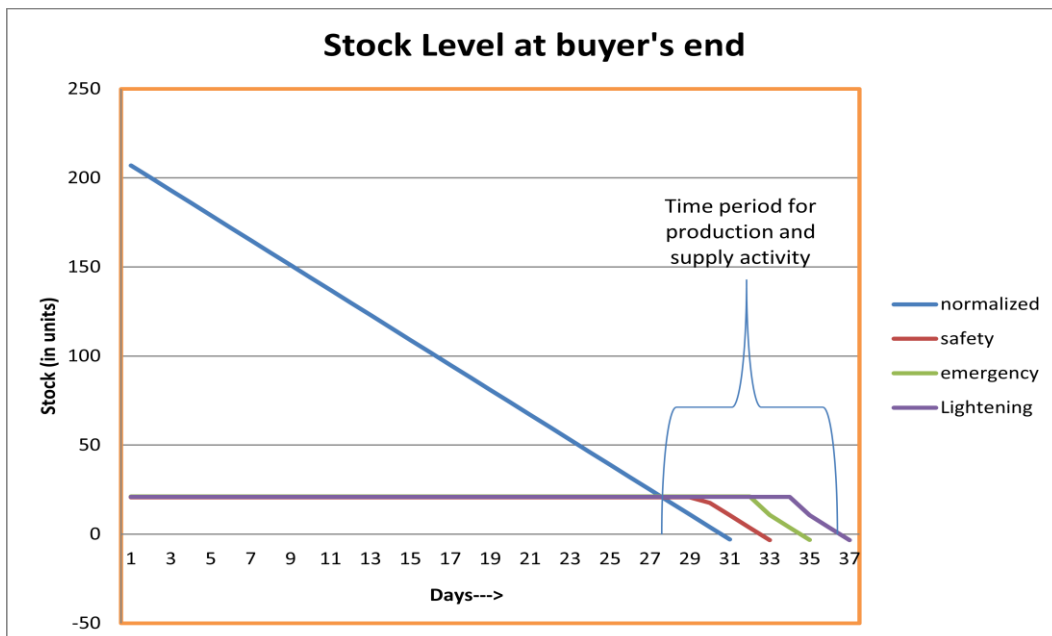

Figure 2

REFERENCES:

(1)   Goyal,S,K. (1995), "*A one-Vendor multi-buyers integrated inventory model -. a comment.*" European journal of operation Research 82, 209-210

(2)   Jha, Pradeep, J (june-2013) "*Buyer- Vendor integrated system- the technique of EOQ dependent shipment size to achieve steady level and cost minimization*" ISOR journal of mathematics(iosr-jm) 46-57

(3)   Rajmanohar, T,P, (2008) "*Inventory Optimization Introduction*" The ICFAI University Press

(4)   Jha, Pradeep, J : Shah, Viranchi, A (nov-dec 2013) "*Production planning and stocking of life saving medicines at Vendors end and Buyers end*" ISOR journal of business management (iosr-jbm) 54-63