Effects of Slow Moving Inventory in Industries: Insights of Other Researchers

K. Balaji and V. S. Senthil Kumar

***Abstract*— This paper discusses the various aspects of several researchers over slow moving inventory. Slow moving item constitute a large volume of firm items. The decision over the liquidation of some quantity of an on-hand stock slow moving items is an unpredictable one. Due to over stock situation, managing the slow moving or obsolescent items is the main problem for several industries. The various strategies involving in the slow moving inventory like optimal level, forecasting and obsolescence are discussed. Further research on the slow moving inventory areas are suggested in this paper.**

***Index Terms*—Slow moving inventory, forecasting, obsolescence, reorder point, optimal level.**

I. Introduction

The problem of slow moving parts in particular was initially investigated by Whitin and Youngs [1]. Operations research methods have been continuously applied to inventory management problems after the World War II [2]. Ever since 1915 work has progressed for smooth and continuous demand control of various stock keeping units, however it is not applicable for slow moving items. The main problem of the slow moving products is the lack of historical data [3].For Industry producing different types of products, large quantity of the items are typically slow moving items. These items should have intermittent demand character and uncertainty about the lead time. It is difficult to predict the reorder point of the slow moving items which results in the increased carrying costs. To avoid this problem, firm must know the manufacturing quantity and retention period of the inventory [4].Due to over stock situation, managing the slow moving or obsolescent items is the main problem for manufacturing, distribution and retail industries.. Every item should liquidate before the salvage value otherwise it will become obsolete [5]. Effective inventory control method for slow moving items could be developed and implemented in order to improve the customer service and to reduce production, inventory and holding costs [6]. A regular review reorder based inventory control system was inappropriate for slow moving items. In many periods the demand rate leads to zero replenishment level [7]. Selecting the right periodic inventory system and determining how to forecast future demands of slow moving item is a major problem [8]. Economic order quantity formula is the best well known one in inventory theory in which the demand should be uniform and lead time is constant. In this case shortages are not considered. In the case of slow moving items the demand seems to be fluctuating. [9]. In this paper the works of various researchers have been summarised and categorized into three levels for analysis which are Optimal stocking level, Forecasting and Obsolescence of a slow moving inventory items and concluded with various issues.

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II. Optimal Stocking Level of Slow Moving Inventory

A. Mathematical Model

Whitin *et al*. established an inventory control policy for the items having extremely low demand .In that case the carrying charge is higher than the expected profit,for which they used exact order system and the demanding unit is considered as a Poisson distribution [1]. A formula was developed for the slow moving item to make the decision whether the item should be stocked at all or not. Croston presented a formulae for optimizing the standard forecasting and inappropriate replenishment levels [10]. In a continuous review (s,Q) modeled by De Wit, an iterative method is proposed to get the accurate optimal integer values of both s and Q considering a poisson distribution for demand. In this case multinomial likelihood function and Dirichlet prior distribution was assumed. Optimal decision was determined in a fast and efficient way [11]. Babai *et al*. developed a method for calculating optimal order level for a single echelon single item inventory in which the demand and lead time are stochastic and follows the compound poisson process. The model is derived from cost- oriented inventory systems where unfilled demands are backordered. The model has relatively quick convergence for slow moving items [12]

B. Analytical Model

Toelle and Tersine developed a method for determining the optimal quantity for slow moving items for, the objective is to find the retention quantity and liquidation quantity. Wagner-Whitin algorithm is used for the optimum schedule. It is based on the assumption that replenishment lead time is zero and no shortages are allowed [13].Grange analysed various difficulties in modelling the demand rate for slow moving inventory. It is difficult to predict the distribution model from the demand history [14]. Kukreja *et al*. developed an analytical model to determine the stock levels in a single echelon location, continuos inventory system. The research is based on electricity utility having multiple power generating plants at different places. A queuing model was

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developed for determining the optimal allocation of inventory. The results showed that there is a reduction in stocking rules accounting for 70 percentage over the present policy. [15]. Johnston *et al*. analysed the stocking strategy for a small electrical products company having 50,000 different items. It is observed that chance of more than one demand in a lead time is small for slow moving items. [16].Tavares and Almeida developed a model for slow moving items to decide whether it is economical to have 0 or 1 item in stock and the model was applied to real situation resulting in substantial savings [17]. Nenes *et al*. developed a Decision support system (DSS) to manage inventories in a small company located in Greece. Enterprise Resource Planning (ERP) system is installed, feeding demand information to DSS which recommends base stock values. These values are updated for every six months [18]. Sakon and Bordin determines high and low cost spare parts by comparing the EOQ model and Lot For Lot(LFL) inventory model for a slow moving item in a spare parts of automatic baggage sorting machine. Based on ordering cost, holding cost and some other parameters, auxiliary switch and voltage coil are low cost material. Battery was a high cost material applied to LFL model for controlling inventory [19].

C. Graphical Decision Model

Heyvaert and Hurt proposed a method for non seasonal parts meeting some conditions .Customer satisfaction and the graphical presentation are rapidly used to find the determination of optimal level for non seasonal parts having long replenishment time. [2]. Silver developed a simple graphical method to determine the reorder point for slow moving items. Poisson distribution was assumed for the demand during the replenishment lead time. The developed method is only for the small firms lacking in computer software and mathematically sophisticated employees [20].Quey-jen yeh *et al*. developed a graphical method for choosing appropriate replenishment size in consistence with the desired service level without calculating the reorder point. Based on the decreasing curve against current available stock, the replenishment decision was taken. The three variables demand size, demand intensity and lead time are assumed to follow a Gamma distribution [7].

D. Model for Expensive Slow Moving Parts

Heyvaert Klein haneveld and Teunter introduced a strategy for specific expensive slow moving part which has a small lead time compared to its lifetime. Closer optimal strategy was introduced initially based on infinite lifetime assumption but it is impossible to give an explicit formula [21]. Kalpakam and Sapna analyzed the ordering policy for high cost slow moving items which have intermittent demand and also possible replenishment delays. Optimal time delay which minimises expected cost rate for demand distribution with increasing and decreasing renewal densities are analysed [22]. Lin Wang *et al.* proposed a model for selecting the order level and reorder point of slow moving spare parts in a nuclear power plant. The model is reliable under constant lead time and poisson demand. [23].

III. Slow Moving Inventory Forecasting

A. Traditional Model

Croston proposed a system which has more representation of the demand pattern for the slow moving items. The proposed system avoids the excess stock levels and achieved the stock probability in addition to that it identifies the uneconomic products which results in the improved profit [24].William classified the product demand into smooth, slow moving or sporadic from the demand variance during a lead time. From the sample of 160 products, mean absolute deviation was calculated for lead time distribution and the products are classified into high, low and no sporadic, in which highly sporadic are termed as very slow moving products., the reorder point is calculated from the lead time and proposed a forecasting system [3]. Bradford and Sugrue proposed a methodology for calculating the demand rate for slow moving C category items. The forecasting procedure was based on conditional demand analysis in which aggregate demand was assumed [25].

B. Computerized Model

Vereecke and Verstraeten proposed a package Poisson model in a computerized inventory management for spare parts of a chemical plant. In this system demand occurrence is assumed to be a poisson distribution. The result of reorder point obtained from this model was compared with the theoretical distribution functions gave a satisfied results. [26].Sani and Kingsman analysed and compared different inventory policies, forecasting methods in order to determine the best one for slow moving items in a spare part depot. They concluded that (s,S) heuristic procedure,Naddors heuristic ,the power and normal approximations are best for low and intermittent demand items on annual cost and customer service, where s is the reorder level, S is the replenishment level. [8]. Synder proposed a parametric bootstrap method for determining the correct values for inventory control parameters and proposed method was compared with the traditional forecasting models .The approach is developed on real demand data for car parts. Many features of these methods reflect the influence of croston forecasting approach [27]. Synder *et al*. developed a forecast models for intermittent demand with low volume and having very high value. The proposed model was compared with the forecasting procedure using demands of car parts. A static model is preferred for the stock control of products having demand one or two per year [28].

IV. Slow Moving Inventory Subject to Obsolescence

A. Dynamic Programming Model

Jesse and Kraushaar developed a dynamic programming model for the determination and disposal situation for the uncertain inventory items. Computer program and an algorithm are proposed to find the lowest discounted expected production cost and disposal terminology for the uncertain items [4]. Rosenfield initially proposed an approach for the disposal and perishability of the slow moving items. In the basic model, a formula was derived for the right number of quantities to keep in the firm. In the next model they analysed the different cases like random time and random separate time associated with the perishability of the inventory items. By means of probabilistic nature holding cost and disposal rates of slow moving inventory are obtained [5]. Pince and Dekker developed a model for slow moving item with non stationary demand process and fixed lead time. The model gives the impact of timing policy on operational costs and optimum time to avoid the risk of obsolescence [29].

B. Heuristic Method

A spreadsheet heuristic approach was developed for stocking and retention of slow moving and obsolescent items by Hummel and Jess. The procedure is an alternative practical approach compared to dynamic programming .the heuristics was developed to minimize total expected cost with an assumption of demand arrival is uncertain. The heuristic procedure is converted into a spread sheet of a computer, comparing the thirteen numerical examples the heuristic achieves the optimal cost [6]. Lindsey and Pavur analysed the issues of estimating the future demand rate for group of products having no demand. They proposed and assessed the prediction intervals for the future demand rate of slow moving items. The prediction intervals are reliable under various assumptions [30].

V. Discussion on Slow Moving Inventory Researchers Analysis

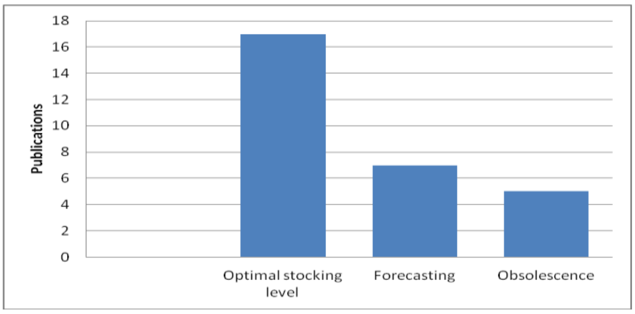

Fig. 1.Various works on slow moving inventory

Fig. 1. Shows the various works on slow moving inventory. From the graph it is observed that more researchers have concentrated on identification of optimal stocking level of slow moving inventory in various industries followed by forecasting and obsolescence. Due to over stock situation, managing slow moving inventory is a main problem in the industry. To avoid this atmosphere,Many of the resarchers have been attempted their research work on optimal stocking level of slow moving inventory compared to other problems

VI. Conclusion

The various issues and examples on slow moving inventory have presented in this paper. The researchers have suggested that inappropriate demand distribution will result in inaccurate inventory optimization in the industry further the persons who have involved in the inventory are generally unfamiliar in using an appropriate probability distribution model for slow moving inventory. Many researchers have concluded that stochastic distribution is most suitable for modelling the demand rate of slow moving items. Most of the studies have attempted in terms of a quantity and timing or reorder point of the replenishment orders with respect to the minimization of a total inventory cost or service level satisfactions**.** There may be a lot of risks involved with inaccurate and inappropriate probability modeling for slow moving inventory. Croston method is often used for forecasting and inventory control of the slow moving items. The problem of identification and elimination of the reasons for the generation of slow moving inventory are not attempted by researchers.

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