

A Novel Approach in Production Planning, to Stabilize Stocks and Prevent Back Orders

Un Nuovo Approccio nella Pianificazione della Produzione, per Stabilizzare le Giacenze e Prevenire Rotture di Scorta

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Riassunto: In generale il livello delle giacenze viene utilizzato, insieme agli ordini, per pianificare la produzione o rifornire i magazzini con approccio deterministico. Il metodo proposto inverte i termini della questione, facendo scaturire la quantità da produrre o da acquistare per rivendere, dal valore assunto da una funzione, costruita sulla previsione statistica della domanda. Questo approccio, che è stato collaudato con successo in ambiente industriale, è più conveniente, perchè, alla semplicità operativa di gestione della domanda associa la conoscenza esatta del rischio di rottura delle scorte.

Keywords: linear time series, safety stock, planning, back order, forecasting.

1. Formulae for planning production and calculating stocks

The quantities considered in the study, (V_t) , $(D_t^{(\tau)})$, $(P_t(\tau))$, $(G_t(\tau))$, (G_0) , $(\varepsilon_t^{(\tau)})$, belong to a *discrete-time time series*, $(-\infty < t < \infty; \tau = 1, 2, \dots)$. A point t of the series represents the month labeled t . The quantity $P_t(\tau)$ must be known before the month starts. The others are known in the last instant of the month. Their meaning is: (V_t) : *actual orders*, $(D_t^{(\tau)})$: τ *steps demand forecast*, $(P_t(\tau))$: *production, planned τ points in advance*, $(G_t(\tau))$: *current stock with this planning system*, (G_0) : *safety stock*, $(\varepsilon_t^{(\tau)} = D_t^{(\tau)} - V_t)$: *demand forecast error*. Left panel of figure 1 shows the relation between discrete model, used in the study, and actual situation, for $\tau = 3$. The analyst works on data, virtually, at point $t = n - \tau$. Two strategies, for planning production at $t = n$, for $n \geq \tau + 1$, say $\Psi = 0; \Psi = 1$, have been considered; formula (1) can describe both of them, by introducing, for Ψ , respectively, the numerical values: 0 or 1.

$$P_n(\tau) = D_n^{(\tau)} - \Psi(D_{n-1}^{(\tau)} + \tau V_{n-\tau} - (\tau - 1)V_{n-\tau-1}) \quad (1)$$

Putting, further, for $1 \leq n \leq \tau$: $P_n^{(a)}(\tau)$: actual production; u_{n-1}, u_{n-2} : unity step functions; $P_n^{(v)}(\tau) = D_n^{(\tau)} - u_{n-1}D_{n-1}^{(\tau)} + (n-1)V_{n-\tau} - u_{n-2}(n-2)V_{n-\tau-1}$; $\Delta_n = P_n^{(a)}(\tau) - P_n^{(v)}(\tau)$,

the following relation (2), which is the stock time series, for $n \geq \tau$, comes from (1). It has been proved by induction on τ and n . The strategy $\Psi = 0$ brings to a non stationary time series and must be managed accordingly; additional information, for $\Psi = 1$, follow.

$$G_n(\tau) = (G_0 + \sum_{n=1}^{\tau} \Delta_n) + \Psi((D_n^{(\tau)} - V_n) + (\tau - 1)V_{n-\tau} - \sum_{i=n-\tau+1}^{n-1} V_i) + (1 - \Psi) \sum_{t=1}^n \varepsilon_t^{(\tau)} \quad (2)$$

To calculate G_0 , put: $G_n(\tau) \geq 0, \forall n \geq \tau$. $(G_n(\tau)), (D_n^{(\tau)} - V_n), ((\tau-1)V_{n-\tau} - \sum_{i=n-\tau+1}^{n-1} V_i)$ are realizations of 3 random variables, say $(\tilde{G}_n^{(\tau)}), (\tilde{\varepsilon}_n^{(\tau)}), (\tilde{C}_n)$. Assuming $\tilde{\varepsilon}_n^{(\tau)}$ and $\tilde{C}_n$, normally and independently distributed, as usually is, indicating by $\mu_{\tilde{C}_n}$ the mean of $\tilde{C}_n$, in order to have $G_n(\tau) \geq 0, \forall n \geq \tau$, at 95% confidence level, it must be:

$$G_0 \geq 2\sigma_{\tilde{G}_n^{(\tau)}} - \mu_{\tilde{C}_n} - \sum_{n=1}^{\tau} \Delta_n.$$

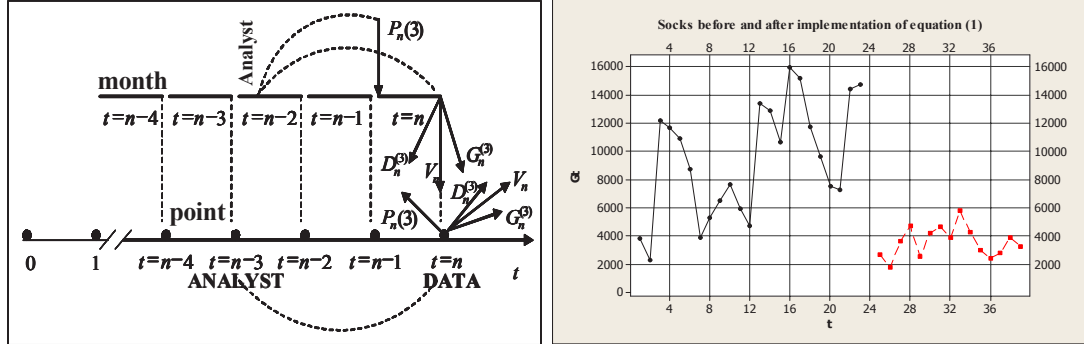
The quantity G_0 must be defined, before the start up of the planning procedure. This is approximately obtained, by analyzing a historical time series of $(K + \tau + 1)$ points, occurred before starting the procedure and replacing the expected values for $\mu_{\tilde{C}_n}$ and $\sigma_{\tilde{G}_n^{(\tau)}}$ with their estimates, indicated below.

$$\hat{\mu}_{\tilde{C}_n} = \sum_{k=\tau+1}^{K+\tau+1} C_k / (K+1) ; \quad \hat{\sigma}_{\tilde{G}_n^{(\tau)}} = \sqrt{\text{Var}(\tilde{\varepsilon}_n^{(\tau)}) + \sum_{k=\tau+1}^{K+\tau+1} (C_k - \mu_{\tilde{C}_n})^2 / K}.$$

2. An application example

In the right panel of figure 1 are reported, on the left: G_n , before this method, on the right: G_n , after the introduction of this method, for a product, manufactured in a primary Italian industry of hydraulic components, the *Comisa S.p.A*, in *Pisogne (BS)*.

Figure 1: *Quantities involved and an example of obtained results (in Comisa S.p.A)*



3. Conclusions

A new planning approach has been designed. Developed equations can be linked to the standard software, used in the industrial organizations. This has been done in a manufacturing industry, where a strategy, based on equations (1) and (2) has been developed, obtaining remarkable quality and economical benefits.

References

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