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RATIONING OF SAFETY STOCK UNDER INSTABILITY

НОРМИРОВАНИЕ СТРАХОВОГО ЗАПАСА В УСЛОВИЯХ НЕУСТОЙЧИВОСТИ

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ABSTRACT

STOCK, SAFETY STOCK, FETTER FORMULA, DEMAND UNCERTAINTY

The paper suggests a methodology for calculating the safety stock size using a modified Fetter formula. It also provides an approach to the rationing of floating safety stock in the face of uncertainty in demand. The proposed approach was probed using real data from the production and trading enterprise DoM-Vetraz; scenario calculations were performed for the conditions of unpredictable increase and decrease in demand.

АННОТАЦИЯ

ЗАПАСЫ, СТРАХОВОЙ ЗАПАС, ФОРМУЛА ФЕТТЕРА, НЕОПРЕДЕЛЕННОСТЬ СПРОСА

В работе предложена методика расчета размера страхового запаса по модифицированной формуле Феттера, также приведено нормирование плавающего страхового запаса в условиях неопределенности спроса. Апробация предложенного подхода проведена на реальных данных производственно-торгового предприятия ЗАО «ДоМ-Ветразь», проведены сценарные расчеты для условий непрогнозируемого увеличения и снижения спроса.

In the current unstable economic environment creating the problem of uncertainty in demand for final products, it is necessary to revise the approaches to managing business processes of an enterprise. Modern enterprise management information systems make it possible to predict economic risks and ensure their minimization by reasonably changing management parameters.

Stocks, which represent one of the largest controlled business assets and a significant investment of an enterprise, can be seen as a balancing element of the entire enterprise management system. They can thus, be considered as an integral indicator of this system's effectiveness [1].

Safety stock is designed to continuously ensure supply in the event of possible change in the delivery time or order size; change in the demand and/or the intensity of consumption, etc. [2, p.17].

In case of well-predicted demand (consumption) and in the presence of reliable suppliers, safety stocks may be inexistent. However, in practice, such a situation is nearly impossible; enterprises operate in the presence of constant risks. Therefore, the solution to the problem of rationing the safety stock in situations of instability is gaining importance.

The purpose of this study is to propose a methodology for rationing safety stock in procurement logistics and its testing on real data of the production and trading enterprise DoM-Vetraz.

The most common methodology for calculating safety stock under uncertainty in foreign and domestic literature is Fetter's formula [3]. This formula was developed for the case when demand and lead-time are normally distributed random variables.

It can be proposed to use a modified Fetter's formula to rationalize the safety stock (Formula 1) [4]:

$$q_{b(t)} = \begin{cases} z_\alpha \sqrt{t_з \sigma_{s_t}^2 + \overline{s_{n_t}^2} \sigma_{t_з}}, & \text{for control system } \boldsymbol{(QR)} \\ z_\alpha \sqrt{(t_з+\tau) \sigma_{s_t}^2 + \overline{s_{n_t}^2} \sigma_{t_з}}, & \text{for control system } \boldsymbol{(ST)} \end{cases} \quad (1)$$

where $\boldsymbol{q_{b(t)}}$ – is the floating size of the safety stock;

z_α – is the quantile of the normal distribution at the significance level α;

$t_з$ – is the lead-time; σst is the standard deviation of demand;

$\sigma_{S(t)}$ – is the average value of demand (consumption);

$\sigma_{t_з}$ – is the standard deviation of the lead-time;

τ – is the time interval between orders.

This formula can be used for continuous control over the stock level (***QR***: replenishment strategy with a fixed order size and order point), as well as for the periodic one (***ST***: replenishment strategy at fixed time intervals).

The distinctive feature of this approach is in use in the formula the deviation of the factual demand for the period i (s_i^{fact}) from the planned demand (s_i^{plan}) for this period instead of the standard deviation of demand. At the same time, it is proposed to take into account the standard deviation of demand for those cases when the value of factual demand is greater than planned in the analyzed period, which is reflected in formulas (2), (3):

$$\sigma_{s_t} = \begin{cases} \sqrt{\dfrac{\sum_{\substack{i=1 \\ s_i^{fact} > s_i^{plan}}}^{n_t} \left(s_i^{fact} - s_i^{plan}\right)^2}{n_t - 1}}, if \ \ \exists i = \overline{1, n_t} \ \ s_i^{fact} > s_i^{plan} \\ 0, if \ \ s_i^{fact} \leq s_i^{plan} \ \forall i = \overline{1, n_t} \end{cases} \quad (2)$$

where $\boldsymbol{nt}$ is the length of the comparison period (determined by the cycle $\boldsymbol{\tau}$), the period is floating and determined according to the moving average principle.

$$\bar{s}_{n_t} = \frac{\sum_{i=1}^{n_t} s_i^{fact}}{n_t} \quad (3)$$

This approach will allow taking into account the unsteady nature of demand in an unstable economic environment and reducing the amount of safety stock thanks to the modern methods for forecasting independent demand.

As part of the study, the QR system for continuous monitoring of the production stock was tested on the real data from the production and trading enterprise DoM-Vetraz for 2019. During the implementation of this system, a modified Fetter's formula was applied to the calculation of the safety stock size.

The calculations showed the effectiveness of using this formula. The size of the safety stock was reduced by 9 % compared with the classical calculation method, while the total stock was reduced by 6 % for the analyzed period. The proposed modification of Fetter's formula for calculating the safety stock for the case of a structural change in demand in the online monitoring mode allows the following:

a) in case of an unpredictable increase in demand by 70 %, ensure a deficit-free supply (including by increasing safety stock in this scenario by 136 %), while using the classical approach leads to a shortage and a halt in production – Figure 1;

b) in case of an unpredictable decrease in demand by 50 %, reduce the level of excess stocks (in this case, by reducing the safety stock by 51 %), thus optimizing the company's stocks and reducing logistics costs – Figure 2.

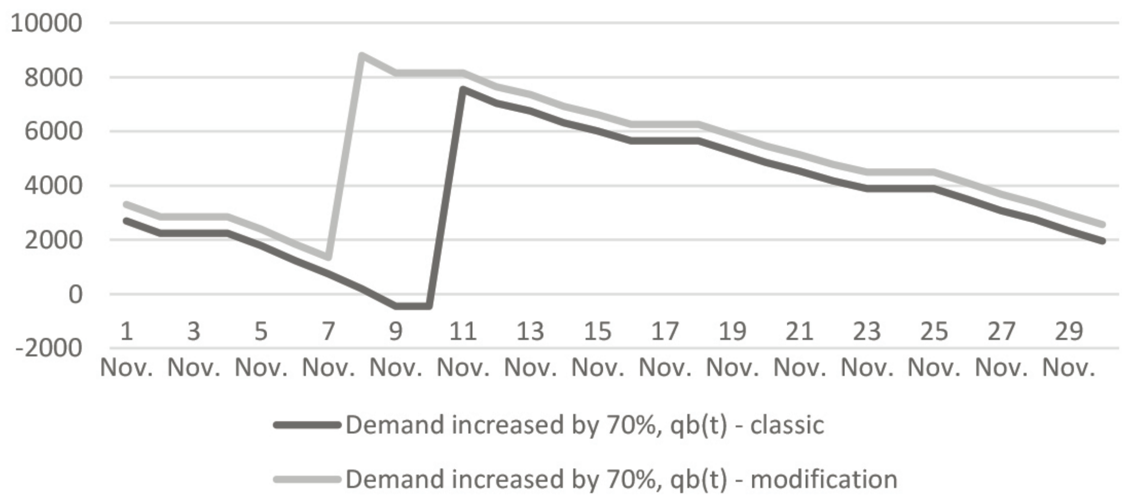

Figure 1 – The movement of the total stock according to scenario 1 using the example of a classical and modified calculation method $q_{b(t)}$

Source: compiled by the author

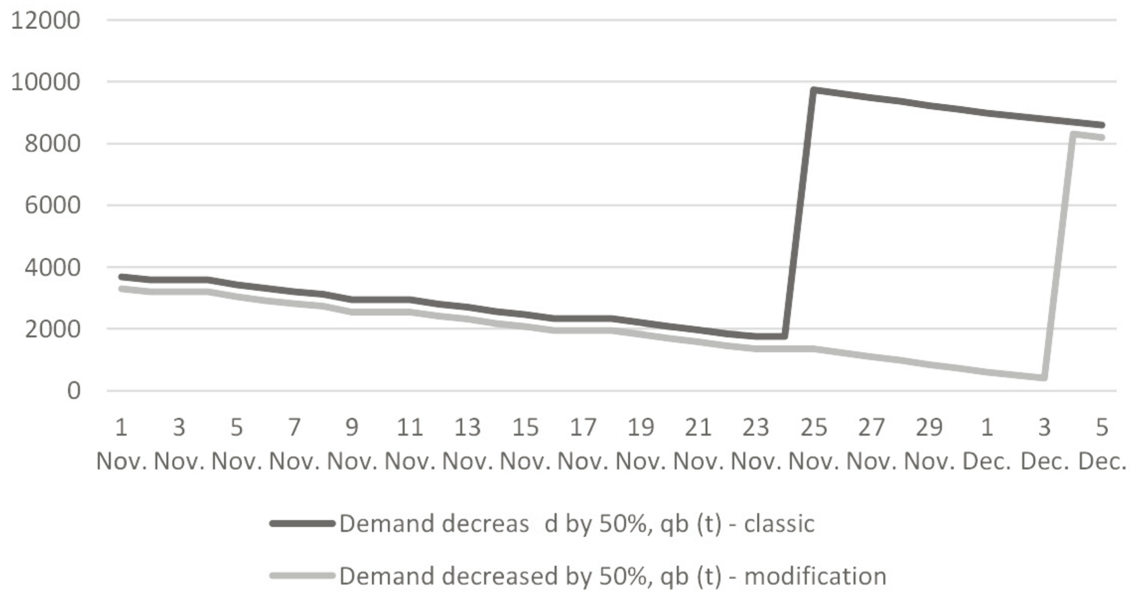

Figure 2 – The movement of the total stock according to scenario 2 on the example of the classical and modified calculation method $q_{b(t)}$

Source: compiled by the author

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