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Modelling Inventory Control System for Federal Universities in Developing World Using Distributed Database

By

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Abstract

Inventory refers to the supply of materials required for the operation of a business. These supplies correspond to an investment in materials. The proper management of these supplies impacts the ability of a business to maximize profits. Inventory control model is a tool to help you manage your inventory and operate your pricing strategy, for an organization. This is a model designed to Study the market, strategize a price, and beat the competition. Inventory control model is used to develop and enact a complex, automated pricing strategy, based on real-time analysis of your industry. It is used to respond to market changes immediately with unlimited lightning-fast updates. Inventory control is faster, simpler, and more accurate communication method with your marketplaces. Seller-Active Inventory Control gives you the power to easily stay on top of inventory levels across all your platforms. It deals with all your marketplaces, get and send pricing updates, integrate with shipping software, and analyze detailed market history data. Inventory management systems track a wide variety of quantities of stock. Inventory is tracked regarding inventory in stock, items that should be ordered in higher quantities and adequate inventory turnover. Volume purchases are often used to ensure lower prices for frequently purchased items. Inventory management systems track when an order should be placed, when inventory is at peak volume, the receipt of deliveries of inventory and the anticipated date to order more stock. Analysis of the inventory system purchasing plan can provide information as to which items are not being used and should no longer be ordered.

Introduction

Different types of inventory control methods can be used to manage inventory. Businesses may use a ticker control system in which staff counts a portion of the inventory on a regular basis to determine inventory levels. Alternately, a click-sheet control system uses a paper record-keeping system to keep track of inventory levels, while stub control is based on the retention of sales receipts to track inventory flow. Offline point-of-sale terminals send information directly from a computer to an inventory management system.

There is need for inventory accuracy. Imagine an organisation having 200,000-square-foot warehouse. Now imagine that warehouse filled with 25,000 different products, spread across 60 rows of shelving, five levels high. This scenario is one that many companies face day in and day out. Because of the level of complexity, it is critical that the inventory system accurately reflect what products are in stock, in what quantities and in what location. Within an inventory control system, the physical storage area is divided into discrete areas. An area could be a spot on the floor or a certain shelf in a rack. The inventory system contains records that show what is in stock. For each of these records, there are three main components: item, quantity, and storage location. An inventory record is accurate if the physical contents of the location matches precisely with the records stored in the inventory system. There is need for common inventory transactions. Think of inventory transactions in terms of "ins" and "outs." Ins are those transactions that add to your inventory. Examples of ins include production receipt, purchasing receipt and customer returns. Example of outs include usage by production, customer shipment and transfers to another location. To ensure inventory accuracy, it is absolutely critical that every movement, usage or sale of product be accurately reflected by a transaction. It is those transactions that modify inventory records to match reality.

Inventory and its control is an aspect that has received considerable attention in contemporary times. This is attributed to the fact that salvaging the challenges posed by inventory drawbacks lies at the heart of management considerations and decisions in companies. For clarity,' Inventory Control focuses on acquiring, storing and managing the inventory in such a manner that it is available as and when due so as to cater for contingencies, maximize profit and to minimize wastage, losses or disservice to the customers. It is worthy of note that lost sales due to disservice are enormous. As it regards Spare/Service Parts which are interchangeable part kept in the inventory for the repair and replacement of failed parts. Spare parts industries and vehicle manufacturing companies strive to achieve the aim of inventory control which is to secure the best balance between "too much and too little." They must provide supply (sales), repair and maintenance services to their customers who would never desire downtime for their equipments because downtime is lost production capacity. Irrespective of the fact that spare part demands are stochastic (unpredictable) and provision of after-sales service compulsory, companies that can predict approximate optimal values for inventory decision making only topple their contemporaries in terms of sales and efficient service delivery. The management of the inventory can only be done with the aid of a computer; hence the inventory complex has a computerized inventory database. There is need for auditing inventory accuracy. There are two ways that inventory accuracy is audited and measured: physical inventory counts and cycle counts. A physical inventory count involves a systematic approach to counting every piece of inventory. Physical inventory counts can take anywhere from a few hours to a few days depending on the size and complexity of the warehouse. A physical count provides the opportunity to adjust inventory records to match up with the current actual inventory. A cycle count is similar to a physical count in that it involves going into the warehouse to count and reconcile inventory. But it is different in that a cycle count only focuses on a section of the warehouse, where the physical count encompasses the entire warehouse. There is need for inventory accuracy and accounting. You now know that inventory accuracy is important for the people who work in the warehouse, but inventory accuracy is also important for finance and accounting. At year end, the corporate finance group publishes the balance statement. The balance statement shows the company's assets, liabilities and equity. Inventory typically is one of the largest assets of a company. For that reason, the company must maintain accurate records of inventory balances and transactions. Inventory control systems are employed in a wide variety of applications, but they all revolve around tracking delivery of goods to customers. Inventory control is crucial in retail stores, especially those with a large number or variety of merchandise items for sale. Inventory control is also used in warehouses to track orders and shipments, and for automated order processing. Other important applications of inventory control systems are in manufacturing, shipping, and receiving.

Background Studies

Nahmias and Demmy (1981) were the first to consider multiple demand classes in a continuous review inventory model. They analyzed an (r; Q) inventory model, with two demand classes, Poisson demand, backordering, a fixed lead-time and a critical level policy, under the crucial assumption that there is at most one outstanding order. This assumption implies that at the point when a replenishment order is triggered, the net inventory and the physical are the same. The model of Nahmias and Demmy was analyzed in a lost sales context by Melchiors et al (2001) which worked very well in environment where lost sales is common. In his paper, Axsater (1993) considered a 1-warehouse, N-retailer inventory system where demand occurs at all locations. He introduced an inventory model which allows setting different service levels for retailers and direct customer demand at the warehouse. For each retailer a critical level is defined, such that a retailer replenishment order is delivered from warehouse stock if and only if the stock level exceeds this critical level. Moinzadeh and Nahmias (1988) and Moinzadeh and Schmidt (1991) also addressed a problem under continuous review policy. The former considered fixed ordering costs for both regular and expedited demands. The authors developed a heuristic that is an extension of the standard (r: Q) policy. The latter assumed that demand and fixed ordering costs are small compared to the holding cost and therefore a one for one ordering policy is reasonable. Not only current inventory is considered but also information on the outstanding demands is considered by the model before placing an expensive emergency order. Their results show considerable savings associated with the dual supply strategy. Deshpande, et al (2003) considered a rationing policy for two demand classes differing in delay and shortage penalty costs with Poisson demand arrivals under a continuous review (r; Q) environment. They defined a so-called threshold clearing mechanism to overcome the difficulty of allocating arriving orders and providing an efficient algorithm for computing the optimal policy parameters which are defined by (Q; r; K), K being the threshold level. Numerical results confirm that the solution under this special threshold clearing mechanism closely approximates that of the priority clearing policy.

Materials and Methods

An inventory control system may be used to automate a sales order fulfillment process. Such a system contains a list of order to be filled, and then prompts workers to pick the necessary items, and provides them with packaging and shipping information. An inventory system also manages in and outwards material of hardware. Real-time inventory control systems may use wireless, mobile terminals to record inventory transactions at the moment they occur. A wireless LAN transmits the transaction information to a central point. Physical inventory counting and cycle counting are features of many inventory control systems which can enhance the organization control systems with computers. To accurately develop a decision support simulation model that will check the stochastic demand of items and to optimize inventory so as to find the fill rate and the average number of backorders, the simulation project life cycle proposed by McHaney (2012) is employed. In view of the above assertion, the present procedure considering the case study is also presented as well as the weaknesses of the present system. In addition, is the arrival of demands and the inventory situations that require the implementation of a particular policy for decision making. This research studied relevant details of the items which satisfied the basic requirements for the models of the study. Researchers on inventory in the 60's concentrated their efforts on Periodic inventory review. They analyzed multiple demand classes in a multi-period, single product, non-stationary inventory environment. They also focused on the question of how much to order and when to replenish, but did so in the context of a periodic review system, without actually rationing levels. Here each demand class is characterized by a different shortage cost. The analysis is facilitated by breaking each review interval into a finite number of sub-periods. At the end of each sub-period, the decision maker allocates inventory to demand that has been realized thus far. The allocation is based on a trade-off between the benefit of filling demand for low class items in the current sub-period and reserving inventory to fill higher class items in subsequent sub-periods. A recent work came from Duran, S. et al.(2007). They considered a manufacturing environment serving two customer classes where one wants the item immediately and the second receives a discount to accept a delay. They showed that an ($S; R; B$) base stock policy is optimal under service differentiation, where S, R and B are the order-up-to, reserve-up-to, and backlog-up-to quantities. The use of tactical inventory was considered by Scarf (1958) and here, the idea of protecting inventory from being sold to current customers or “discretionary sales" is introduced. Scarf showed that a base-stock policy is optimal for a single-class problem when production setup costs are fixed, but that the optimal discretionary sales decision may be different for different demand realizations. It is possible to incorporate the idea of tactical inventory decisions for a single-class stochastic inventory model with multi-period pricing and production decisions under limited capacity when demand is a general stochastic function. At the end of each period the inventory is issued with priority such that stock is used to satisfy high-priority demand first, followed by low-priority demand.

System Design

Inventory control is important to ensure quality control in businesses that handle transactions revolving around consumer goods. Without proper inventory control, a large retail store may run out of stock on an important item. A good inventory control system will alert the retailer when it is time to reorder. Inventory control is also an important means of automatically tracking large shipments. An automated inventory control system helps to minimize the risk of error. In retail stores, an inventory control system also helps track theft of retail merchandise, providing valuable information about store profits and the need for theft-prevention systems. Automation can dramatically impact all phases of inventory management, including counting and monitoring of inventory items; recording and retrieval of item storage location; recording changes to inventory; and anticipating inventory needs, including inventory handling requirements. The inventory control system can serve a variety of functions in this case. It can help a worker locate the items on the order list in the warehouse, it can encode shipping information like tracking numbers and delivery addresses, and it can remove these purchased items from the inventory tally to keep an accurate count of in-stock items. The subsystems that perform these functions include sales, manufacturing, warehousing, ordering, and receiving. In different firms the activities associated with each of these areas may not be strictly contained within separate subsystems, but these functions must be performed in sequence in order to have a well-run inventory control system. In designing the models, service differentiation through rationing is incorporated. This is because, in inventory, just as different customers may require different product specifications, they may also require different service levels. Therefore, it can be imperative to distinguish between classes of customers thereby offering them different service.

BACKORDER AND CLEARING MECHANISM

Here the model to be designer adopted a two static threshold levels (**K^2, K^1**) that shows when to fill a particular demand and when to backorder it (rationing policy). Backorder and threshold clearing mechanism are incorporated in the proposed models. Backordering is employed in this model because the company studied and indeed many other companies of its nature, most of the time, have service agreement with its major customers. Therefore, the issue of lost sales rarely occurs. At a time when demands are backlogged because they can’t be filled as a result of stockout or having on-hand inventory below the threshold level, in a service differentiated environment. Then there is need to decide how the backordered demands are to be cleared using any of the notable clearing mechanism. The threshold clearing mechanism is ensure adopted in the models and it ensures that silver demands are not filled below the threshold level (K).

RANDOM NUMBER GENERATION

Random variables form the basis for the generation of all random numbers. There are many different ways of generating random numbers, but they fall into two main categories.

a. Using a physical device
b. Algebraic method

Algebraic methods are simple to maintain, fast and reproducible, hence they are widely used. The inverse transform algebraic method will be used in the simulation development. The random phenomenon has a negative exponential density function, expressed thus:

$$F(t) = \lambda e^{-\lambda t}$$

$$F(x) = \int_0^x \lambda e^{-\lambda t} dt = 1 - e^{-\lambda t}$$

The given value of x is 0 < x < 1

$$F(x) = 1 - e^{-\lambda t}$$

$$e^{-\lambda t} = 1 - F(x)$$

$$-\lambda x = In\{1 - F(x)\}$$

$x = -(1/\lambda) In R(x)$ Where $R(x) = 1 - F(x)$

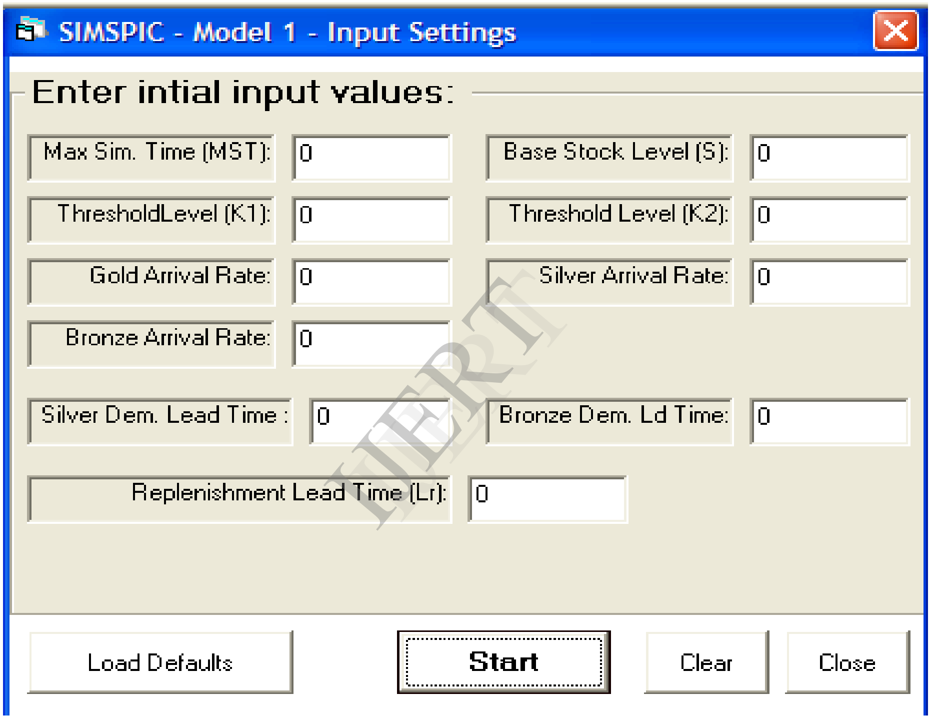
R(x) is a random number between zero and one and x is the variable. Thus generating a sequence uniform random decimal numbers $F(x_1), F(x_2), F(x_3), \ldots$, the exponential distributed random variable $(x_1), (x_2), (x_3), \ldots$ can be obtained. Random numbers as generated above are not strictly random since, if one knows the seed (Y_0), all the remaining numbers in the sequence can be known. Consequently, these random numbers are often 'Pseudo-Random Numbers', however, this is a philosophical assertion: if the random numbers appear to be independent draws from the U, (0, 1) distribution and they pass a series of statistical tests. The next event method will be considered in this study because discrete event simulation models will be carried out. In this method, the clock is incremented by a variable amount rather than a fixed amount. This variable amount is the time from the event that has just occurred until the next event of any kind, occurs. In other words, the clock jumps from event to event and remains constant between events.

Results and Discussions

The Main Menu displays dialog box. By clicking on this model the software launches the simulation environment. The sensitivity analysis is also performed.

Model Interface

The input dialogue box of this model.



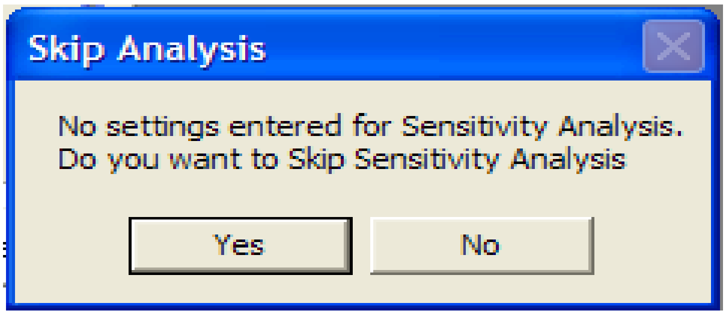
SIMSPIC - Model 1 - Input Settings

Enter intial input values:

Max Sim. Time (MST): 0
Base Stock Level (S): 0
ThresholdLevel (K1): 0
Threshold Level (K2): 0
Gold Arrival Rate: 0
Silver Arrival Rate: 0
Bronze Arrival Rate: 0
Silver Dem. Lead Time : 0
Bronze Dem. Ld Time: 0
Replenishment Lead Time (Lr): 0

Input Dialogue Box for the Model

In this dialogue box the required input parameters for the simulation are keyed in, one after another, in line with the dataset to be simulated. To use the default values, the defaults button is clicked and the values are automatically supplied. The clear button is used to clear the inputted values when the need arises while the close button closes the dialogue box entirely. The Start button prompts the computer to start simulation, which invokes a direction dialogue box.

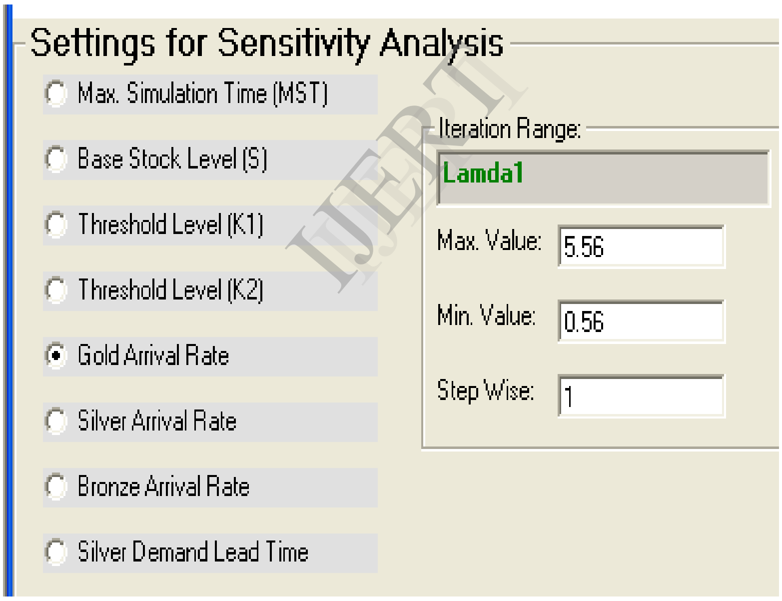


Skip Analysis

No settings entered for Sensitivity Analysis.
Do you want to Skip Sensitivity Analysis

Start or Continue Simulation Request Dialogue Box

It should be noted that if the *Yes* button is selected the simulation proceeds and completes the run without performing any sensitivity analysis. However, if sensitivity analysis is required, the *No* button is selected, it allows for the setting of the sensitivity analysis that is desired.



Settings for Sensitivity Analysis

○ Max. Simulation Time (MST)
○ Base Stock Level (S)
○ Threshold Level (K1)
○ Threshold Level (K2)
● Gold Arrival Rate
○ Silver Arrival Rate
○ Bronze Arrival Rate
○ Silver Demand Lead Time

Iteration Range:
Lamda1
Max. Value: 5.56
Min. Value: 0.56
Step Wise: 1

Sensitivity Analysis Dialogue Box for Model

This setting of this sensitivity analysis dialogue box is completely flexible. The step wise value is 1. In other words, the value changes while other input parameters remain constant. At each change of the arrival rate, the simulation is run and its outputs are displayed in the intermediate and final simulation outputs. Similarly, any of other sensitivity parameters can be chosen while any value can be inputted in the iteration range as step wise value. After setting the values for the sensitivity analysis, the start button is clicked and a confirmation dialogue box appears, requesting for a *Yes* selection for the simulation to start. If continue button is selected, it will increase the sensitivity parameter to the next step value and run again after which the dialogue box will reappear. It continues like this until the end of the sensitivity analysis.

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