RESEARCH ARTICLE OPEN ACCESS

Chronological Developments in Inventory Control Best Practices for FMCG Sector: a review paper of inventory control system

Roopa Singh[1*], Anurag Singh[2], Ajay[3]
[1&3] *Department of Industrial & Production Engineering, G. B. Pant University of Agriculture & Technology, Pantnagar- 263145 Uttarakhand*
[2.] *Department of Mechanical engineering, MMCAE,(Akbarpur) NDUAT, Faizabad-224 229 U.P.*
Corresponding author: Roopa Singh

ABSTRACT
Agriculture contributes a major share in the national economy of India. A major portion of Indian economy (about 70%) depends upon agriculture as it forms the main source of livelihood and income. About 43% of India's geographical area is used for agricultural activity which involves 65-75% of total population of India. Apart from this percentage of population who are directly involved in agricultural activities, rest of the population also depends on agriculture in the form of different consumer products that uses from agricultural produce as their major raw material. These products are categorised as Fast Moving Consumer Goods (FMCG). The given work deals with the Fast Moving Consumer Goods (FMCG) industries and their inventories which involves cyclical variation in their costs throughout the year due to law of demand and supply. Since the beginning of inventory practices, many developments took place which can be categorised into three phases, based on the review of various works. The first phase is related with development and utilization of Economic Order Quantity (EOQ) model and methods for optimizing costs and profits. Second phase deals with inventory optimization method, alongwith MRP I i.e. Material Requirement Planning & MRP II i.e. Manufacturing Resource Planning with the purpose of balancing capital investment constraints and services level goals. The third and recent phase has emerged inventory control with electrical control theory. Maintenance of inventory is considered negative, as a large amount of capital is blocked especially in mechanical and electrical industries. But the case is different in food processing and agro-based industries and their inventories due to cyclic variation in the cost of raw materials of such industries which is the reason for selection of these industries in the mentioned work.The application of electrical control theory in inventory control makes the decision-making highly instantaneous for FMCG industries without loss in their proposed profits, which happened earlier during first and second phases, mainly due to late implementation of decision. The work also replaces various inventories and work-in-progress (WIP) related errors with their monetary values, so that the decision-making is fully target-oriented.

Keywords: Control theory, Inventory control, Manufacturing Sector, EOQ, Feedback, FMCG sector

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Date of Submission: 21-08-2017 Date of acceptance: 25-08-2017

I. INTRODUCTION

There is a need to revise decisions related to inventory control when it is done for FMCG sector as the input variables which is used for inventory control like commodity cost, demand & supply changes very rapidly for commodity used in FMCG. Any method that has to be implemented for a large period of time and cannot be changed easily before of a certain period of time is not cost effective in FMCG sector. The work related to inventory control before 1913 was very limited to estimating various costs in an organization and developing various equations in order to balance all those costs (inventory costs, capital costs, storage costs, risk costs, service costs).

Reviews for the first phase related with development and utilization of Economic Order Quantity (EOQ) model and methods for optimizing costs and profits are discussed below.

Harris, 1913 presented the familiar Economic Order Quantity (EOQ) model in his paper. The simple square root formula for the optimal order quantity followed directly from the assumptions of a continuous constant rate for demand and the recognition of the need to balanced intangible inventory costs and against the tangible costs for ordering. **Taft 1918** presented the second major economic order quantity paper with the development of production lot size model. This model extends the simple EOQ model by incorporating a finite production rate. **Wagner *et al.* 1958** gave a forward algorithm for a solution to the following dynamic version of the economic lot size model which is as given and allowing the possibility of demands for a single item, inventory holding charges, and setup costs to vary over 'N' periods. They desired a minimum total cost inventory management scheme which satisfies known demand in every period of time. Disjoint planning horizons were shown to be possible for eliminating the necessity of having data for the full N periods.

Erlenkotter 1990 explored the early literature on EOQ model given by Harris 1913 which was disseminated widely but was unnoticed for many years before its rediscovery in 1988. During this period, a lot of confusion developed over the origin of EOQ model. This paper also traced the evolution of confusion. **Fazel *et al.* 1997** compared inventory costs under economic order quantity model with a quantity discount to the costs under just-in-time. It has been shown that at low levels of demand, JIT is the preferred method whereas EOQ has cost advantage for an item with a high demand. The model also predicted that the higher value of the item, the carrying cost, or the ordering cost associated with the EOQ model and the smaller the quantity discount rate, the wider will be the range of demand for which JIT remains preferable.

Second phase dealing with inventory optimization method, alongwith MRP I; Material Requirement Planning & MRP II; Manufacturing Resource Planning with the purpose of balancing capital investment constraints and services level goals are reviewed herewith.

In 1964, Joseph Orlicky developed Material Requirements Planning (MRP), as a response to the Toyota Manufacturing Program. The first company to use MRP was Black & Decker in 1964. By 1975, MRP was implemented in 700 companies. In 1983, MRP was developed into manufacturing resource planning (MRP II) by Oliver Wight which brings master scheduling, rough-cut capacity planning & capacity requirements planning. **(https://en.wikipedia.org/wiki)**. **Ho *et al* 2007** considered the effects of deteriorating inventory on lot-sizing in material requirements planning systems. Five existing heuristics were extended to address the single-level lot-sizing problem with deteriorating inventory and evaluated via a large-scale simulation study. Three factors were taken into consideration for the simulation study, namely, rate of inventory deterioration, percentage of periods with zero demand, and setup cost. The results, undertaken within a wide range of experimental conditions, indicated that one of the modified heuristics exhibits the best overall cost performance. An insight with regard to the cost performance behaviour of the five modified heuristics was also indicated.

Sadeghian, 2011 introduced, a new form of MRP, named as continuous materials requirements planning (CMRP) approach. Moreover, the priorities and advantages of this approach over the discrete MRP (DMRP) were further discussed and the conditions and manner of CMRP application in different types of problems were analyzed. The CMRP system, introduced in this paper does not have any safety stock (SS) and its order type (OT) was lot for lot (L4L). **Ghobbar *et al.* 2004** queried airline operators and maintenance organizations regarding their maintenance and inventory procedures. Of 175 respondents, 152 were using the reorder point system and the remainder the material requirements planning (MRP) system. It indicated that the aircraft parts industry took this system seriously. However, it was more difficult to implement in the aircraft maintenance environment than in a commercial environment, where the need for spare parts was unpredictable. But if the obstacles were understood and a sound plan was realised by good management, MRP could be successfully implemented, with substantial benefits.

Wei *et al.* 1992 described the need to solve production management problems in Chinese manufacturing enterprises which resulted in the development and implementation of a hybrid system of manufacturing resource planning (MRP II) and just-in-time manufacturing (JIT). This article gives an overview of some basic concepts in this area including a classification of manufacturing modes and three kinds of hybrid systems.

Sum *et al.* 1993 discussed that in response to the increasing regional and international competition, many manufacturing companies in Singapore adopted MRP II systems to improve on their business operations. Despite its growing popularity, very little work has been done to monitor how companies were actually using MRP II. They presented the largest survey study ever undertaken on the state-of-the-art application of MRP II in Singapore. It described the major survey findings on the practices, costs and benefits obtained, and implementation process in MRP II companies. This study provided useful information to managers, current users, potential users, vendors and promoters of MRP II. The study also served as a basis for future research.

Lovell 2003 demonstrated that the disciplines of operations research/management science and economics are complementary by drawing on both in analyzing the effects of the introduction of just in time (JIT) on prices and product variety. Inventories were introduced into the model of monopolistic competition by incorporating optimized setup and inventory carrying costs into the representative firm's total cost function. The author showed that adoption of JIT, implemented by reengineering the product so as to drastically reduce or eliminate setup costs, benefits consumers, at least in the long run. Adoption of JIT leads to both a reduction in price and an increase in the variety of products offered in the marketplace.

H'mida *et al.* 2005 introduced the new concept of cost entity which was made necessary due to the current context of growth of indirect costs, especially in manufacturing. Establishing a tight link between technical variables and economic variables requires modelling of the reasoning procedure and associated knowledge related to cost estimating. To achieve this, two models; a product model and a cost grammas model were presented and used to represent and capitalize technical knowledge. The cost estimating reasoning procedure that takes into account alternative process plans of a product is modelled and solved by a constraint satisfaction problem (CSP). The solutions are ranked by economic satisfaction order.

Gharbi *et al.* 2006 considered a manufacturing system with preventive maintenance that produces a single part type. For such a system, the failure frequencies can be reduced through preventive maintenance resulting in possible increase in system performance. In the cases where finished goods inventories are considered, restrictive assumptions are used such as, not allowing breakdown during stock build up period and during backlog situations due to the complexity of the mathematical model. To solve this problem, the author derived expressions and developed models for the overall incurred cost which was used as the basis for optimal determination of the jointly production and preventive maintenance policies. Such a cost consists of inventory, backlog, and corrective and preventive maintenance costs.

Persona *et al.* 2007) examined that in order to control the time to market and manufacturing costs, companies purchase and produce many parts and components before receiving customer orders. Demand forecasting is a critical design process. Using modular product design and super bills of materials are two effective strategies for developing a reliable demand forecasting process. They reduced the probability of stock outs in diversified production contexts. Also managing and controlling safety stocks for pre-assembled modules provided an effective solution to the problem of minimizing the effects of forecast errors. This work developed, evaluated, and applied innovative cost-based analytical models so that the optimal safety stock of modular sub-assemblies and components in assembly to order and manufacturing to order systems, respectively, can be rapidly quantified. The implementation of the proposed models in two industrial case applications demonstrated that they significantly reduced the safety stock inventory levels and the global logistical cost.

The third and recent phase has merged inventory control with electrical control theory which has been reviewed below.

John, 1994 employed an ordering policy known as APIOBPCS (Automatic Pipeline, inventory and order based production control system) to minimize the variance of inventory levels with a sequence of forecast errors of demand over the lead time given. The classical control theory was merged with the optimization techniques for proper tuning of parameters and for obtaining appropriate results. **Grubbstrom *et al.* 1996** modelled standard inventory ordering rules in terms of control systems theory. A differential equation was designed describing the development of a system in which an input signal reaches a predefined level triggering an output. The reorder point of inventory control systems may be interpreted as such a level triggering replenishment.

Disney *et al.* 1999 described a procedure for optimising the performance of an industrially designed inventory control system. It consists of the three classical control policies utilising sales, inventory and pipeline information to set the order rate so as to achieve a desired balance between capacity, demand and minimum associated stock level. A genetic algorithm for optimising system performance via inventory recovery to shock demands, in-built filtering capability; robustness to production lead-time variations, robustness to pipeline level information fidelity; and systems selectivity, was described. The optimum design parameters were presented for various vector weightings. This led to a decision support system for the correct setting of the system controls under various operating scenarios.

Dejonckheere *et al.* 2000 analysed the bullwhip effect problem generated by using exponential smoothing algorithm in both "stand alone" passing-on-orders mode, and within inventory controlled feedback systems. Results were predicted from transfer function analysis and then confirmed by simulation. The concept of "matched filter" adjusts the value of the smoothing constant depending on type of forecasting model used. It was shown that matching the filter via noise bandwidth equalises the output variance when the demand is a random signal. A little benefit was obtained by using sophisticated forecasting methods within inventory controlled feedback systems as their tracking ability was reduced. **Dejonckheere *et al.* 2002** firstly analysed the bullwhip effect induced by the use of different forecasting methods in order-up-to replenishment policies. Variance amplification was quantified and it was proved that the bullwhip effect is guaranteed in the order-up-to model irrespective of the forecasting method used. Thus, when production is inflexible and significant costs are incurred by frequently switching production quantities up and down, order-up-to policies may no longer be desirable or even achievable. Secondly a general decision rule was introduced that avoids variance amplification and succeeded in generating smooth ordering patterns, even when demand was to be forecasted. The methodology was based on control systems engineering and allows important insights to be gained about the dynamic behaviour of replenishment rules.

Hoberg *et al.* 2006 applied linear control theory to study the effect of various inventory policies on order and inventory variability, which are key drivers of supply chain performance. It has been proved analytically that the inventory-on-hand policy is unstable in practical settings, confirming analytically what has been observed in experimental settings and in practice. It has been also proved that the installation-stock and echelon-stock policies are stable and their effects were analyzed on order and inventory fluctuation. Specifically, the paper shows the general superiority of the echelon-stock in their settings and demonstrated analytically the effect of forecasting parameters on order and inventory fluctuations.

Schwartz *et al.* 2006 presented a simulation based optimization framework involving simultaneous perturbation stochastic approximation as a means for optimally specifying parameters of internal model control and model predictive control based decision policies for inventory management in supply chains under conditions involving supply and demand uncertainty. The effective use of the SPSA technique served to enhance the performance and functionality of given class of decision algorithms and was illustrated with case studies involving the simultaneous optimization of controller tuning parameters and safety stock levels for supply chain networks inspired from semiconductor manufacturing. The results of the case studies demonstrated that safety stock levels can be significantly reduced and financial benefits can be achieved while maintaining satisfactory operating performance in the supply chain.

Paul *et.al.* 2010 considered a static divergent two-stage supply chain with one distributor and many retailers. The distributor used an inventory rationing mechanism to distribute the available on-hand inventory among the retailers, when the sum of demands from the retailers was greater than the on-hand inventory at the distributor. The work presented in the study aimed at determining the best installation inventory-control policy or order-policy parameters such as the base stock levels and review periods and inventory rationing quantities, with the objective of minimising the total supply chain costs (TSCC) consisting of holding costs, shortage costs and review costs in the supply chain over a finite planning horizon. On account of the computational complexity involved in optimally solving problems over a large finite time horizon, a genetic algorithm (GA) based heuristic methodology was presented.

Schwartz *et al.* 2010 presented a fundamental and practical approach for applying control-theoretic principles to tactical inventory management problem in a production-inventory system which is the basic unit in a supply chain. Internal model control and model predictive control has been used for the generation of a series of increasingly sophisticated decision policies for inventory management. A combined feedback- feed forward multi-degree-of-freedom IMC policy is shown to properly adjust factory starts in the presence of inventory target changes, forecasted shifts in customer demand, and stochastic changes in demand. The MPC policy displays equivalent performance, but incorporates the added functionality of managing inventory in the presence of constraints, an important practical consideration. The MPC policy shows improved performance, greater flexibility, and higher functionality relative to an advanced order-up-to policy based on control engineering principles found in the literature.

Bijvank *et al.* 2011 described that in classic inventory models it is common to assume that excess demand was backordered. However, studies analyzing customer behaviour in practice shows that most unfulfilled demand is lost or an alternative item or location is looked for in many retail environments. Inventory systems that include this lost-sales characteristic appear to be more difficult to analyze and to solve. Furthermore, lost-sales inventory systems required different replenishment policies to minimize costs compared to backorder systems. The given paper classifies the models in the literature based on the characteristics of the inventory system and reviewed the proposed replenishment policies. The work also discusses the available models and their performance for each classification and type of replenishment policy.

Inderfurth *et al.* 2012 considered a manufacturer's stochastic production/inventory problem under periodic review and presented methods for safety stock determination to cope with uncertainties that are caused by stochastic demand and different types of yield randomness. A simple approach for calculating these dynamic safety stocks for different yield models is presented. In addition, various approaches for determination of appropriate static safety stocks which are easier to apply in practice are suggested. **Fritzsche 2012** presented an analytical model for cost-estimation in a single-item, multi-hub, inventory policy pooling model for high-value spare parts in the aviation industry. The model extended existing, static pooling models by implementing a dynamic failure rate using a maintenance free operating period as a measurement technique to increase availability of aircraft components. The gained results through a dynamic failure rate which shown significant effects for reduction of total costs of ownership and a way of achieving better operational stock planning, which was demonstrated through a numerical application.

Taleizadeh *et al.* 2012 relieved the two assumptions i.e. first, the continuous review where depending on the inventory level, orders can happen at any time and second, the periodic review where orders can only be placed at the beginning of each period; as these were employed in multi-periodic inventory control problems. Here it is assumed that the time between two replenishments are independent random variables. The model of given problem is of an integer-nonlinear-programming type. A hybrid method of fuzzy simulation and genetic algorithm is proposed to solve this problem. The performance of the proposed method is then compared with the performance of an existing hybrid fuzzy simulation and simulated annealing algorithm with the help of numerical examples.

Horenbeek *et al.* 2012 reviewed the pertinent literature on joint maintenance and inventory optimization models for non-repairable parts and suggested possible gaps. A classification based on the following seven sets of criteria was made: inventory policies, maintenance characteristics, delays, multi-echelon networks, single-unit versus multi-unit systems, objective function and optimization techniques.

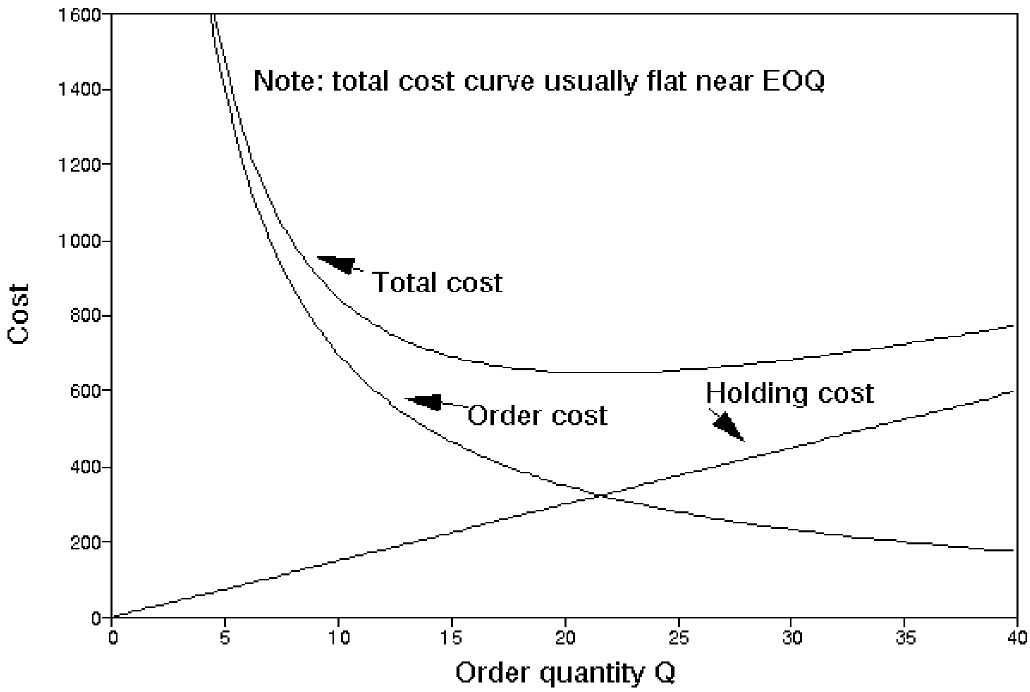
The objective of this work is to carry out a comparative study of all inventory control practices and to investigate the hidden theme responsible for chronological development in this area that will provide an insight view of an inventory control practice to make it extensively cost effective.

II. TECHNIQUES USED IN INVENTORY CONTROL AND OPTIMIZATION

2.1 EOQ (Economic Order Quantity) based Inventory Control

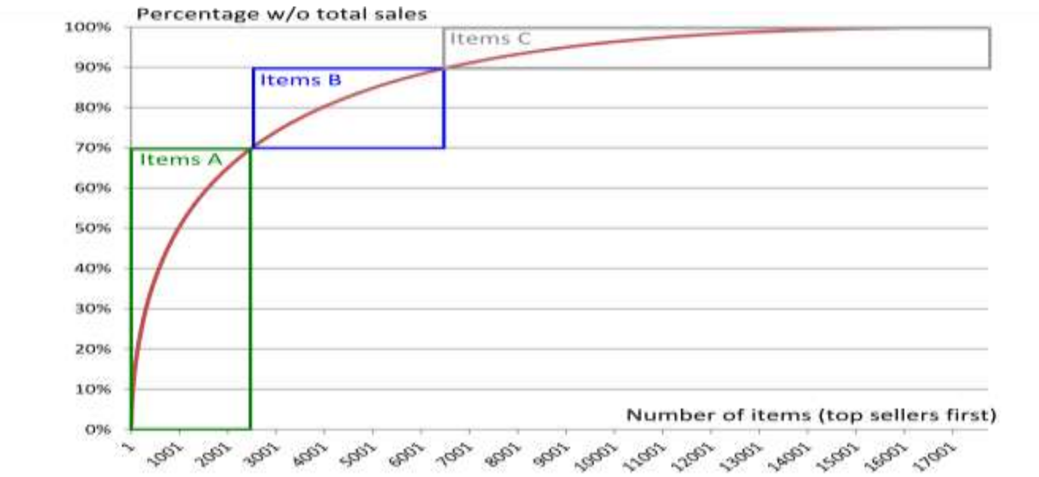
Economic order quantity (EOQ) is the order quantity of inventory that minimizes the total cost of inventory management. Two most important categories of inventory costs are ordering costs and carrying costs. Ordering costs are costs that are incurred on obtaining additional inventories. They include costs incurred on communicating the order, transportation cost, etc. Carrying costs represent the costs incurred on holding inventory in hand. They include the opportunity cost of money held up in inventories, storage costs, spoilage costs, etc.

Ordering costs and carrying costs are quite opposite to each other. If we need to minimize carrying costs we have to place small order which increases the ordering costs. If we want minimize our ordering costs we have to place few orders in a year and this requires placing large orders which in turn increases the total carrying costs for the period. **(http://accountingexplained.com/managerial/inventory-management/economic-order-quantity)**



2.1.1 ABC analysis

ABC analysis is an inventory categorization method which consists in dividing items into three categories, A, B and C: A being the most valuable items, C being the least valuable ones. This method aims to draw managers' attention on the critical few (A-items) and not on the trivial many (C-items). The Pareto principle states that 80% of the overall consumption value is based on only 20% of total items. In other words, demand is not evenly distributed between items: top sellers vastly outperform the rest.



(**https://www.lokad.com/abc-analysis-(inventory)-definition**) **(***By Joffrey Collignon, Joannes Vermorel, February 2012)*

The cost of carrying out inventory control analysis is also an important criterion because EOQ for individual commodity has to be determined to avoid the analysis for that type of commodity where cost of inventory control is greater than the savings done after the inventory control. Some supporting techniques are followed:

1. **S-OS (Seasonal-Off Seasonal):** Seasonal items refer to the inventory of those materials which are available just after crop harvesting and require very less or no inventory control. The purchase cost of these items is less while the inventory carrying cost is more. Off-seasonal items are those which are quite limited and present during crop sowing. Since the material in inventory is limited, it requires proper inventory control and the purchase cost increases.
2. **SDE (Scarce, Difficult & Easy):** Scarce items are generally short in supply, or are channelized through government agencies. If the company feels that a lot of time as well as expenditure are involved in procuring these items, it would be advisable for the company to procure these items, say once a year. Difficult items are available indigenously, but are difficult to procure. Sometimes it may happen that certain items are difficult to manufacture and further, there may be only one or two companies who manufacture this item. In order to procure such items in time for production, the manufacturers may have to be given an order well in advance. Easy items are easily and readily available. They include all those items that are produced according to commercial standards, items which are able to be procured locally without any difficulty, etc**. (http://www.bms.co.in/explain-sde-analysis/).**
3. **VED (Vital, Essential & Desirable):** VED Analysis attempts to classify the items used into three broad categories, namely Vital, Essential, and Desirable. Vital category items are those items without which the production activities or any other activity of the company, would come to a halt, or at least be drastically affected. Essential items are those items whose stock – out cost is very high for the company. Desirable items are those items whose stock-out or shortage causes only a minor disruption for a short duration in the production schedule. The cost incurred is very nominal. **(http://www.bms.co.in/write-a-note-on-ved-analysis/)**
4. **FSN (Fast, Slow & Neutral):** In F-S-N analysis, items are classified according to their rate of consumption. The items are classified broadly into three groups: F – means Fast moving, S – means Slow moving, N – means Non-moving. **(http://www.bms.co.in/write-a-note-on-f-s-n-analysis/).**

2.1.2 HML (High, Medium & Low)

Items are classified into three groups labelled as High – Medium – Low. The HML analysis is very similar to the ABC Analysis, the difference being instead of usage value, the price criterion is used. In their classification, the items used by the company are arranged in descending orders of their unit price. After this, the management of the company uses its discretion and judgment to decide the cut off lines for deciding the three categories.

HML analysis helps an organization to take decisions on the following:

a) It helps to assess the security requirements and the type of storage for high priced items. For example, expensive ball bearings can be kept under lock and key in a cupboard.

b) The frequency of stock checking is decided on the basis of the cost item. In other words, more expensive the item, more frequent will be its stock-checking.

c) A control on purchases and buying policies can be exercised by the company. This means H and M items will not be ordered in excess of the required minimum quantity. However, in the case of L items, they may be purchased in bulk in order to avail the benefits of bulk purchase. (http://www.bms.co.in/explain-hml-analysis/)

2.2 MRP based Inventory Control

Material Requirements Planning (MRP) is a computer-based production planning and inventory control system. MRP is concerned with both production scheduling and inventory control. It is a material control system that attempts to keep adequate inventory levels to assure that required materials are available when needed. MRP is applicable in situations of multiple items with complex bills of materials. MRP is not useful for job shops or for continuous processes that are tightly linked.

MRP is especially suited to manufacturing settings where the demand of many of the components and subassemblies depend on the demands of items that face external demands. Demands for end items are independent. In contrast, demand for components used to manufacture end items depend on the demands for the end items. MRP systems were developed to cope better with dependent demand items. The three major inputs of an MRP system are the master production schedule, the product structure records, and the inventory status records. Without these basic inputs the MRP system cannot function.

The demand for end items is scheduled over a number of time periods and recorded on a master production schedule (MPS). The master production schedule expresses how much of each item is wanted and when it is wanted. The MPS is developed from forecasts and firm customer orders for end items, safety stock requirements, and internal orders. MRP takes the master schedule for end items and translates it into individual time-phased component requirements.

The product structure records, also known as bill of material records (BOM), contain information on every item or assembly required to produce end items. Information on each item, such as part number, description, quantity per assembly, next higher assembly, lead times, and quantity per end item, must be available.

The inventory status records contain the status of all items in inventory, including on hand inventory and scheduled receipts. These records must be kept up to date, with each receipt, disbursement, or withdrawal documented to maintain record integrity. MRP will determine from the master production schedule and the product structure records the gross component requirements; the gross component requirements will be reduced by the available inventory as indicated in the inventory status records **(http://www.columbia.edu/~gmg2/4000/pdf/lect_06.pdf).**

2.3 Continuous Inventory Control

Continuous inventory also known as perpetual inventory is a method of accounting for inventory that records the sale or purchase of inventory in near real-time, through the use of computerized point-of-sale and enterprise asset management systems Perpetual inventory provides a highly detailed view of changes in inventory and allows real-time reporting of the amount of inventory in stock, hence, accurately reflecting the level of goods on hand **(http://www.investopedia.com/terms/p/perpetualinventory.asp).**

Continuous inventory describes systems of trading stock where information on inventory quantity and availability is updated on a continuous basis as a function of doing business **(https://en.wikipedia.org/wiki/Perpetual_inventory)**. In this type of inventory control, all additions (purchases) and withdrawals (sales or consumption) are recorded in inventory cards as they occur to provide a running balance of quantity and cost of items, a certain number of items are counted every day (or week or month) so that, by the year end, every item has been actually (physically) counted at least once. If there is any mismatch (due to human error, leakage, pilferage, loss) between the physical quantity and the quantity shown in inventory cards, the records are adjusted accordingly **(http://www.businessdictionary.com/definition/perpetual-inventory-method-IM.html).**

III. COMPARISON

The discussion above clearly indicates that there has been a considerable change in inventory control practices since the beginning of time. The research work related to inventory practices can be categorised into three phases based upon the different techniques used. In the first phase, Economic Order Quantity model was used as the principle technique of inventory control as this model was used to reduce the total cost of inventory management using the two basic costs i.e. ordering costs and carrying costs. This model was further modified and improvised with the introduction of various other parameters.

The second phase witnessed the development of MRP system which was mostly software-based but they could be used by hand as well. Development of this system ensured the availability of materials for production and products for delivery to customers along with their lowest possible levels in the store. MRP system also planned manufacturing activities, delivery schedules and purchasing activities **(https://en.wikipedia.org/wiki/Material_requirements_planning)**. MRP system was further developed into CMRP i.e. continuous materials requirements planning and DMRP i.e. discrete material requirement planning. Some of the priorities of CMRP over DMRP are as follows:

- DMRP cannot be applied in the industries of petrochemical, gas, oil, water and waste and other continuous production industries, while CMRP can be.
- Selecting a suitable and applicable time period in DMRP is difficult, while in CMRP such a selection is not needed at all.
- In CMRP approach, instead of gross requirements (GR), scheduled receipts (SR), on hand (OH) inventory and other parameters applied in discrete form, some continuous functions such as regression functions, interpolations, extrapolations and even multi rules functions can be defined, which enables us to perform sensitivity analysis and forecast on the required parameters of the model.
- In CMRP approach, users can supply and demand in any point of time and not necessarily in the beginning or the end of a time period; hence, this method can help in obtaining more benefits or decreasing waiting time **(Sadeghian, 2011)**.

Further, MRP was integrated with MRP II i.e. Manufacturing Resource Planning which was concerned with the coordination of the entire manufacturing production, including materials, finance, and human relations. The goal of MRP II was to provide consistent data to all members in the manufacturing process as the product moved through the production line. Integration and development of MRP & MRP II made today's ERP (Enterprise Resource Planning) system possible **(https://en.wikipedia.org/wiki/Manufacturing_resource_planning).**

The third and recent phase includes the application of electrical control theory in inventory control practices which is considered as a continuous control tool for instantaneous decision making. A new approach has been designed where modern and classical control theory is applied in inventory management, known as APIOBPCS model i.e. Automatic Pipeline Inventory and Order Based Production Control System. This ordering policy minimizes the variance of the inventory levels with a sequence of forecast errors of demand over the lead time given (**Vassian, 1954**). The APIOBPCS is a production control model for a single stage, single product manufacturing system with continuous flow, unconstrained production capacity and infinite availability of raw material. The product is manufactured and placed in stock while external demand is met from the available stock of finished product inventory (**Capozzi, 2003)**.

IV. CONCLUSIONS

Application of control theory in inventory control practices is considered as a landmark development as it prevents loss of any portion of profit due to late implementation of decisions because decision making becomes highly instantaneous with the use of control theory. The latest method of inventory control is helpful in industrial decision making and their implementation for continuous improvement with increased frequency to accommodate the instantaneous changes as real time information and so it can be described as on-line control of business performance. This method is still in the development phase and so it is not fully implemented (**Singh *et al.* 2015)**. Simulation can be applied on various industrial parameters to explore the validation of control theory in inventory control practices.

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International Journal of Engineering Research and Applications (IJERA) is **UGC approved** Journal with Sl. No. 4525, Journal no. 47088. Indexed in Cross Ref, Index Copernicus (ICV 80.82), NASA, Ads, Researcher Id Thomson Reuters, DOAJ.

Roopa Singh. “Chronological Developments in Inventory Control Best Practices for FMCG Sector: a review paper of inventory control system.” International Journal of Engineering Research and Applications (IJERA) , vol. 7, no. 9, 2017, pp. 61–70.