# Optimizing the Level of Inventory by Reducing Uncertainity in Production Management under Variable Demand

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*Abstract*— The quantity of goods and materials on hand is termed as inventory. Optimization of inventory is a difficult task because excess inventory results in high cost and lower inventory results in stock outs. Inventory cost is reduced by forecasting the desired inventory with continuously varying demand. If the transportation cost is less than inventory cost, the inventory level can be separated with respect to production time. When transportation cost exceeds the inventory cost, the products can be purchased in large scale. So in order to reduce the rate of uncertainty a model is developed for managing the level of inventory. This model minimizes the inventory level as the raw materials are purchased at the production start time by knowing the availability of the production sources and it avoids production stoppages.

***Key words:*** Variable Demand, Inventory Management

## I. Introduction

A.S. White[8] described an investigation of the effects on the variation of profitability with time. The controlling parameters are formulated in a model for an Automatic pipeline, variable inventory and order based production control system using Proportional, Integral and Derivative (PID) controller. The numerical results were optimized using MATLAB TM routines. The results show that using a range of PID gains for a controlled production system, will increase profitability. The desired level of inventory also can increase profitability with a definite optimum value. The model shows increased production delays result in lower overall profit and cumulative profit is increased with increased PID gains up to a limit. Baris Selcuk [3] (2012) proposed that cost effective lead time quoting procedure when using the MRP system for both dynamic control and the static control. The lead time value has been updated through the various parameters and established a cost effective lead time quoting procedure. The problem is modeled as a two-dimensional Markov chain and it is solved explicitly by using matrix geometric techniques. Comparative analysis is done between static and dynamic lead time quoting procedures and significant cost benefits of the dynamic procedure are shown under various scenarios. Dong Hai[5] (2011) proposed a predictive model to forecast the changes in the market in order to maintain the inventory level for satisfaction of the customer. He determined an equation for the percentage of customer satisfactory level and the upper confidence limit for the inventory. After the determination of the values he proposed a control algorithm for the control of the inventory horizon by minimizing the cost function and the coefficient parameters can be tuned for that multiple regression forecaster is used. He made a quick response for the demand of market and controls the dynamic inventory in under the difficulties of delay and uncertainties. A.Foul et.al [8] (2011) proposed an adaptive control tracking the output of the system with feedback in production inventory system for reaching the desired inventory goal level. The model is generated by assuming the deterioration rate as the constant, inventory goal lead time, and production goal time and safety stock. He justified the theory proposed by (khalil 2002; sastry and Bosdon, 1989) in which Lyapunov function is not unique; rather, many different Lyapunov functions may be found for a given system. Likewise, the inability to find a satisfactory Lyapunov function does not mean that the system is unstable. In the context of adaptive control, the use of the Lyapunov approach allows us not only to analyze the stability properties of the system which allows us to differentiate between the stability and asymptotic stability of a system. Eleni aggelogiannaki[6] defined the dynamic behavior was seemed to be very difficult in inventory due to the inventory drift or the uncertainty over the customer demand so for that he proposed the finite impulse theory through which you can filter the error and for the identification of the online model the recursive least square method has been used. Through that model we can determine the maximum range and the minimum range of the horizon with in which the inventory level system will be formulated. Eleni Aggelogiannaki [6] defined the inventory drift problem with an online identification method for lead time in order to improve the efficiency of the system. He derived the Adaptive Automatic Pipeline variable inventory and order based production control system with proportional control law for the criteria of not knowing the lead time exactly or varies with time. And he proved that this produces better results than the other algorithm previously derived through the graphical representation. Finally he shown the simulation results approach can track customer demand and maintain a proper inventory without causing the bull whip effect. Awad El gohary[2] proposed an optimal control to adjust the production rate of a deteriorating inventory system using an explicit model under the various conditions of constant demand rate, linear demand rate, and sinusoidal demand rate. The inventory level can be derived using the first order differential equation and control algorithm can be proposed by Eigen value and compute through the vecto0ch for linking manufacturing strategy with market strategy through a reconfigurable Manufacturing Planning and Control (MPC) system to support agility in this context. He described the control parameters are Work In Progress, production and inventory levels. Finally he has shown that the simulation results approach can track customer demand and maintain a proper inventory without causing the bull whip effect. A comprehensive MPC model capable of adopting different MPC strategies through distributed controllers of inventory, capacity, and Work In Progress is presented. A hierarchical supervisory controller (referred to as decision logic unit, DLU) that intakes the high-level strategic market decisions and constraints together with feedback of the current manufacturing system state (WIP, production, and inventory levels) and optimally manages the distributed controllers is introduced. Chandra S.Lalwani [4] proposed a state of space models for the Inventory Order Based Production Control System family of production and distribution ordering policies of the transfer functions. The model and all the functions have been illustrated. And he has all controlling parameters for all the models related to the order based production control. He also produced a Venn diagram for the control of IOBPCS system. Lyapunov (1892) proposed two methods for demonstrating stability. The first method developed the solution in a series which was then proved convergent within limits. The second method, which is almost universally used nowadays, makes use of a Lyapunov function V(x) which has an analogy to the potential function of classical dynamics

## II. UNCERTAINITY IN INVENTORY MANAGEMENT

### A. *Reason for Uncertainity in Inventory Management:*

The problem with the current scenario when there will be more difficulty to have an optimal inventory management when your benchmarking is unstable. For continuous variable demand the target work in progress should be flexible with respect to time.

### B. *To Reduce the Level of Uncertainity:*

The best method for reducing uncertainty is forecasting. The accuracy of forecasting is inversely proportional to rate of uncertainty in inventory management for continuously varying demand.

## III. MATHEMATICAL MODEL FOR REDUCING THE LEVEL OF UNCERTANITY IN INVENTORY MANAGEMENT

The following assumptions are made for the mathematical model 1. The production lead time is deterministic and known in advance. 2. The working hours in a company is assumed to be 8 hours per day & 30 days in a month. 3. The delay time is deterministic. 4. The dispatching is done immediately after the production had been over. 5. The delay due to the transportation and other environmental issues is neglected. 6. To manage uncertainty a safety stock with a time buffer of 2 days is considered for all products. 7. The manufacturing operations are done in the sequence of product A followed by product B and product C. 8. In the system order cost is assumed as negligible. 9. Variation in transportation cost fluctuation is negligible.

The symbols used in algorithm are described as follows,

- $M_j$ = Month (j = 1,2,3….12),
- $D_i$ = Demand (i= 1,2,3),
- $T_{LA}$ = Lead time required for product A (min)
- $T_{LB}$ = Lead time required for product B (min),
- $T_{LC}$ = Lead time required for product C (min),
- $T_{PA}$ = Required Production time for Product A(min),
- $T_{PB}$ = Required Production time for product B(min),
- $T_{PC}$ = Required Production time for product C(min),
- $D_T$ = Delay time(min),
- $E_T$ = Excessive time required (min),
- I =Inventory Level( No of parts to be stored),
- $R_A$ =Days required to complete the product A (Days)
- $R_B$ = Days required to complete the product B (Days)
- $R_C$ = Days required to complete the product C (Days)
- $I_D$ = Desired inventory level (no of parts) ,
- $T_c$ = Transportation cost ,
- $I_c$ = Inventory cost

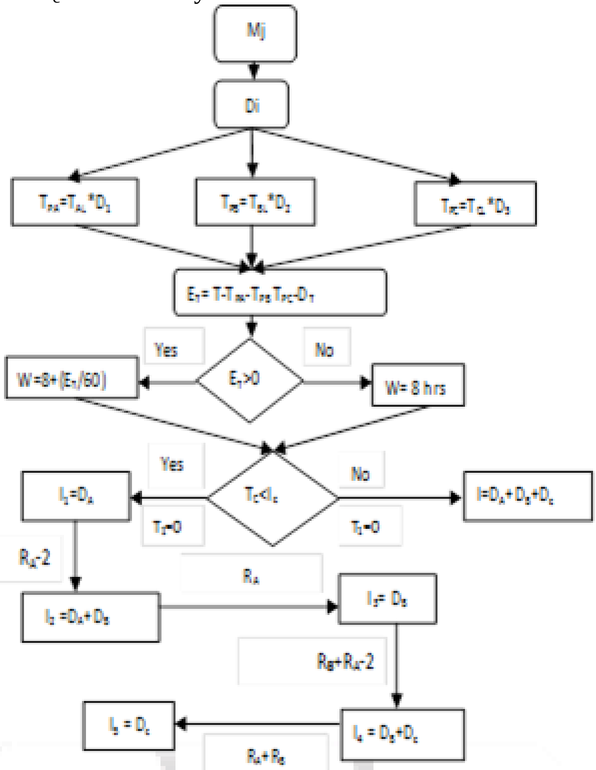


Fig. 1: Algorithm for reduction of Uncertainity

### A. *Mathematical Formulation for Reducing the Level of Uncertainity:*

The Mathematical model is formulated for the reduction of level of uncertainty is described as follows.

$$I_D = \sum_{T=0}^{30} \text{Min } I \quad \forall \quad T_c < I_c \qquad (1)$$

$$I_1 = \sum_{T=0}^{R_A-2} D_A \qquad (2)$$

$$I_2 = \sum_{R_A-2}^{R_A} D_A + D_B \qquad (3)$$

$$I_3 = \sum_{R_A}^{R_A+R_B-2} D_B \qquad (4)$$

$$I_4 = \sum_{R_A+R_B-2}^{R_A+R_B} D_B + D_C \qquad (5)$$

$$I_5 = \sum_{R_A+R_B}^{R_A+R_B+R_C} D_C \qquad (6)$$

The objective function of this mathematical model formulated is the minimization of the desired inventory level and the level of the inventory separated into the respective production time required for the product. Here the time horizon required for this mathematical model is explained in the above equation.

## IV. CONCLUSION

In the proposed model, the desired inventory level is determined in consideration with the customer demand fluctuations. This model minimizes the inventory level as the raw materials are purchased at the starting time of production by knowing the availability of production resources and production sequence. The finished goods are dispatched soon after their production. A throughput of the system is improved as the tied up inventory in all forms is reduced.

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