A PROCEDURE FOR FORECASTING OF REQUIREMENT AND OPENING STOCK IN INVENTORY CONTROL SYSTEMS

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(Received March 14, 1974)

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A number of procedures have been published in the issue of inventory control and these procedures are suitable for forecasting demands and safety stocks. Another simple procedure will be suggested taking into consideration the expected value required by the reliability of forecasting.

Introduction

An integrated inventory information and control system may be defined as an inventory oriented information system, conceived and designed as a system for controlling the operations of an entire stocking organization. Management is currently involved in organization changes caused by recent advances in computer technology and by the growth of a system approach to problem solving. The emphasis is shifted from how to keep things running to how to run things better as concerns innovation and planning. [1, 2].

Specific characteristics of an inventory system are the following:

— order processing
— forecasting
— inventory control
— requirements generation.

Properly designed decision rules must be formulated within the integrated system. Routine decisions may be handled automatically, exceptions must be noted and reported by the system. Each inventory control system has a distinct set of criteria on historic data to be updated. A system periodically issues forecast of demands for some future time period and revises inventory control parameters such as economic order quantity and reorder points as a basis for controlling inventories.

Thus, the combination of order process and forecast determines the future supply against the time-based production requirements or against demands of distribution industry.

A forecast unit generally [3]

— uses the technique of exponential smoothing because of its accuracy, responsiveness to changes and by its simplicity, [4]

— manipulates historical data in order to screen out erratic fluctuations normally encountered,

— measures the trend in historical data and adjust the forecast accordingly

— considers the seasonal nature of the demand pattern and adjusts the forecast accordingly, after making corrections for previously mentioned deviations.

The forecasting and control unit

First a reasonable demand history is needed to decrease the effect of extremely high or low demands which may result from wrong orders, shipments or other things.

After calculating seasonal indices based on this history, indices isolate seasonality as a percentage of the base demand. The seasonal calculating unit assumes the demand to consist of three elements: base or trend, seasonality, and noise or randomness.

Since demands of an item can be approximated by a constant, a linear or a quadratic forecasting model forecasting statistics will be used to generate them. A forecasting program then selects the forecasting scheme. The selection is based on the decision which also insures that the forecast is within statistical control.

An inventory control unit must provide a variety of control, depending on the degree of control required by each inventory line item. The control unit calculates the parameters — such as reorder point, economical order quantity, safety stock — which are used for determining when to place an order and what quantity to order.

A control unit must minimize the capital investment to the desired level and provides control to minimize stocking of obsolete material.

Inventory control generally maintains inventories of items at a level sufficient to meet delivery requirements while preventing the unnecessary expense for obsolescence and overstocking. The maintenance of inventories at optimum level depends on varying control techniques. The selection of items is generally based on classifications, inventory by costs. Provisions must be made to handle all other classifications of inventory using such techniques as: fixed-order quantity technique, fixed-order point technique, min-max technique, base-stock technique, or reliability technique etc. [3, 11].

Demands can be got by requirements generation that involves establishing the quantity of items to be needed at future time periods in a production plan. By examining inventory conditions at each time period and indicating all shortage conditions the required quantities of items will be available when needed.

Also strategies of inventory control, of requirements generation can be realized: the production-oriented and the market-oriented one, the first one being the more important.

The problem of accuracy of forecast

A measure of the accuracy of a prediction is to get an expected value and a range within which the actual expected value is expected to fall in its simplest form. A forecast system must have a measurable degree of error: it is to be qualified as to how good or how bad it really is. The range is very simple but it is relatively by rough way to express the forecasting accuracy. In [7] a procedure is presented to eypress the error as a function of the probabi ity for the system to provide the desired level of servicing consumers or production. Let us see now how to calculate the safety stock or the beginning stock.

Calculating the standard deviation of requirements with or without a trend and with exponential smoothing permits to forecast the requirements.

Over a long period of time the level of an item is assumed to be approximated by a linear, quadratic, constant or seasonal (periodical) curve.

The times series of requirements is given $\{k_1, k_2, \dots k_N\}$, the average is:

$$\bar{k}(N) = \frac{1}{N} \sum_{i=1}^{N} k_i. \tag{1}$$

The so-called moving average is:

$$\bar{k}_t(n) = \frac{1}{n} \sum_{i=0}^{n-1} k_{t-i} \tag{2}$$

and $n \leq t \leq N$.
If $\bar{k}(N) - \bar{k}_t(n)$

— is nonperiodically fluctuating around $\bar{k}(N)$ there is a stationary case, i.e. constant curve,

— is increasing or decreasing there is a trended case, i.e. linear or quadratic curve,

— is periodically fluctuating around the value of $\bar{k}(N)$ the case is a seasonal one.

In the followings these curves are called $\bar{k}(t)$. Replacing $\bar{k}(N)$ by $\bar{k}(t)$ the standard deviation can be reduced.

Estimating the standard deviations by exponential smoothing [10]:

$$S^2_{NH} = S^2_N + \eta_N[(k_N - \bar{k}_N)^2 - S^2_N] \tag{3}$$

$$S^2_{tNH} = S^2_{tN} + \eta_N[(k_N - \bar{k}(t))^2 - S^2_{tN}] \tag{4}$$

η_N — characteristic of the goodness of trend and estimation — is advisably chosen as:

$$\eta_N = \frac{S_{tN}}{S_N}\,\alpha \tag{5}$$

and

$$0 < \eta_N < 1\,. \tag{6}$$

It is usually chosen in the range 0.1 to 0.3 The forecast is:

$$k_{N+1} = \eta_N\, k_N + (1 - \eta_N)\bar{k}(t_N)\,. \tag{7}$$

The method is analog with the TRIGG method [5, 6, 10]. Choice of η_N by (5) is based on the idea that equations (3) and (4) can be considered as an autocorrelation, linear function of the standard deviation. The linear regression is also theoretically a fair approximation of nearly normal distributions and it is frequently assumed that time series of requirements have normal distributions, as well. The constant in (5) is characterizing the speed of forgetting and

$$0 < \alpha < 1\,. \tag{8}$$

To a high α value a low forgetting rate is assigned, if the system has to follow the changes rapidly a low value will be chosen for α. It is generally 0.3.

Calculation of the opening and safety stock

The equation of this problem is [7, 11]:

$$P\left\{\min\left(M + c(t) - \bar{k}(t)\right) > 0\right\} = 1 - \varepsilon\,. \tag{9}$$

Assumed the supply quantities to be equal, smoothly distributed and independent. On the other hand, the quantities to be supplied are a linear function of time between t_N and t_{N+1}. Without details, the result is [11]:

$$\varepsilon = \frac{M_{N+1}}{k_{N+1}} \sum_{j=0}^{n\left(1-\frac{M_{N+1}}{k_{N+1}}\right)} \binom{n}{j} \left(1 - \frac{M_{N+1}}{k_{N+1}} - \frac{j}{n}\right)^{n-j} \left(\frac{M_{N+1}}{k_{N+1}} + \frac{j}{n}\right)^{j-1}. \tag{10}$$

An approximation for M_{N+1}:

$$M_{N+1} = k_{N+1}\sqrt{\frac{1}{2n}\ln\frac{1}{\varepsilon}}\,. \tag{11}$$

The number of shipments n is supposed to be high. If they are not equal [7, 9, 10]:

$$M_{N+1} = k_{N+1} \sqrt{\frac{1 + (1-\lambda)^2}{2n} \ln \frac{1}{\varepsilon}} \tag{12}$$

$$\lambda = \frac{n \cdot \delta}{k_{N+1}}$$

δ = the least quantity supplied.

By solving equation (10) grafically:

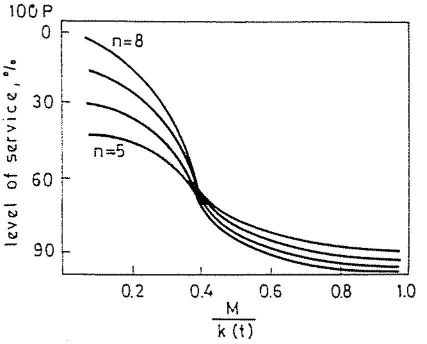

Fig. 1. The value of P vs. n has been plotted on the diagram

Conclusions

A modification of the Trigg forecasting technique has been introduced. This forecasting procedure applies for cases where the expectable mean value of the trend is easy to generate.

The Prekopa A.—Dr. Ziermann M. has been applied to calculate the opening stock in the case where supplied quantities are equal and the shipment number is less than ten [8, 9].

One of the problems of concern is to extend the forecasting procedure to cases with discrete probability functions and with not independent probability functions.

Summary

A number of procedures have been published in the issue of inventory control and these procedures suit to forecasting demands or safety stocks. A simple modification is proposed taking into consideration the expected value required by the reliability of forecasting.

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Printed in Hungary

A kiadásért felel az Akadémiai Kiadó igazgatója. Műszaki szerkesztő: Botyánszky Pál
A kézirat nyomdába érkezett: 1974. VI. 9. -- Terjedelem: 7,5 (A/5) ív, 40 ábra

75.655 Akadémiai Nyomda, Budapest — Felelős vezető: Bernát György