

## Inventory System Simulation Based on Witness

Yunrui Wang

School of Mechanical Engineering, Xi'an University of Science and Technology, Xi'an, China

2002wyr@sina.com

**Abstract.** Inventory was breakthrough point of enterprise "the third profit source" and has been abroad paid attention to sale, manufacture and other industries, a good inventory management system could provide some assurance and support for fine operation of enterprises. Ceramic sale inventory system as a research object, author counted sales data for nearly three years, calculated the enterprise safety stock, order point and the highest inventory, determined the nine inventory strategies and inventory simulation model was established based on Witness. The minimum total cost of inventory strategies that allowing and not allowing out of stock were got by running simulation software. To solve the blindness of enterprises based on past experience to determine the ordering strategy, provide help for enterprises to determine fit ordering point and the highest inventory.

**Keywords:** Inventory; Order Strategy; Simulation Model; Witness

### 1. Introduction

The right amount of inventory can meet customer uncertainty inquire in product at any time which avoid customer dissatisfaction for out of stock, can guarantee continuity of production, prevent stop operation caused by "bottleneck" material. The use of computer simulation software running on strategy to optimize inventory decision is more labor-saving and useful method. There are more research in this aspect but more focused on inventory site management on the basis of experience[1,2], in view of the individual enterprise internal inventory of how to realize the dynamic management of the whole process is lack of , author realize management of enterprise inventory system and simulation by combing witness software with individual enterprise. Help company find shipment time, quantity and so on, boost the development.

Figure 1 is a stock level, "stock" means resource idle temporarily [3]. Under normal circumstance, the aim is to prevent a shortage, in addition, it also has some role that to maintain continuity of production process, share ordering cost, meet need of order of users quickly. In enterprise, inventory exists for various economic considerations, but it is also a result of frustration which due to the change of demand forecasting. Therefore, the relevant data need to determine such as safety stock, order point, etc.

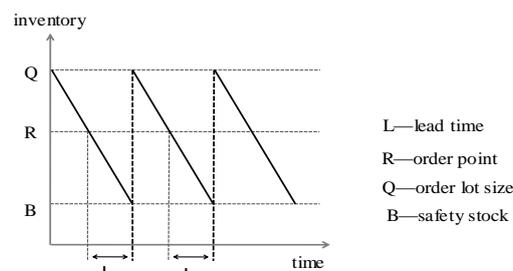


Fig. 1 Stock Level

### 2. Determine Safety Stock and Order Point

**Determine Safety Stock (B).** Safety stock is a kind of insurance reserve, means in order to prevent sudden orders, temporary increased dosage, the date of delivery delay and delivery overdue, etc. or uncertainty factors. Calculation of safety stock is obtained by using standard deviation, expected

service level, normal distribution according to customer demand and lead time changed or fixed. For enterprises, the amount of safety stock is greater, the possibility of less goods phenomenon is small; but it will lead to excess inventory, occupy more and more enterprises liquidity while safety stock bigger. So out of stock should be maintained at an appropriate level according to diverse need of customer, certain degree shortage can be allowed according to the actual situation.

Ceramic sale as the main research object for simulation in inventory management system who selling products mainly include wall brick of outside and inside, culture stone, art wall brick, archaize floor tile and multi-series foot line. Research and analysis for the vendors and finding that the sellers in inventory management have no a suitable order point and the highest inventory control strategy, resulting in high inventory cost and lower customer service level. Therefore, need to combine actual situation of the vendor to determine inventory levels, add up amount of products sold.

Considering the ceramic vendor sell more type product, using weight to calculate sale volume, unit is kg. Products can be divided into ABC three categories according to inventory management [4]:

Class A kind of product as the best selling goods, 80% of the total cost;

Class B product is non-selling products, 15% of the total cost;

Class C is drug products, 5% of the total cost.

Class A is mainly study object in the inventory management.

Table 1 is statistical result from 2009 to 2011 of sale volume, according to these data to calculate mean  $\bar{x}$  and standard deviation  $\sigma(X)$  of every day, provide basis for determining safety stock.

Table 1 2009 ~ 2011 Sales of Average Monthly/Average Daily [Kg]

Sales	Monthly	Daily	Sales	Monthly	Daily	Sales	Monthly	Daily
Jan	65100	2100	May	186000	6000	Sep	189000	6300
Feb	42000	1500	Jun	330000	11000	Oct	167400	5400
Mar	139500	4500	Jul	179800	5800	Nov	150000	5000
Apr	225000	7500	Aug	201500	6500	Dec	139500	4500

$$\bar{x} = \frac{1}{n} \sum_{i=1}^x x_i = 6610kg \tag{1}$$

$$\sigma(X) = 2450.4kg \tag{2}$$

Safety stock B is:

$$B = Z * \sqrt{L} * \sigma(X) \tag{3}$$

Where: L is lead time, Z is safety coefficient.

According to past experience to determine purchasing lead time is 10 days, level of customer service is 98%, safety coefficient Z = 2.05 by looking up table.

$$B = 2.05 * \sqrt{10} * 2450.4 = 15885.13kg$$

**Determine Order Point (R).** Order point used to determine the start time of ordering strategy, once the inventory is less than order point place the order at once. When demand or complete cycle uncertainty, must use the appropriate safety stock to buffer or compensation of uncertainty.

$$\begin{aligned} R &= \bar{x} * L + B \\ &= 6610 * 10 + 15885.13 \\ &= 81985.13kg \end{aligned} \tag{4}$$

Order point question to consider: first is the relationship between market supply and demand; second to think about market price factor, price trend, market price trend and freight, human resource price, price of raw materials etc.; third, the transport distance, distance between production enterprise and sales, traffic condition will have a certain impact on order point; fourth, product sale;

fifth, consider financial strength. The order point is set into 3 types in the enterprise: 72000Kg, 82000 Kg, 92000 Kg.

### 3 Determine the Highest Inventory and Ordering Strategy

The highest inventory is the enterprise to limit stipulated in the standard for materials inventory control, which is calculated in formula (5) basis on order point.

$$\begin{aligned} &\text{The highest inventory} \\ &= L * \bar{x} + R \tag{5} \\ &= 10 * 6610 + 72000/82000/92000 \end{aligned}$$

The highest inventory includes three kinds: 138100 Kg, 148100 Kg, 158100Kg.

Order point and the highest inventory have three different values respectively [5,6], which can form 9 kinds of combination, namely nine kinds of inventory strategy:

- ① {72000,138100}                      ② {72000,148100}                      ③ {72000,158100}
- ④ {82000,138100}                      ⑤ {82000,148100}                      ⑥ {82000,158100}
- ⑦ {92000,138100}                      ⑧ {92000,148100}                      ⑨ {92000,158100}

Combing different order point and the highest inventory will produce different cost, choose the lowest as appropriate inventory strategy. The value of the interval could be reduced more precise lot sizing value if wanted.

### 4 Inventory System Simulation

**Establishment of Inventory System Simulation Model.** Inventory simulation element is defined by using Witness software, where 19 number elements are shown in table 2, all elements need display so reveal their motion state in system operation. Witness software provides a standard random distribution function, according to the average daily sale from 2009 to 2011, customer needs tends to a normal distribution, where distribution of mean is a real number 6610, standard deviation is also a real number 2450.4, and pseudo random number stream is integer number 1, so determine customer demand daily arrival obeys NORMAL (6610, 2450.4, 1) [7, 8].

Table 2 Inventory Simulation Element Definition

Element name	Type	NO	Caption
Guke	Part	1	Demand side
Chanpi	Part	1	Ceramic product
Cangku	Buffer	1	Inventory system
Xiaoshou	Machine	1	Service station to meet demand
Tongdao	Conveyor	1	Path for product to enter the warehouse
Caigou	Variable	3	1 Custody rate
			2 The fixed cost of purchase
			3 Procurement unit variable cost
Shuliang	Attribute	1	Demand / vehicle shipments
kucunshangxiang	Variable	1	Maximum inventory
dinghuodian	Variable	1	Re-order point
Caigoupiliang	Variable	1	Purchasing volume
Jilu	Variable	9	1 Total amount of statistical shortage
			2 Beyond the maximum inventory quantity statistic
			3 Consumption to meet customer need
			4 Total purchases
			5 Average inventory of warehouse
			6 The total number of purchases
			7 Inventory cost
			8 Procurement cost
			9 The total cost

Pici	Variable	1	Control to sending purchase information
Chushihuakucun	Variable	1	Initial inventory
Dongtaikucun	Variable	1	Record daily warehouse inventory
Caigouhanshu	Function	1	Product procurement function
Gukexiqiu	Function	1	Daily demand
Pingjunkucun	Function	1	Calculate the average warehouse inventory
Zongfeiyong	Function	1	Calculate total cost
lujing	Path	1	products path of outbound

**Analysis and Run for the Model.** Simulation model of clock 1:1 day, ceramic inventory simulation model run a year (365 days), first run inventory strategy {72000,138100}, the simulation model to check inventory once a day, when inventory level is less than the order point, issue purchase order to production enterprise, lot size is fixed at 80000 Kg, procurement lead time is 10 days. Statistical report can be obtained as shown in table 3.

Table 3 Running Cost Statistics of Inventory Strategy (72000, 138100) Unit: Yuan

Project	Money
Inventory cost	778545
Procurement cost	150000
Total cost	923545

It can be seen from statistic reporter, total cost of strategy {72000,138100} is 923545 yuan. On basis of the first scheme, run the second strategy need to make the following changes:

Initial Actions:

kucunshangxian = 138100 !

dinghuodian = 82000 !

The nine kinds of initial value of kucunshangxian, dinghuodian are modified in order in the simulation system [9], nine inventory strategies running results are shown in table 4.

Table 4 Nine Inventory Strategies and Total Cost

Scheme	Inventory strategy(L,S)	Shortage	Explosive amount	Inventory cost	Procurement cost	Total cost
1	(72000, 138100)	44067	0	778545	150000	923545
2	(82000, 138100)	2721	0	938853	150000	1088853
3	(92000, 138100)	0	0	1104909	150000	1254909
4	(72000, 148100)	39067	0	780315	150000	925315
5	(82000, 148100)	2639	0	927227	150000	1077277
6	(92000, 148100)	0	0	1108158	150000	1258158
7	(72000, 158100)	61661	0	743158	145000	888158
8	(82000, 158100)	130	0	945167	150000	1095167
9	(92000, 158100)	0	0	1115403	150000	1265403

**The Rate of Inventory Shortage.** There is a shortage listed in table 3, inventory shortage rate reflects service level and quality in a period and is an important data for inventory information. The rate is greater, the worse of service level. In the model customer service level is 98%, and shortage of theory value is 2%. Considering the changeable actual customer demand and unstable inventory level, shortage rate can be set to 3%, in order to improve the fitting with the actual inventory model.

$$\begin{aligned}
 \text{Inventory shortage rate} &= \frac{\text{shortage}}{\text{demand}} \times 100\% \\
 &= \frac{61661}{2342960} \times 100\% = 0.026\%
 \end{aligned}
 \tag{6}$$

Demand is the total amount of customer requirements of the system run for a year, statistics obtained by the simulation software; shortage is the maximum in nine strategies, the simulation result is the seventh strategy namely 61661. So, shortage rate of several strategies is within the scope of the permit.

## 5 Conclusion

Author thinks practical problems of ceramic seller, inventory system related theory and the basic theory of Witness , NORMAL (6610,2450.4, N) as the objective function, Witness simulation software for the ceramic seller inventory system has carried on modeling and simulation, it can be seen from the table 3, for this ceramic seller, consider a shortage, the seventh scheme (72000, 158100) of the total cost minimum is 888158 yuan, when considering allowing a small amount of shortage, the Eighth scheme( 82000,158100 ) minimum total cost is 1095167 yuan; the third scheme when considering not allowed out of stock (92000,138100) the least total cost is 1254909 yuan.

Apply this scheme in the ceramic seller inventory management, improving quality and level of enterprise inventory management, making the enterprise keep inventory in a more ideal state and creating a certain benefit for the enterprise.

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